OBSERVATIONS

ON

TERRESTRIAL MAGNETISM.

BY

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ACCEPTED FOR PUBLICATION

BY THE SMITHSONIAN INSTITUTION,

JULY, 1851.

COMMISSION

TO WHICH THIS PAPER HAS BEEN REFERRED.

Prof. Elias Loomis,
Julius E. Hilgard, Esq.

Joseph Henry,
Secretary S. I.

OBSERVATIONS

MADE IN THE

YEARS 1845, '46, AND '47, TO DETERMINE THE MAGNETICAL DIP AND DECLINATION, AND INTENSITY OF MAGNETICAL FORCE IN SEVERAL PARTS OF THE UNITED STATES.

THE Observations here recorded form part of a series commenced in 1838, and continued annually for ten years. The results, from 1838 to 1844, inclusive, were published, in 1846, in the "Transactions of the American Philosophical Society."

The first paper on the subject, read to that Society April 19, 1844, is prefaced by some popular definitions of the elements of terrestrial magnetism, and by an account of the instruments used in making the observations. To this preface the reader is referred for the proper beginning of the subject to which the present pages form a continuation. But as my researches have since been, to a considerable extent, incorporated by Col. Sabine in his "Contributions to Terrestrial Magnetism," they have received additional value and interest by being now connected with other labors of the same kind throughout the enlightened world. It seems, therefore, not improper to quote so much of that paper as may show the degree of confidence to be placed in my results, and the basis upon which rests their connection with similar observations in this and other countries.

Corresponding Observations.—It so happened that Capt. Lefroy, R. A., in his magnetic researches, chiefly confined to the British Provinces of North America, made observations at several stations which were, unknowingly, occupied by myself, either before or after him. They were made with different instruments, and at different temperatures, and could be compared only after proper corrections and reductions. We both communicated our observations, independently of each other, to Col. Sabine, who reduced and compared them with very satisfactory results as regards their correspondence and the mutual support which they afford to each other. I copy the following from Col. Sabine's "Contributions to Terrestrial Magnetism," published in the "Philosophical Transactions" for 1846.

"*Total Intensity as observed by* Capt. LEFROY *and* Dr. LOCKE, *at Stations nearly identical.*

Station.	Observer.	Mag. force.	Observer.	Mag. force.
Detroit	LEFROY	1.814	LOCKE	1.815
Toronto	LEFROY	1.836	LOCKE	1.836
Princeton	LEFROY	1.783	LOCKE	1.783
Albany	LEFROY	1.797	LOCKE	1.792
New York	LEFROY	1.769	LOCKE	1.781
New Haven	LEFROY	1.773	LOCKE	1.773
Cambridge	LEFROY	1.777	LOCKE	1.774
Washington[1]	LEFROY	1.772	LOCKE	1.773
Washington[2]	LEFROY	1.778	LOCKE	1.800
Baltimore	LEFROY	1.782	LOCKE	1.784

[1] Grounds of the Capitol. [2] Magnetic Observatory.

At several of the above places, the stations were not strictly identical; and it may be seen, from the results at Washington, what changes are often produced by a very short distance, such as from the Capitol to the Observatory; still, even here, Capt. Lefroy's results and my own both confirm the fact that the difference exists. It will be seen, also, that there is a discrepancy of 0.011 between us at New York, and likewise one of 0.009 at Philadelphia; but even that amount of difference will be found by the same observer, with the same instruments, at different times, in an identical locality.

Reduction of my Observations to the Arbitrary Scale most commonly used.—In the following tables, I have assumed the terrestrial magnetism at Longworth's Garden, in Cincinnati, as a provisional standard of comparison, or a base of all of my observations. It was, therefore, important that this standard or base should be strictly compared with other bases more generally connected and compared; and it was with this view that, at the request of Col. Sabine, I made observations at Toronto the base of the British observations in North America.

Col. Sabine has made the comparison as extensively as possible from the observations of Capt. Lefroy and myself; and his conclusions are quoted below, from the paper to which I have already referred, p. 313.

"Collecting into one view the results of the three comparisons, we have—

"1. By the direct comparison of the horizontal force at Cincinnati and Toronto, by Dr. Locke, 1.795.[1]

"2. By three intermediate stations, at which the ratios of the horizontal force were determined by Dr. Locke to the force at Cincinnati, and by Capt. Lefroy to the force at Toronto, 1.794.

"3. By six intermediate stations at which the ratios of the horizontal force were determined to the force at Cincinnati by Dr. Locke, and the ratios of the total force to its value at Toronto by Capt. Lefroy, 1.796.

"The total force at Cincinnati, the base station of Dr. Locke's survey, has, therefore, been taken at 1.795."

Hence, to reduce the total intensity at any station named in my paper to the comparative or "arbitrary scale," it is only necessary to apply the following simple equation—

$$x = \frac{1.795\, a}{1000},$$

in which $a =$ the tabulated total intensity at any station in my papers, and $x =$ the arbitrary or comparative quantity sought.

Explanation of the following Tables.—At the head of each is placed the date, the name of the place, the latitude and the longitude, either from the best observations or from the most approved maps—Tanner's being, for the most part, preferred. In the Iowa and Wisconsin region, Jackson's map was used, and in the region of Lake Superior, Capt. Bayfield's, as published by the Society for the Promotion of Useful Knowledge. In regions where nothing better was available, I have reduced the United States surveys, made by chain-measuring in the woods, to an approximate

[1] Total force at Cincinnati.

geodetic latitude and longitude. This I have done, especially in the upper peninsula of Michigan, taking the Sault St. Mary as the starting-point. But these latitudes and longitudes are, at best, only approximate.

The tabulated results are given in ten columns. In the first, is placed the dip o inclination, and sometimes, also, the variation or declination; in the second, th number designating the intensity needle; in the third, the epoch of commencing o vibrations of the intensity needles; in the fourth, the duration of 500 vibrations in the fifth, the mean temperature, as indicated by the interior thermometer; i the sixth, the calculated duration of 500 vibrations, at the standard temperature o 60° F.; in the seventh, the square of the number found in the sixth; in the eighth the horizontal intensity, that at Cincinnati, at some specified time, being reckone 1000; in the ninth, the total intensity of force in terms of the above-named hori zontal intensity at Cincinnati; in the tenth, the total intensity of force, that a Cincinnati being 1000.

VIII. Series for 1845.—Cincinnati to the White Mountains.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that a Cincinnati = 1000.
136. **Cincinnati, Ohio**.—Lat. 39° 06′. Long. 84° 22′ W. April 23, 1845.									
70° 26′	4	11 27 5.4 P	1112	81.5	1110.45	12330992025			
Var. 4 4 E.	5	4 58 03.8	1349.4	82	1347.32	18152711824			
	6	5 28 02.4	1344.4	80.5	1341.97	18008834809	1000	2986.0	1000
137. **Marietta, Ohio.**—Lat. 39° 26′ N. Long. 81° 29′ W. April 28, 1845.									
71° 22′ 15″	4	1 52 57.6 P	1136.4	83.5	1134.66	12874533150	957.76		
Var. 2 25 E.	5	12 22 03.6	1380.4	84.5	1378.03	18989666809	955.46		
	6	12 53 00.8	1378.8	85.5	1375.71	18957709969			
						Mean	956.61	2994	1002.50
138. Near **Marietta**—On a hill below the Muskingum River. April 28, 1845.									
71° 23′ 02″	5	6 00 04 P	1384	82.5	1381.82	19094265124	950.69	2982	999.87
Var. 2 25 E.									

REMARKS.

136. Cincinnati, Ohio.—Geology as heretofore described.

137. Marietta, Ohio.—The above observations were made on Marietta Island. Soil alluvium, under laid at unknown depths by the rocks of the coal-formation, sandstone, shale, &c.

138. Near Marietta—Geology: rocks of the coal-formation. Clear.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
139. **Wheeling Hill, Va.**—Lat. 40° 08′ N. Long. 80° 47′ W. April 30, 1845.									
72° 13′ 45″	4	3 52 56.6 P	1159.6	78.0	1156.25	13369140625	922.3		
Var. 2 04 E.	5	4 21 04.0	1408.8	79.0	1406.80	19793113344	917.1		
	6	4 51 00.4	1404.4	78.0	1402.63	19673709169	915.1		
						Mean	918.2	3007	1007
140. **Pittsburg, Pa.**—Lat. 40° 26′ N. Long. 79° 58′ W. May 3, 1845.									
72° 46′ 45″	4	4 02 57.6 P	1178.0	74.0	1176.93	13851642249	890.2		
Var. 0 33 04 W.	5	4 29 00.8	1432.0	72.0	1430.80	20471886400	886.7		
	6	5 13 00.8	1428.8	71.5	1427.35	20373280225	883.9		
						Mean	886.9	2993.7	1003.4
141. **Alleghany Summit, Pa.**—Lat. 40° 27′ N. Long. 78° 10′ W. May 5, 1845.									
72° 27′ 05″	5	11 43 04.4 A	1418.4	58	1418.3	20115748900	902.41		
	6	12 43 04.0 P	1412.4	60	1412.4	19948737600	902.75		
						Mean	902.58	2993.2	1002.5
142. **Cambridge, Mass.**—Lat. 42° 22′ 15″. Long. 71° 7′ 21″. June 2, 1845.									
74° 19′ 26″	4	2 58 20 P	1244.0	87.0	1242.7	15443032900	798.48		
Var. 9 32 00 W.	5	3 34 00.8	1612.0	87.0	1509.15	22775337225	797.03		
	6	4 07 04.0	1508.4	87.0	1504.8	22644230400	790.87		
						Mean	795.46	2944.1	985.99
143. **Portland, Maine.**—Lat. 43° 41′ N. Long. 70° 20′ 30″. June 4, 1845.									
75° 13′ 10″	4	5 11 01.8 P	1277.2	79.5	1275.5	16269002500	755.95		
Var. 11 28 20 W.									
Portland Maine.—F. O. J. Smith. June 5, 1845.									
	5	12 59 00.0 P	1555.6	82.0	1553.2	24123302400	752.47		
	6	1 31 01.2	1548.0	82.0	1545.0	23870250000	754.44		
						Mean	753.46	2955.0	989.66

REMARKS.

139. Wheeling Hill, Va.—On the hill, immediately back of the town. Geology: sandstone and shales of the coal-formation. Cloudy, threatening to rain.

140. Pittsburg, Pa.—Locality: "Whale's back." Geology: a hill of shale belonging to the coal-formation.

141. Alleghany Summit, Pa.—Geology: sandstone and shale of the coal-formation.

142. Cambridge, Mass.—Within the new magnetical observatory of Harvard University, about one mile northwardly from the locality of the experiments of 1841. Geology: deep diluvium, superimposed on gneiss rocks.

143. Portland, Maine.—Geology: gneiss rock, traversed by veins of granite. Soil thin and wet. Clear, with some very slight showers.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
144. **Locke's Mills, Maine.**—Lat. 44° 23′ 34″ N. Long. 70° 44′ W. June 15, 1845.									
75° 50′ 40″	4	3 50 02.4 P	1302.4	77.5	1300.92	16923928464	728.60		
Var. 12 08 00 W.	5	5 23 01.6	1583.2	71.0	1582.00	25027240000	725.32		
	6	4 48 01.2	1577.2	74.0	1575.26	24814440676	725.74		
						Mean	726.55	2970.9	994.96
145. **Charles R. Locke's, in Bethel, Maine.**—Lat. 44° 27′ 46″ N. Long. 70° 51′ W. June 10, 1845.									
75° 51′ Var. 11 50 W.	4	5 11 05.2 P	1304.0	85.0	1302.00	16952040000	727.40	2975.5	996.51
146. **Gorham, N. H.**—Lat. 44° 27′ N. Long. 71° 13′ W. June 17, 1845.									
75° 33′ 25″	4	7 55 02.4 A	1278.4	65.0	1278.00	16568323524	744.24	2983.9	999.32
147. **Mount Washington, White Mountains.**—Lat. 44° 16′ 34″ Long. 71° 19′. June 18, 1845.									
75° 45′	5	4 14 03.2 P	1577.2	46.0	1579.14	24936831396	728.66	2960.0	991.5
	0	4 50 00.0	1572.4	44.0	1574.18				
148. **Camp on Mount Washington,** about one mile westwardly from the summit. June 19, 1845.									
75° 50′ 49″	5	2 44 01.2 P	1578.8	69.7	1577.73	24892319529	729.25	2981.6	998.66
149. **Fabyan's Hotel,** seven miles west of Mount Washington.—Lat. 44° 16′ 15″ N. Long. 71° 29′ W. June 20, 1845.									
75° 39′ 54″	4	7 55 02.0 A	1298.0	70.0	1297.15	16825981225	732.85		
Var. 11 32 00 W.	5	9 00 04.8	1573.2	68.0	1572.09	24714669681	734.46		
	6	9 32 03.2	1568.0	63.0	1567.60	24573697600	732.85		
						Mean	733.39	2960.3	991.41

REMARKS.

144. Locke's Mills, Maine.—Geology: deep drift, filled with large bowlders of granite and gneiss rocks, gravel, and sand, forming what is known by the name of "Pine plane." Mountains in the neighborhood, gneiss and granite, from 2000 to 3000 feet high.

145. Charles R. Locke's, in Bethel, Maine.—Geology: on the fertile alluvion of Sunday River; gneiss and granite at unknown depths, and in the adjacent hills and mountains.

146. Gorham, N. H.—Locality: at the bend of the Androscoggin, and near to the White Mountains. Geology: a mass of small bowlders and gravel; gneiss and gravel below.

147. Mount Washington, White Mountains.—Geology: gneiss rock, broken at the surface into a pile of huge angular masses, but solid and in place below.

148. Camp on Mount Washington.—Geology: gneiss rock of Mount Washington.

149. Fabyan's Hotel.—Geology: alluvion of the Amonoosuc River.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
150. **Montpelier, Vt.**—Lat. 44° 17′ N. Long. 72° 36′ W. June 25, 1845.									
75° 16′ 15″	5	9 27 08 A	1549.6	60.0	1549.60	24012601600	755.96		
	6	11 04 52	1547.0	58.0	1547.40	23944467600	752.11		
						Mean	754.03	2965.8	998.10
151. **Burlington, Vt.**—Lat. 44° 27′ N. Long. 73° 10′ W. June 26, 1845.									
75° 37′	5	10 51 05 A	1560.0	70.00	1559.00	24304810000	746.90		
Var. 9 22 W.	6	12 28 02 P	1556.0	74.75	1554.40	24161593600	745.30		
						Mean	746.10	2999.6	1003.5
152. **Columbus, Ohio.**—Lat. 39° 57′ N. Long. 83° 03′ W. July 19, 1845.									
71° 04′ 15″	5	6 37 01.2 P	1375.0	79.0	1371.37	18806556760	965.23		
Var. 2 29 21 E.	6	7 06 00.2	1368.8	74.5	1367.05	18682570250	963.64		
						Mean	964.43		995.66
153. **Cincinnati, Ohio.**—Lat. 39° 06′ N. Long. 84° 22′ W. August 12, 1845.									
70° 29′ 27″	5	12 59 00.0	1350.4	79.5	1348.56	18186140736	1000		
	6	1 33 03.6	1346.8	81.0	1344.31	18071693761	1000	2993.2	1000
154. **Oxford, Ohio.**—Lat. 39° 30′ 15″ N. Long. 84° 38′ W. August 29, 1845.									
71° 10′	5	5 28 58 P	1366.0	74.50	1364.62	18621877444	974.80		
Var. 4 50 E.	6	6 04 00.8	1363.0	73.00	1361.44	18535188730	971.60		
						Mean	973.20	3005.9	1005.6
155. **Richmond, Ia.**—Lat. 39° 49′ N. Long. 84° 47′ W. September 1, 1845.									
71° 20′ 20″	4	11 03 00.8 A	1136.4	94.00	1133.90	12857292100	959.06		
Var. 4 52 00 E.	5	2 01 40.4 P	1380.0	89.00	1377.20	18966798400	957.08		
	6	1 30 00.0 P	1376.4	92.00	1372.53	1883838609	955.96		
						Mean	957.37	2992.1	1002.00

REMARKS.

150. Montpelier, Vt.—Geology: talcose slate, highly inclined. Local attraction evident at the state-house.

151. Burlington, Vt.—Geology: limestone.

152. Columbus, Ohio.—Geology (upper silurian?): cliff limestone, horizontally stratified.

153. Cincinnati, Ohio.—The above observation will give a higher intensity at Cincinnati than was indicated April 23, and this I attribute to an error in the dip, which was taken by a needle known to be imperfect. Compared with the observation of April 23 as 1000, it equals 1002.3.

154. Oxford, Ohio.—Geology: blue limestone or lower silurian. Showers; some small rain during observations.

155. Richmond, Ia.—Done in the garden of Dr. Plummer. A blanket was stretched, to screen the apparatus from the sun; but it radiated heat so much as to raise the temperature above the surrounding medium. Geology: upper part of the blue limestone (lower silurian); horizontally-stratified rocks eight or ten feet below the surface. Clear, but with a disposition to showers.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
156. **St. Mary's, Ohio.**—Lat. 40° 32′ N. Long. 84° 19′ W. September 5, 1845.									
72° 00′ 20″	4	1 50 00.0 P	1153.0	78.0	1151.06	13249391236	923.14		
Var. 3 04 00 E.	5	2 28 03.0	1400.8	77.0	1399.03	19592849409	926.50		
	6	3 02 00.2	1396.2	78.0	1394.00	19432360000	923.14		
						Mean	925.45	3002.6	1005.6
157. **Carrolton, Ohio.**—Lat. 39° 38′ N. Long. 84° 09′ W. September 8, 1845.									
71° 10′ 00″ Var. 4 45 27 E.	4	4 40 02.4	1130.8	75.25	1129.68	12761769024	966.25	2993.2	1002.4

REMARKS.

156. St. Mary's, Ohio.—Geology: deep diluvium of clay, sand, and gravel, superimposed on the cliff limestone, or upper silurian rocks.

157. Carrolton, Ohio.—Geology: blue limestone of Cincinnati; lower silurian.

IX. Series for 1846.—Made in the Service of the United States Coast Survey.

The following observations have been reported by me to Prof. A. D. Bache, the Superintendent of the Coast Survey, and they are the property of that department of our government. But, by the special permission of the Secretary, procured by the kindness of Prof. Bache, I am permitted to publish them here, in order to complete my series. The following tables do not, however, include all of the observations made by me for that survey, the results of the experiments with Lieut. Riddell's apparatus to determine absolute horizontal intensity of magnetic force being omitted. These results will appear in the course of the publications of the Coast Survey.

The *latitudes* and *longitudes* are in part those which have been determined by the Coast Survey. In other cases, they have been fixed by approximate admeasurements from the survey stations, and are probably correct within a small fraction of a mile. Those which are most doubtful, I have marked with the sign (?).

The *dips* or *inclinations* were determined by the same dip-circle heretofore used by me, but the needles had been recently repaired, and, unfortunately, gave unsatisfactory results. An expedient was, however, resorted to, which, especially in the last part of the series, enabled me to obtain a very close approximation to the true inclination. A particular account of this expedient will be given in this paper. (See article "Fort Delaware.")

The *declination* or "*variation*" was in all cases determined with the utmost care, as being of the greatest practical importance in forming the charts of the Coast Survey. The apparatus used for this purpose was the portable declinometer described by Lieut. Riddell, consisting of a tubular magnet, mounted and suspended as a collimator, and read by a theodolite telescope. The instruments at each station were mounted under a tent, with all necessary precautions of removing every iron or steel article, and adjusted sufficiently early in the day to begin with the maximum or eastern declination, and continue the readings, at least as often as every half hour, say from 8 A. M. until the minimum or extreme western reading in the afternoon about 2 P. M. Finally, after making the proper equations for the error of the theodolite, and for that of the zero of the scale of the collimator, the mean of the declination for the day has been tabulated as in the following paper. The azimuths, and, of course, the true meridian to which these declinations have been referred, are, in most cases, those of the Coast Survey, determined by intervisible stations, and accurate within ten seconds of space. In some few cases, where such azimuths could not be obtained, the meridian was determined by altitudes and azimuths of the sun, observed at the time by means of the theodolite.

The *intensity of magnetic force* has been determined, as heretofore, by oscillating three Hansteenian needles in the exhausted receiver invented by Prof. Bache. As my dip-needles were gone at the time, I could not make my usual comparative observations at Cincinnati, including the element of the dip.

Under these circumstances, I have compared the following series with Cincinnati, through observations previously made at Mrs. Morris's garden, at Washington Place, in Newark, N. J. By means of the observations made there in April 29, 1844, the dip at Cincinnati was calculated to be 70° 24′, which, although less by from 1′ to 3′ than has been usually observed, has still been found to be consistent with the observations previously made at Bloomingdale Asylum and at Girard College.

TABULATED RESULTS OF SERIES IX.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
158. **Finley's Station**, about 10 miles from Baltimore.—Lat. —° —′ —″ N. Long. —° —′ W. April 13, 1846.									
71° 46′ 50″	4	11 27 01.2 A	1157.6	50.25	1158.37	13418210569	914.05		
Var. 2 19 30 W.	5	10 44 01.2	1406.8	49.00	1407.88	19821260944	917.50		
	6	9 40 04.4	1401.2	48.00	1402.68	19675111824	918.50		
						Mean	916.69	2931.96	983.00
159. **Bloomingdale Asylum, N. Y.**—Lat. 40° 49′? N. Long. —° —′ W. April 27, 1846.									
72° 38′ 17″	4	10 46 01.2 A	1183.4	66.00	1182.94	13993470436	880.67		
Var. 5 12 27 W.	5	11 13 59.8	1436.0	66.50	1435.45	20605167025	882.60		
	6	12 47 00.2 P	1430.8	68.50	1429.73	20441278729	884.08		
						Mean	882.45	2957.20	992.00

REMARKS.

158. Finley's Station.—Geology primitive. Soil abounding with metamorphic small bowlders and pebbles, white, yellow, and brown, apparently not magnetic.

159. Bloomingdale Asylum, N. Y.—Geology primitive; prismatic gneiss rock, underlaying the soil, some trappean bowlders, but none near the instruments.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
160. Mount Prospect Station.—Lat. 40° 40′ 13″ N. Long. 74° 00′ 43″ W. May 5, 1846.									
72° 27′ 33″	4	12 23 02.8 P	1177.2	82.0	1175.52	13818472704	891.83		
Var. 5 54 04 W.	5	12 52 59.2	1430.4	81.5	1428.25	20398980625	891.52		
	6	1 24 01.6	1422.8	83.5	1419.92	20159658064	896.43		
						Mean	893.26	2963.85	994.22
161. Coles's Station, Staten Island.—Lat. 40° 31′ 50″ N. Long. 74° 16′ 50″ W. May 11, 1846.									
72° 36′ 03″	4	2 03 00.0 P	1179.2	54.5	1179.62	13915033444	885.64		
Var. 5 37 36 W.	5	3 16 01.2	1430.8	53.5	1431.45	20490491025	887.54		
	6	4 01 03.8	1426.6	52.0	1427.60	20380417600	886.72		
						Mean	886.63	2965.1	994.63
162. Newark, N. J.—Lat. 40° 44′ 49″? N. Long. 74° 10′ 00″? W. May 16, 1846.									
72° [illegible]0′ 30″	4	7 59 00.0 A	1189.2	68.25	1188.56	14126748736	872.36		
Var. 5 32 42 W.	5	8 29 59.8	1444.4	69.00	1443.49	20836633801	872.79		
	6	8 57 59.6	1440.4	69.80	1439.16	20711815056	872.53		
						Mean	872.56	2957.70	992.17
163. White Hill, N. J. (near Bordentown).—Lat. 40° 08′ 17″ N. Long. 74° 46′ 47″ W. May 20, 1846.									
72° 06′ 14″	4	11 04 01.2 A	1158.8	66.0	1158.35	13417[illegible]47225	918.46		
Var. 4 22 28 W.	5	11 38 02.8	1412.4	65.0	1411.91	19934[illegible]98481	912.27		
	6	6 18 02.0 P	1407.6	68.8	1406.73	19788[illegible]92929	913 22		
						Mean	914.65	2976.5	998.46

REMARKS.

160. Mount Prospect Station.—Geology: a hill of sand and gravel, which commences at this point and extends interiorly into Long Island. The sand and gravel abound with small trappean and granitic bowlders.

161. Coles's Station, Staten Island.—Locality: the dip and intensity, by the Hansteenian needles, were taken in a grove about one-third of a mile northwardly from the station. Geology: the drifted materials of this neighborhood abounding with primitive and trappean gravel, and bowlders. The declination was taken precisely at the survey station, as indicated by latitude and longitude above.

162. Newark, N. J.—Geology: alluvial soil, sand and gravel superimposed on the new red sandstone in place. Had been some rain and wind.

163. White Hill, N. J. (near Bordentown).—At the station immediately on the bank of the Delaware. Geology: the tertiary marls of New Jersey.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
164. White Hill, Woodland Station, about half a mile east of the Survey Station.—Lat. 40° 08′ 17″? N. Long. 74° 46′ 46″? W. May 21, 1846.									
72° 01′ 23″	4	8 12 01.2 A	1163.2	66.0	1162.82	13521503524	911.41		
	5	8 43 00.8	1415.2	65.5	1414.80	20016590400	908.55		
	6	9 14 01.2	1410.4	67.0	1409.55	19868311025	909.57		
						Mean	909.84	2947.4	988.61
165. Girard College, Philad.—Lat. 39° 58′ 21″ N. Long. 75° 12′ 57″ W. May 23, 1846.									
72° 00′ 58″	4	9 02 00.0 A	1163.6	79.5	1162.13	13505461369	912.49		
Var. 3 50 44 W.	5	9 34 32.0	1414.4	84.0	1412 66	19956082756	911.31		
	6	10 13 02.8	1408.4	78.0	1406.63	19785079569	913.30		
						Mean	912.37	2955.1	991.31
166. Wilmington.—Lat. 39° 44′ 53″ N. Long. 75° 36′ 39″ W. May 29, 1846.									
71° 24′ 39″	4	8 06 01.6 A	1149.8	61.0	1149.73	13202010000	933.47		
Var. 2 31 46 W.	5	2 02 59.6 P	1396.8	68.0	1396.02	19488718404	933.16		
	6	2 38 04.0	1392.4	68.5	1391.36	19358826496	933.51		
						Mean	933.38	2931.85	983.50
167. Smith's Quarry, near Wilmington.—May 31, 1846.									
74° 11′ 41″ !	4	1 49 03.2	1246.8	81.5	1246.00	15500250000	795.06	2912.3	976.95

REMARKS.

164. White Hill, Woodland Station.—Geology: same as above. Day exceedingly clear, calm, and fine. The mean of these two observations corresponds very well with surrounding observations, as follows:—

Dip,	72° 03′ 48″.
Horizontal intensity,	912.25.
Total intensity,	993.51.

165. Girard College, Philad.—At the usual locality in the yard of the Magnetical Observatory. It will be seen that the total intensity above is less than I have formerly made it to be at this station. I know of no circumstance which will account for this. I bring the various observations at this locality together that they may be compared at one view.

March 30, 1841.	Total intensity at Girard College,		994.78
March 31, 1841.	"	"	994.97
April 21, 1841.	"	"	993.24
May 15, 1842.	"	"	995.48
April 19, 1844.	"	"	991.84
May 23, 1846.	"	"	921.31
		Mean,	993.60

166. Wilmington.—Geology: a hill of trap, but the rock does not show itself at the surface, being covered with red clay. Dip and intensity evidently too low for the latitude.

167. Smith's Quarry.—Geology: the rock at this place is a solid mass of lienitic trap in place. It has a fine prismatic structure, which lies horizontally, in the direction of the meridian; and in this direction it possesses permanent polarity, which it retains after being quarried—even in small hand specimens.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
168. **Brandywine River,** near Wilmington. May 31, 1846.									
67° 30′ 00″	4	11 2 00.0 A	1053.0	74.0	1052.00	11067040000	1113.54	2909.8	976.11
169. **Sawyer, Del.**—Lat. 39° 42′ 53″ N. Long. 75° 42′ 39″ W. June 3, 1846.									
71° 57′ 26″	4	11 38 20.0 A	1160.0	79.0	1158.57	13422844449	918.11		
Var. 2 47 48 W.	5	12 19 02.0 P	1410.0	83.0	1407.73	19817037529	917.70		
	6	12 49 02.4	1404.0	84.5	1401.00	19630251664	920.60		
						Mean	918.80	2966.50	995.11
170. **Church Landing, N. J.**—Lat. 39° 40′ 56″ N. Long. 75° 33′ 23″ W. June 6, 1846.									
71° 23′ 58″	4	11 05 01.2 A	1142.0	83.0	1140.30	13002840900	947.76		
Var. 5 45 47 W.	5	11 37 17.0	1386.8	81.5	1384.71	19174217841	948.46		
	6	1 03 01.2 P	1382.0	82.5	1379.26	19023581476	949.96		
						Mean	948.73	2969.66	996.06

REMARKS.

So strong is this polarity in a specimen procured near the Wilmington station, that I was enabled, by a dexterous application of it towards the suspended dipping-needle, to bring that needle into an oscillation through more than half a circle. This specimen was found to contain small grains of black oxide of iron similar to those which constitute "black magnetic sand."

From Wilmington, I addressed a note to the Amer. Phil. Society, on the subject of the effects of magnetic iron sand in the trappean rocks. Indeed, the trappean rocks, so far as I have observed, seem to be the source and fountain of this sand. I found it abundant at the foot of the hills about Wilmington, where it had evidently washed down from the disintegrated trappean rocks forming the elevations. It abounds in the trap-rocks of Lake Superior, and can be gathered on all of the great lakes below, even upon the south shore of Lake Erie. The diluvial drift along the Ohio River contains it, and, after a shower, it can be collected by a magnet from the rain trenches formed in the fine sand. Dr. Jackson found that when the trap-rocks were smelted to procure copper which they contained, a button of pure iron was not unfrequently found as a result. The black magnetic sand, distributed from Lake Superior to Cincinnati, is accompanied by a garnet sand of a deep brown color and with translucent particles.

168. Brandywine River.—Locality: in a deep recess, almost a cavern, in the trap-rocks near the water's edge, about one-third of a mile above Riddle's Mill. This locality is not more than a half mile distant from "Smith's Quarry," and not over two miles from the Wilmington signal. Geology: the same as at Smith's Quarry. A strong local influence is here evinced by the extraordinary difference of the dip. Still, the law that I have heretofore alluded to is observed, viz., an increased dip at trappean pinnacles (Smith's Quarry), and a diminished dip at the base (Brandywine River). This is the most extreme case of the kind, the difference of dip being 6° 41′ 41″ in a distance of half a mile.

169. Sawyer, Del.—Geology: at the edge of the tertiary. No rocks or bowlders apparent.

170. Church Landing, N. J.—Geology: tertiary sands of New Jersey. No rocks; nothing especially magnetic apparent; still, there are local influences, for the declination is extraordinary, and, by partial trials at three localities, distant each about half of a mile, it was found to vary about 1°. From this, I infer that the magnetic rocks of Wilmington extend a moderate depth under the tertiary deposits at this place.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
171. **Fort Delaware, Pea-patch Island.**—Lat. 39° 38′ 16″ N. Long. 75° 36′ 52″ W. June 14, 1846.									
71° 33′ 42″	4	7 35 28.0 A	1152.0	88.5	1150.80	13243406400	930.55		
Var. 3 13 09 W.	5	8 40 32.4	1402.8	89.0	1399.90	19597200100	928.00		
	6	9 21 02.4	1396.0	88.0	1393.56	19420094736	930.56		
						Mean	929.70	2939.45	986.04

REMARKS.

171. Fort Delaware, Pea-patch Island.—Geology: Alluvial mud, at least 70 feet deep. Water diked out, and the experiments made at a point lower than high-water mark.

Remarks on a New Method of ascertaining the Magnetic Inclination.—It occurred to me at this place, as the needles had performed consistently at White Hill and at Girard College, where the dip is about 72°, that, at all places where the dip is less than 72°, the dip-circle might be turned in azimuth so much that the readings should always be near to 72°, and then use might be made of such points of the needle-pivots as had been proved to be good. I accordingly calculated a table, by which, when the approximate dip, by direct experiment in the magnetic meridian, had been ascertained, the azimuth in which the dip would be 72°, was given. This was afterwards applied in the following manner: Having ascertained the approximate dip by direct observation, the azimuth was set off as above, say eastwardly, and a reading noted; the dip-circle was then turned in azimuth to the magnetic meridian, where a second reading was noted; and, finally, it was turned in azimuth westwardly, equal to the first eastward azimuth, where a third reading was noted. This was repeated through all of the usual eight reversals and readings, thus producing three columns in the field-book, two in equal azimuth east and west, and one in the meridian. The mean of the readings in azimuth was then reduced by the ratio—

cos. az. : R : : *cot.* dip in az. : *cot.* dip in meridian.

The following is an example:—

DIP AT PORT NORRIS.

		Needle No 2.			*Needle No.* 1.	
		11° Az. E.	0° Az.	11° Az. W.	11° Az. E.	0° Az.	11° Az. W.
A. North,	E.E.	72° 21′ 00″	72° 00′ 00″	72° 20′ 00″	71° 09′ 30″	71° 05′ 00″	71° 09′ 00″
	E.W.	71 39 00	71 28 30	71 39 00	71 05 30	70 51 00	71 05 00
	W.E.	72 15 00	71 57 00	72 11 00	71 04 30	70 45 30	71 05 30
	W.W.	71 05 00	71 48 30	72 04 30	71 00 30	70 48 30	71 04 30
B. North,	W.W.	71 53 00	71 40 00	71 57 30	72 41 00	72 16 30	72 38 30
	W.E.	71 55 30	71 45 00	71 55 30	72 33 00	72 02 00	72 34 00
	E.W.	72 04 30	71 41 30	71 58 30	72 46 00	72 29 30	72 44 30
	E.E.	72 04 30	71 45 30	72 05 30	72 44 30	72 28 30	72 42 30
Mean		72 02 04	71 40 45	72 01 02	71 53 04	71 37 34	71 53 00
				72 02 04			71 53 04

Mean of readings in Az. 72 01 33 by No. 2. Mean of reading in Az. 71 53 02 by No. 1.

Then: as *cos.* 11°	9.9919466	And: as *cos.* 11°	9.9919466
to R	10	to R	10
so *cot.* 72° 01′ 33″	9.5111100	so *cot.* 71° 53′ 02″	9.5147644
to *cot.* 71 42 42	9.5191634	to *cot.* 71 34 03	9.5228158

As the above results, from the dip in azimuth, agree very nearly with the dip direct, I have included the last in the calculation, giving a double value to the mean of the readings in azimuth, as follows:—

71° 42′ 42″	71° 34′ 03″
71 42 42	71 34 03
71 40 45	71 37 34
3)215 06 07	214 45 40
Mean 71 42 02 by No. 2.	Mean 71 35 13 by No. 1.

Finally,

By No. 2, 71° 42′ 02″
By No. 1, 71 35 13

Mean, 71 38 37 = Dip at Port Norris.

It will be observed that the letters E.E., E.W., &c., stand for the position of the face of the dip-circle and of the needle; the first letter indicating the position of the instrument, and the second that of the needle.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
172. Bombay Hook Lighthouse.—Lat. 39° 21′ 43″ N. Long. 75° 33′ 22″ W. June 17, 1846.									
71° 38′ 21″	4	9 51 00.2 A	1156.0	81.25	1154.42	13326855364	924.72		
Var. 3 17 56 W.	5	10 20 01.4	1405.2	82.00	1403.00	19684090000	923.90		
	6	10 46 44.0	1400.8	89.00	1397.23	19520116729	925.79		
						Mean	924.80	2935.87	984.84
173. Hawkins, N. J.—Lat. 39° 25′ 30″ N. Long. 72° 20′ 07″ W. June 21, 1846.									
71° 43′ 41″	4	12 55 00.6 P	1153.4	82.25	1151.73	13264819929	929.05		
Var. 2 58 43 W.	5	1 24 04.4	1400.8	86.00	1398.46	19556903716	929.90		
	6	1 53 20.0	1397.2	86.00	1394.00	19432360000	929.97		
						Mean	929.64	2965.10	994.65

REMARKS.

172. Bombay Hook Lighthouse.—Geology: tertiary of New Jersey.

173. Hawkins, N. J.—Geology: tertiary. In this neighborhood there is some ferruginous sandstone, but it is hardly magnetic.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
174. Pine Mount, N. J.—Lat. 39° 24′ 57″ N. Long. 75° 23′ 01″ W. June 20, 1846.									
71° 41′ 22″	4	12 17 16.0 P	1152.8	94.0	1150.26	13230980676	931.42		
Var. 3 12 46 W.	5	12 44 04.4	1399.0	93.0	1395.77	19481738929	933.49		
	6	1 16 02.0	1395.8	93.0	1391.75	19369680625	932.98		
						Mean	932.62	2969.79	996.19
175. Port Norris, N. J.—Lat. 39° 14′ 30″ N. Long. 75° 04′ 00″ W. June 23, 1846.									
71° 38′ 37″	4	3 26 01.2 P	1153.6	70.0	1152.85	13290631225	927.23		
Var. 3 06 28	5	3 52 02.8	1401.2	72.0	1400.02	19600360004	927.85		
	6	4 18 03.6	1398.4	71.0	1397.05	19517487025	925.92		
						Mean	927.00	2943.65	987.45
176. Egg Island Point Lighthouse, N. J.—Lat. 39° 10′ 58″ N. Long. 75° 11′ 04″ W. June 24, 1846.									
71° 44′ 31″	4	5 17 00.0 P	1155.2	76.0	1154.00	13317160000	925.39		
Var. 2 59 20 W.	5	5 40 01.2	1404.0	75.0	1402.53	19670904009	924.52		
						Mean	924.95	2952.31	990.36
177. Cape May Lighthouse, N. J.—Lat. 38° 55′ 45″ N. Long. 75° 00′ 42″ W. June 28, 1846.									
71° 25′ 01″	4	7 34 03.0 A	1148.0	73.5	1147.00	13156090000	936.72		
Var. 3 03 23 W.	5	8 06 03.2	1395.6	77.5	1393.83	19427620689	936.09		
	6	8 43 05.2	1392.4	83.0	1389.60	19309881600	935.87		
						Mean	936.23	2937.72	985.48
178. Town Bank.—Lat. 38° 58′ 33″ N. Long. 75° 00′ 09″ W. June 30, 1846.									
71° 23′ 38″	4	5 43 36.0 P	1147.2	70.50	1144.62	13142788164	930.07	2915.00	977.85
Var. 3 01 10 W.									
Lewestown Landing.									
Var. 2° 47′ 44″ W. No observation for dip or intensity made here.									

REMARKS.

174. Pine Mount, N. J.—Locality: an isolated hill between 100 and 200 feet high. Geology: tertiary. A few inches beneath the surface is a hard iron ore, but, by trial, it appears to be incapable of attracting the magnet.

175. Port Norris, N. J.—Geology: tertiary or alluvial. Non-magnetic.

176. Egg Island Point Lighthouse, N. J.—Geology: tertiary on the sand-banks of the bay shore.

177. Cape May Lighthouse, N. J.—Geology: tertiary on the drifting sands of the bay shore.

178. Town Bank.—Locality: not at the survey "station," but at Price's, near half a mile to the east of it. Geology: tertiary.

Lewestown Landing.—Locality: on the sands of the usual landing, within half a mile of Lewestown.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	[illegible] intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
179. **Pilottown, Del.**—Lat. 38° 47′ 04″ N. Long. 75° 12′ 15″ W. July 3, 1846.									
71° 16′ 16″	4	2 23 59.8 P	1144.0	82.5	1142.33	13049178289	943.94		
Var. 2 41 56	5	2 50 00.2	1390.0	78.0	1388.25	19272380625	943.64		
	6	12 13 52.0	1384.8	78.0	1382.61	19115827600	945.38		
						Mean	944.19	3140.59	986.42
180. **Chew, N. J.**[1]—Lat. 39° 49′ 21″? N. Long. 75° 12′ 57″? W. July 15, 1846.									
72° 14′ 37″	4	11 03 35.6 A	1169.2	80.0	1167.68	13632565824	903.98		
Var. 3 20 22	5	11 23 37.2	1420.8	79.5	1419.00	20135610000	903.18		
	6	1 57 02.8 P	1416.0	75.4	1414.08	19996222464	903.75		
						Mean	903.64	2962.70	993.86
181. **Vanuxem.**—Lat. 40° 05′ 46″? N. Long. 74° 47′ 00″? W. July 10, 1846.									
72° 21′ 29″	4	8 20 00.8 A	1176.4	90.0	1174.10	13785108100	893.97		
Var. 4 20 32 W.	5	8 57 1.2	1429.2	91.5	1426.05	20336186025	894.27		
	6	9 55 01.2	1424.4	93.5	1420.20	20169680400	895.98		
						Mean	894.74	2952.32	990.36[2]

REMARKS.

179. Pilottown, Del.—Geology: tertiary. On an arable bank of an inlet.

180. Chew, N. J.—Locality: a hill, but, so far as could be seen, without hard rocks. Geology: ter-iary. I conceive this to be a more unexceptionable locality than Girard College, and as it is south of it, nd still exhibits a higher dip, I infer that the dip at that station is made by some local attraction too low or its geographic situation.

181. Vanuxem.—Locality: at Prof. Vanuxem's, about two miles above Bristol, Pa., and near the anal. Geology: diluvium of clay, sand, and gravel, superimposed on primitive rocks? At a distance of mile or more to the north-west, a heavy dike or ridge of trap-rock crops out along the surface.

X. Series for 1847.

Ever since my journey to Lake Superior in 1844, I had been extremely desirous o make a further exploration of the extraordinary magnetism which I found to xist there. An appropriation for a geological survey of that region, in 1847, fforded the opportunity of attaching magnetical observations to those more spe-ifically geological. Such, however, is the connection of the two subjects, and espe-ially in that region, that the one is incomplete without the other. At the request

[1] The name of a coast survey station, derived, as many such names have been, from the name of some eighboring resident.

[2] This result disagrees with that obtained at Prof. Vanuxem's in 1842 (985); but it should be observed hat the stations were not identical, this station (1846) being several hundred feet to the westward of the ormer. So near as I found we were to trappean rocks, it is not strange that so much difference should xist.

of the Secretary of the Smithsonian Institution, I was appointed Dr. Jackson's assistant, with the understanding that I was to perform both magnetical and geological duty. It was also the intention of the Hon. Secretary, Mr. Walker, as I am informed, that the magnetical observation should be communicated to the Smithsonian Institution. The rules of subordination, however, did not permit me to do otherwise than to report them to my superior; and, as Mr. Walker's term of office had in the mean time expired, the observations took their course, and were incorporated with the documents of Congress, and published without my supervision. By an oversight of my own, which I should have corrected instantly, had I seen the proof-sheets, the headings of the tables were omitted, and they were thus rendered unintelligible. There is, therefore, not only a propriety, but a necessity, for appending them to this communication, in order to their republication.

I have incidentally mentioned the connection of terrestrial magnetism with geology. This is intimate and practically important, and I have been particular in all my researches to note the geology of the station. I have elsewhere noticed that primitive or igneous rocks, and especially trappean rocks, are accompanied by extraordinary and evident magnetical effects. Nowhere in my researches are these effects more conspicuous than in the trappean developments of the region of Lake Superior. In the aqueous formations of the great valley of the Mississippi and its tributaries, where the rocks are horizontally stratified, the elements of terrestrial magnetism are so regularly graduated that, after making a few observations, and learning the rate of increase or decrease of any magnetic quantity corresponding to known distances and directions, one is enabled to calculate the one from the other—the magnetism from the distance, or the distance from the magnetism—with an approximate accuracy, within moderate distances; yet not, as some have supposed, with such precision as is reliable for the geodetic accuracy of latitude and longitude. But in the trappean regions of Lake Superior, the magnetic quantities are changed very abruptly in very short distances, and that, too, according to no known law. Yet, even here, when one passes from the upturned conglomerate alternating with, or traversed by, dikes of trap, and, perhaps, containing metalliferous veins of copper and silver, to the horizontally stratified sandstone—as at the Apostles' Islands or the Pictured Rocks—the magnetic elements become again consistent, and increase or diminish according to magnetic latitude and longitude. So constant and evident were these effects, that Dr. Houghton and Judge Burt, in their land surveys of those regions, relied upon a single magnetic element, the declination (variation), to indicate the general geology of rocks concealed under the soil of the tangled forests. Whenever the needle became so abruptly deflected by local attractions as to render the running of the lines by magnetic direction difficult, then they ventured to note "trap-rocks;" and the researches of subsequent geologists have not found any error in their decisions, thus founded on a single element of terrestrial magnetism. Some extraordinary magnetic manifestations, in connection with metalliferous veins, will be pointed out in the course of this paper.

Although the local variations of magnetism seem, in general, to follow no known law, yet the reader will see, by referring to the series for 1844, published in the "Transactions of the Am. Phil. Society" for 1846, that trappean hills and pinnacles have a special magnetism, the magnetic axis coinciding with the axis of form, being more or less vertical. Any limited portion of the earth resolving itself thus into a local magnet, may have its opposite poles accessible; while a corresponding column of the earth, having only its normal portion of terrestrial magnetism, will present, so far as our examination of heights and depths extends, only one pole; and that, scarcely affected by the small distance by which we are able to approach towards the neutral centre, may be considered the pole of a magnet of infinite length. Now, if we consider a trappean hill to be itself a magnet, presenting one pole at the base and the other at the summit, it follows that the indicated magnetism at the summit will be the normal terrestrial magnetism of that place *plus* the local polarity of the magnetical column of the trappean hill; while the indicated magnetism at the base will be the same normal terrestrial magnetism *minus* the local polarity of the same magnetical column.

It is not, however, the intention of this paper to speculate, or advance and advocate theories; and the previous remarks may be regarded rather as inviting the attention of the scientific reader to the very curious *facts* which I have ascertained at Snake Hill, the Palisades, Weasel Mountain, near Patterson, Smith's Quarry, and the Brandywine, near Wilmington, &c., than as with any desire to advocate pertinaciously a *theory* to account for the phenomena. (See "Trans. Am. Phil. Soc.," 1846, p. 322.)

Pole of Greatest Intensity of Magnetic Force.—That the pole of greatest magnetic force is far distant from the pole of convergence, or of dip, was first suggested by Col. Sabine, and has now been fully confirmed by him. To determine precisely the point of that pole is a far more difficult problem than to determine the pole of convergence. This difficulty arises from the complication of the force of local attractions, with what may be considered the force of the normal magnetism of the earth, and the impossibility, so far, of separating, by any reliable standard, the one from the other. As a figurative illustration of this subject, we may suppose the force of terrestrial magnetism to be represented by a prolate spheroid, and that the distance from the centre to any point of the surface is proportionate to the intensity. By means of local attractions, the surface of this spheroid would be rendered uneven and hilly, having table lands and low swamps, sharp pinnacles and deep pits, as it is with the surface of the earth. Now the magnetical surveyor comes upon this surface as if he descended from a balloon in the night, and ascertained the altitude of his point by a barometer, without any means of knowing the height of that point in reference to any standard, as "the level of the sea," and without knowing whether he has alighted upon a mountain or in a valley. His measures are, therefore, merely comparative amongst themselves. From a great many observations at different points, we may approximate to the law of curvature which shall represent the normal magnetism of the earth, if it be first assumed that this normal magnetism be represented by any regular curve. By means of this kind of calculation, Col. Sabine has inferred that the point or pole of maximum intensity of magnetic force is at latitude 52° 19′ N., and longitude 91° 59′ W., although no actual observations have been made within about three degrees of that point. It is not my purpose to attempt to show that Col. Sabine is in error in his calculation; on the other hand, I believe he is right, so far as observations have been made on which to found the calculations made. Nor have I made it at all a study to compare the general curvature which would best represent the magnetic quantities ascertained by experiment. No person, within my knowledge, is better qualified for this task than Col. Sabine. I merely wish a comparison of the magnetism of the region south of Lake Superior with that north of it, in order to show that, in the actual state of knowledge in 1844, I committed no absurdity in announcing that I had reached what was probably the point of maximum intensity at Lake Superior. The observations on trappean rocks are always irregular, so much so that one does not feel satisfied with a mean of a multitude of observations. I have taken, therefore, only those observations which were made on horizontally-stratified rocks of the aqueous formation. I refer especially to the observations made along the south shore of Lake Superior from Chocolate River to Little Taquammanon River. These I have compared with the observations made by Capt. Lefroy from Lake Superior to Hudson's Bay. This series of observations was made along a line nearly semicircular in form, beginning, say, at Fort William, Lake Superior, curving westward, and terminating at Hudson's Bay. This curved line passes around Col. Sabine's point of maximum intensity, in general as a centre, and about three or four degrees from that point. It embraces about thirty-two stations, the intensities of which I have grouped into parcels of about four, obtaining the mean in each case as below:—

INTENSITY AT CAPT. LEFROY'S STATIONS NORTH OF LAKE SUPERIOR, PROCEEDING TOWARDS HUDSON'S BAY.

1.	Near Lake Superior			1.876
2.	The mean of 4 next in order			1.861
3.	"	4	"	1.859
4.	"	4	"	1.860
5.	"	4	"	1.860
6.	"	4	"	1.869
7.	"	4	"	1.867
8.	"	5	"	1.869
9.	"	4	"	1.872
			Mean =	1.875

The second and the ninth groups are near the isodynamic line of 1.875 of Col. Sabine. The other intermediate groups are about half way between that of 1.850 and 1.875, and their mean is very nearly 1.862.

INTENSITY AT STATIONS OF DR. LOCKE'S SURVEY ON THE SOUTH SHORE OF LAKE SUPERIOR, WHERE THE GEOLOGY IS AQUEOUS AND NON-MAGNETIC.

	Lat. N.	Long. W.	
Train River	46° 30′	87° 01′	1.870
Grand Island	46 27	86 45	1.875
Chapel River, Pictured Rocks	46 43	86 40	1.883
Portal Rock, "	46 43	86 39 45″	1.883
Grand Marais	46 42	86 09	1.872
Two Heart River	46 43	85 38	1.868
Near White Fish Point	46 46	85 13	1.868
Little Taquammanon River	46 41	85 13	1.877
		Mean,	1.877
Mean of Capt. Lefroy's stations, as above			1.875
Col. Sabine's calculated maximum			1.878

The foregoing quantities do not differ among themselves more than observations at the same place by the same person will differ at different times.

It would seem, then, that, although the spheroid of magnetic force may have its pole at latitude 52° 19′ N., yet there is a high table-land, so to speak, extending to the south shore of Lake Superior, where there is a "district" intensity. It follows from these observations, that the figurative spheroid of magnetic force would be nearly level from the lake region to the above latitude; or, strictly, it would be spherical instead of spheroidal, on that special line, with, perhaps, a slight depression between the two points. The comparison which I have here used suggests the construction of a solid spheroid, on the surface of which the stations should have their proper angular distances as represented spherically by latitude and longitude, but with distances from the centre proportionate to the intensity of magnetic force. My line of observations along the north shore of Lakes Huron and Michigan, presented in the following tables, will give an idea of the rate of decrease of magnetic intensity southwardly from Lake Superior; and with quantities formed by taking means of groups of observations, judiciously selected at various points towards Hudson's Bay, as ordinates, would exhibit an instructive curve, in which the point at the south shore of Lake Superior would probably be prominent.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
182. **Fort Wilkins.**—Lat. 47° 28′ N. Long. 88° 45′ W. July 5, 1847.									
78° 03′ 00″		8 51 16.0 A	1319.9	71.5	1318.9	17394972100	712.14	3439.3	1149.6
183. **Horseshoe Harbor.**—Lat. 47° 28′ N. Long. 87° 57′ W. July 8, 1847.									
78° 15′ 05″	5	9 20 04.0 A	1690.4	81.5	1688	284934400	640.07		
	6	9 50 01.2	1686.0	88.5	1682	282912400	637.15		
						Mean	638.92	1339.7	1046.9
184. **Eagle River Mine.**—Lat. 47° 24′ N. Long. 88° 25′ W. June 30, 1847.									
77° 24′ 00″	4	3 03 00 P	1465.93	86.0	1463.45	21416859025	569.06		
	5	4 00 00	1791.22	87.5	1787.84	31963718656	570.83		
	6	4 40 00	1774.43	86.0	1770.37	31342099369	575.19		
						Mean	571.69	3108.8	1038.7

REMARKS.

182. Fort Wilkins.—Geology: Metamorphic conglomerate near to the trap.

183. Horseshoe Harbor.—Geology: conglomerate.

184. Eagle River Mine.—Range 31, township 57, section 30; United States survey. Locality: in the ravine of the river, and at an angle opposite to an adit. Geology: trappean rocks. Weather clear.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
185. **Eagle River,** a few rods eastward of the last, and on the high bank over the adit, being near the burying-ground.									
77° 39′ 00″	4	5 35 00	1359.12	62	1358.95	18467451025	670.77	3136.1	1048.1
186. **Eagle River Mine,** on a hill about three-quarters of a mile west of the works, as by the previous latitude and longitude.—July 1, 1847.									
77° 56′ 04″	4	7 49 00.0	1370.72	71.5	1669.70	18760780900	660.29		
	5	8 20 03.6	1668.80	74.0	1667.16	27794224656	656.50		
	6	8 44 03.6	1662.40	74.0	1660.74	27580633476	653.68		
						Mean	656.82	3[illegible]41.9	1050.1
187. **Cliff Mine.**—Lat. 47° 24′ N. Long. 88° 26′ W. July 1, 1847.									
77° 46′ 20″	4	4 30 00 P	1380.33	53	1381.00	19067610000	649.67	30[illegible]68.1	1025.4
77 37 37	4	5 56 00	1363.60	70	1362.72	1857776900	666.80	3[illegible]11.4	1039.8
188. **Copper Falls.**—Lat. 47° 27′ N. Long. 88° 12′ 30″ W. July 2, 1847.									
78° 20′ 00″	4	3 32 01.2	1538.36	69	1537.44	19146256900	647.00	31[illegible]25.5	1044.6
78 16 29	4	3 01 04.0	1372.8	76	1371.31	18804636700	658.75	3[illegible]41.6	1083.2
189. **Baite du Gris** (*Encampment*).—Lat. 47° 24′ N. Long. 88° 06′ W. July 9, 1847.									
77° 06′ 30″	5	8 19 25 A	1620.39	69	1619.37	26223591969	695.00	3[illegible]15.1	1041.1
190. **Sibley's Mine** (*Lac La Belle*).—Lat. 47° 24′ N. Long. 88° 08′ W. July 8, 1847.									
76° 13′ 26″	5	12 46 04	1557.36	77	1555.51	24195802500	754.1	3167.1	1058.5

REMARKS.

186. Eagle River Mine.—Geology: feldspathic greenstone.

187. Cliff Mine.—Range 32, township 58, section 36; United States surveys. Locality: inside of the mine. Geology: the instruments were placed on the immense mass of native copper which laid exposed in the gallery.

Second locality: outside of the mine, and over the vein on the highest point of the ridge. Geology: trappean.

188. Copper Falls.—Range 31 W., township 58 N., section 11. Geology: over the vein of metallic copper.

Second locality: in a wood one-fifth of a mile below the falls.

189. Baite du Gris (*Encampment*).—Range 29, township 58, section 34; United States surveys. Geology: sandstone, very near to the trap.

190. Sibley's Mine (*Lac La Belle*).—Range 29, township 58, section 32; United States surveys Geology: sienite, with sulphuret of copper.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
191. **Bohemian Mountain.**—Lat. 47° 25′ N. Long. —° —′ W. July 9, 1847.									
78° 30′ 38″	5	5 29 01 P	1445.52	80	1443.52	20837499904	875.63		
	6	5 54 06	1440.34	77	1438.19	20683904761	871.59		
						Mean	873.61	4281.9	1464.6
192. **East and West Vein Mendelbaum's Mine,** about half of a mile south of the Bohemian Mountain.—July 10, 1847.									
89° 02′ 00″	Dipping-needle vibrated 30 in one minute. This extraordinary result was obtained on a precipice looking southward, with a thin vein of blue sulphuret of copper traversing from east to west. From the above, and from the vibrations of the same needle at Cedar Swamp, on the lake margin, we deduce the total intensity (see below) 1182.4.								
193. **Cedar Swamp,** at the landing of Sibley's Mine, margin of Lac La Belle.—June 10, 1847.									
76° 52′ 41″	5	11 14 12	1617.38	82.5	1614.76	26074498576	699.8	3081.8	1030.0
194. **Mount Houghton.**—Lat. 47° 25′ N. Long. 88° 04′ W. July 10, 1847.									
77° 28′ 00″	5	5 31 01 P	1636.39	80	1634.10	26702828100	683.40	3149.2	1052.5
195. **Baite du Gris** (*Western Point*).—Lat. 47° 22′ N. Long. 88° 05′ W. July 12, 1847.									
77° 25′ 26″	5	7 45 03	1640.39	75	1638.67	26852393689	679 48	3120.9	1043.1
196. **South Part of Point Kewenon.**—Lat. 47° 26′ N. Long. 87° 51′ W. July 12, 1847.									
78° 30′ 39″	5	1 45 01 P	1689.6	87	1686.4	28439449600	641.57	3222.7	1077.1
197. **Point Kewenon,** north-east angle, about two miles north of the preceding.—July 13, 1847.									
78° 11′ 30″	5	5 24 05 A	1696.4	60	1696.4	287777296	634.03	3099.0	1035.7

REMARKS.

191. Bohemian Mountain.—Range 29, township 58, section 29; United States surveys. Geology sienite.

193. Cedar Swamp.—Range 29, township 58, section 32; south part. The same needle whicl vibrated 30 in a minute at the above station, performed 28 vibrations in the same time. Of course, these are but approximations. They indicate a high intensity at the east and west vein. Geology: sandstone very near to the sienite, which rises very precipitously to the north.

194. Mount Houghton.—Range 29, township 58, section 32; United States surveys. Geology: a broad vein of red jasper.

195. Baite du Gris (*Western Point*).—Range 29, township 57, section 14. Geology: sandstone nearly horizontal.

196. South part of Point Kewenon.—Range 27, township 58, section 27. Geology: sandstone, near the junction of trap.

197. Point Kewenon.—Geology: vesicular and amygdaloid trap, containing agates.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
198. **Traverse, Presq'Isle.**—Lat. 47° 11′ N. Long. 88° 23′ W. July 18, 1847.									
77° 08′ 29″	5	5 25 02 A	1631.4	64	1630.83	26596064889	686.04	3082.7	1030.3
199. **Mouth of Portage River, or "Entrance."**—Lat. 47° 01′ N. Long. 88° 30′ W. July 18, 1847.									
77° 00′ 30″	5	2 58 04 P	1620.8	74	1619.2	26217086400	695.95	3098.7	1035.6
200. **Anse.**—Lat. 46° 49′ N. Long. 88° 34′ W. July 19, 1847.									
76° 51′ 34″	4	4 31 03 P	1329.68	76.0	1328.39	17646199921	702.00		
	5	5 02 04	1613.52	74.0	1611.94	25983505636	702.21		
	6	5 29 36	1607.58	72.5	1605.82	25786578724	698.35		
						Mean	700.85	3032.6	1036.7
201. **Mouth of Huron River.**—Lat. 46° 56′ N. Long. 88° 09′ W. July 21, 1847.									
77° 10′ 48″	5	8 04 02 A	1630.4	73	1629.0	26536410000	687.58	3099.5	1036.9
202. **Mouth of Dead River.**—Lat. 46° 34′ 17″ N. Long. 87° 33′ W. July 23, 1847.									
77° 16′ 36″	4	9 50 00.0	1355.72	80.0	1353.96	18332076816	670.27		
	5	10 21 02.8	1644.40	79.5	1644.10	27030648100	671.31		
	6	10 47 01.0	1642.00	80.0	1641.10	26932092100	669.39		
						Mean	670.32	3043.1	1017.1
203. **Jackson Mining Co.'s Office.**—Lat. 46° 30′ N. Long. 87° 43′ W. July 26, 1847.									
77° 01′ 26″	5	7 15 05.6 A	1624	61	1624.3	26283504900	691.56	3080.0	1029.4
204. **Iron Mountain.**—Lat. 46° 27′ N. Long. 87° 49′ W. July 26, 1847.									
77° 58′ 10″	5	3 05 03 P	1698.4	60	1698.4	28835125600	632.78	3035.2	1014.4

REMARKS.

198. Traverse, Presq'Isle.—Range 31, township 55, section 16; United States surveys. Geology: horizontally-stratified sandstone.

199. Mouth of Portage River, or "Entrance."—Range 33, township 53, section 13 Geology: horizontally-stratified sandstone.

200. Anse.—Range 33, township 51, section 25; United States surveys. Geology: horizontally-stratified sandstone.

201. Mouth of Huron River.—Range 29, township 52, section 18 (?). Geology: sand, probably superimposed on horizontally-stratified sandstone.

202. Mouth of Dead River.—Range 25 N., 4th correction line, township 48, section 12. Geology: sand, superimposed on sienite.

203. Jackson Mining Co.'s Office.—Range 26, township 48, section 28, south-west part. Geology: metamorphic sandstone.

204. Iron Mountain.—Range 27, township 47, section 1. Geology: anhydrous peroxide of iron.

205. **Loadstone Encampment.**—Lat. —° —′ N. Long. 87° 44′ W. July 27, 1847.								
42° 53′ 00″	5	10 16 00	822.00	60	822.00	65963284	2766.0	1261.6	
206. **East Branch of the Esconawby.**—Lat. 46° 24′ N. Long. 87° 47′ W. July 28, 1847.									
76° 14′ 21″	4	9 41 01 A	1304.3	62	1304.13	17007550569	728.36	3062.6	1023.6
207. **Falls of East Branch of Esconawby.**—July 29, 1847.									
76° 39′ 00″	5	7 58 08 A	1601.4	60	1601.4	25644819600	715.39	3098.3	1035.5
208. **Train River.**—Lat. 46° 30′ N. Long. 87° 01′ W. August 7, 1847.									
76° 41′ 37″	5	6 52 32 A	1593.63	55	1594.18	25414098724	717.95	3118.7	1042.4
209. **Grand Island.**—Lat. 46° 27′ N. Long. 86° 45′ W. August 8, 1847.									
76° 37′ 52″	5	7 01 03	1589.2	64	1583.76	25241383376	722.86	312.18	1045.1
210. **Chapel River.**—Lat. 46° 43′ N. Long. 86° 40′ W. August 11, 1847.									
77° 11′ 30″	5	5 37 02	1618.3	62	1618.08	26181828864	696.93	3143.7	1050.7
211. **At the Cave of Portal Rock,** about three-quarters of a mile to the north-west of the preceding. August 11, 1847.									
77° 12′ 48″	5	9 48 02.4	1621.61	64	1621.16	26281597456	694.27	3139.8	1049.4
212. **Grand Marais, East Point.**—Lat. 46° 42′ N. Long. 86° 09′ W. August 12, 1847.									
77° 18′ 03″	5	8 57 04 A	1631	64.5	1630.5	26574216256	686.61	3123.2	1043.6

REMARKS.

205. Loadstone Encampment.—Range 26, township 47, section 18. Geology: a loadstone in place broken mostly into sharp angular fragments. Here were two poles, 17.67 feet apart, one attracting th north and the other the south pole of a magnetic needle. (See notes.)

206. East Branch of the Esconawby.—Range 26, township 46, section 6. Geology: probably sienite

207. Falls of East Branch of Esconawby.—Range 26, township 46, section 30. Geology: porphyriti sienite.

208. Train River.—Range 20, township 47, section 32.

209. Grand Island.—Range 19, township 47, section 22, at the point west of Williams's.

210. Chapel River.—Range 18, township 48, section 35.

211. At the Cave of Portal Rock.—Geology: horizontal sandstone.

212. Grand Marais, East Point.—Range 13, township 49, section 4.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor being .000.	Total intensity: that at Cincinnati = 1000.
213. Near Double-Heart River.—Lat. 46° 43′ N. Long. 85° 38′ W. August 13, 1847.									
77° 31′ 07″	5	5 21 00 A	1636.0	64.5	1635.50	26748602500	682.13		
	6	5 50 08	1632.2	66.5	1631.34	26616702056	677.41		
						Mean	679.72	3116.5	1041.5
214. Two miles west of White Fish Point.—Lat. 46° 46′ N. Long. 85° 15′ W. August 13, 1847.									
77° 32′ 00″	5	8 50 00.8	1639.6	65	1639	2686320000	679.22	3146.4	1051.6
215. Little Taquamanon River.—Lat. 46° 41′ N. Long. 85° 13′ W. August 14, 1847.									
77° 19′ 30″	5	4 46 00	1634.4	78	1632.47	26549583009	687.24	3133.1	1046.8
216. St. Mary's River, opposite Palmer's.—Lat. 46° 32′ N. Long. 84° 24′ W. August 20, 1847.									
77° 23′ 15″	5	8 33 15	1637.1	69.5	1637.01	26800964100	680.81		
	6	8 02 03	1631.2	66.5	1630.46	26583998116	678.19		
						Mean	679.00	3109.6	1039.3
217. Drummond's Island.—Lat. 46° 00′ N. Long. 84° 03′ W. August 25, 1847.									
77° 06′ 34″	5	11 48 03	1623.6	79.5	1621.44	26290376736	694.02		
	6	11 26 00	1617.6	79.0	1614.90	26079037636	691.27		
						Mean	692.64	[illegible]10[illegible]1.5	1037.6
218. Bruce's Mine, at the landing—Lat. 46° 19′ N. Long. 83° 58′ W. August 22, 1847.									
77° 02′ 32.5″	5	6 28 02	1624.6	63	1624.26	26382205476	691.60		
	6	6 47 03.8	1614.6	60	1614.60	26069331600	691.54		
						Mean	691.58	3084.1	1030.7
219. Bruce's Mine, near the principal vein of ore.—August 23, 1847.									
77° 16′ 00″	6	6 16 02 A	1649.6	56	1650.18	27230940324	662.04	3003.6	1004.9
220. Bruce's Mine, at the basaltic bluffs, 40 rods north of the mine.									
74° 24′ 22″	6	9 51 01 A	1485.6	68	1484.56	22000371600	819.43	3049.5	1019.2

REMARKS.

213. Near Double-Heart River.—Range 10, township 49, section 1.
214. Two miles west of White Fish Point.—Range 6, township 51, section 31.
215. Little Taquamanon River.—Range 6, township 49, section 3.
216. St. Mary's River.—Range 2, township 48, section 29.
217. Drummond's Island.—Range —, township 42, section 31.
218. Bruce's Mine.—Geology: over a trappean dike, and near the lake.
220. Bruce's Mine.—Geology: pieces of basaltic rock, decidedly magnetic.

Dip.	No. of needle.	Epoch of commencing vibration. hrs. min. sec.	Duration of 500 vibrations.	Temperature.	Calculated duration at 60°.	Square of the preceding.	Horizontal intensity.	Total intensity: hor. being 1000.	Total intensity: that at Cincinnati = 1000.
221. **Island five or six miles north of Mackinaw** (*St. Martin's Island?*).—Lat. 45° 59′ N. Long. 84° 47′ W. August 28, 1847.									
76° 43′ 30″	4	3 18 02.4	1318.88	66	1318.34	17380203556	712.74		
	5	3 42 24.0 P	1599.61	66	1598.94	25566091236	713.68		
	6	4 05 05.0 P	1590.82	64	1590.25	25289268676	713.26		
						Mean	713.22	3106.0	1038.1
222. **Twenty-five miles west of Mackinaw,** on the lake shore.—Lat. 46° 03′ N. Long. 85° 21′ W. September 3, 1847.									
76° 55′ 31″	5	1 40 04.0	1609.6	67	1608.81	25882374400	704.96		
		2 02 01.6	1602.6	66	1601.75	25656030625	702.67		
						Mean	703.82	3111.1	1039.8
223. **Mouth of Seul Choix River.**—Lat. 45° 59′ N. Long. 86° 08′ W. September 6, 1847.									
76° 35′ 15″	5	9 38 04 A	1589.62	67	1588.74	25240947876	722.87	1041.3	
224. **Seven miles west of Seul Choix Point.**—Lat. 45° 58′ N. Long. 86° 15′ W. September 8, 1847.									
76° 25′ 37″	5	12 42 44.0	1590.62	60	1590.62	25300719844	721.17		
	6	12 57 59.2	1581.62	60	1581.62	25005096900	720.82		
						Mean	720.99	3071.8	1026.6
225. **Ministique River.**—Lat. 45° 58′ N. Long. 86° 29′ W. September 9, 1847.									
76° 24′ 09″	4	6 16 04 P	1303.70	60	1303.70	16997336900	728.79		
	5	5 49 05	1581.62	60	1581.62	25015218244	729.40		
	6	5 31 00	1574.62	61	1574.50	24790502500	727.21		
						Mean	728.47	3098.0	1035.4
226. **Moon Island.**—Lat. 45° 36′ N. Long. 87° 17′ W. September 11, 1847.									
76° 18′ 40″	5	11 31 08.0 A	1580.62	64.0	1580.22	24964000000	730.70		
	6	11 59 01.6	1574.62	65.5	1574.02	24774760000	727.60		
						Mean	729.15	3080.5	1029.6

REMARKS.

221. Island five or six miles north of Mackinaw. (*St. Martin's Island?*)—Range 2 W., township 41 N., section 9. Geology: cliff limestone, horizontally stratified.

222. Twenty-five miles west of Mackinaw.—Range 7 W., township 42 N., section 12; United States surveys. Geology: sand, superimposed on cliff limestone.

223. Mouth of Seul Choix River.—Range 13, township 40, section 11. Geology: cliff limestone.

224. Seven miles west of Seul Choix Point.—Range 14, township 41, section 10. Geology: sand, superimposed on cliff limestone.

225. Ministique River.—Range 26 W., township 41, section 18. Geology: sand, superimposed on cliff limestone.

226. Moon Island.—Geology: sand, superimposed on cliff limestone.

CLASSIFICATION AND COMPARISON OF THE PRECEDING RESULTS.

Kewenon Peninsula.

	Latitude.	Longitude.	Total Intensity.
Fort Wilkins	47° 28′ 00″	88° 00′ 45″	1149.6
Horseshoe Harbor	47 28 00	87 57 00	1046.9
Eagle River Mine	47 24 00	88 25 00	1038.7
"	47 24 00	88 24 45	1048.1
"	47 24 00	88 26 00	1050.1
Cliff Mine	47 24 00	88 28 00	1025.4
"	47 24 00	88 28 00	1039.8
Copper Falls	47 27 00	88 12 00	1044.6
"	47 26 50	88 12 00	1083.2
Baite du Gris	47 24 00	88 06 00	1041.1
Sibley's Mine	47 24 00	88 08 00	1058.5
Bohemian Mountain	47 25 00	88 08 00	1464.6
Mendelbaum's	47 24 00	88 08 00	1182.4
Landing near Sibley's	47 23 40	88 08 00	1030.0
Mount Houghton	47 25 00	88 04 00	1052.5
Western Point of Baite du Gris . . .	47 22 00	87 51 00	1048.1
Point Kewenon	47 26 00	87 50 00	1077.1
"	47 28 00	87 50 00	1035.7
Hawk's Bill	47 11 00	87 30 00	1030.3
Mouth of Portage River	47 01 00	87 30 00	1035.6
Anse	46 49 00	87 34 00	1036.7
Mean	47 22 36	88 12 24	1077.1
Total intensity reduced to arbitrary scale .	. . . .	. . . .	1.9334

REMARKS.

In April, 1844, I announced to the American Philosophical Society that, at Point Kewenon, I had probably reached the place or region of maximum intensity; at the same time qualifying that announcement on account of the want of more extended and multiplied research.

Since Capt. Lefroy has examined the region between Lake Superior and Hudson's Bay, Col. Sabine has calculated the maximum to be 1.878, and situated in latitude 52° 19′ and longitude 91° 59′.

The high intensity of Point Kewenon—determined by numerous observations made over a region of thirty miles in extent—must, then, be considered a case of extraordinary and extensive local attraction, the mean being higher than Col. Sabine's maximum. Indeed, the abrupt changes and extraordinary results along the trappean dikes and near the metallic veins are sufficient evidence of unusual magnetic forces, although they operate on a scale coextensive with the peculiar geological formations of trap and metalliferous conglomerate, occupying so large a portion of that peninsula.

If, however, we select such observations as were made on the horizontally-stratified sandstone of the peninsula, we find them not only consistent among themselves, but conforming to the results which Capt. Lefroy obtained between Lake Superior and Hudson's Bay. They are as follows:—

	Latitude.	Longitude.	Total intensity.
Baite du Gris	47° 24′ 00″	88° 08′ 00″	1041.5
" western part . .	47 22 00	88 05 00	1048.1
Hawk's Bill	47 11 00	88 30 00	1030.3
Portage River	47 01 00	88 30 00	1035.6
Anse	46 49 00	88 34 00	1036.7
	47 09 06	88 21 06	1038.3
Total intensity, reduced to arbitrary scale			1.8637

The observations at La Pointe and at Ontonagon River were made on the same sandstone. The results are as follows:—

	Latitude.	Longitude.	Total intensity.
La Pointe . . .	46° 47′ 00″	90° 58′ 00″	1044.5
Ontonagon River . .	46 52 00	89 31 00	1039.0
	46 49 30	90 44 00	1041.7
Reduced to arbitrary scale, total intensity			1.870

South Shore of Lake Superior, from Chocolate River to Taquamanon.

	Latitude.	Longitude.	Total intensity.
Train River	46° 30′ 00″	87° 01′ 00″	1042.000
Grand Island	46 27 00	86 45 00	1045.000
Chapel River . . .	46 43 00	86 40 00	1049.000
Portal Rock	46 43 00	86 39 45	1049.000
Grand Marais . . .	46 42 00	86 09 00	1043.000
Two-Heart River . . .	46 43 00	85 38 00	1041.000
Near White Fish Point . .	46 46 00	85 13 00	1052.000
Little Taquamanon River .	46 41 00	85 13 00	1046.000
	46 39 22	86 09 50	1045.875
By arbitrary scale . .	. . .	. . .	1.877
Maximum of Col. Sabine	. . .	. . .	1.878

These observations, which are remarkably consistent, and made along a sandstone coast entirely unexceptionable as regards the geological formations, exhibit a mean within a unit of being equal to the maximum of Col. Sabine. Why it should be higher than a mean of the most unexceptionable observations on Kewenon peninsula, it is difficult to decide, unless the cold water of the lake, extending along so nearly a magnetic parallel, has some modifying influence.

It appears that the intensities, as indicated by No. 5, are higher than the mean where the three needles have been used. In order to be able to apply an equation where No. 5 alone was used, I have made comparisons of nine cases in which two or three needles were used. I find by the mean of this comparison that the ratio of the indications of No. 5 to those of the means of the several needles, is as 1 to 0.99852. The mean of total intensity at eight stations along the south shore of Lake Superior, from Train River to Little Taquamanon, by No. 5, is equal to 1046, or by arbitrary scale 1877.6, which, being reduced by the above coefficient, is 1874.8

PUBLISHED BY THE SMITHSONIAN INSTITUTION,
WASHINGTON CITY,
APRIL, 1852.