MARYLAND GEOLOGICAL SURVEY.

WM. BULLOCK CLARK, STATE GEOLOGIST.

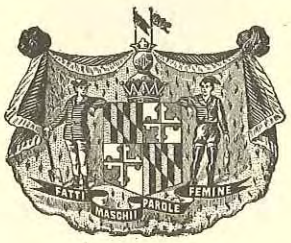
FINAL REPORT

ON THE

SURVEY OF THE BOUNDARY LINE

BETWEEN

ALLEGANY AND GARRETT COUNTIES



In Accordance with an Act Passed by

THE GENERAL ASSEMBLY OF 1898.

(LAWS OF MARYLAND, 1898, CHAPTER 304.)

BY

L. A. BAUER,

Chief of Party.

(Special Publication, Volume V, Part II.)

THE JOHNS HOPKINS PRESS,

Baltimore, April, 1903.

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BALTIMORE, MD., U.S.A.

LETTER OF TRANSMITTAL.

To His Excellency JOHN WALTER SMITH,

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

Sir:—I have the honor to present herewith the final report of Dr. L. A. Bauer on the survey of the Boundary Line between Allegany and Garrett counties, which was conducted in 1898 in accordance with an act (Chapter 304 of the Acts of 1898) of the General Assembly. A preliminary report was issued the same year, and now after considerable lapse of time the final results are published in permanent form in Volume V of the Maryland Geological Survey with much important additional information. Dr. Bauer, the chief of the surveying party, has been in charge of the magnetic studies of the State Geological Survey for the past seven years, and in that capacity also conducted the astronomical and magnetic work of the Western Boundary Survey at the request of the Attorney-General of the State. He is a member of the staff of the U. S. Coast and Geodetic Survey, having special charge of the magnetic survey of the United States, and is an engineer of national reputation. The results of his work in the survey of the boundary line between Allegany and Garrett counties may be regarded as permanently settling a question which has been in dispute since the establishment of Garrett county by the General Assembly of 1872. His report demonstrates the futility of endeavoring to run an important boundary line by other than trigonometrical methods, by clearly showing the multitudinous errors which the ordinary surveyor necessarily makes when he attempts to run a line of several miles in length by means of the compass alone. The people of Allegany and Garrett counties are to be congratulated upon the final location of this line after the several fruitless attempts which have been made to run it in the past. I am,

Very respectfully,

WILLIAM BULLOCK CLARK,

State Geologist.

JOHNS HOPKINS UNIVERSITY,

April 4, 1903.

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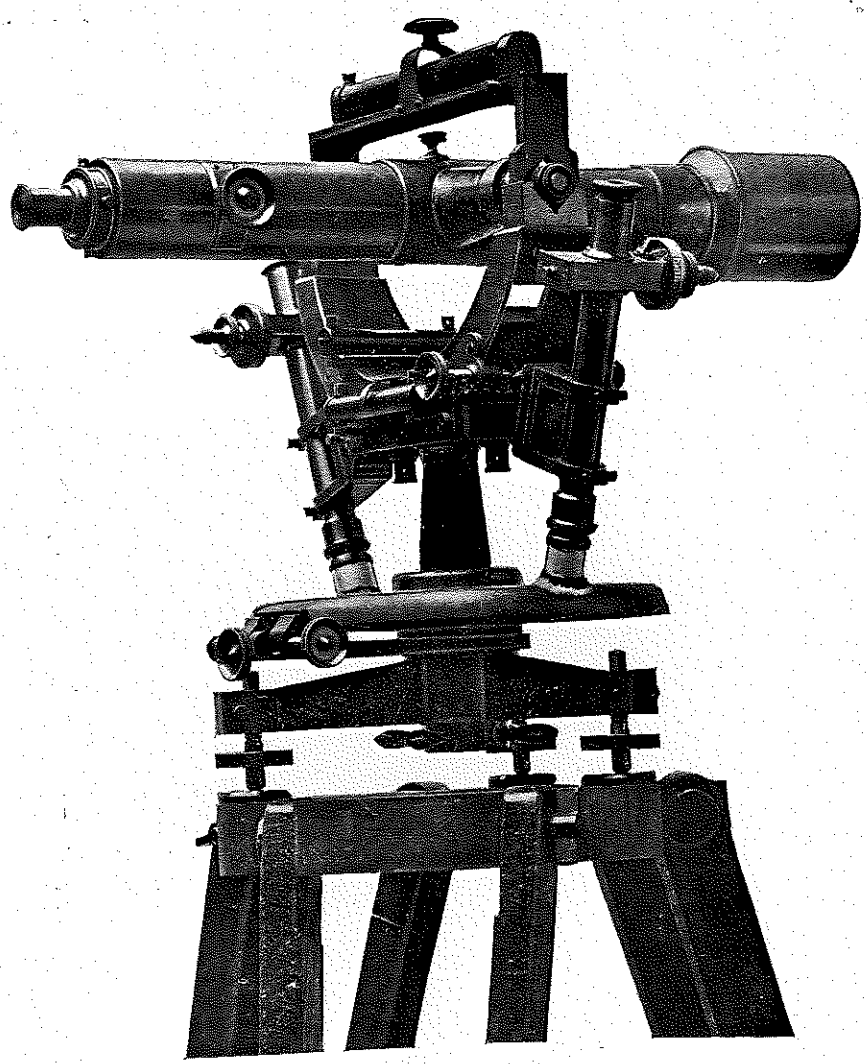

EIGHT-INCH THEODOLITE.

FINAL REPORT

ON THE

SURVEY OF THE BOUNDARY LINE BETWEEN ALLEGANY AND GARRETT COUNTIES,[1]

BY

L. A. BAUER, Chief of Party.

Introduction.

A perusal of the following act passed by the Maryland Legislature at the January session, 1898, will explain the nature and purpose of this survey.

LAWS OF MARYLAND, 1898.

Chapter 304.

AN ACT to provide for the definite establishment and location of the boundary line between Allegany and Garrett counties, in order to bring under the assessment law certain untaxed lands in said counties. (January session, chapter 304.)

Whereas, By chapter 212 of the Acts of Assembly of 1872, provision was made for the formation and establishment of Garrett county out of the lands within the then corporate limits of Allegany county; and

Whereas, Provision was by said Act also made for a survey of the boundary lines of said counties, as established by said Act between certain terminal points therein named, and that return of said survey and the plats of said lines should be reported to and filed with the Governor, the County Commissioners and the clerk of the Circuit Court for Allegany county, under certain provisions in said Act contained, which provisions were complied with, but the said returns and plats have not been returned in compliance with the requirements; and

Whereas, By reason of said failure to make said return and file said plats, the boundary line between said counties is now an unsettled question, thus involving both questions of jurisdiction of courts and the rights of taxation; and,

Whereas, There are now large and valuable areas of land in both of said counties untaxed or unassessed, to the great loss and injury of said counties, as well as the state of Maryland; and

[1] A preliminary report was published by the Survey in September, 1898.

Whereas, It is to the interest of all of the taxpayers of said counties and the state of Maryland, that said boundary line should be definitely located, and thus increase the taxable areas of said counties; therefore

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That immediately after the passage of this Act the Governor shall appoint or procure the services of a competent and skillful civil engineer or surveyor, who shall at once survey and definitely locate on the ground the boundary line between Allegany and Garrett counties, on line between terminal points established by chapter 212 of the Acts of 1872, which said civil engineer or surveyor shall employ, at his own cost, the necessary chainmen and axmen, or other necessary assistance, and procure the stones for marking the line as hereinafter provided; and for all said services of said engineer, and for his expenses for chainmen, axmen and other assistance, and for stones, plats and all materials used by him, he shall be paid a sum of money not exceeding one thousand dollars, one-half thereof by the County Commissioners of Allegany county and one-half thereof by the county commissioners of Garrett county; and said commissioners of said counties shall in their levies of taxes next occurring after the passage of this Act, levy the sum of five hundred dollars for each of said counties for the cost of said survey; and they shall pay said engineer such part of said amount as is necessary in full compensation for all his services, assistance, materials and expenses as aforesaid; and the Governor shall require said engineer to give bond with such sureties and in such sum as he shall deem proper conditioned to the faithful discharge of the trust reposed in him.

SEC. 2. Said engineer shall, as soon as he has surveyed and established the true division line, as aforesaid, permanently mark said line on the ground at its terminal points, and along said line by planting thereon and along the same suitable stones, properly marked, to designate said division line, so placed as not to be more than one mile apart along said whole line.

SEC. 3. *And be it enacted*, That immediately after the completion of said survey said engineer shall make a full and detailed report of said survey with the courses and distances of the same and a plat of the same, which report and plat shall be made in triplicate, and one each of the same shall be filed by him with the clerks of the Circuit Courts for Allegany and Garrett counties and one with the Commissioner of the Land Office, and be recorded by said officers in the record books of their said offices; and a copy of said report shall be also transmitted to the Governor, who, upon approval of the same, shall notify the County Commissioners of said counties, after which they shall make full payment to said engineer as aforesaid; but nothing in this Act shall be construed to prevent the County Commissioners of either or both of said counties from advancing to said engineer any part of his said compensation as they may see fit prior to said final payments, upon being satisfied from the progress of the survey that such engineer is entitled to such advance payments; and upon the approval of the Governor of the true made and established line by the surveyor, approved under this Act, the said line shall be and is hereby made the legal and established boundary line between Allegany and Garrett counties, between the terminal points as established by chapter 212, acts of 1872.

SEC. 4. *And be it further enacted*, That said boundary line shall be com-

pleted and permanently established within one year from the date of the passage of this Act.

SEC. 5. *And be it enacted*, That this Act shall take effect from the date of its passage.

Approved April 7, 1898.

LLOYD LOWNDES,
Governor.
J. WIRT RANDALL,
President of the Senate.
LOUIS SCHAEFER,
Speaker of the House of Delegates.

The original act referred to in the foregoing is as follows:

LAWS OF MARYLAND, 1872.
Chapter 212.

AN ACT to provide for taking the vote of the people for or against a new county in certain election districts in Allegany county at the election to be held in the fall of eighteen hundred and seventy-two.

SECTION 1. *Be it enacted by the General Assembly of Maryland*, That all that part of Allegany county lying south and west of a line beginning at the summit of Big Back Bone, or Savage Mountain, where that mountain is crossed by Mason's and Dixon's line, and running thence by a straight line to the middle of Savage River where it empties into the Potomac River; thence by a straight line to the nearest point or boundary of the State of West Virginia; then with the said boundary to the Fairfax Stone shall be a new county, to be called the county of Garrett; *provided* the provisions of this Act as to taking census of the people and the area of the said new county, and the sense of the people therein, shall be complied with in accordance with the Constitution of this State. . . .

SEC. 11. *And be it enacted*, That . . . and on application of five citizens of the proposed new county of Garrett, the County Surveyor of Allegany county shall at once run and locate the lines of the proposed new county of Garrett, at the expense of said petitioners, and shall make a plat of said lines and report the same to the Governor, the County Commissioners and the clerk of the Circuit Court for Allegany county, to be by him recorded in the land records of said county, said report to be made under oath.

The Governor, being empowered to appoint the civil engineer in charge and desiring that the work should be done in as thorough a manner as possible and in accordance with modern and approved methods, requested the Maryland Geological Survey, through its representative, Professor Wm. Bullock Clark, to undertake the survey of the desired boundary line. Professor Clark accepted the Governor's proposal and referred the execution of the work to my division.

It will be noticed that the act made no provision for the appointment of commissioners or surveyors representing the counties involved. This was a great oversight, and in order to rectify it, the State Geologist requested the following two surveyors to represent their respective counties and to render me any assistance in their power, viz.: Mr. W. McCulloh Brown of Garrett county and Mr. John Schaidt of Allegany county. Mr. Schaidt, finding that his private interests would not permit him to accept, recommended Mr. L. L. Beall, who accordingly was appointed as the surveyor representing Allegany county. The surveying party was finally composed as follows:

L. A. Bauer, in charge.
L. L. Beall, surveyor for Allegany county.
W. McCulloh Brown, surveyor for Garrett county.
C. A. Ashby, head lineman.
J. M. Harris,
J. L. A. Burrell, } Assistants.
G. P. Blackiston,

The necessary axmen and laborers were hired as occasion demanded.

The entire instrumental outfit, with the exception of the transits belonging to the surveyors, was furnished by the United States Coast and Geodetic Survey, viz.:

1. 8-inch position theodolite, reading with the aid of two opposite micrometer microscopes to 2″ (by estimation to $\frac{1}{5}$ of a second) and numbered "133."

2. 4-inch Fauth theodolite, No. 163. The horizontal limb could be read, with the aid of two small microscopes, to 20″ and the vertical circle to 30″.

3. Magnetometer No. 18 and attached theodolite.

4. Kew Dip Circle No. 56/4440.

5. Mean Time Chronometer, Dent, No. 2256.

6. Two heliotropes (Nos. 53 and 304).

7. 50-foot Steel Tape No. 86.

Besides these instruments, each surveyor had his own transit (the usual engineer's transit, horizontal circles reading by opposite ver-

niers to nearest half-minute). Mr. Brown furthermore provided two 100-foot steel tapes, one of which had been compared at the Coast and Geodetic Survey Office. The "standard" tape was never used for the field work, but was left at our headquarters and the second 100-foot tape was compared with it whenever necessary.

The special observing tent was the property of the Maryland Geological Survey, and is, in fact, the one used in the magnetic work.

The Maryland Geological Survey desires to make herewith grateful acknowledgment of the great service rendered by the Superintendent of the Coast and Geodetic Survey in providing it with such a valuable instrumental outfit.

Our thanks are also due to the Topographic Corps of the U. S. Geological Survey for promptly furnishing triangulation data and photographic copies of their topographic field sheets.

Previous Attempts at a Determination of the Boundary Line.

chisholm's line.

The first line was run in 1872 by Mr. Dan Chisholm, at that time county surveyor for Allegany county. He used a compass, and, it is said, planted his tripod in the middle of the mouth of the Savage river—the southern terminal point of the line—and ran by the needle N. 26° E. In the absence of any returns from this survey, it is not now possible to say how Chisholm obtained this trial course—doubtless by plotting the line on the best map procurable at the time. From various statements made to me, it would appear that Chisholm did not run continuously on this course, but made various offsets. Instead of hitting the summit of the great Savage mountain, where it is crossed by the Mason and Dixon line, as called for by the act, he came out on the Little Savage mountain, 4307 feet, or 4/5 of a mile, to the west of the initial point called for by the act. Chisholm marked his line by blazes (a cross) in trees. In justice to him, it is stated that he regarded his line merely as a trial line, and that it was his intention to run a second and final line on a corrected course, an intention which was never carried out. This line is referred to by the people living in its vicinity as "the old line."

Whenever it was possible to do so, measurements were made from our line to the trees bearing Chisholm's blazes.

In view of the fact that Chisholm's line did not comply with the provisions of the act of 1872, viz., that the boundary should be a straight line connecting two given terminal points, one at the mouth of the Savage river and the other on top of the Great Savage mountain (not the Little Savage mountain where Chisholm's line terminated), it cannot be looked upon in any sense whatever as a boundary line actually run. Had Chisholm connected his last station with the point on the Great Savage mountain called for by law, it is quite probable that his line, as defined by the still existing blazed trees, no matter how crooked this line may be, would have to be accepted to-day as the boundary line. Chisholm, furthermore, made no official returns of his survey as called for by the act.

HARNED'S LINE.

The next attempt at a determination of the boundary line was made in 1878 by Mr. John Harned, county surveyor for Garrett county.

In this survey, Mr. John Schaidt, surveyor for Allegany county, was present. Harned used a compass mounted on a Jacob's staff, and began "at stone pile on summit of Savage mountain where crossed by Mason and Dixon line." The course he ran on brought him out at Westernport, considerably to the east of the terminal point, the mouth of the Savage river. It is stated that he ran a second line on a corrected course, but he did not mark it in a permanent manner, and, in fact, it is not possible at present to readily identify his line. He prepared a map of this line and filed it with the county commissioners of Garrett county, but his work was not adopted by either county. This map bears the following inscription:

"Garrett and Allegany county line Resurveyed for the Commissioners of Garrett in June, 1878; true bearing S. 28° 33′ W., and whole distance 18 miles, 212 perches, differing from former survey 2° 33′, and adding to the area of Garrett 4266⅛ acres of land. Beginning at stone pile on summit of Savage mountain where crossed by Mason and Dixon line, then S. 28° 33′ W. 18 miles, 212 perches to mouth of Savage river. 22nd day of June, 1878, by John Harned, surveyor for Garrett county."

The course referred to above (S. 28° 33′ W.) is doubtless the magnetic course of the corrected line, not of the first or trial line.

From the preceding remarks it is evident that it was my duty, as defined by the act of 1898, to disregard all previous surveys and existing marks and determine the line anew in conformity with the provisions of the original act.

The Problem Stated.

The boundary line begins at a point on top of the Great Savage mountain, where that mountain is crossed by the dividing line between Maryland and Pennsylvania, and runs thence to the middle of the mouth of the Savage river, 18.6 miles distant, and across the Potomac river 121½ feet, to the nearest point of the West Virginia boundary. The main problem then is to connect by a straight line two non-intervisible points, one on top of a mountain, the other in the middle of a river, completely encircled by high hills. The direction of the line connecting the two points is not given. We cannot tell then on what course to run if we start out at the northern terminus, for example, and endeavor to run a perfectly straight line to the mouth of the Savage river. Supposing the terminals precisely fixed, the first problem, then, is to determine by some means the direction or bearing of the straight line connecting the two main points. There are three general methods for doing this if the two points are not intervisible:

1. By connecting the terminal points by triangulation.
2. By determining the latitudes and longitudes of the terminal points.
3. By running a trial line.

Trial Line Method.

The third method might be the simplest one under certain circumstances. For example, if the region between the terminal points consisted largely of cleared land or bare hills, so that a trial line could be run through from one end to the other without a great deal of expense and without consuming too much time, it might be advan-

tageous to employ this method, especially if the direction of the line, as referred to the true meridian, is approximately known.[1]

For every minute of error in its bearing, the trial line would diverge in the present instance at the rate of nearly 1½ foot per mile, or, in the total distance, 28½ feet. If the trial line is out by 5 minutes, ⅓ of a quarter of a degree, then it will not hit the mouth of the Savage by 143 feet. A glance over the figures in the foot-note,[1] with the added statement that the actual direction of the line at the Mason and Dixon line, as found by us, is 26° 04.9′ and 25° 59.1′ at the mouth of the Savage, will give an idea of the error involved by adopting any one of the quantities given in the foot-note table. In the present case, as the region traversed is densely wooded and exceedingly hilly throughout, a trial line run on a random course would have been a matter of considerable expense. It would have necessitated as much cutting as the actual line required. Again, if the trial line is out considerably, the distances to various points along the line must be accurately known, so that the proper offsets can be made from them to the true line.

The foregoing remarks apply to running a trial line with a *transit*. To attempt to run a trial boundary line with a *compass* is so ridiculous that the matter would not be seriously discussed here had not the previous attempts been made in precisely this way. A trial line

[1] *Approximate True Bearing of Boundary Line as Obtained from Previous Work.*

Locality.	True bearing. ° ′	Authority.	How obtained.
Mouth of Savage,	N 26 23 E	Chisholm	With aid of following data: Chisholm's magnetic course in 1872 was N 26° E, and his line was 4307 feet west, of true line at Mason and Dixon line.
"	N 26 06 E		Scaled from the U. S. Geological preliminary topographical map of region north of Mouth of Savage.
Mason and Dixon Line,	S 25 49 W	Harned	Harned says his magnetic course in June, 1878, was S 28° 33′ W.
"	S 25 52 W		Scaled from U. S. Geological Survey topographical map (Frostburg sheet, 1898).
Mean	26 02.5		Referring to middle point of ine.

should be as nearly straight as possible. *It is a physical impossibility to run a straight line with the magnetic needle under the most favorable circumstances.* These favorable circumstances would imply extraordinary facilities, such, for example, as the establishment and maintenance of a magnetic observatory, with the aid of which the manifold fluctuations of the magnetic needle could be duly allowed for while tracing out the trial line. The whole matter would be so expensive and so cumbersome that this method would be summarily abandoned. The surveyor is not accompanied by these favorable circumstances. He runs his lines regardless of diurnal variation, of magnetic storms, or even of geographical variation of the deviation of the compass from the true north. The diurnal variation alone may throw him out on a summer's day 15-20 feet in a mile. A magnetic storm may produce an error of the same magnitude and even greater. From a table given later, it will be seen that the magnetic bearing of the boundary line changes by nearly $\frac{1}{2}°$ from one end to the other. This alone would throw a magnetic trial line out, even if it were started correctly, by $\frac{1}{6}$ of a mile at the other end. The surveyor very rarely determines the magnetic declination himself, and so the precise change from point to point on the line he either would not make at all (as being of too trifling a nature) or he would guess at it. Then, in addition, come the troublesome local variations. Thus, at the mouth of the Savage river, where Chisholm began, the needle is thrown out by $\frac{2}{3}$ of a degree, or at the rate of about 60 feet per mile.

It will thus be seen that a line run by the "point of the needle" is one upon the correctness of which no reliance could or should be put.

LATITUDE AND LONGITUDE METHOD.

The second method, that of determining the latitudes and longitudes of the terminal points, would be one wholly out of the reach of the ordinary surveyor. To determine the true bearing of the boundary line by this method would require most superior astronomical instruments, expert observers, the adoption of very accurate methods,

and an expenditure of time of at least a month. And then this elaborate method would not furnish the direction of the line, in the present case, closer than to within 2 to 4 minutes. In other words, the line determined thus might easily be out 60 feet and more at its terminal point. In the present case, as the line had to be traced almost entirely from one thickly wooded hilltop to the other, and could not be sighted through, two cuttings would have been required—one for the first line and another for the corrected line. We may therefore dismiss this method as not practical in the present instance.

TRIANGULATION METHOD.

We thus come as a final resort to the triangulation method. This is one that the surveyor, provided with a good engineer's transit, if he knows how to use his instrument so as to get the full benefit of its various adjustments, can safely and advantageously employ.

After making a brief reconnaissance of the line, I quickly came to the conclusion that the triangulation method was the only practicable one in this case and at the same time the most expeditious.

There were several triangulation points in the vicinity of the line, established by the U. S. Geological Survey. (See Fig. 7.) I concluded, therefore, that the best method would be to connect the terminal points with each other and with the U. S. Geological Survey triangulation points by a series of triangles.

My original intention was to measure all the angles with the aid of the 8-inch theodolite, which, as stated, reads with the aid of micrometer microscopes to 2″, and, by estimation, can be read to $\frac{1}{5}$ of a second. It was, however, a great task to transport this cumbersome instrument from hilltop to hilltop. The roads were at times exceedingly rough and steep. After reaching the top, the instrument would usually have to be carried a considerable distance, in some cases nearly a mile, and over rough rocks and through thick undergrowth. The instrument in its case weighs about 100 pounds. As the funds were rapidly ebbing and time was slipping away at a continually accelerating rate, I was compelled to give up this idea and depend in a large measure upon the smaller instruments—the surveyors' instru-

ments and my four-inch theodolite. A rough calculation convinced me that with proper care, the direction of the boundary line could be obtained in this way to within one minute and less in a comparatively short time and at little expense. To have gotten the direction so close as not to require any corrections would have made necessary the expenditure of considerable more time on the triangulation. This our limited appropriation would not permit. And I considered that

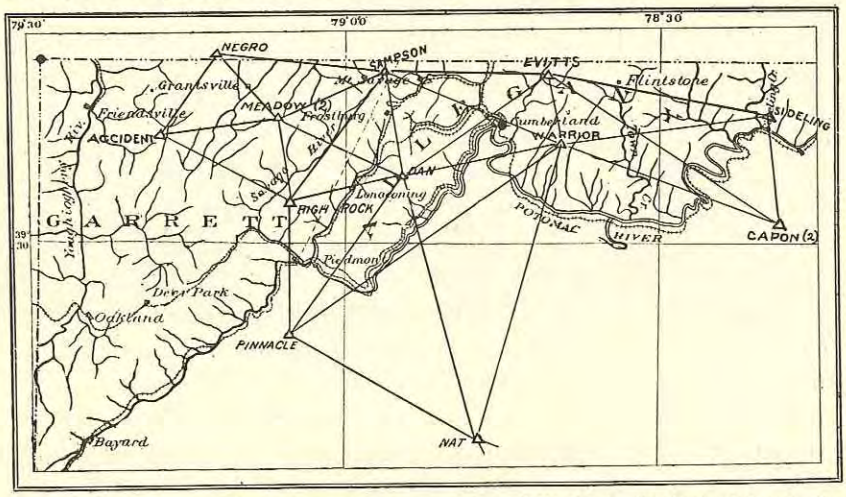

FIG. 7.—Showing the triangulation stations of the U. S. Geological Survey in the vicinity of the boundary line between Allegany and Garrett Counties. Scale: 1 inch = 16 miles.

a trial line correct within 1′ was close enough for the purpose at hand. I therefore pushed the triangulation ahead to the utmost, so that the ranging out of the line could be begun and the proper corrections made, and, if possible, the line marked, before the appropriation ran out. And there was every danger of the funds running short, for we encountered most unfavorable weather. For three weeks we had rains almost every day, only three or four days in that time being absolutely clear.

A "STRAIGHT" LINE ON THE EARTH'S SURFACE.

Another point deserves elucidation in this connection. The law calls for a "straight" line connecting two points, whose position on the earth's surface is approximately:

	Latitude.	Longitude west of Greenwich.
Top of Big Savage mountain,	39° 43′.4	78° 54′.8
Mouth of Savage river,	39 28 .8	79 04 .0

Between these two points the rotundity of the earth makes itself appreciably felt. If we define a straight line in the customary manner, viz., as the arc of a great circle passing through the two given points, then the bearing of that line will be different at every point in that line. The difference in the bearings of the line at the two end points amounts to the difference of longitude into the sine of the average latitude of the two points, or to 5′ 51″ or 5′.85. So that if the true bearing of the line were S. 26° 04′.9 W. at the top of Savage mountain, it would be 5′.85 less at the mouth of the Savage river, or N. 25° 59′.1 E.

In other words, suppose a surveyor, provided with a good transit, were to begin at the mouth of the Savage river and run a line on the true course of the line at the upper end, viz. N. 26° 04′.7 E., then he would strike 50 yards to the west of the terminal point on the Mason and Dixon line. Two surveyors, one beginning at one end and the other at the other end, would therefore not meet each other unless they started their line, not on precisely the same courses, but on courses differing nearly 6 minutes, or 1/10 of a degree from each other. It is thus seen that the sphericity of the earth between the terminal points is a factor which must be duly considered in this problem.

That the bearing of the line, as referred to the true meridian, should vary continuously from one end to the other, can easily be seen thus: The two end points are not situated in the same true north and south line, but lie in different meridians, or, roughly, the mouth of the Savage is 8 miles west of the top of Savage mountain. As the meridians, if prolonged northward, all pass through the same point on the earth's surface—the North Pole—and are therefore not strictly parallel lines, but converge so that the distance apart between the two meridians passing through the end points of the line is about 50 yards less at the Mason and Dixon line than along a due east and west line passing through the mouth of the Savage river, hence the angle made by a line cutting the two meridians is less at the southern than at the northern point, as can be readily seen by drawing a diagram. (See Fig. 8.)

FIG. 1.- MOUND ON MASON AND DIXON LINE.

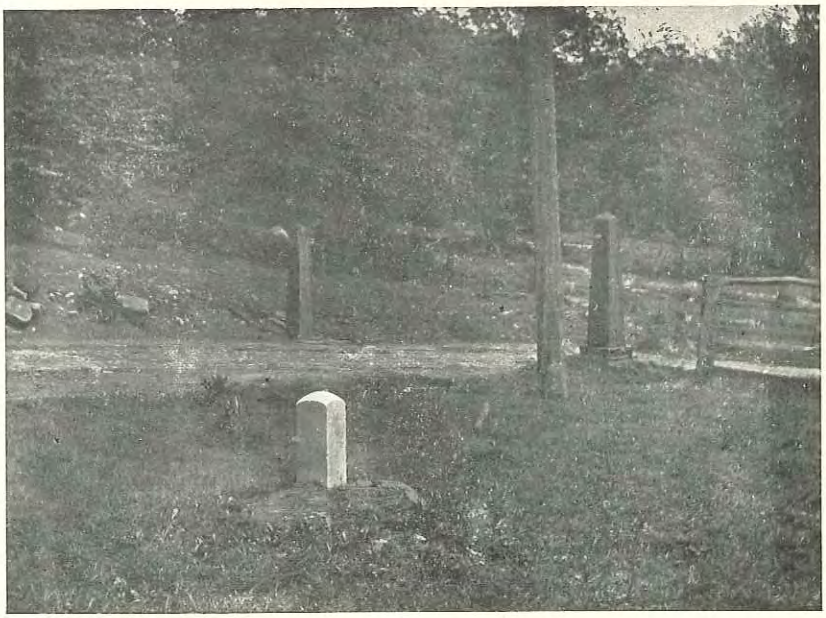

FIG. 2.—MOUND ON NATIONAL ROAD.

The magnetic bearing of the line, *i. e.* the angle made by the line with the direction pointed by the north end of the compass needle, varies even more than the true bearing. The total change from one end of the line to the other amounts to nearly $\frac{1}{2}$ of a degree. See table giving courses and distances.

It is quite possible to have traced such a line passing through the given points so that the angle it made with the true meridian would be the same all along. Such a line is known as a "rhumb" line and would not be a straight line, but a curved one, *i. e.* it would not be a line that the surveyor could prolong indefinitely by backsighting and foresighting. He would have to make offsets in order to get back into the "rhumb" line. As, for example, he must do if he endeavors to prolong a due east and west line such as the Mason and Dixon line. This line is not a "straight" one, but a continuously curving one. The "rhumb" line as a boundary line should be avoided whenever possible.

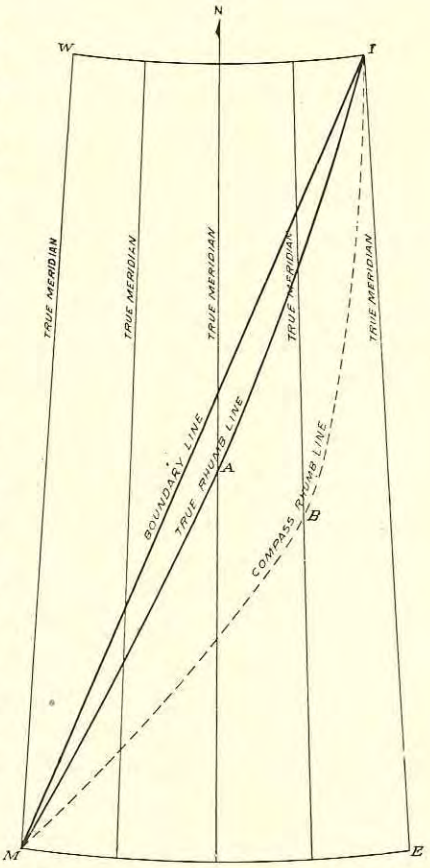

FIG. 8.—Diagram showing effect of convergence of true and of magnetic meridians.

Fig. 8 will give some idea as to the course of a line connecting the terminal points in such a manner so that:

1. The true bearing, *i. e.* the angle between the true meridian and the boundary line, shall be the same at every point in the line (true rhumb line).

2. The magnetic bearing, *i. e.* the angle between the magnetic

meridian (direction pointed out by compass needle) and the boundary line shall be everywhere the same (magnetic rhumb line).

Both lines, it will be noticed, are curved, the second one much more than the first, as the magnetic meridians converge much more rapidly than the true meridians. The second line would in reality not be as smooth a curve as shown, but would be a very sinuous one on account of the many fluctuations to which the magnetic needle is subject. The magnetic or compass rhumb line would, furthermore, vary its nature somewhat with lapse of time by reason of the secular variation of the magnetic needle.

Now that the boundary line has been traced and permanently marked, the surveyor need no longer take into account the variation in the bearing of the line, if he will get the direction by sighting on one of our established mounds. He can establish any number of intermediate points by simply backsighting and foresighting. Should he be obliged, however, to know the bearing of the line (true or magnetic), he must make use of the table given later on.

The Triangulation.

Let us suppose for the moment that the terminal points have been precisely fixed. It is desired to connect these two points (I and M_1 in the sketch, Fig. 9) by a series of triangles. Some idea of the roughness of the country can be obtained from the map, Plate VII, and the profile of the line, Fig. 10.

Several hills and mountains were climbed in West Virginia by my head lineman, Ashby, and myself before a suitable point was found, from the top of which the mouth of the Savage river was visible, and also points in Maryland forward along the line and situated on opposite sides of it. This point is in an oatfield on the hill between Piedmont and Bloomington, on property owned by Thos. Davis and farmed by Mr. Daniels. From this point I could look right down into the mouth of the Savage river 1.4 miles away, and could also see High Rock (U. S. Geological Survey triangulation station), 6 miles distant, and establish a point on the high hill east of Pekin in a cornfield on the Jackson property farmed by Mr. Shimer. This point J was about $6\frac{1}{2}$ miles away. It will be seen that the triangle formed by the three stations, "Daniels," "High Rock" and "Jackson" is a

FIG. 9.

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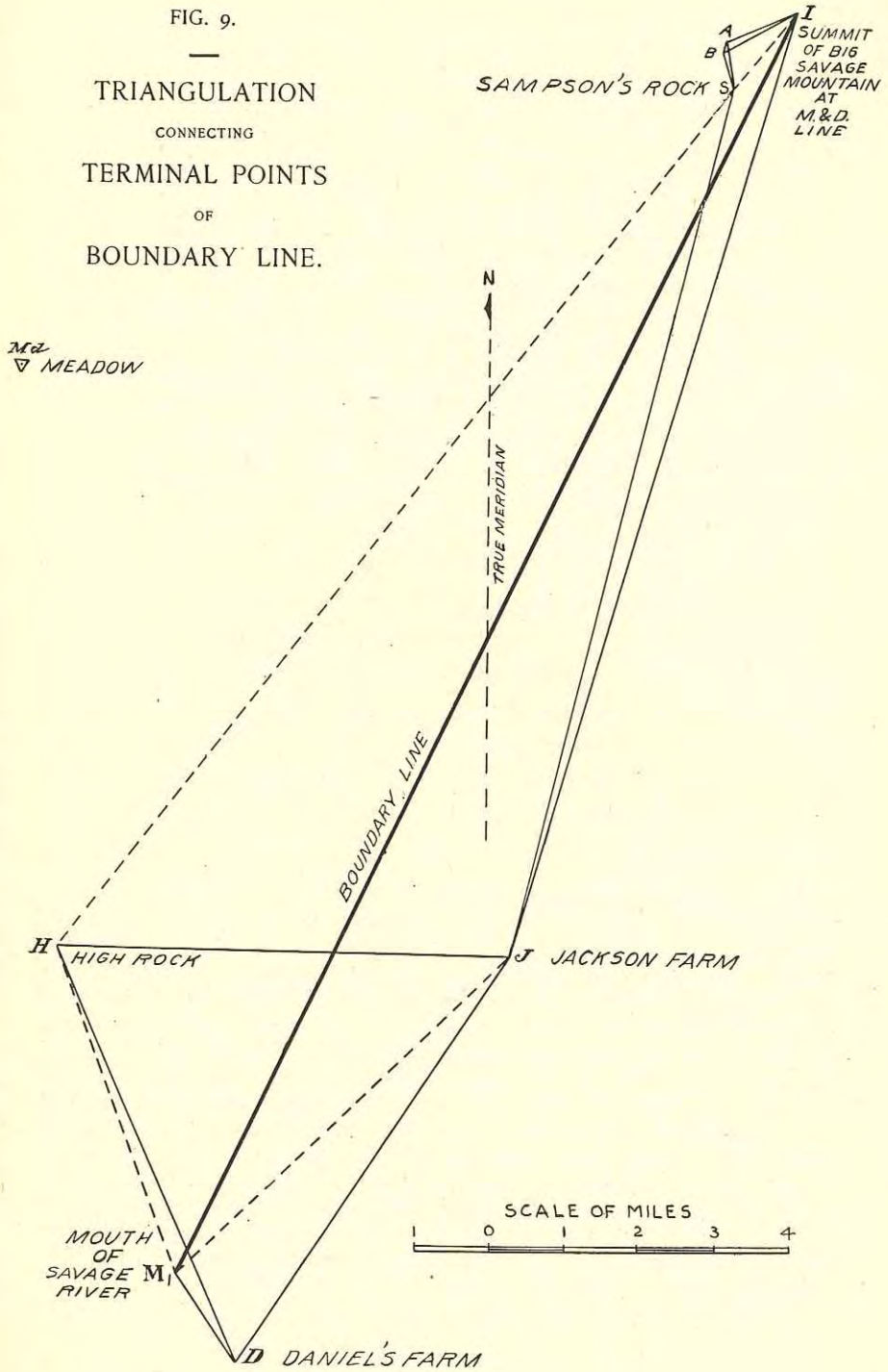
TRIANGULATION

CONNECTING

TERMINAL POINTS

OF

BOUNDARY LINE.



very good one, being almost equilateral. The angles were measured at D with the 8-inch theodolite by sighting upon poles placed at M_1, H and J.

The 8-inch theodolite and tent were next moved to " Jackson," and it was found that from this point could be seen the U. S. Geological Survey triangulation stations, " High Rock " and " Sampson," and also with a little cutting the initial point of the boundary line on the top of Savage mountain. " High Rock " was 6 miles away, " Sampson " nearly 12 miles and " Initial " 13 miles. At " High Rock " and " Daniels " were poles, and from " Sampson " and " Initial " small mirrors were flashed. Mr. Ashby found that at " Sampson " considerable cutting would be required before the station at the ground could be made visible to me stationed at " Jackson." He therefore climbed to the top of the tripod left at this point by the U. S. Geological Survey, centered himself precisely with the plumb-bob over the bolt in the rock marking the precise station, and then held a 4 x 4-inch mirror in the proper direction, so that the sun striking it would be reflected toward me. By prearrangement, Mr. Brown, located at " Initial Point," not having a heliotrope at hand, flashed a small mirror at the same time at Mr. Ashby at " Sampson." Since one minute would correspond to a distance of about 20 feet at S and I, the method employed to make S and I visible was amply sufficient for the purpose.[1]

[1] By employing this simple device the surveyor can very often get very long sights. No special heliotrope is needed. His rodman should be provided with a mirror which he can easily put in his pocket, say 4 x 4 inches. If his station is so far away as to make sighting on a pole difficult, or should he wish to make sure that the pole he is sighting upon is the right one, let the rodman plant a stick about 5 feet high as nearly in line as he can with the eye and about 15 yards away from him. Now, if the sun is shining the rodman can place himself over the station point and hold the mirror in such a position that the reflected sun-ray will strike the stick planted 15 yards away. It is well for him to turn the mirror up and down, so that the reflected sun-ray will travel up along the stick and pass beyond it, and to keep on doing this until operations have been completed. In the same way the rodman can be put in line many miles away, if the surveyor likewise provides himself with a mirror and sends the rodman signal flashes according to a prearranged code. For signalling, a somewhat larger mirror than the rodman's will in general be found better. Of course a heliotrope is the best of all, but it is not always convenient to carry one.

When both mirrors showed up at the same time it was an hour's work to measure the angles in three different positions of the circle with the desired degree of accuracy. The mouth of the Savage was not visible from "Jackson," and so the line is broken. For the same reason we find the lines connecting *H, S* and *I* broken. These were "blind" lines in the triangulation scheme, *i. e.* the end points were not intervisible.

As only the distance *HS,* as determined by the U. S. Geological Survey, was known, it was necessary to measure some additional angles and to determine the distances *MD* and *SI* by measuring small bases and connecting the ends of the bases with the main triangulation, by secondary triangulations, before the angle, which the boundary line would make with *J,* for example, could be computed. The base measurements and secondary triangulations were undertaken by the two surveyors and their work will be detailed below.

The triangle *HDJ* was closed at *H* with my small 4-inch theodolite, measuring the angle by method of repetitions, and the angle *SHJ* was obtained. As *S* and *H* are not intervisible, it was necessary to measure the angle *MdHJ, i. e.* the angle between the U. S. Geological Survey triangulation station, "Meadow," and my station, "Jackson." Computing now the angle *MdHS* with the aid of preliminary data[1] furnished by the U. S. Geological Survey, the angle *SHJ* was finally determined.

[1]*Final Geodetic Co-ordinates of Certain Primary Triangulation Stations of the U. S. Geological Survey, in the Neighborhood of the Allegany-Garrett Boundary Line.*

Station.	Latitude.			Longitude.			Azimuth.			Logarithm Distance Meters.	To Station.
	°	′	″	°	′	″	°	′	″		
Dan.....	39	34	54.54	78	53	51.47	168	55	52	4.1547327	To Sampson.
							76	29	58	4.2463642	" High Rock.
							114	23	15	4.2921955	" Meadow (2).
Sampson....	39	42	28.94	78	55	46.56	289	54	51	4.4505251	" Warrior.
							68	34	20	4.2102258	" Meadow (2).
Evitts.....	39	42	49.36	78	39	53.38	88	29	46	4.3562999	" Sampson.
Meadow (2)..	39	39	16.25	79	06	20.15	294	15	18	4.2921955	" Dan.
							248	27	36	4.2102258	" Sampson.
							356	34	46	4.0873862	" High Rock.
High Rock...	39	32	40.43	79	05	49.59	256	22	20	4.2463642	" Dan.
							176	35	05	4.0873862	" Meadow (2).
Pinnacle.....	39	22	55.53	79	04	44.04					

These final co-ordinates were furnished in December, 1898, and hence were not at my disposal until after the completion of the line and the publication of the preliminary report in September, 1898.

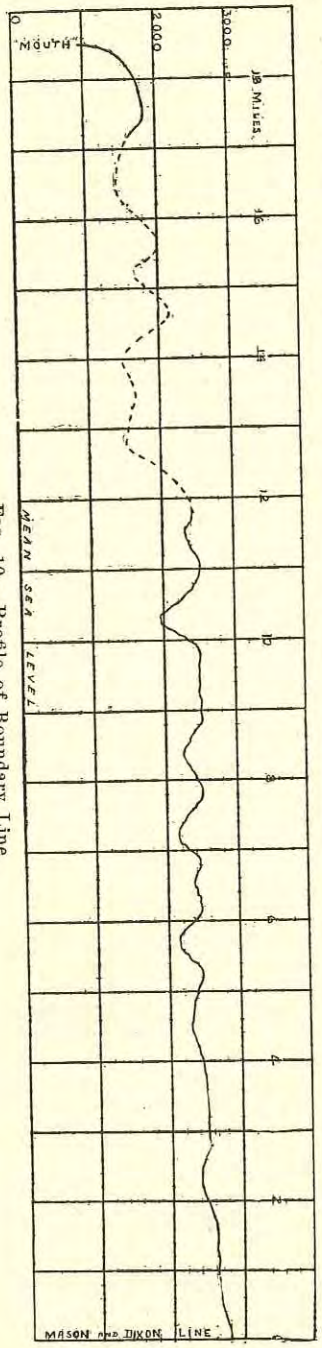


Fig. 10.—Profile of Boundary Line.

In precisely the same manner Mr. Brown, using his engineer's transit and the method of repetitions, obtained the angle *HSJ*, this angle closing the triangle *HSJ*.

It was most desirable also to close the triangle *JSI*. For this purpose the large theodolite and tent were transported to the top of the Savage mountain, *I*, and were left there until the line had been ranged out and marked. Messrs. Brown and Burrell measured a small base, 675.41 feet in length, on McKenzie's farm (*AB* in the sketch, Fig. 9). Mr. Brown used his 100-foot tape, the correction upon the standard tape being known and temperature correction being allowed for. From *A* and *B*, *S* and *I* were visible, and the various angles were measured by Messrs. Beall and Brown independently of each other, each using his own engineer's transit, and measuring the angles in three different positions of the circle. The small angle *AIB* was measured with my 8-inch theodolite; the angle *BSA* was measured by Mr. Brown with his transit, employing the method of repetitions. The only angles in the quadrilateral *IABS* which could not be measured were *BIS* and *ASI*—this because *S* and *I* could not easily be made intervisible, a high ridge intervening. But these angles could be computed with the aid of the angles measured and knowing the

length of *BA*. Hence the angles *BIS* and *ASI* or *BSI* and *AIS* were known. When Mr. Brown had measured the angle *BSJ* with his instrument by method of repetitions and I had measured the angle *JIA* with my 8-inch theodolite, the triangle *JSI* had been closed. In order to be able to sight on "Jackson" (13 miles away) whenever occasion demanded, Mr. Harris was stationed at "Jackson" with one of the Coast and Geodetic Survey heliotropes. He also put up a white screen back of the pole erected at this point, so that when the heliotrope was not in use the pole could be sighted.

It only remained to know the horizontal distance from "Daniels" to "Mouth," M_1D. This was obtained in the manner shown by the sketch of the secondary triangulation given below (Fig. 11.) The pole *W* was planted on hill back of Warnick's house in Bloomington, and the angle M_1DW was measured when the large instrument was stationed at "Daniels." The remaining angles in the triangle M_1DW were measured by Messrs. Beall and Brown independently of each other and in three positions of the circle. If now M_1W (about $\frac{2}{5}$ of a mile) were known, then M_1D could be computed. To obtain M_1W the two surveyors carefully measured the small base *EC* at the foot of Hampshire hill in West Virginia and measured all the angles at the four points, M_1, *E*, *C*, *W*, in the manner already detailed. The length of the base with cor-

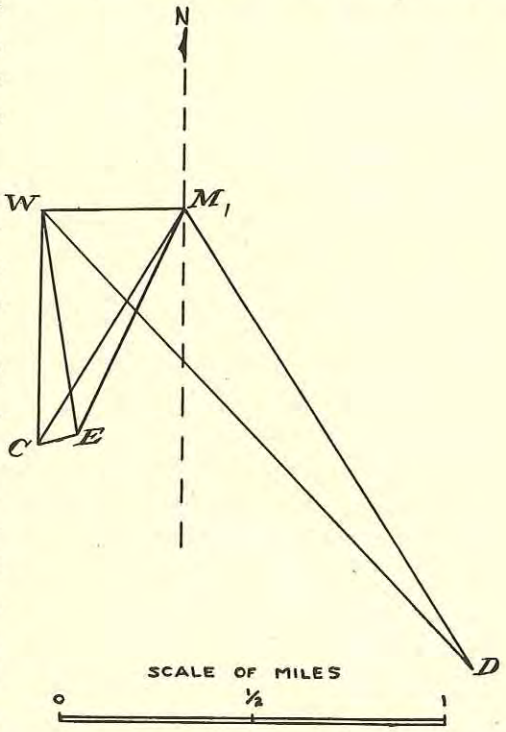


FIG. 11.—Secondary triangulation at the mouth of Savage River for the determination of the Distance from "Mouth" to "Daniels."

rections applied was 529.92 feet, and the distance M_1D was 7421.35 feet, the probable error being about 1 foot.

It was now possible to compute the angle which the boundary line made with one of the triangulation points, as, for example, the angle M_1IJ. Starting with the distance HS, as given by the U. S. Geological Survey data, it was possible to solve all the triangles without knowing the distance SI, which had been obtained by us with the aid of the McKenzie base, AB. The resulting angle M_1IJ was found to be:

$9° \ 22' \ 37''$ I

Since the length of SI, however, as obtained from HS differed from that derived by us by the small base measurement much more than it should, indicating that HS was not known with sufficient accuracy for our purpose,[1] I computed the angle M_1IJ again, this time starting with our distance SI and supposing HS not known. The angle obtained thus was:

$9° \ 22' \ 06''$ II

Had we not been pushed for time, I should have checked this angle further by determining the distance DJ. For this purpose, as I ascertained later, a base from which D and J would be visible could have been measured on Caledonia hill, back of Barton. It was then too late to carry out this idea. I therefore gave double weight to II and adopted for the angle M_1IJ:

$9° \ 22' \ 16''$ III

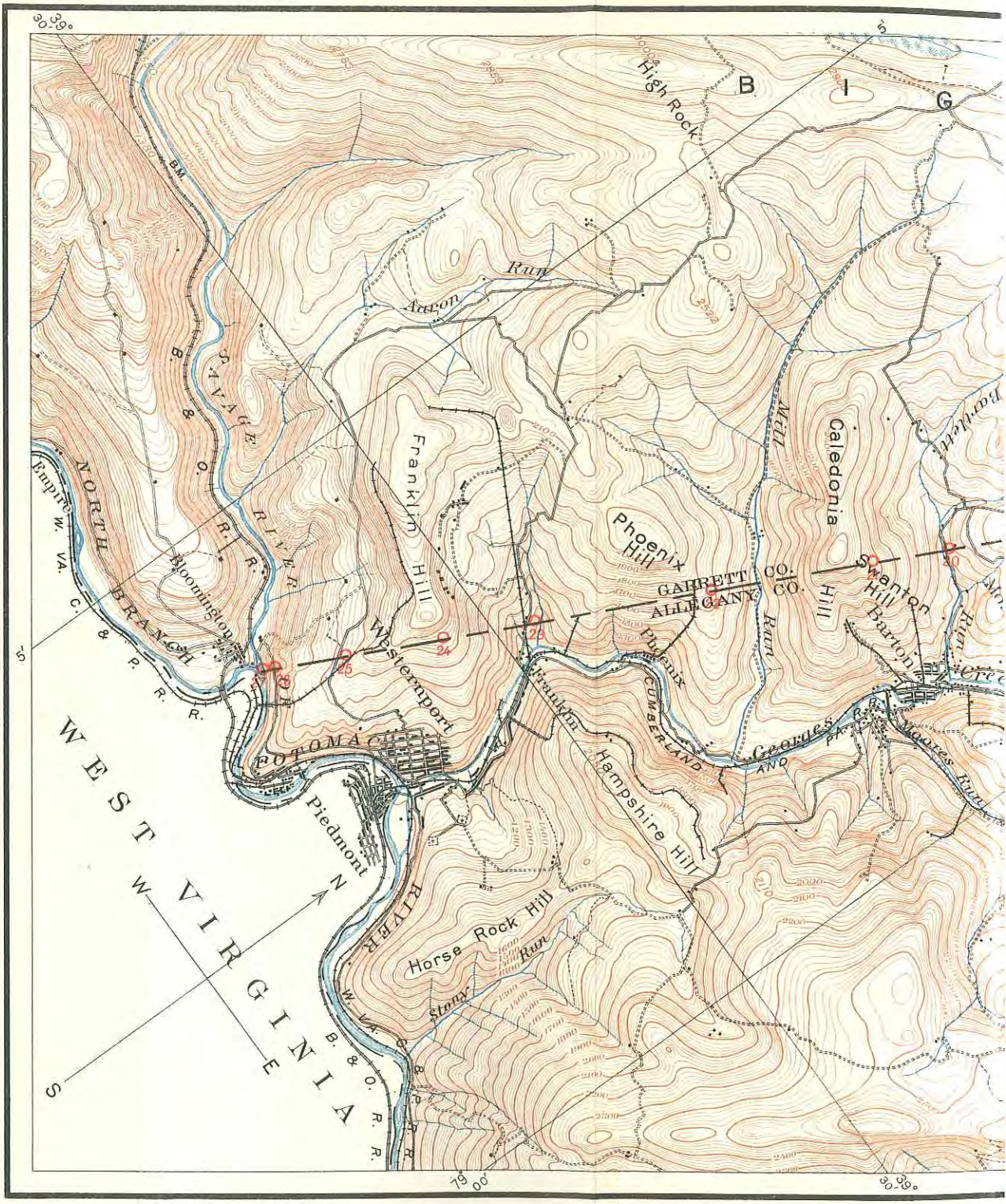
and ranged out a trial line. I felt sure that his line would be correct certainly to within one minute. As will be seen later, this surmise was found to be true.[2]

Tracing the Trial Line.

The longest sight that could be obtained was gotten with the 8-inch theodolite from Station I, on the top of the Savage mountain, to the

[1] Mr. Wilson, geographer of the U. S. Geological Survey, informs me that a much superior connection of their triangulation points with those of the Coast and Geodetic Survey has been recently made, which will necessarily improve their distances when the office computations have been made. [Sept., 1898.]

[2] With the aid of the revised co-ordinates, p. 117, I now get for the first angle, 9° 22′ 19″. [Aug. 29, 1899.]



Engineers:

L. A. Bauer, in charge
L. L. Beall, Surveyor for Allegany County
W. M. Brown, Surveyor for Garrett County

MAP OF THE BOUNDARY LINE BETWEEN ALLE

IN ACCORDANCE WITH AN ACT PASSED BY THE GENERAL ASSEMBLY OF

MARYLAND GEOLOGICAL S

WM. BULLOCK CLARK, STATE GEOLO

Note: The location of the Boundary Monuments is shor

ANY AND GARRETT COUNTIES

3 (LAWS OF MARYLAND 1898, CHAPTER, 304).

VEY

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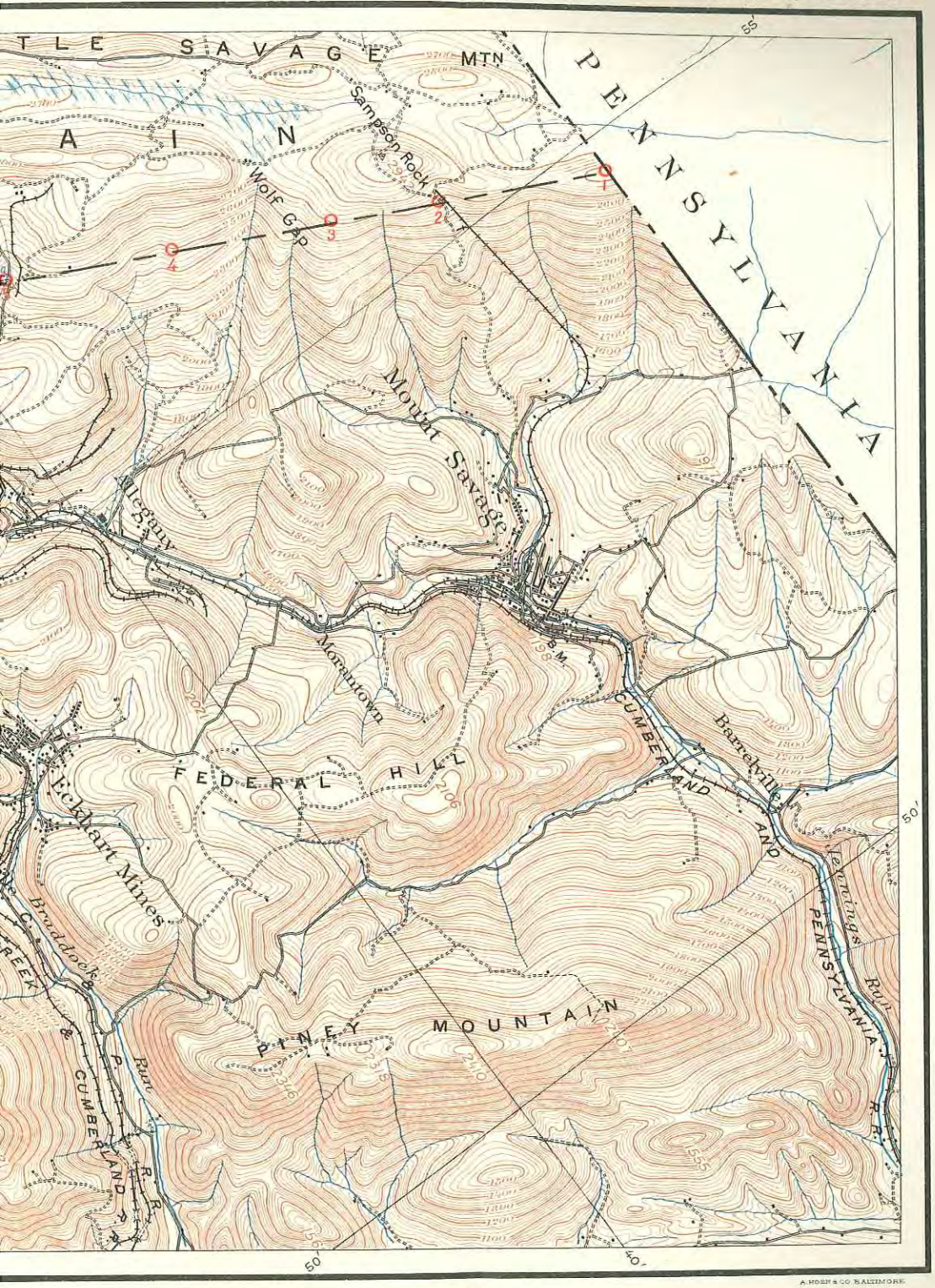

A. HOEN & CO. BALTIMORE.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 20 feet.

Datum is mean sea level.

top of the hill west of Carlos, 7¾ miles distant. To Mr. Brown, assisted by Mr. Finzel, was assigned the establishment of intermediate points between Carlos and the Initial Point. Messrs. Beall and Ashby undertook the tracing of the line southward from Carlos, and I, assisted by Mr. Harris, began at the mouth of the Savage and ran northward.

Mr. Beall's portion of the line was the heaviest one. The line invariably struck in the roughest portion of the numerous hills encountered and always at about the same level, so that the line had to be cut clear through. He had to set up his instrument 9 times before he succeeded in tracing the trial line through from Carlos to Franklin hill, 9¾ miles away.

Not knowing how the trial line would come out, it was very essential that I should meet Mr. Beall as far from the mouth of the Savage river as possible. The top of the high hill directly north of the Savage river—Franklin hill—was thickly wooded, and if the trial line should be out by 1 minute, the cutting on Franklin hill, as made from the north, would be out by about 25 feet.

The easiest way of getting over Franklin hill was to prolong the line somewhat over a mile into West Virginia to a point high enough up on Hampshire hill that the line could be run forward from this point to the highest point of Franklin hill reached by the line. For this purpose the angle IM_1D—the angle which the line to "Daniels" made at the "mouth" with the boundary line—was computed and laid off and the boundary line was prolonged into West Virginia and then forward again across Franklin hill and to the north end of it.

When I reached the point thus established at the north end of Franklin hill, about 1¼ mile from the mouth, I found that I could sight north along the line as far as the cutting on hill west of Lonaconing, somewhat over six miles away. Mr. Beall was seen putting Mr. Ashby on Caledonia hill, 3 miles north of me, in line with the aid of sun-flash signals. The supreme moment had come—the line had been sighted through! On the next day Messrs. Beall and Brown prolonged the trial line from Caledonia hill to my point on Franklin hill. Mr. Brown measured the distance between the two

points—the one obtained from the northward and the other from the south—and found that the former was 20.84 feet west of the latter. This was taken as the total error of the trial line. It represented the error in the bearing of the trial line, plus the error made in the running of the line.

Taking everything into consideration, I believe that this must be regarded as very satisfactory. This error was uniformly distributed along the line, the correction amounting to $20.84 \div 18.6 = 1.12$ foot per mile. As the correction was so small, it was not necessary to know the distances between the established mounds very accurately, the nearest $\frac{1}{10}$ of a mile amply sufficing. The correction was to the *west* from the "Mouth" to my hub on north end of Franklin hill and thereafter to the *east*.[1]

The Terminal Points.

The first problem really was to determine these precisely and to mark them as permanently as possible, so that they might be readily recovered at any future time. This had not been done by our predecessors.

The boundary, as stated, consists of two straight lines, one 18.6 miles long and the other 121½ feet in length. The first line begins "at the summit of Big Back Bone or Savage mountain, where that mountain is crossed by Mason's and Dixon's line." This point I have called the "Initial Point" and have designated it by the letter *I;* and this part of the boundary line was to end at the "middle of Savage river where it empties into the Potomac river." This point I have referred to as "Mouth" or *M*. The second straight line begins at the "Mouth" and proceeds to the "nearest point or boundary of the state of West Virginia." This latter point is, therefore, the "Terminal Point," *T*, of the entire boundary line. (See Fig. 12.)

The determination of these points was done largely by the two surveyors, Messrs. Beall and Brown. The terminal points having been agreed upon by the representatives of the two counties involved,

[1] As I ran north, while Mr. Beall ran south, the errors we committed, due to erroneous bearing of trial line, would be in the opposite direction.

it was my duty to connect their points in the simplest manner possible by straight lines.

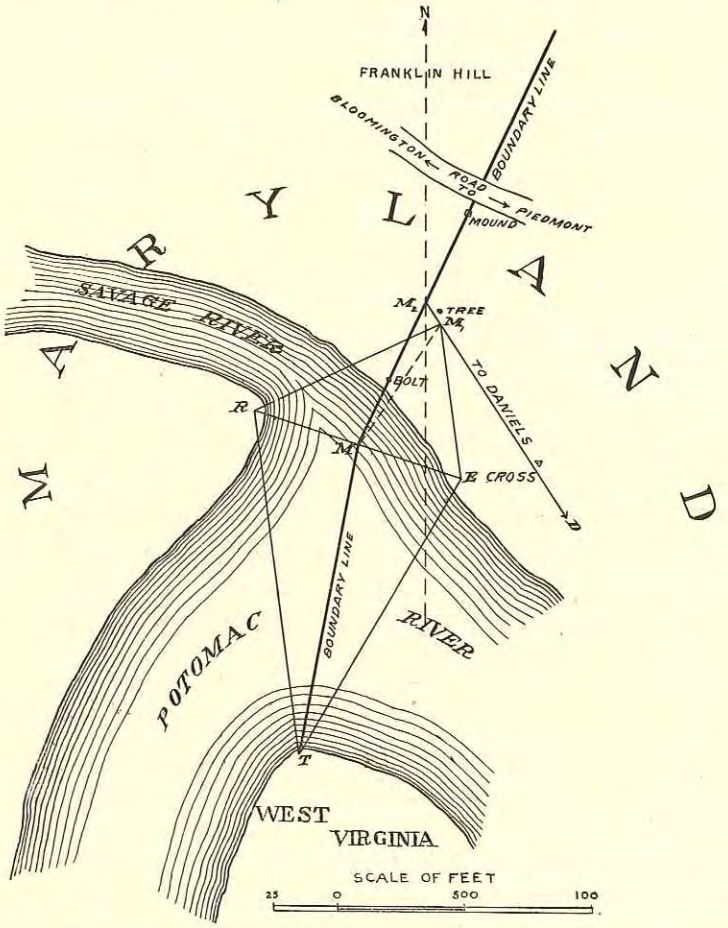

FIG. 12.—Sketch showing Triangulation at Mouth of Savage River, to determine Middle of Mouth and Terminal Point of Boundary Line.

DETERMINATION OF "MIDDLE OF MOUTH OF SAVAGE RIVER" (POINT M).

The triangulation, as carried out by the two surveyors, for the determination of this point is shown in the accompanying sketch (Fig. 12). From their note-books I extract the following information:

"The Potomac river near the mouth of the Savage river makes several sharp curves forming a letter S. At this point the waters of both rivers flow against a thick ledge of hard sandstone rock, which forms the base of Franklin hill (see Plate IX, Fig. 2). The waters of the rivers, which were high at the time (July 19), are of different color, and thus aided materially in determining the 'middle of Savage river where it empties into the Potomac.' A 100-foot tape was stretched across the water along the dividing line of the two rivers, from the point R to point E in the sketch (Fig. 12), and the distance found to be 86 feet. One-half of this gave us the middle of the Savage as called for by the act—the point M in the sketch. The water being deep and the current swift, we transferred the point M by triangulation to the north bank of the Savage—to the point M_1."

At the point M_1, I had previously planted a pole which had been sighted upon from Daniels triangulation station. The point is marked by a half-inch hole drilled in a large, solid, flat rock projecting out of the hillside about 40 feet above the level of the river. The rock is large enough for a tripod to be comfortably placed upon it. $3\frac{3}{4}$ feet to the west is a white oak tree (see Plate IX, Fig. 2), about one foot in diameter. It made an excellent triangulation station. The angles obtained by the surveyors with their transits are:

Angle.	
RM_1E	72° 31′ 13″
M_1ER	64 15 53
ERM_1	43 12 54

Since $RE = 86$ feet, we find by calculation that $EM_1 = 61.738$ feet, $M_1R = 81.220$ feet, $MM_1 = 57.924$ feet, and angle $MM_1E = 41° 58′ 06″$. As angle between Daniels triangulation station and point E is 25° 50′ 26″, angle $M_2M_1M = 180° - (25° 50′ 26″ + 41° 58′ 06″ = 67° 48′ 32″) = 112° 11′ 28″$. True bearing of line M_1D as obtained by solar azimuth observations at Daniels is S. 33° 02′ E. Approximate true bearing of boundary line is S. 26° W. (see foot-note p. 108); hence angle $MM_2M_1 = 33° 02′ + 26° = 59° 02′$. With the aid of these data we find $M_1M_2 = 10.29$ feet, and $MM_2 = 62.55$ feet. Hence the "middle of Savage river where

it empties into the Potomac" is 62.55 feet in the direction of the boundary line from the point M_2, where the triangulation line M_1D (see Figs. 9 and 12) prolonged intersects the boundary line.

When the line M_1D was extended backwards and the distance $M_1M_2 = 10.29$ feet was laid off, it was found to coincide with the lower left hand corner of a large rock lying flat against and firmly bedded in the hillside, $6\frac{1}{2}$ feet to the west of the white oak tree shown in the sketch (Fig. 6 and Plate IX, Fig. 2). The rock measures 1.25 feet in direction up the hill and 3.2 feet in direction along the hill. When the line was permanently marked, the point M_2 was referred to the bolt and mound shown in the sketch. Horizontal distance of M_2 from the bolt is 34.14 feet, and from mound (middle of hole in top of marble post) 40 feet. *Hence the "middle of the Savage river where it empties into the Potomac" is* 28.4 *and* $102\frac{1}{2}$ *feet, measured horizontally along the boundary line from the bolt and the mound respectively.* For description of bolt and mound see page 133. The point E has likewise been marked by a cross cut in the rocky ledge, so that with the aid of the data given above M can also be recovered from E.

In the main triangulation system the pole sighted upon was always at M_1, *i. e.* the triangulation station representing the "mouth of the Savage" was a so-called "eccentric one." The simplest way of making the proper correction in the computation so as to refer M_1 to the "mouth" was by substituting for the point M_1 the point M_2, obtained with the aid of the known approximate bearing of the boundary line. And as M_2 was in the same line with M_1 and D, it was only necessary when solving the triangles of the main system to substitute instead of the side M_1D the side M_2D.

DETERMINATION OF TERMINAL POINT OF ENTIRE BOUNDARY LINE.

This point was to be the terminal point of a straight line connecting the middle of the mouth of the Savage river (M) with the nearest point of the boundary of the state of West Virginia (the further bank of the Potomac). This point was determined by Mr. Beall and then referred by triangulation to the station M_1 by Messrs. Beall and Brown. The angles measured for this purpose were:

Angle.	Observer.	Observed.
TM_1E	Brown	25° 30′ 26″
ERT	Beall	63 30 22
RET	Brown	77 43 45

With the aid of these quantities we find that the horizontal length of $ET = 122.9$ feet, and of $M_1T = 175.6$ feet, and of $MT = 121\frac{1}{2}$ feet.

These data will suffice to enable one to recover T from any of the points (bolt, cross, M_1, M_2, mound).

THE INITIAL POINT OF THE LINE.

This, according to the act of 1872, was to be "at the summit of Big Back Bone or Savage mountain, where that mountain is crossed by Mason's and Dixon's line." On July 20th the two surveyors and I went to the top of Savage mountain in order to determine the starting point of our line. A mound on the top of the mountain, about 50 yards south of the gate-house of the Standard Oil Pipe Line, had been pointed out to me by Mr. C. Bolden, living in the vicinity, as being doubtless one of the Mason and Dixon mounds.

In this region the real Mason and Dixon line was in dispute. Two lines differing 100 feet and more have been taken at various times as the state boundary line. The original mounds seemed to have been lost, and, unfortunately, the corners of the old military lots were likewise marked by mounds, so that it was difficult to vouch for the authenticity of a mound found in this locality. The engineer who laid out the pipe line was instructed to remain everywhere 10 yards away from the Mason and Dixon mounds. Not finding any authentic mounds in this locality, he went far enough away to be surely in Pennsylvania. When he had run west several miles, he found authentic mounds again and switched his line back again, introducing thus a very noticeable crook in his line.

We were accordingly, obliged to spend more time in the determination of the initial point than we had bargained for. We first ran a line due east from the mound pointed out by Mr. Bolden, and levels were taken by Messrs. Brown and Beall. The result of these levels

is shown in Fig. 13. The highest point, as agreed upon by Messrs. Beall and Brown, was 278 feet due east of the center of the mound. This point was temporarily accepted as the initial point of the boundary line. It was found, furthermore, that the crest of the mountain for nearly 100 yards ran in the direction of the boundary line, hence a very precise determination of the point of the crest where the true Mason and Dixon line crossed was not essential for the purpose of running the boundary line we were called upon to trace. I therefore decided to make the point determined by the surveyors my triangulation station, and, in fact, traced out the entire line from this point.

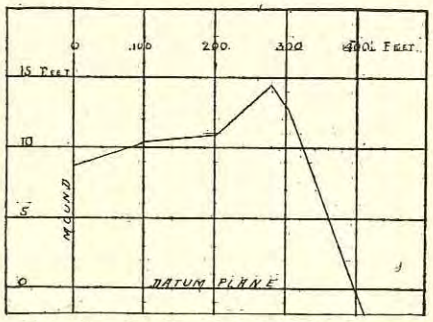

FIG. 13.—Profile of line of levels across the top of Big Savage Mountain.

This point has since been found, in 1902, by Captain W. C. Hodgkins of the U. S. Coast and Geodetic Survey, the engineer in charge in behalf of the states of Maryland and Pennsylvania for re-tracing the Mason and Dixon line, to be on the state line and has been permanently marked by him.

In 1898, when the true location of the Mason and Dixon line was, as stated, a matter of dispute, the following additional work was done in order to test the point from which the boundary line was traced.

Messrs. Beall and Brown ran a due west line for nearly a mile and likewise examined a large stone mound 2½ miles to the west. No entirely conclusive evidence as to the real state line could, however, be obtained. It was therefore decided that Mr. Beall should examine the mounds to the east of the Big Savage mountain, viz.: the one on the top of Little Allegany mountain, about 5 miles away, and the other on the top of Wills mountain, 9 miles from the top of Savage mountain. It was found that according to the Mason and Dixon line as defined by these two mounds, my triangulation station, referred to above, was 42.05 feet too far south. I, accordingly,

placed a temporary initial monument, 46.82[1] back of my triangulation station and in the direction of the boundary line. In the winter of 1902, when Captain Hodgkins determined the true location of the Mason and Dixon line he found, as already stated, that my triangulation station was situated on the Mason and Dixon line and that the reason it appeared in 1898 to be too far south by 42.05 feet was because of there being a cusp in the original Mason and Dixon line to the east of Savage mountain. He, accordingly, under authority of the State Geologist, moved the temporary initial monument above mentioned to a point southward, coinciding practically with my triangulation station; the distance the temporary initial monument of 1898 was moved along the line southward was 45.6 feet.

The Marking of the Boundary Line.

THE MANNER OF MARKING.

Section 2 of the act creating the survey designates that the boundary line shall be permanently marked at its terminal points, and that along the same shall be planted suitable stones properly marked at intervals of not over a mile. A great deal of thought was spent upon the kind of monuments to be planted along the line. The monuments must be such as to insure their not being disturbed or destroyed for a long time to come. The appropriation was not sufficient to warrant our having stones especially cut and lettered for the purpose and to defray the cost of their transportation to the tops of the many high, steep hills and mountains along the line. Nor has it been found especially desirable in the marking of boundary lines to have as a marking stone one possessing an inherent commercial value. It was finally decided to mark the line in the following manner. A hole 2-3 feet square and about 2 feet deep was dug. At the bottom of this hole was placed a good, substantial, flat stone obtained in the vicinity, usually about 4 inches thick and squaring from two to four feet. A hole drilled in this subsurface stone or a cross cut in it marked the precise point of the line. On top of the flat stone

[1] 42.05 feet multiplied into the secant of the true bearing of the boundary line, N. 26° 04.9′ E.= 46.82 feet.

FIG. 1.—CONFLUENCE OF SAVAGE RIVER AND NORTH BRANCH OF THE POTOMAC.

FIG. 2.—TRIANGULATION STATION (M_1).

was next placed the surface marking stone. The surface stone was a rough sandstone also obtained in the vicinity, one so large as to require two or three men in handling it. The length was about three feet; the top was 50 square inches and more. A cross or a hole in the top of the stone marked the precise point. Around the marking stone was raised a mound, 8 feet in diameter, generally consisting of earth and stones and coming up to the top of the stone or to within a few inches of the top. The marking stone was then most firmly packed and braced on all sides. Finally a trench 6-8 inches deep and a foot wide was dug around the mound.

In placing the mounds we were governed by the following considerations, as far as the scanty funds at our disposal would permit:

1. From any one mound at least one other mound should be visible or might be made visible with a little cutting or by the planting of a pole on the mound, so that the surveyor could get the direction of the line from the mounds for the purpose of locating intermediate points.

2. The mounds were not to be over a mile apart, as called for by the act. (This provision occasionally obliged us, on account of the nature of the ground, to put in additional mounds at intervals of very much less than a mile.)

3. A mound should be put on the highest ground in the vicinity whenever circumstances permit and provision (2) is not violated thereby.

4. A mound should be placed as far as possible near a fence, a road or some easily described place. It should never be in an open field where it is exposed to the ravages of the ploughshare.

In a total distance of 18.6 miles 25 mounds of the above description were constructed.

LOCATION OF THE MOUNDS.

As the mounds were all constructed in the same manner, no detailed description of each is necessary. Simply such information will be given as will enable one to find a desired mound. I shall begin with the mound on the Mason and Dixon line, as the act requires the line to begin at this point. No number will be found marked on the boundary stones. The number was omitted so as to prevent the natural inference that they are milestones; as above-mentioned the stones could not be placed exactly a mile apart.

1. Mound on Mason and Dixon line. "On the summit of Big Backbone or Savage mountain, where that mountain is crossed by Mason's and Dixon's line." Reached by mountain road from Mount Savage railroad station. A more roundabout way, but a better road, is from Frostburg by way of Finzell postoffice. The gate-house of the Standard Oil Pipe Line is about 70 yards to the north of the mound.

The monument is tightly wedged between two ledges of rock with stones piled around. A hole 1 inch in diameter and ¾ inch deep was drilled in the top of the western and higher rock 3.74 feet west of the monument. This stone monument can be replaced easily in case it should be thrown out of position in some manner with the aid of the following marks:

(1) An expansion bolt[1] driven in a sandstone rock 109.1 feet forward (i. e. southward) of the center of hole in monument.

(2) Two similar bolts, 22¾ feet and 60¾ feet, respectively, driven in solid sandstone rocks, back of center of hole in monument.

The boundary line passes through the centers of these three bolts.

[The above description applies to the present (1903) site of the initial mound. As already related on page 128, the temporary initial mound was 45.6 feet back of the present one.]

2. Mound on Mount Savage fire-clay hill. About 500 feet from second dump on fire-clay incline plane. Most easily reached from Mount Savage or from Finzell. Marking stone is 3½ feet high and 8 x 10 inches square, with a hole in top marking precise center. Mound, trench, subsurface stone as prescribed. Pitch pine tree 18 inches in diameter stands about 9 feet north of mound.

3. Mound on Piney Hill, better known as Cranberry Hill. About 300 feet east of mountain road known as Cranberry road, running north from National Road to fire-clay mine. The subsurface stone is about 5 inches thick with center marked on it; on this was placed a stone 2½ feet high and 5 x 10 inches square with hole in top. Mound and trench around the stone as usual.

4. Mound on Roaring Hill. About one mile north of National Road, where old toll-gate formerly was, not far from house occupied at present by John Workman. A subsurface stone (with center), mound and trench as usual. The upper stone is 2 feet long and 5 x 12 inches square, the longer dimension being along the line. A drill hole started in top of stone marks precise point.

5. Mound on National Road, 1½ mile from Frostburg, on south side of pike and about 56 feet west of iron columns marking site of old toll-gate. The principal stone is dressed, of white marble, 3 feet long and 6 x 6 inches square, with corners rounded off to prevent chipping. A ¼-inch hole in top marks precise point, and the top of stone is lettered as follows:

[1] These bolts wedge tight in driving; the head is one inch square, and they are ½ inch in diameter and 2½ inches long.

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On the east side of stone is the letter *A* and on the west side *G*. The monument rests on a flat rock (the subsurface mark) and is set in a mixture of broken stone and hydraulic cement. The usual mound and trench surround the monument.

6. Mound on hill south of National Road. About ¾ of a mile south of pike, between two runs, on level piece of cleared ground near an old road and near Frostburg pipe line for water supply, and not many feet west of artesian well. The upper rock is 2½ feet long and about 6 inches square on top. A drill hole started in top marks center. Subsurface stone, mound (9 feet in diameter) and trench as usual.

7. Mound near old Braddock road, on hill north of Winebrenner run, 1½ mile north of Midlothian. The mound is about 50 yards north of the Braddock road. The upper stone is about 3 feet long, 8 inches square, rudely dressed and with center marked in top. Subsurface mark, mound and trench as prescribed.

8. Mound on hill south of Winebrenner run. ¾ of a mile northwest of Midlothian. On the face of hill sloping toward N. E., upon lower part of spur, about half-way to top of hill and near an old log road, one-quarter of a mile south of Benjamin Filer's house, which is in sight. The upper stone is 2.2 feet long and 8 inches square on top with center marked. Subsurface stone, mound and trench as usual.

9. Mound on hill north of Staub Run. About ¾ of a mile northwest of Carlos, on farm belonging to William Filer. In the woods, about 100 yards south of rail fence at brow of hill, where miner's path intersects fence. This path leads down to road coming out at Carlos. The upper stone is a red sandstone, about .5 inches thick and about 2½ feet long, with hole drilled in top. Subsurface stone, mound, trench. Mound had to consist chiefly of stone.

10. First mound on hill south of Staub Run. About ¾ of a mile west of Carlos. Take road as far as William Filer's house, then follow miner's path to mine opening about ½ mile, then bear to the right to cutting. The hill belongs to the Consolidation Coal Company.

11. Second mound on hill south of Staub's run. About 268 paces south of first mound. The two mounds were placed so near to each other so as to give intervisible points to the north and south. From north mound, mounds 9, 7, 4 and 1 are visible (or can be made so), and from south mound No. 12 can be seen.

12. Mound on north side of Koontz Hill. South of Wright's Run and reached from either Lonaconing, Midland or Ocean. A road passes within 20 yards of the mound and continues northward on down the hill to Ocean, or southward past Cutter's barn down the hill to Lonaconing. Not a very good looking stone, but a substantial one, forms the principal stone. The mound consists chiefly of stone.

13. Mound on south side of Koontz Hill. About 2 miles northwest of Lonaconing. On the south side of lane leading to the west of gate to Cutter's barn and house, and 70 yards from the gate. The farm belongs to the New Central Coal Co., and is rented by Barney Cutter, whose brother, Henry, is at present living on the place. The precise point is marked by a cross cut in stone, 3½ feet long and about 7 x 7 inches square. In center of cross was drilled a ⅛-inch hole. From this mound, mound No. 15 can be seen by planting a pole on top of it.

14. Mound on Pea Ridge road. On the north side of the road leading from Lonaconing to Pea Ridge, about 1½ mile from Lonaconing. Center stone is about 13 inches square and about 3½ feet long, resting about 2 feet in the ground. Precise point was marked with a pick in center of stone. No subsurface mark. Mound about 1½ foot high and 6 feet in diameter, consisting of earth and stone thrown up against center stone.

15. Mound on hill west of Lonaconing. On property of Maryland Coal Company; near fence on west side of meadow south of house occupied by Mr. Weir, who is the present tenant of the farm. Precise point is marked by a cross and ¼-inch hole in center of top of central stone of mound. Subsurface stone, mound and trench as usual. From this mound are visible several points in the line as far south as Franklin Hill.

16. Mound on Detmold Hill. On the west end and on the highest point of the hill. Reached by Miller road running from Detmold to Grantsville, within about ¼ of a mile to the west of mound. Mound is built on an undisturbed, solid stone with subsurface mark on it, and around a smooth, upright stone, 3 feet long and 6 x 9 inches on top.

17. Mound near Miller road. South of Detmold Hill, between Laurel Run and Miller road, which runs from George's Creek road to Grantsville; one rod north of road and about ¼ of a mile from Robert Green's farm. The precise point is marked by a hole in the central stone, which is 3 feet long and 8 x 10 inches on top. Subsurface mark, mound, trench.

18. Stone on North Pickell Hill. About ¼ mile to the north of next mound (No. 19). No mound was built, but simply a stone 2 feet long and 4 x 14 inches on top was set in the ground and stones firmly packed around it. The stone is north of a road to meadow on hill. Coal mines are on fire on this hill.

19. Mound on South Pickell Hill. Reached from Barton by taking county road to Grantsville, or also from Moscow, mound being about 2 miles west of latter point. Constructed in the usual manner. Precise point is a cross cut in top of central stone.

20. Mound on Bartlett Road. On county road leading from Barton to Grantsville, about 1½ rod north of road, on land owned by Wm. Sommerville. Constructed in the prescribed manner.

21. Mound on Swanton Hill. Reached from Barton by a very steep road to top of hill. Mound is about 40 paces north of barbed-wire fence dividing the American Coal Co. property from that of the Swanton Coal Co. The precise location can be pointed out by Peter Shaw, who lives on top of hill. The central stone of the mound has a cross cut in the top and the letters *A* and *G* rudely cut in the sides. Franklin Hill mound (No. 24) can be seen from this point; also No. 15.

22. Mound on Phoenix Hill. Reached from Morrison switch by taking Phoenix Hill road. It is on the summit of the hill in a meadow owned by Davis Coal Co. and leased by John Lannon. Built in the usual manner.

23. Monument on county road south of Phoenix Hill. Reached from Franklin railroad station. On the north side of the road. A good, substantial stone firmly set in the ground and smaller stones packed around it. The mound is about three rods east of U. P. Gannon's house.

24. Mound on north side of Franklin Hill. On the highest point of the hill reached by the line. About 50 feet to the south the hill breaks off very abruptly and only a short distance beyond the tramway curves around the hill to the west. The central stone is about 2½ feet long and about 12 inches square. A cross cut in the top marks the precise point. Subsurface stone, mound and trench.

25. Mound on south side of Franklin Hill. About 20 yards north of county road where it crosses bridge over the Davis coal mine plane. The subsurface is a cross cut in a sandstone about 1½ foot long, 8 inches wide and 10 inches thick lying with the longer dimension at right angles to the line. On this solid stone rests a dressed marble post 2½ feet long and 6 inches square. Around the stone is a mound 8 feet in diameter, consisting of earth and stone; a trench encircles the mound. The stone is lettered on top:

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On the west side is the letter *G* and on the east side *A*. The precise center is marked by a half-inch hole drilled in the top of the stone.

26. Mound at mouth of the Savage. On the south side of the road leading to Bloomington about 100 feet above the Savage River. The central stone is a dressed marble post, 2½ feet long and 6 inches square, marked and lettered as in the case of No. 24.

27. Bolt in rock at mouth of Savage river. Set with plaster of paris in a good firm rock close to the river. Bolt is ¾ inch in diameter; head about 1¼ inch round. For references and distances to other marks at the mouth of the Savage, see page —.

Magnetic Work done in connection with the Boundary Line.

I found it impracticable with the limited time and funds at my disposal to transport the special magnetic outfit to the tops of the many high hills along the line. Instead of this, Mr. Brown, whose magnetic needle was in very excellent condition, was instructed to read his needle whenever opportunity afforded. On a subsequent page are given the data for determining the approximate correction to be applied to Mr. Brown's results in order to reduce them to those

Magnetic Readings taken by Surveyor Brown, with the needle of his transit, at various points along the Boundary Line.

Station.	Date, 1898.	Time of day (Eastern time).	Magnetic Bearing of Mark.	True Bearing of Mark.	Mag'tic declination (West).	CORRECTIONS. Index.	Diurnal Variat'n	Secular Variat'n	Mean Magnetic Declination in 1898½ (West).
		h m	° ′	° ′	° ′	′	′	′	° ′
Mound 1[1]	July 20	3 30 p	S 85 50 E	S 90 02.2 E	4 12.2	−1.0	−3.4	−0.1	4 07.7
Mound 2.....	Aug. 29	3 50 p	N 30 15 E	N 26 04.8 E	4 10.2	−1.0	−2.2	−0.5	4 06.5
Sampson Rock..	July 30	1 30 p	S 18 05 W	S 14 17.7 W	3 47.3	−1.0	−4.8	−0.2	3 41.3
		2 00 p	S 18 25 W	S 14 17.7 W	4 07.3	−1.0	−4.8	−0.2	4 01.3
		5 30 p	S 18 28 W	S 14 17.7 W	4 10.3	−1.0	−0.5	−0.2	4 08.6
		1 50 p	S 72 30 W	S 68 33.8 W	3 56.2	−1.0	−4.8	−0.2	3 50.2
		2 00 p	S 72 45 W	S 68 33.8 W	4 11.2	−1.0	−4.8	−0.2	4 05.2
		5 30 p	S 72 35 W	S 68 33.8 W	4 01.2	−1.0	−0.5	−0.2	3 59.5
		2 00 p	S 7 00 E	S 11 05.4 W	4 05.4	−1.0	−4.8	−0.2	3 59.4
		5 30 p	S 7 02 E	S 11 05.4 W	4 03.4	−1.0	−0.5	−0.2	4 01.7
									Mean 3 58.4
Mound 4.....	Aug. 27	4 30 p	N 30 11 E	N 26 04.3 E	4 06.7	−1.0	−1.1	−0.5	4 04.1
Mound 5.....	Aug. 29	12 30 p	N 30 15 E	N 26 04.1 E	4 10.9	−1.0	−4.7	−0.5	4 04.7
Mound 7.....	Aug. 25	9 50 a	N 30 05 E	N 26 04.3 E	4 00.7	−1.0	+0.9	−0.5	4 00.1
		1 50 p	N 30 12 E	N 26 04.3 E	4 07.7	−1.0	−4.8	−0.5	4 01.4
		3 50 p	N 30 10 E	N 26 04.3 E	4 05.7	−1.0	−2.1	−0.5	4 02.1
	Aug. 26	10 20 a	N 30 03 E	N 26 04.3 E	3 58.7	−1.0	−0.6	−0.5	3 56.6
		12 15 a	N 30 10 E	N 26 04.3 E	4 05.7	−1.0	−4.7	−0.5	3 59.5
									Mean 3 59.9
Mound 8.....	Aug. 26	2 00 p	N 30 11 E	N 26 04.3 E	4 05.7	−1.0	−4.8	−0.5	3 59.4
Mound 10.....	Aug. 23	10 50 a	N 30 06 E	N 26 03.4 E	4 04.6	−1.0	−2.8	−0.4	4 00.4
		1 30 p	N 30 08 E	N 26 03.4 E	4 04.6	−1.0	−4.9	−0.4	3 58.3
		4 00 p	N 30 05 E	N 26 03.4 E	4 01.6	−1.0	−1.8	−0.4	3 58.4
	Aug. 24	9 15 a	N 30 02 E	N 26 03.4 E	3 58.6	−1.0	+2.0	−0.4	3 59.2
		2 00 p	N 30 02 E	N 26 03.4 E	3 58.6	−1.0	−4.1	−0.4	3 53.1
									Mean 3 57.9
Mound 13.....	Aug. 22	9 25 a	N 29 59 E	N 26 02.1 E	3 56.9	−1.0	+1.8	−0.4	3 57.3
		1 00 p	N 29 52 E	N 26 02.1 E	3 49.9	−1.0	−5.0	−0.4	43.5
									Mean 3 50.4
Mound 15.....	Aug. 19	2 15 p	N 30 03 E	N 26 02.4 E	4 00.6	−1.0	−4.6	−0.4	3 54.6
Mound 18.....	Aug. 31	5 30 p	N 29 59 E	N 26 00.9 E	3 58.1	−1.0	−0.2	−0.5	3 56.4
Mound 19.....	Aug. 31	2 30 p	N 30 02 E	N 26 00.9 E	4 01.3	−1.0	−4.2	−0.5	3 55.6
Mound 21.....	Aug. 18	9 43 a	N 29 50 E	N 26 01.3 E	3 48.7	−1.0	+1.2	−0.4	3 48.5
		10 43 a	N 29 53 E		3 51.7	−1.0	−1.8	−0.4	3 48.5
		3 00 p	N 29 58 E		3 56.7	−1.0	−3.7	−0.4	3 52.6
									Mean 3 49.9
Mound 23	Aug. 20	5 15 p	N 29 50 E	N 25 59.7 E	3 50.3	−1.0	−0.4	−0.4	3 48.5
Mound 24.....	Aug. 20	12 30 p	N 29 52 E	N 25 59.6 E	3 53.4	−1.0	−4.9	−0.4	3 47.1
		2 40 p	N 29 52 E	N 25 59.6 E	3 53.4	−1.0	−4.1	−0.4	3 47.9
									Mean 3 47.5
Mark 27[2]	July 19	about 4 p	S 29 52 E	S 33 02.9 E	3 10.9	−1.0	−3.0	−0.1	3 06.8
			S 29 50 E	S 33 02.9 E	3 12.9	−1.0	−3.0	−0.1	3 08.8
	July 19		N 89 46 W	N 93 01.5 W	3 15.5	−1.0	−3.0	−0.1	3 11.4
			N 89 50 W	N 93 01.5 W	3 11.5	−1.0	−3.0	−0.1	3 07.4
	Aug. 11	9 50 a	S 29 57 E	S 33 02.9 E	3 05.9	−1.0	+0.8	−0.3	3 05.4
		4 00 p	S 29 57 E	S 33 02.9 E	3 05.9	−1.0	−1.9	−0.3	3 02.7
									Mean 3 07.1
Daniels △	July 28	2 00 p	N 29 45 W	N 33 02.1 W	3 17.1	−1.0	−4.8	−0.2	3 11.1

[1] At triangulation station, 46.84 feet from Mound 1 and forward along boundary line.

[2] At triangulation station M_1, 28 feet north of bolt.

obtained with the instrument used in the magnetic survey of Maryland, viz. Coast and Geodetic Survey magnetometer No. 18.

Complete magnetic observations, *i. e.* magnetic declination, magnetic inclination and intensity of magnetic force, were made by me with the special magnetic outfit at two places near the line: at Westernport in 1897 and at Lonaconing on August 31, 1898. Only the results for magnetic declination need be given herewith.

Station.	Date.	Magnetic decl'n approximately reduced to mean of day.
		° ′
Westernport,	Aug. 3, 1897.	3 46.2 West
Lonaconing,	Aug. 31, 1898.	3 51.0 "

The station at Westernport is on north side of hill, along road leading down to the river from W. Va. R. R. station, and about 100 yards east of last house. The station at Lonaconing is in south part of base-ball field, south of Maryland Coal Company's office. The precise point at Lonaconing is marked by a locust stake and can be pointed out by Mr. F. E. Bracket.

Mr. Brown states that none of his magnetic readings is the result of one reading alone, but always the average of two or more readings, the needle having been lifted between times.

The corrections applied to the observed magnetic declinations in the foregoing table were derived as follows:

I.—Index or Needle Correction The data furnishing the correction to be applied to the declinations observed with Mr. Brown's needle, are:

Station.	Date, 1898.	Eastern time.	Brown's obs'd mag'c decl'n.	Mean Magnetic Decl'n.		Correction to Brown's needle.
				Brown.	Bauer.	
		h. m.	° ′	° ′	° ′	′
1. Oakland C. H. Meridian,	June 24.	10 50 a	3 26.5	3 25.4	3 25.7	+0.3
2. Lonaconing Mag. S. station,	Sept. 1.	4 12 p	3 55.9	3 54.6	3 51.0	−3.6
3. Corunna Meridian.	Sept. 5.	10 40 a	3 22	3 20.3	3 19.5	−0.8

Brown remarks that Nos. 1 and 3 were observed in shade and No. 2 in hot sun. Bauer's magnetic declinations for Nos. 1 and 3 are the values obtained in 1897 with Coast and Geodetic Survey Magnetometer 18, reduced to date of Brown's observations; the value for No. 2 was obtained on Aug. 31, 1898, with same magnetometer.

Correction adopted to be applied to Brown's values, $\frac{1}{2}[+0.3+\frac{1}{2}(-3.6-0.8)] = -1'.0$

II. Correction on account of diurnal variation. See my table for reducing an observed magnetic declination to mean of day, p. 457 in First Report on Magnetic Work in Maryland, in Vol. I, Md. Geol. Survey. This table has been reproduced on p. 138, but *with the signs reversed.*

III. Secular variation correction. At the rate of 3′ per annum; all of Brown's observed magnetic declinations have thus been reduced to the middle of year of survey—1898½.

Collecting the various results obtained, we have the following values of the magnetic declination in the region traversed by the boundary line.

Summary of the Values of the Magnetic Declinations along the Boundary Line.

Station.	Latitude.[1]	Longitude[1] W. of Gr.	Mean magnetic declination in 1898½.	Observer.	Normal magnetic declination in 1898½	Difference.
	° ′	° ′	° ′		° ′	′
Mound 1	39 43.4	78 54.8	4 07.7 W	W. M. B.	4 07.7	0.0
Mound 2	39 42.5	78 55.4	4 06.5	"	4 06.6	+0.1
Sampson Rock	39 42.5	78 55.8	3 58.4	"	4 06.6	+8.2
Mound 4	39 41.2	78 56.1	4 04.1	"	4 04.6	+0.5
Mound 5	39 40.5	78 56.6	4 04.7	"	4 03.6	−1.1
Mound 7	39 39.3	78 57.3	3 59.9	"	4 01.7	+1.8
Mound 8	39 38.6	78 57.7	3 59.4	"	4 00.8	+1.4
Mound 10	39 37.3	78 58.5	3 57.9	"	3 58.8	+0.9
Mound 13	39 35.7	78 59.5	3 50.4	"	3 56.4	+6.0
Mound 15	39 34.7	79 00.1	3 54.6	"	3 55.0	+0.4
Mound 18	39 33.0	79 01.2	3 56.4	"	3 52.1	−4.3
Mound 19	39 32.8	79 01.3	3 55.6	"	3 52.1	−4.5
Mound 21	39 31.8	79 01.9	3 49.9	"	3 50.8	+0.9
Mound 23	39 30.1	79 03.0	3 48.5	"	3 48.2	−0.3
Mound 24	39 29.7	79 03.3	3 47.5	"	3 47.5	0.0
Mark 27	39 28.8	79 04.0	3 07.1	"	3 46.2	+39.1
Daniels △	39 28.0	79 02.7	3 11.1	"		
Lonaconing	39 33.6	78 59.1	3 50.5	L. A. B.		
Westernport	39 28.9	79 02.2	3 48.9	"		

[1] The latitudes and longitudes here given have been scaled from the topographic sheets of the U. S. Geological Survey with exception of Mounds 1 and 27 and Sampson Rock.

By looking over the figures in the fourth column it will be noticed that the magnetic declination decreases quite uniformly from the initial point of the line on the top of Savage mountain to Franklin hill (mound 24). The total change is 20′.2 in a total distance of 17½ miles, or the rate of decrease is 1′.15 per mile. The same thing is shown by my chart of the lines of equal magnetic declination published in the "Second Report on Magnetic Work in Maryland." From this chart we find that the normal value of the magnetic declination for middle of this year would be about 3° 46′ at the mouth of the Savage and 4° 06′ at the initial point of the boundary line.

There exists, however, a decided local attraction at the mouth of the Savage river, the needle being thrown out of its normal direction by ⅔ of a degree—see last column of table.

The declination on Daniel's farm, back of Piedmont, appears to be disturbed by about the same amount.

Additional Magnetic Data Obtained by Mr. Brown, After the Completion of the Survey of the Boundary Line.[1]

Station.	Date, 1899.	Time of Day (Eastern Time).	Magnetic Bearing of Mark.	True Bearing of Mark.	Magn'tc Decl'n (West).	Corrections.			Mean Magn'tc Decl'n in 1898.5 (West).
						Index.	Diurnal Var'n.	Secular Var'n.	
		h. m.	° ′	° ′	° ′	′	′	′	° ′
Mound 8	Jan. 18	2 00 p	N30 08. E	N26 03.3E	4 04.7	−1.2	−2.6	−1.7	3 59.2
9	" 19	9 50 a	N30 07. E	N26 03.0E	4 04.0	−1.2	+2.3	−1.7	4 03.4
13	.....	9 25 a	N29 59. E	N26 02.1E	3 56.9	−1.2	+2.2	−1.7	3 56.2
14	Jan. 2	2 00 p	N30 01. E	N26 01.8E	3 59.2	−1.2	−2.5	−1.5	3 54.0
		4 00 p	N30 00.3E	N26 01.8E	3 58.5	−1.2	−1.2	−1.5	3 54.6
						Mean for Md. 14			3 54.3
21	Jan. 20	4 30 p	N29 57. E	N26 00.6E	3 56.4	−1.2	−0.8	−1.7	3 52.7
22	" 21	1 20 p	N29 57. E	N26 00.3E	3 56.7	−1.2	−2.6	−1.7	3 51.2
26[2]	Feb. 4	2 15	N29 44.0E						
		2 20	N29 45.5E						
	Mean for Md. 26		N29 44.8E	N25 59.3E	3 45.5	−1.2	−2.5	−1.7	3 40.1

These readings were taken with the same needle and instrument as used by Mr. Brown in his previous work and are generally the result of several readings. By comparing these later values with those in the foregoing table, it will be seen that they are in good accord. Mr. Brown also re-occupied my station at Lonaconing on December 23, 1898. The value obtained by him reduced to 1898.5 is 3° 50′.9 W.

[1] This table was added in August, 1899.

[2] Over hub twenty feet south of monument in direction of Boundary Line.

Courses and Distances.

On following page is a table giving the courses and distances for the various mounds. No additional explanation is needed beyond that already given in the preceding pages.

Number[1] of mound.	Approximate distance from initial mound in tenths of a mile.	True bearing of boundary line at mound.	Magnetic[2] bearing in 1898.5.	Magnetic[2] bearing in 1900.5.
		° ′	° ′	° ′
1	0.0	S 26 04.9 W	S 30 13 W	S 30 19 W
2	1.0	26 04.6	30 11	30 17
3	1.7	26 04.4		
4	2.7	26 04.1	30 09	30 15
5	3.7	26 03.8	30 08	30 14
6	4.4	26 03.6		
7	5.2	26 03.3	30 05	30 11
8	6.0	26 03.1	30 04	30 10
9	6.9	26 02.8	30 04	30 10
10	7.7	26 02.5	30 01	30 07
11	7.85	26 02.5		
12	8.8	26 02.2		
13	9.8	26 01.9	29 57	30 03
14	10.6	26 01.6	29 57	30 03
15	11.0	26 01.5	29 56	30 02
16	12.0	26 01.2		
17	12.9	26 01.0		
18	13.25	26 00.8	29 55	30 01
19	13.5	26 00.7	29 55	30 01
20	14.1	26 00.6		
21	14.6	26 00.4	29 52	29 58
22	15.65	26 00.1		
23	16.75	25 59.7	29 48	29 54
24	17.4	25 59.5	29 47	29 53
25	18.1	25 59.3		
26	18.6	25 59.1	29 39	29 45
27	18.6	25 59.1	S 29 06 W	S 29 12 W

[1] Note that the number is not marked on stone, but refers to designation as given in "Location of Mounds."

[2] 1898.5 and 1900.5 stand, respectively, for middle of year. To get magnetic bearings for subsequent years, add a correction at the rate of 3′ per annum. It should be noted that the given quantities are the mean values for the day. To obtain the bearing at any time of the day, apply the corrections given in table below with the sign as affixed.

Month.	6 A.M.	7	8	9	10	11	Noon.	1	2	3	4	5	6 P.M.
	′	′	′	′	′	′	′	′	′	′	′	′	′
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

For example, wanted the magnetic bearing at Mound 5 in June, 1899, at 8.30 a. m.

Magnetic bearing as given by the table in 1898½, S 30° 08′ W

Secular change for one year..... +03

Correction to reduce to 8.30 a. m..... −04

Magnetic bearing in 1899½ at 8.30 a. m. 30° 07′

Miscellaneous Field Notes.

Fire Clay Hill, Union Mining Company's land.—"Boundary line crosses plane about 250 feet above stable." (Brown.)

Roaring Hill, Borden Mining Company's land.—"Boundary line cuts across porch of house occupied by John Workman, leaving most of it in Garrett county." (Brown.)

National Road.—"Boundary line is about 200 feet east of old Frostburg reservoir, and about 19 yards west from center of iron posts marking site of old toll-gate." (Brown.)

Carlos.—Boundary line passes east of William Filer's house.

Chisholm's line, as pointed out to us, is west of true boundary line, 4307 feet at Mason and Dixon line, 30 feet on Koontz mine hill, at point $\frac{1}{4}$ mile north of mound 13, 696 feet on hill west of Lonaconing, at point 294 feet north of mound 15, 345 feet at county road north of Franklin hill at mound 23, 32 feet on Franklin hill at point 78 feet south of mound 25, and east of true boundary line 123 feet along road to Bloomington at mound 26.

Azimuth of Observations.—For the purpose of determining the azimuth or bearing of the boundary line, the following determinations of the azimuth of the north end of McKenzie base (the station *A* on the sketch showing main triangulation) at the triangulation station on Big Savage mountain:

Date, 1898.	Azimuth.	Remarks.
July 20, p. m.	66° 23′. 8	Two sets solar azimuth observations with 4-in. theodolite.
Aug. 3, a. m.	66 24 . 4	" " " " " " "
Mean	66 24.10	
Aug. 26,	66 24.07	One set, Polaris near eastern elongation with 8-in. theodolite; rain prevented obtaining further results.
Adopted,	66° 24′.07	

Weather.—The very large proportion of cloudy days and nights during the brief time that we were in the field prevented our getting additional azimuth observations. When at last fair weather set in, the appropriation had been exhausted, further field work had to be abandoned, and so we had to leave undone many things that would have been desirable. Thus, for example, at several places it would

have been well to clear out the line a little better. A comparatively small additional appropriation would have sufficed to have cleared out the entire line while we were in the field. Then, again, with the aid of the triangulation stations, the horizontal distances between the various mounds might have been determined with great accuracy could we have spent a few days in the field. This would have been of great benefit in referring land surveys made in the vicinity of the line to established mounds whose positions would be so accurately known that they could always be precisely recovered when lost.

Length of Boundary Line.

With the aid of the final data referring to the triangulation stations of the U. S. Geological Survey as given on page 117, the length of the boundary line from mound 1, on the Mason and Dixon line to the bolt near the mouth of the Savage river is found to be 98,230 feet.

Since the "middle of the mouth of the Savage river where it empties into the Potomac" is 28 feet from the bolt (see p. 125 and sketch p. 123), the total length of this portion of the boundary line is 98,258[1] feet = 18.61 miles.

The length of the boundary line from the "middle of the mouth" to the terminal point as stated on p. 126, is 121½ feet.

Azimuth of Boundary Line Between Mound 1 and "Middle of Mouth of Savage River."

From astronomical observations (mainly solar-azimuth observations, see p. 139) we obtain for the azimuth of the boundary line at the initial point (mound 1)

S 26° 05′.12 W.

From the geodetic data on p. 117 we get

S 26° 04′.73 W.

Adopted . . . . S 26° 04′.92 W.

[1] An approximate check upon this value is obtained with the aid of the small McKenzie base (AB of Fig. 9), viz.: 98,365 feet.

At the middle of the mouth of the Savage river the bearing of this portion of the boundary line would be 5′.85 less than at mound 1, hence:

N 25° 59′.07 E.

[As an approximate check upon the bearing of the line at the "Mouth," we have the following value as dependent upon two sets of solar-azimuth observations, with 4 inch theodolite, at station Daniels, viz: N 26° 00′.0 E.]

Latitudes and Longitudes.

Starting with the geodetic latitude and longitude of triangulation station "Sampson" as given on p. 117 and knowing the distance and bearing of the initial point of the line from "Sampson," and likewise knowing the distance and bearing of middle of mouth from mound 1 as above given, we get the following *geodetic* latitudes and longitudes:

	Latitude.	Longitude.
Initial Point [1](Mound 1)	39° 43′ 22″	78° 54′ 50″
"Middle of Mouth"	39 28 50	79 04 01

Note.—The foregoing report gives abundant evidence of the very effective and valuable assistance rendered by Surveyors Beall and Brown. I desire to express here my warm appreciation of the zeal and enthusiasm shown by them and in fact by all assisting in the work. The successful issue of the survey and the expedition with which it was accomplished under most adverse circumstances are in a very large degree due to my associates.

L. A. Bauer.

Office of
Maryland Geological Survey,
Baltimore, April 4, 1903.

[1] This point being on the Mason and Dixon line, we have a check upon the latitude above given from the *astronomical* determinations made by Mr. C. H. Sinclair, assistant in the Coast and Geodetic Survey, in 1883, at "Maryland Corner" (Michler Monument, on the Mason and Dixon line), who obtained 39° 43′ 18.0″. The difference between this value and the one given above may be partly due to local deflections of the plumb line and partly due to deviations of the state boundary from a true east and west line.

MARYLAND GEOLOGICAL SURVEY.

WM. BULLOCK CLARK, STATE GEOLOGIST.

FINAL REPORT

ON THE

SURVEY OF THE BOUNDARY LINE

BETWEEN

ALLEGANY AND GARRETT COUNTIES

In Accordance with an Act Passed by
THE GENERAL ASSEMBLY OF 1898.
(LAWS OF MARYLAND, 1898, CHAPTER 304.)

BY

L. A. BAUER
Chief of Party.

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