PHILOSOPHICAL TRANSACTIONS.

XVII. *Contributions to Terrestrial Magnetism.—No. VII.*

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Containing a Magnetic Survey of a considerable portion of the North American Continent.

FROM the moment that the fact was known, that the locality of the maximum of the magnetic Force in a hemisphere is not coincident, as was previously supposed, with the locality where the dip of the needle is 90°, researches in terrestrial magnetism assumed an interest and importance greatly exceeding that which they before possessed; for it was obvious that the hypothesis which then generally prevailed regarding the distribution of the magnetic Force at the surface of the globe, and which had been based on a too-limited induction, was erroneous, and that even the broad outline of the general view of terrestrial magnetism had to be recast.

The observations on which this discovery rested, (being those which I had had an opportunity of making in 1818, 1819 and 1820 within the Arctic Circle, and at New York in 1822,) were published in 1825*; they constituted, I may be permitted to say, an important feature in the views, which led the British Association in the year 1835 to request that a report should be prepared, in which the state of our knowledge in respect to the variations of the magnetic Force at different parts of the earth's surface should be reviewed, and, as is customary in the reports presented to that very useful institution, that those measures should be pointed out which appeared most desirable for the advancement of this branch of science. In the maps attached to the report†, the isodynamic lines on the surface of the globe were drawn simply in conformity with observations, and unmixed with hypothesis of any sort. The observations collected for that purpose were not those of any particular individual or of any single nation, but embodied the results obtained by all persons who up to that period had taken part in such researches, subjected to such amount of discussion

* Pendulum and other Experiments, pp. 460–499. † Reports of the British Association for 1837.

only as conveyed a knowledge of the modes of observation severally employed, and reduced the whole to a common unit. The observations thus combined gave for the highest isodynamic lines of the northern hemisphere, closed and irregularly elliptical curves, extending across the North American Continent nearly in a north-west and south-east direction, and having their central point, or the point of maximum of Force, approximately in 52° north latitude, and 270° east longitude*.

To confirm this previously unsuspected characteristic of the magnetic system of the globe,—to establish beyond a question so remarkable a fact in Physical Geography,—to fix within narrow limits the geographical situation of the point of maximum corresponding to a particular epoch,—to ascertain with the precision of modern instruments and methods the intensity of the magnetic Force at its point of maximum,—and to assign the form and geographical localities of the isodynamic curves adjacent to that point,—were objects which presented themselves amongst the most important desiderata for our present knowledge, and as likely to have a peculiar value at a future period in respect to the Ætiology of the science; when, like the earlier determinations in astronomy, these researches might serve to elucidate the laws of those secular changes, which, in our present ignorance of the causes of the earth's magnetism, seem even more mysterious than the apparently complex relations of contemporary phenomena.

The report referred to contained accordingly a suggestion of the expediency of measures being taken to procure a magnetic survey of that portion of the North American Continent, which is comprised within the isodynamic line of 1·8 in the arbitrary scale. This suggestion was treated as second in importance only to the recommendation which it was the primary object of that report to urge, and which has since been carried into execution; viz. a magnetic survey of the high latitudes of the southern hemisphere by a British naval expedition.

The extensive territory over which it would be necessary to travel, in order to execute the proposed survey in North America, forms a part of the British dominions on that Continent, and is annually traversed during the summer months by the boats of the Hudson's Bay Company conveying merchandize. A navigation conducted on lakes and rivers is better suited for the safe transport of small and delicate instruments, than where the travelling has to be performed exclusively on land. The good offices which the Hudson's Bay Company had contributed to the success of the geographical expeditions, undertaken by the British Government, for the purpose of tracing the American rivers and coasts of the polar sea, and their liberality in originating expeditions of the same nature, and in executing them at their own cost and by their own officers, justified the hope that assistance might be given by the Hudson's Bay Company, which should render an undertaking feasible, which undoubtedly would not have been so without their aid.

With this expectation, and having reason to believe that leave of absence from

* Vide Map 2 of the Report referred to.

military duty might be obtained, I applied in 1839 to the respected Chairman of the Hudson's Bay Company, Sir JOHN PELLY, Bart., and received from him the assurance that a conveyance in the Company's boats from Montreal to York Factory, and back to Canada by a different route, would readily be granted me on my personal application; and I accordingly commenced the preparation of the instruments which I proposed to employ. The execution of this design was prevented by the appointment in that year of officers and detachments of the Royal Artillery to conduct the Colonial magnetic observatories: these were placed under my superintendence, and the publication of the observations made at them entrusted to me. The project of a North American magnetic survey, however, was not suffered to drop.

Having ascertained from Sir JOHN PELLY that a conveyance in the Company's boats would be granted to an officer of the magnetic observatory at Toronto, on a representation from the President and Council of the Royal Society of the scientific interest attached to the undertaking, the late Lord VIVIAN, then Master-General of the Ordnance,—always desirous to encourage the officers who had the honour to serve under his command in rendering, in times of peace, such public though not strictly professional services as their public education qualified them to perform,—was pleased to annex the survey in question to the duties of the Toronto Observatory, and to add for that purpose an officer and a non-commissioned officer to the establishment of the observatory. This addition was proposed to Lord VIVIAN, with the concurrence and approval of the Deputy Adjutant-General of the Royal Artillery, Major-General Sir HEW DALRYMPLE ROSS, K.C.B.; and on Lord VIVIAN's recommendation, the Treasury granted extra pay to the officer and the non-commissioned officer, with 130*l.* for the purchase of instruments, and 50*l.* a year for three years for the contingencies of the survey.

On the proposal of Sir JOHN HERSCHEL, Bart., Chairman of the Committee of Physics of the Royal Society, the President and Council of that body addressed the Hudson's Bay Company in recommendation of the proposed undertaking, and received a favourable reply.

In the autumn of 1842, Lieut. (since Captain) LEFROY, of the Royal Artillery, who had been the director of the magnetic observatory at St. Helena, and was appointed to the Toronto Observatory with a special view to his employment on the survey, left England for America, accompanied by Bombardier (since Sergeant) HENRY of the same corps, to join the brigade of canoes of the Hudson's Bay Company, which would leave Montreal early in the following spring; the interval was employed in the preparation and trial of instruments, and in connecting, by an excursion in the United States, the observations about to be made in the British territories, with those which were in progress in different parts of the Union.

In January 1843 I waited on Sir GEORGE SIMPSON, by appointment, at the Hudson's Bay House, to arrange with him the route by which it would be convenient to the Hudson's Bay Company to convey Lieut. LEFROY, so as to enable him to fulfil the objects of his employment. It was proposed by Sir GEORGE SIMPSON that Lieut.

Lefroy should be conveyed, with his assistant and instruments, in one of the regular canoes of the brigade from Montreal to York Factory, and that from thence he should be provided with a light canoe to proceed, independently of others, to Moose Fort, near the head of Hudson's Bay, from whence he should return to Toronto overland as soon as the winter travelling should commence. By this route a circuit would be made completely round the supposed point of maximum of the Force, and within the isodynamic curve of 1·8. It was stated by Sir George Simpson, that the progress of the Brigade would admit of two hours in each day being taken for observation; that four hours would be given at each of the Company's posts, and twenty-four hours on the term-days of May and June; and that directions should be given accordingly to the conductor of the Brigade.

Lieut. Lefroy was provided with the following instruments:—

1. An Inclinometer of nine French inches diameter, by Gambey. This instrument is the property of Captain Robert Fitzroy, R.N., and is the same which was previously lent by him for the survey of the British Islands, and by his permission is still employed for the public service. The needles belonging to it were the same which had been used in the British Survey, when they were proved to be free from index error at all inclinations, by the observations of Captain Johnson, R.N. and myself in the Regent's Park, reported in the account of that survey. Two additional needles were fitted to this instrument for the purpose of determining variations of the total force by Dr. Lloyd's method: they were made in 1839 by the late Mr. Robinson, and had been laid by in the hope that their magnetism would become steady.

2. A Fox's Inclinometer of seven inches diameter, with one reversing needle, and two needles for observing variations of the total force by Mr. Fox's method.

3. A portable unifilar magnetometer, for measurements of the absolute horizontal force, of the construction described in Lieut. Riddell's instructions for the use of portable magnetical instruments.

4. An azimuth compass of the construction proposed by the Committee for the improvement of ships' compasses, and now in use in Her Majesty's Navy; the bowl was reduced in height to render it more portable.

5. A portable declinometer.

6. A portable bifilar magnetometer; and

7. A portable induction inclinometer. These three instruments were designed for observations on term-days, and for the observations of diurnal variation and of disturbances in case of detention at any of the Company's posts.

Lieut. Lefroy was also furnished with a Dollond's repeating and reflecting circle and mercurial horizon, for determining geographical positions; with meteorological instruments, including an apparatus for measuring heights by the boiling-point of water; and with two pocket chronometers, which were kindly lent for the occasion by the Hydrographer of the Admiralty.

Lieut. Lefroy met Sir George Simpson at Montreal towards the end of April 1843, and embarked with Bombardier Henry and the instruments on board one of

the Company's canoes at La Chine, commencing his observations on the 24th of May, in the ascent of the Ottawa river. The weather being favourable observations were made daily, with not more than one or two exceptions, until the Brigade arrived at Fort William on the 29th of May. It was there proposed by Sir GEORGE SIMPSON, who had preceded the Brigade, that Lieut. LEFROY should be provided with a canoe to himself, and should follow the Brigade at his convenience, but be entirely independent of it. This arrangement was consequently adopted, and Lieut. LEFROY left Fort William furnished with a guide and a canoe at his exclusive disposal, to carry out the original design of proceeding to York Factory. At the Rat Portage, however, on the Lake of the Woods, on the 20th of June, an accident happened to GAMBEY's inclinometer, which was thrown down, the glass cover broken, and one of the LLOYD's needles injured; Lieut. LEFROY was induced by this accident to deviate from the direct course to York Factory, and to proceed to the Red River settlement, where the damage was repaired. Here he met Sir GEORGE SIMPSON, and being of opinion that he should best promote the objects of the Survey by passing a winter in the interior, instead of carrying out the plan at first proposed of returning to Canada from York Factory, he arranged with that gentleman that, after returning to Norway House from Hudson's Bay, he should proceed direct to Fort Chipewyan on Lake Athabasca, winter there, descend M'Kenzie's River in the spring to the Arctic Circle, visit the Company's posts on the Saskatchewan and Peace Rivers, and return to Toronto at the conclusion of the summer of 1844. By this arrangement a considerable extension was given to the survey, and an opportunity was afforded of making the observations of a fixed magnetic observatory during several months of winter at Athabasca, where the magnetic variations, both regular and irregular, are of great magnitude, and have particular interest: on the other hand, some expense was incurred which had not been originally contemplated or provided for. The plan thus formed was executed; and the present number of the Contributions contains the observations during this survey of two of the magnetic elements, viz. of the Inclination and of the Force; the Declination is reserved for a future occasion, because a considerable augmentation of materials is expected. The winter observations with the magnetometers will have an appropriate place in the publication which contains the observations at the Colonial Magnetic Observatories.

I am much gratified in being able to add to the interest and value of this number of the Contributions, by including observations not previously published, communicated to me by several gentlemen of the United States. In acknowledging the liberality and disinterested view for the advancement of science, with which the results of laborious and extensive researches have thus been unreservedly placed at my disposal, in anticipation of the publications in which they will respectively appear, I have great pleasure in calling attention to this example of the cordiality and good feeling, which happily subsist amongst the individuals of different nations, who have a common bond of union in the cultivation of magnetical science.

I am indebted to Major JAMES D. GRAHAM of the Corps of Topographical Engineers

of the United States, (Commissioner for exploring the North-Eastern Boundary of the United States under the act of Congress of July 20th, 1840, Principal Astronomer and Head of the Scientific Corps on the part of the Government of the United States for the joint survey and demarcation of the Boundary under the Treaty of Washington,) for the results of observations of the Inclination made from 1841 to 1845 at thirty-eight stations, chiefly in the parts of the country in which the Boundary Commissioners have been engaged. These observations were made with an inclinometer by GAMBEY, with the exception of three stations, where an instrument of TROUGHTON and SIMMS was employed*; they appear to have been made with extreme care, and the results are remarkably accordant and satisfactory. Major GRAHAM's observations have a particular value, in placing beyond question the fact that the direction of the isoclinal lines in that part of the American Continent is to the northward of east, whilst in the whole range of country elsewhere comprehended in this survey, these lines have a direction more or less from the northward of west to the southward of east: the geographical position in which certain of the isoclinal lines attain their greatest southing is thus satisfactorily ascertained. Major GRAHAM states that the results now communicated are abstracted from a paper which has been presented to the American Philosophical Society of Philadelphia, and which will be hereafter published in the Transactions of that Society.

From Dr. LOCKE of Cincinnati I have received the result of a very extensive series of observations of the Inclination and Force, on which he has been engaged for eight years (1838 to 1845 inclusive), comprehending the determination of both elements at about 100 stations, distributed in longitude from the seaboard of the United States to the Mississippi River, and in latitude from 38° to 48°. It is in fact a magnetic survey of the Inclination and Force over the north-western and north-eastern States of the Union, conducted by an individual on his own unaided resources, and is one of the many notable instances of private research elicited by the impulse and systematic direction which have been given of late years to the study of terrestrial magnetism. The full account of these observations is designed to be published in the Transactions of the American Philosophical Society; but in the mean time the results have been spontaneously communicated to me by Dr. LOCKE (with whom I had not previously the pleasure of being acquainted), with full permission to make such use of them as I might deem advantageous to science. The Inclinations were observed with an inclinometer made by the late Mr. ROBINSON, and the variations of the magnetic Force by a HANSTEEN's apparatus, in which the needles vibrate in a partial vacuum, according to the plan devised by Dr. ALEXANDER DALLAS BACHE.

To Dr. A. D. BACHE, Director of the Coast Survey of the United States, and to JAMES RENWICK, Esq., late Commissioner for Surveying and Exploring the North-Eastern Boundary of the United States, I am indebted for observations of the Inclination and of the absolute horizontal Force, which have been made by direction of the Government

* These stations were the Military Academy, West Point, New York; near the monument for marking the source of the River St. Croix; and Park's Hill on the boundary of Maine and New Brunswick.

of the United States at stations of the Coast Survey, and which will hereafter be published in the Government reports. In the mean time the results have been communicated to me by Dr. BACHE, with the permission of the Government.

I have also availed myself of the Inclinations observed in different parts of the United States, by Professor LOOMIS and M. NICOLLET, published in the seventh and eighth volumes of the Transactions of the American Philosophical Society. The skill of these gentlemen as observers, and the scrupulous care with which their observations are recorded, are too well-known to require comment.

In conformity with the plan adopted in former numbers of these Contributions, I shall now proceed to discuss the general results of the observations embodied in this memoir under the separate heads of Magnetic Force and Inclination; referring where necessary to the documents in the sequel.

Magnetic Force.

The statical observations of the total Force furnish determinations at 120 stations, at 73 of which LLOYD's needles were employed, and Fox's needles at 109 stations. The observations of the horizontal force, with the magnets of the portable magnetometers, furnish determinations at 57 stations. The statical and horizontal methods together comprise 140 stations: the observations are given, and the results deduced in § 11. To these we have to add 10 determinations made at 10 stations near New York by Mr. RENWICK, with a portable unifilar; and the ratios of the horizontal force at 101 stations, chiefly in the United States, by Dr. LOCKE, with a HANSTEEN's apparatus in which the needles vibrated in a partial vacuum. The connection of Dr. LOCKE's observations with those of Lieut. LEFROY, has been established by means of eleven stations common to both series, enabling both to be expressed in a common unit. The general table, No. XLVIII., which concludes § 11, comprehends 288 determinations of the magnetic force at 234 stations. Of the determinations 32 are of the absolute horizontal force, in which the magnetic moments of the magnets employed were examined on the spot: 35 were obtained with the same magnets, and give also the absolute horizontal force, but the magnetic moments were computed for the stations from experiments of deflection at other stations: 101 are of the ratios of the horizontal force, observed with needles whose magnetism was proved to be constant by their having been frequently brought back and examined at a base station; and 120 are ratios of the total force obtained by the statical method, in which also the magnetism of the needles was proved by their having been brought back to a base station. The number of stations at which statical ratios only were obtained is 74; the number at which horizontal ratios only were observed is 85; the number of the stations of absolute horizontal determinations only (whether by vibrations and deflections, or by vibrations alone) is 29; and finally, there are 37 stations at which both absolute and relative determinations were made.

As all the stations of relative determination have the observatory at Toronto as a

common base, it becomes an object to investigate with more than ordinary care the value of the total magnetic Force at that observatory, both in the arbitrary scale and in absolute measure.

In the present state of experimental methods and apparatus we must obtain the absolute Force from the observations of its horizontal component, combined with observations of the Inclination. At Toronto we have for this purpose the values of the horizontal component resulting from the regular monthly series, made in the observatory on the 16th, 17th and 18th of each month in the year 1845, with a suspended magnet of three inches, and a deflecting magnet of 3·67 inches, the same magnets being used throughout. The details of these observations will be printed in the volume of the proceedings at the Toronto Observatory for the year 1845; the results are as follows:—

January	3·5377.	April	3·5351.	July	3·5413.	October	3·5373.
February	3·5376.	May	3·5388.	August	3·5383.	November	3·5360.
March	3·5375.	June	3·5421.	September	3·5373.	December	3·5379.

The mean of the twelve months is 3·5380; and the mean of the Inclinations observed on the days in each month, nearest to those on which the Force was observed, is 75° 15′·5: hence we have for the total force in absolute measure, 13·904.

The magnets employed in the preceding determination were those of the Observatory unifilar. In September of the same year (1845), a very careful series of observations were made with the magnets Nos. 30, 31 and 17, of the unifilar magnetometer which had been employed on the survey; the particulars are given in the following Table:—

TABLE I.—Observations on the absolute Horizontal Force made at Toronto with the Survey bars, Nos. 30, 31 and 17, in September 1845, reduced to the mean reading of the Bifilar Magnetometer for the day of observation.

Date.	Bars.	Distances.	Bifilar. Mean of the day. Sc. div.	Bifilar. Mean of the day. Therm.	Bifilar. At the observation. Sc. div.	Bifilar. At the observation. Therm.	Deflections. Angles.	Deflections. Therm.	Vibrations. Times.	Vibrations. Therm.	Corresponding bifilar. Sc. div.	Corresponding bifilar. Therm.	Suspension.	Value of m.	Value of X.
		feet.		°		°	° ′ ″	°	s.	°		°			
Sept. 19.	30	1·0257	568·9	64·0	564·2	65·0	11 26 26	61·5	4·8666	61·6	558·2	64·4	*s.*	·3806	3·5311
19.	30	1·0257	.....	.....	569·7	64·9	8 37 49	61·8	4·0136	62·7	565·2	65·9	...	·3805	3·5315
19.	30	1·2257	.....	.....	572·0	64·7	6 40 47	61·9	.....	.....	.....	.....	...	·3806	3·5311
19.	30	1·3257	.....	.....	571·7	65·2	5 16 35	61·5	.....	.....	.....	.....	...	·3806	3·5313
20.	31	1·0257	575·5	60·2	569·9	62·1	9 54 19	61·3	4·3292	60·0	558·3	61·9	...	·3305	3·5353
20.	31	1·1257	.....	.....	571·2	62·1	7 29 4	61·3	5·2409	62·0	575·9	62·4	*s.*	·3306	3·5347
20.	31	1·2257	.....	.....	569·6	62·1	5 47 35	61·5	.....	.....	.....	.....	...	·3305	3·5354
20.	31	1·3257	.....	.....	569·3	62·0	4 34 53	61·7	.....	.....	.....	.....	...	·3306	3·5340
22.	17	1·1517	589·2	56·3	592·6	57·2	13 26 57	55·8	4·4196	57·6	592·8	57·9	...	·6291	3·5390
22.	17	1·4517	.....	.....	591·6	57·1	6 39 38	56·2	4·4149	56·0	584·7	55·8	...	·6290	3·5396
24.	17	1·1517	573·1	57·4	586·8	57·0	13 26 2	57·5	4·4138	56·5	581·1	56·7	...	·6287	3·5362
24.	17	1·4517	.....	.....	587·0	57·0	6 39 11	57·5	.....	.....	.....	.....	...	·6279	3·5404
															3·5350

The 2nd observation of vibration of bar 17 entered on the 22nd was made on the 23rd, but is reduced to the mean bifilar reading of the 22nd. When *s.* is inserted in the column entitled "suspension," it implies that the magnet was suspended in a stirrup; otherwise the magnet was suspended without a stirrup. The value of $\pi^2 K$ for bar 30 is 21·580 without the stirrup, and 31·745 with the stirrup; for bar 31, 21·853 without the stirrup, and 32·004 with the stirrup.

The mean result of this series is 3·5350; and the Inclination from observations made on the same days 75° 15′·8: hence we have the total force 13·897.

Finally, we have another series made with Nos. 30 and 31 in April 1846, and on this occasion unusual care was bestowed on the observations both of the Force and of the Inclination, preparatory to a repetition with the same instruments at Woolwich, for the purpose of making the comparison between Woolwich and Toronto as *relatively* correct as possible. The particulars of these observations are contained in the following Tables :—

TABLE II.—Observations on the absolute Horizontal Force made at Toronto with the Survey bars Nos. 30 and 31, in April 1846, reduced to the mean reading of the Bifilar Magnetometer for the day of observation.

Date.	Bars.	Distances.	Bifilar.				Deflections.		Vibrations.		Corresponding bifilar.		Value of *m*.	Value of X.
			Mean of the day.		At the observation.									
			Sc. div.	Therm.	Sc. div.	Therm.	Angles.	Therm.	Times.	Therm.	Sc. div.	Therm.		
		feet.		°		°	° ′	°	s.	°		°		
April 6.	31	1·026	579·5	55·0	572·6	56·3	10 27·9	59·2	4·2061	50	581·0	54·5	0·349	3·538
6.	31	1·126	.....	.....	606·6	57·0	7 54·5	58·2	4·2062	50	615·6	57·1	0·349	3·535
7.	30	1·026	580·5	55·4	576·5	56·2	11 28·0	48·5	4·0084	50	573·2	54·5	0·380	3·530
7.	30	1·126	.....	.....	573·8	56·5	8 39·4	48·8	4·0114	50	578·7	56·6	0·380	3·530
8.	31	1·026	592·4	51·7	581·6	52·2	10 28·8	48·7	5·0985	50	586·7	51·6	0·348	3·535
8.	31	1·126	.....	.....	584·0	52·1	7 54·9	48·3	.....	.....	.....	.....	0·348	3·535
8.	31	1·226	.....	.....	586·2	52·1	6 8·0	48·3	5·0995	50	592·3	52·7	0·348	3·533
9.	30	1·026	595·6	51·2	581·7	52·8	11 23·3	61·2	4·8685	50	588·2	51·2	0·379	3·532
9.	30	1·126	.....	.....	583·2	52·7	8 36·0	62·0	.....	.....	.....	.....	0·379	3·531
9.	30	1·226	.....	.....	582·5	52·6	6 39·4	62·5	4·8749	50	594·9	53·6	0·379	3·531
														3·533

TABLE III.—Observations of the Inclination made on the Pedestal of the Telescope used in the Observations of Vibration, and intended for comparison with a Base series of observations of the absolute Horizontal Force. April, 1846.

Date.	Observer.	Poles direct.					Poles reversed.					Mean Inclination.
		a.	*a′*.	*a″*.	*a‴*.	Mean.	*b*.	*b′*.	*b″*.	*b‴*.	Mean.	
April.												
6 A.M.	L.	74 55·8	75 42·9	75 29·1	74 43·6	75 12·8	75 4·8	75 31·6	75 33·1	75 2·8	75 18·1	75 15·5
P.M.	H.	75 3·8	75 45·6	75 32·8	75 1·7	75 21·0	75 2·2	75 30·9	75 27·6	74 46·2	74 11·7	75 16·3
7 A.M.	H.	75 4·3	75 34·8	75 34·8	75 4·0	75 19·4	74 57·4	75 41·8	75 31·4	74 44·4	75 13·7	75 16·5
P.M.	H.	75 4·3	75 31·2	75 24·9	74 48·1	75 12·1	75 1·4	75 45·3	75 33·2	75 1·4	75 20·3	75 16·2
8 A.M.	Y.	74 54·9	75 41·1	75 24·0	74 38·2	75 9·5	75 3·5	75 27·7	75 39·7	74 56·3	75 16·8	75 13·1
P.M.	H.	75 3·7	75 43·1	75 33·9	75 0·8	75 20·4	75 1·1	75 29·1	75 31·3	74 44·5	75 11·5	75 16·0
9 A.M.	L.	75 6·3	75 31 6	75 30·2	75 1·0	75 19·3	75 2·4	75 37·2	75 39·3	75 2·6	75 20·3	75 18·8
P.M.	L.	74 56·1	75 27·5	75 33·2	74 45·4	75 10·5	74 58·8	75 42·9	75 36·7	75 0·6	75 19·2	75 15·0
11 A.M.	W.	74 56·2	75 38·4	75 21·2	74 46·0	75 10·4	75 3·0	75 30·8	75 31·0	75 2·2	75 16·7	75 13·6
13 A.M.	H.	75 3·2	75 39·7	75 34·1	75 3·3	75 20·1	75 0·5	75 29·3	75 28·4	75 45·6	75 10·9	75 15·5
Mean Inclination, corresponding to the series of absolute horizontal Force.....												75 15·65

The instrument employed was GAMBEY's circle. Needle 1 was used for all the A.M. observations, and Needle 2 for all the P.M. observations, with the exception of the A.M. observation on the 13th, for which 2 was employed. The observers were, L. Lieut. LEFROY; Y. Lieut. YOUNGHUSBAND; H. Sergeant HENRY; W. Sergeant WALKER.

The mean of this series of the Force is 3·5330, and of the Inclination 75° 15′·65; hence we have the total Force 13·887.

The three determinations are as follows:—

By the observatory magnets in the twelve months of 1845 . . . 13·904
By the three survey magnets in September 1845 . . . . . 13·897
By two of the three survey magnets in April 1846 . . . . . 13·887

Whence we have the total Force in absolute measure at Toronto = 13·896.

For the value of the total Force in the arbitrary scale, we have,—

1. A determination of the absolute Horizontal Force at Woolwich in June 1846, made by Captain Lefroy with the survey magnets Nos. 30 and 31, as shown in the following Table:—

Table IV.—Observations of the absolute Horizontal Force, made at Woolwich with the Survey bars Nos. 30 and 31. The corresponding readings of the Bifilar at Greenwich, kindly communicated by Mr. Airy, are inserted for reference. The times of vibration are entered as reduced to the common temperature of 80°, and corrected for torsion and rate: the angles of deflection are entered as observed.

Date.	Bar.	Distance.	Deflection.			Vibration.			Values of *m*.	Values of X.	
			Angles.	Therm.	Bifilar at Greenwich.	Times.	Therm.	Bifilar at Greenwich.			
1846.		feet.	° ′	°		s	°				
June 8.	30	1·026	10 43·5	75·7	.....	4·7621	80	0·01897	0·375	3·725	
8.	30	1·126	8 6·0	76·0	0·01938	.....	80	.....	0·375	3·725	
8.	30	1·226	6 15·8	79·3	.....	3·9287	80	0·01973	0·375	3·726	
11.	31	1·026	9 47·9	85·2	.....	4·9944	80	0·01872	0·344	3·730	3·7284
11.	31	1·126	7 23·7	85·8	0·01977	.....	80	.....	0·344	3·732	
11.	31	1·226	5 43·0	84·5	.....	4·1204	80	0·02112	0·344	3·735	
12.	31	1·026	9 45·6	89·0	0·01888	4·1240	80	0·01826	0·344	3·727	
12.	31	1·126	7 22·4	91·0	.....	4·9975	80	0·02221	0·344	3·727	

The mean is 3·7284; and the mean of eight observations of the Inclination, made also between the 8th and 12th of June, with the same needles of Gambey's Inclinometer which had been employed to give the Inclination at Toronto, was 68° 57′·9; hence we have the total force in absolute measure at Woolwich = 10·388.

We have therefore the total magnetic Force at Toronto to that at Woolwich as 13·896 to 10·388; or as 1·338 : 1: and taking 1·372 as the Force at Woolwich expressed in the arbitrary scale, we have the corresponding value at Toronto 1·835.

2°. A statical determination of the ratio of the Force at Toronto and Woolwich by Mr. Fox's apparatus, conveyed by Lieut. Lefroy in 1842 from Woolwich to Toronto; the particulars will be found under their proper dates in the general detail of the observations in § 11; the result was 1·340 at Toronto to unity at Woolwich; or 1·838 to 1·372.

3°. A second statical determination with the same apparatus, which Captain

Lefroy, having occasion to return to England in the spring of 1846, brought with him from Toronto to Woolwich for that purpose. The particulars are contained in the subjoined Table; the ratio resulting from them is identical with that obtained by the absolute method, viz. 1·835 to 1·372.

Table V.—Observations with Fox's Circle to determine the relative Intensity of the Magnetic Force between Toronto and Woolwich. Needle C. $q=\cdot00017$.

Station.	1846.	Angles of deflection. 1·5 gr.	2·0 grs.	2·5 grs.	3·0 grs.	Thermometer.	Intensity. Woolwich =1·372.
Toronto ..	March 28.	19° 59′·2	27° 44′·7	35° 19′·7	44° 18′·5	42·6	1·835
	March 31.	20 02·8	27 37·7	35 11·0	44 13·5	57·3	
	April 2.	19 59·5	27 39·6	35 13·5	44 18·0	69·0	
Woolwich..	May 26.	27 03·2	38 34·6	50 41·7	69 42·5	68·4	1·372
	May 28.	27 14·5	38 33·8	50 53·2	69 30·3		

We have therefore three determinations of the total Force at Toronto expressed in the arbitrary scale, which are as follows:—

By the statical method in 1842	1·838
By the absolute method in 1845–46	1·835
By the statical method in 1846	1·835

I have therefore concluded on taking 1·836 as the value in the arbitrary scale of the total Force at Toronto; and as all the relative determinations discussed in this memoir were either originally made in reference to Toronto as a base station, or have become connected with it by subsequent comparison, they form one series, and the values expressed in this scale, in the general table, No. XLVIII., are all dependent on 1·836 as the Force at Toronto; and will all require to be increased or diminished should future investigations show that 1·836 has been incorrectly adopted.

Having then the values of the total Force at Toronto, 1·836 in the arbitrary scale, and 13·896 in absolute measure, arbitrary values are convertible into absolute by the factor $\frac{13\cdot896}{1\cdot836}$, and absolute into arbitrary by $\frac{1\cdot836}{13\cdot896}$. The absolute values of the total Force in the general table, No. XLVIII., have been thus computed in all cases when the original determination was a ratio, either total or horizontal; when the original determination was of the absolute horizontal Force, the absolute total Force computed therefrom is the product of the horizontal component and the secant of the observed Inclination.

The simplest form, in which an approximate representation of the isodynamic ovals round the point of maximum, and within a limited distance of it, may be *computed*

from observations distributed in the space included by those lines, appears to be that of concentric and similar ellipses. The representation will not be strictly just, because the curves which include the two points of maximum in a hemisphere are of the nature of lemniscates, and not of true ellipses, and the curves of higher intensity inclosed within them partake of the same form. I have taken for a calculation of this nature all the observations by the statical methods of Lloyd and Fox in which the resulting value of the Force equals or exceeds 1·838; with the exception of two stations, viz. the Little Rock Portage and Pierre au Calumet, where a comparison of the values, both of the Inclination and Force, with those at adjacent stations, shows that a great disturbing influence prevailed: and I have included the three stations at the foot of the Rocky Mountains, viz. Forts Vermilion, Dunvegan and Edmonton, where the intensity is less than 1·838, but the position important; as well as Toronto, where the value of the force is just beyond the limit (being 1·836), but has the advantage of having been remarkably well determined. The number of stations in this combination is seventy-eight, and double weight has been given to four, viz. Norway House, Cumberland House, Shamatawa and York Factory, on account of the repetition of the observations. These stations furnish therefore eighty-two equations of condition of the form described in the following Note, for which I am indebted to Archibald Smith, Esq., of Lincoln's-Inn, Fellow of Trinity College, Cambridge.

"*Note on the calculation of the Isodynamic Curves and the Focus of greatest intensity in North America.*

"These isodynamic curves consist of a series of ovals surrounding the point of greatest intensity.

"The method of combining the observations at different stations which was used in the Magnetic Survey of Great Britain*, and which proceeded on the assumption that the isodynamic lines were nearly straight, cannot therefore be applied. The most simple assumption which will give an approximate result, and admit of all the observations within a given limited space being combined in the calculation, appears to be the following:—

"Let a place near the centre of the region which is to be included in the calculations, be taken as the central station and origin of coordinates. Let y_1 and y_2, &c. be the differences of the latitudes of the several stations (which may be called s_1, s_2, &c.), and that of the central station:

"Let x_1, x_2, &c. be the differences, multiplied respectively by the cosines of the latitudes of s_1, s_2, &c., of the longitudes of s_1, s_2, &c., and that of the central station.

* See Reports of the British Association for 1838.

"The position of a station of observation is thus determined by a distance in geographical miles measured along the meridian which passes through the central station, and a distance in geographical miles measured along that parallel of latitude which passes through the station of observation.

"Let z be the magnetic element whose value is to be determined, which in this case is the total intensity, and let z_1, z_2, &c. represent the values observed at s_1, s_2, &c.

"Assume that z may be expressed by the formula

$$z=ax^2+bxy+cy^2+dx+ey+f.$$

"This amounts to assuming that the isodynamic curves may be represented by a series of similar and similarly situated concentric ellipses, on a plane projection of the sphere, in which parallels of latitude are represented by equidistant horizontal straight lines, the meridian passing through the central station by a vertical straight line, and the other meridians by curved lines which all intersect in the projection of the poles, and each of which intersects the projection of the equator at right angles at a distance from the central meridian proportional to the difference of its longitude and that of the central meridian, (and equal to the projection of a corresponding number of degrees of latitude,) and intersects the other parallels of latitude at distances from the central meridian, which are to the last-mentioned distance as the cosines of the latitude of the respective parallels of latitude are to unity.

"Each station gives an equation of the form

$$\begin{aligned} z_1&=ax_1^2+bx_1y_1+cy_1^2+dx_1+ey_1+f\\ z_2&=ax_2^2+bx_2y_2+cy_2^2+dx_2+ey_2+f\\ &\cdots\cdots\cdots\cdots\\ z_n&=ax_n^2+bx_ny_n+cy_n^2+dx_n+ey_n+f. \end{aligned}$$

"These equations being properly *weighted* are then combined by the method of least squares, and the values of the constants a, b, c, d, e and f are to be determined by elimination. One test of the applicability of this method is, that the resulting curves should be ellipses and not hyperbolas; a and c must therefore have the same signs, and $4ac$ must be greater than b^2.

"Having determined the constants a, b, &c., the coordinates $\bar{x}$, $\bar{y}$ of the common centre of the ellipses, which is also the place of the greatest intensity, are given by the equations

$$\begin{aligned} 2a\bar{x}+b\bar{y}+d&=0,\\ b\bar{x}+2c\bar{y}+e&=0, \end{aligned}$$

which give $$\bar{x}=\frac{be-2cd}{4ac-b^2}. \quad \ldots \quad (1.)$$ $$\bar{y}=\frac{bd-2ae}{4ac-b^2}. \quad \ldots \quad (2.)$$

The maximum value of the intensity is

$$\bar{z}=f+\frac{bde-cd^2-ae^2}{4ac-b^2}. \quad \ldots \quad (3.)$$

"If θ be the angle which either axis of the ellipses makes with the parallels of latitude, we have

$$\tan 2\theta = \frac{b}{a-c} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4.)$$

"This expression is ambiguous, giving two directions at right angles to each other, and does not determine which of these directions is that of the major axis. This will generally be apparent from the observations themselves; and it may be determined by this consideration, that if the numerical value of a be greater than that of c, the inclination of the major axis to the parallel of latitude is greater than 45°; if less, less.

"The values of the semi-axes of the isodynamic ellipse for which the intensity has the value z, are given by the two values of the expression

$$\text{semi-axis} = \sqrt{\frac{2(z-\bar{z})}{a+c \pm \sqrt{(a-c)^2+b^2}}} \quad \ldots\ldots\ldots\ldots \quad (5.)$$

"The proportions of the semi-axes are

$$a+c \pm \sqrt{(a-c)^2+b^2} : 4ac-b^2 \quad \ldots\ldots\ldots\ldots \quad (6.)$$

"The simplest method of drawing the isodynamic ellipses will be to lay down the parallels of latitude and meridians in the manner above described; the isodynamic curves are true ellipses on that projection and may be easily constructed, and the points at which they intersect the meridians and parallels of latitude may then be laid down on any other map." A. S.

Lincoln's Inn.

I have taken the intersection of the latitude of 53° with the meridian of 260° as the origin of coordinates; the values of x_1, x_2, &c., y_1, y_2, &c., were taken in units each of ten geographical miles; and, for convenience in calculation, the excess above 1·798 has been taken at the value of z, the observed force at each station, and the decimals regarded as integers; the eighty-two equations thus furnished of the form described in Mr. Smith's Note have been combined by the method of least squares, to obtain the most probable values of the constants a, b, c, d, e and f, the calculations having been performed by Sergeant McGrath and Corporal Hendley of the Royal Artillery, independently of each other, and agreeing; the six final equations were:—

$$\begin{array}{rrrrrrrrrrrr}
+ & 5081 = + & 134394a & - & 69949b & + & 48449c & + & 1632d & - & 660e & + & 82f \\
- & 37298 = - & 3779899a & + & 2198523b & - & 1142033c & - & 69949d & + & 48449e & - & 660f \\
+ & 98527 = + & 7136612a & - & 3779899b & + & 2198523c & + & 134394d & - & 69949e & + & 1632f \\
+ & 2603880 = + & 177659938a & - & 96701976b & + & 57677688c & + & 2198523d & - & 1142033e & + & 48449f \\
- & 3570819 = - & 323660394a & + & 177659938b & - & 96701976c & - & 3779899d & + & 2198523e & - & 69949f \\
+ & 6822989 = + & 622718413a & - & 323660394b & + & 177659938c & + & 7136612d & - & 3779899e & + & 134394f.
\end{array}$$

From these equations the values of the constants were obtained by elimination as follows:—

$a=-\cdot01138$	$d=+\ 0\cdot5633$
$b=-\cdot02522$	$e=+\ 0\cdot4485$
$c=-\cdot0356$	$f=+72\cdot54.$

With these constants we obtain

$\bar{z}=79\cdot9$; and the Force at the point of maximum $=(1\cdot798+\cdot0799=)1\cdot878$:

$\bar{x}=+29\cdot38$; whence the difference of longitude between the origin of coordinates and the point of maximum $=(+293\cdot8$ miles $\times \sec 52^\circ\cdot19'=+481'=)+8^\circ\cdot01'$:

$\bar{y}=-4\cdot07$; whence the difference of latitude between the origin and the point of maximum $=-40'\cdot7$.

The geographical position of the maximum therefore is 52° 19′ N., and 268° 01′ E. The angle which the major axes make with the parallel of geographical latitude is $\frac{180-46^\circ\ 10'}{2}=66^\circ\ 55'$; and the values of the semi-axes of the ellipse of 1·875 are 223 and 85 geographical miles respectively.

The line of 1·875 has been drawn first on a map on a plane projection, and then transferred to the map on the polar projection which accompanies this memoir. The lines more distant from the maximum, viz. those of 1·850 and 1·800, have been drawn by the hand without the employment of calculation, and in such accordance with the observations as could be judged by the eye. The intensities entered in the map, and by which the lines have been drawn, are those of 192 stations. They include all the stations at which the total Force has been computed in the arbitrary scale, and inserted in the general table, No. XLVIII., except at 15 stations, where there is reason to believe that local disturbance prevailed to a considerable amount. The values of the total Force are derived from horizontal and statical ratios in the United States, and from statical ratios only in the countries to the north, where the Inclination became so great as to introduce an element of much uncertainty in the deduction of the total Force from its horizontal component. The intensities at four stations on the western side of the continent, on the shores of the Pacific, are introduced from the observations of Sir Edward Belcher, discussed in the IVth number of these Contributions. The line of 1·7, distinguished by a different character from that in which the other lines are drawn, is taken from the map (already referred to) in the Reports of the British Association for 1837, and is introduced into the present map for the purpose of affording a more ready means of comparing the form and geographical position of this line, with those of the lines inclosed within it, which are now for the first time delineated from observations, all of which have been made subsequently to the period when the map from which the line of 1·7 is taken was published. The accordance of the earlier and more recent observations is thus distinctly brought into view; and it will be perceived that the modifications, if any, which the line of 1·7 will require, will be very slight. With respect to the geographical position of the point of maximum

of the Force, as it has been now computed from seventy-eight stations visited in 1843 and 1844, and surrounding the maximum in all directions, the coincidence with the central point of the closed curve of 1·7, as drawn in the map of 1837, could scarcely have been more perfect.

Materials for the extension of the isodynamic lines to the north and east of the present survey will shortly be supplied,—to the north by the Expedition under Sir JOHN FRANKLIN,—and to the east by Lieut. MOORE of the Royal Navy, whose magnetic observations in Her Majesty's ship Terror form an important portion of the Survey accomplished by the Expedition under Sir JAMES Ross; and whose subsequent observations in the Pagoda, in conjunction with those of Lieut. CLERK, R.A., in the completion of that survey, will form the VIIIth number of the Contributions. Under the direction of the Lords of the Admiralty, Lieut. MOORE has proceeded in the present summer to Hudson's Bay, in one of the vessels of the Hudson's Bay Company in which a passage has been kindly granted him, for the purpose of obtaining a suite of determinations intermediate between those which form the subject of the present communication, and those which are now in progress by the officers of the Arctic Expedition. The magnetic lines surrounding the one of the two points of maximum intensity which is on British territory, will thus be completely delineated: and I may be permitted to express a hope, founded on the unsparing liberality of the Russian Government in other branches of magnetical research, that the lines which surround the other point of maximum intensity in the northern hemisphere, which is within the Russian dominions, may ere long be determined with an equal completeness. The geographical longitude of the Siberian maximum is approximately known from the observations of HANSTEEN, DUE and ERMAN; but an equally correct knowledge of its latitude appears to require an extension of the researches to the shores of the Polar Ocean.

The intensity of the magnetic Force at its point of maximum in North America is 1·878 in the arbitrary scale; or 14·21 in absolute measure, of which the units are,—of mass a grain, of time a second, and of space a foot, in British weights and measures.

The intensity of the Force near the corresponding point in the southern hemisphere may be taken approximately, from a group composed of the daily determinations made by Sir JAMES Ross's Expedition from the 19th to the 27th of March 1841, between the latitudes of $-58°$ and $-64°\ 26'$, and longitudes of $128°\ 40'$ E. and $148°\ 20'$ E., the track of the Expedition when crossing the southern isodynamic ellipse of 2·000 about midway between the extremities of its principal axis. The mean of the results of this group is 2·059, or in round numbers, 2·06 in lat. $-64°$ and long. $137°{\cdot}5$, or in absolute measure 15·60. Neither the position of this maximum, nor the value of the Force, can be regarded as determined with as much precision as we may consider those at the northern maximum now to be; but we may conclude with certainty, that at the present magnetic epoch the Force at the southern maximum is consider-

ably greater in amount than at the northern, and that its position is in a somewhat higher geographical latitude than the corresponding point in the north; as is also apparently the southern point of 90° of Inclination; and probably also the position of the minor maximum of Force. If however we take a general view of the isodynamic lines in the two hemispheres, we see reason to believe that the difference under notice is rather a consequence of a different distribution of Force, than of an actual disparity in the magnetic charge of the two hemispheres. The two points of maximum in the south being nearer together at the present epoch (*i. e.* their shortest distance apart being less) than in the north, the intensity of the Force at both is raised, and a greater inequality is produced in the intensity on opposite sides of the southern hemisphere, than is the case in the northern hemisphere.

The progress of secular change, as it may be inferred from the comparison of the earlier and more recent observations of the Declination and Inclination, is tending to bring the two points of maximum in each hemisphere nearer to each other; whilst this progressive approximation continues, we may expect that the Force in each hemisphere will become more and more unequally distributed, and that the intensity at each of the four points of maximum will augment. The increase or decrease of the distance in geographical longitude between the two points of maximum in a hemisphere appears to be chiefly occasioned by the rapid secular change in respect to locality (or the rapid movement in translation) which the phenomena of the minor system undergo. The minor maximum was probably at its greatest elongation (180° of geographical longitude) from the major maximum in the *northern* hemisphere, some time in the last century. At that epoch therefore the distribution of Force in that hemisphere made its nearest approach to equality; the opposite geographical longitudes had the minimum of dissimilarity in their respective intensities, and the values of the Force at the major and minor maxima were respectively lower than at any other epoch. In this conclusion I have omitted the subordinate consideration of the influence which the distribution of the Force in the southern hemisphere exercises on the northern intensities, which is distinctly perceptible even in the middle magnetic latitudes, and adds to the complication of the phenomena of progressive motion occasioned by secular change. The influence of the one hemisphere becomes of course more and more effective on the phenomena of the other, as the line which separates the magnetic hemispheres is approached: it is this circumstance which renders the phenomena in the equatorial regions of the globe so much more complicated than elsewhere, so much more difficult to disentangle, and consequently so much less suited to conduct readily to a comprehension of laws. It has been justly said that meteorological phenomena should be studied, in the first instance, in the tropical rather than in the temperate zones, because they present themselves under a simpler aspect: the contrary is true in respect to the magnetical phenomena, both in the distribution of the Force at a particular epoch, and in the order and succession of secular changes, which nowhere appear so complicated as in the lower magnetic latitudes, where they

cannot be understood unless the magnetic state of both hemispheres is taken into the account.

The coincidence of two or more points of maxima, (whether in the same or in different hemispheres,) under one and the same geographical meridian, may constitute *magnetic epochs*, which in the future history of the science may create an interest which can be very little conceived at present. The first conjunction of this kind, which our present purely empirical knowledge permits us to anticipate, is that of the *two minor maxima*, which, if the same progress of translation should continue that appears to have taken place in the last two and a half centuries, will hereafter be found on the same geographical meridian, and on the same side of the globe. Accompanying the movement of the two minor maxima of Force, the remarkable closed systems of the Declination lines, which are now found respectively in Siberia and in the Southern Pacific, by a movement of translation corresponding to that which they have undergone in the last two centuries, will also be found hereafter in the same geographical meridian, and will then doubtless have experienced a considerable modification of their form.

If we connect the two points of 90° of Inclination, the one in the northern and the other in the southern hemisphere, by an arc of a great circle crossing the terrestrial equator in the Atlantic Ocean, and if we examine the Inclination and Force along this arc, we shall find that the portions in which the Force *decreases* whilst the Inclination *increases*, amount to nearly a *third* of the whole distance between the points of 90° thus measured along the surface of the globe. Not only therefore is the once-supposed law, according to which the magnetic Force should everywhere increase in a certain expressed ratio with the increase of the magnetic latitude, inapplicable to the phenomena, but the modification which has latterly been substituted,—"*the law*," as it has been lately expressed, "of the *general* increase of the magnetic Force with the magnetic latitude,"—seems scarcely justified by the facts; and it may be doubted whether this expression is not more likely to mislead, by perpetuating the erroneous hypothesis in which it first took its rise, than to be of advantage as an empirical law, where the exceptions are so considerable. It is obvious that a too hasty generalization from observations made in those regions of the globe where the Force decreases with the increase of the dip, (as for example in the twenty degrees of latitude, or thereabouts, in North America, comprised between the point of maximum of the Force, and the point of 90° of Inclination,) might have appeared to justify an inference which would have been the direct contrary of the above-mentioned law. There is in fact no such connection between the Inclination and the Force as will justify the one being spoken of as an immediate function of the other, or will sanction a *general* statement, that the increase of the one is to be looked for from the increase of the other, or *vice versâ*.

I have generally preferred, in these Contributions, the employment of the expres-

sions "line of no Inclination" and "position or point where the Inclination is 90°," to the more technical designations of "magnetic equator" and "magnetic pole," because I have noticed that, since it has been known that the locality of the dip of 90° is not that of the maximum of Force, and that the line of no Inclination is not that of least intensity, an ambiguity has prevailed in the use of the technical expressions, which has frequently been prejudicial to a clear understanding of the passages in which those terms are employed. It would not be difficult to show, in the recent writings even of persons actively engaged in the advancement of magnetical science, instances in which the term "magnetic pole" is used, where it can have no other meaning than that of a point of greatest intensity; and other instances in which the meaning is doubtful in itself, and is not cleared by the context. The line of no dip is also frequently confounded with that of least intensity, although they represent different phenomena, and occupy different positions on the globe. By some authors the terms "pole of intensity" and "pole of verticity" have been introduced, by which ambiguity is indeed avoided; but, whilst the term "pole" is retained, it must be admitted that in one of the two instances at least, it is used in a sense which (whatever may have been its earlier signification) is inconsistent with modern definition from high authority (that of M. Gauss), and with that general understanding of its meaning, which has grown up under the hypothesis, imagined by some natural philosophers and now known to be erroneous, that the magnetism of the globe is analogous to that of a sphere of soft iron rendered magnetic by induction. The points of maximum of Force have also been called "foci" or "centres of Force," terms however which have not been suffered to pass without objection. In papers strictly limited as these Contributions are to investigations into the facts of terrestrial magnetism, I have thought it preferable to employ expressions, which although they may have the real disadvantage of appearing somewhat awkward, especially when they come to be frequently repeated, are subject to no ambiguity, and are obviously unconnected with any hypothesis.

In advocating the consideration which, in a general view of the earth's magnetism, appears to be due to the points in each hemisphere which form the centres of the systems of isodynamic lines, and are themselves points of greatest Force,—and to the circle or curve which encompasses the earth and unites the points in each geographical meridian where the magnetic force is weakest,—I am far from desiring an undue importance to be attached to them, over the points where the needle is vertical (or its inclination is 90°,) and over the line where the direction of the needle is horizontal (or is parallel to the surface of the earth). No general view of terrestrial magnetism is just, or is agreeable to our present knowledge, of which the characteristic features of both phenomena, both of the Inclination and of the Force, do not form a part. In purely magnetical relations indeed,—and remembering that as yet there is no connection established between polar and gravitating forces,—the points of the earth's surface, where the action of the magnetic forces is most intense, have, as it

appears to me, an importance beyond those where the magnetic direction, the resultant of those forces, may happen to coincide with the direction of the gravitating force. In like manner, I consider that the line of least intensity, (or the line on which in every meridian the magnetic Force, having progressively diminished from the high latitudes of the one hemisphere, attains a minimum, and commences a progressive increase to the high latitudes of the other hemisphere,) deserves to be considered as the separating line between the northern and southern *magnetic* hemispheres, more properly than does the line in which the resultant direction of the magnetic forces happens to be perpendicular to the direction of the gravitating force. It may be a question whether this association of the phenomena of independent forces may not have been too exclusively dwelt upon, and have thus become in some respects prejudicial to the advancement of terrestrial magnetism; but the view of the philosopher is imperfect, who, in the contemplation to which he subjects the magnetic phenomena, in the hope of being conducted by the sure path of induction to a knowledge of their laws, omits to give a due consideration, either to those relations which have the advantage of being purely magnetical, or to those coincidences or contrasts which the magnetic phenomena may present in respect to the phenomena of gravitation, or to those of any other of the great physical agents at the surface of our planet.

Magnetic Inclination.

The observations of the Inclination made in Lieut. LEFROY's survey are contained in § 12. The number of determinations amounts to 179 (including 8 by Lieut. YOUNGHUSBAND, R.A. with the same instruments, and 5 by Dr. RAE, an officer of the Hudson's Bay establishment, furnished with an Inclinometer by BARROW), and the number of stations to 162. The general table, which includes the Inclinations observed by gentlemen of the United States, contains 450 determinations made at 335 stations. These were all observed between the years 1835 and 1846, and by far the greater number between 1839 and 1846. I have not attempted to introduce a correction for secular change, as the difference of epoch is small, and the rate of secular change is far from being even approximately known: without doubt also it varies in different parts of the wide district comprehended in this survey. At Toronto, its amount is so extremely small as to be scarcely appreciable by means of the most careful and multiplied observations continued for several years. The earliest observation of the Inclination in the United States, from which a satisfactory conclusion in respect to secular change may be derived, appears by Mr. LOOMIS's investigation*, to have been made by myself in 1822, in the garden of the Lunatic Asylum, near New York. By comparing the result which I then obtained (73° 05′) with those of LOCKE, LEFROY and RENWICK, at the same spot in 1841, 1842 and 1844 (72° 42′·5), we find a diminution in twenty years amounting to 22′·5, or rather more than 1′ an-

* SILLIMAN's Journal, 1842, Art. IX. I believe that I may also claim the credit of having made in the same year the earliest determination of the magnetic force in the United States.

nually. We may therefore presume from these instances, that the error in strict comparability, arising from the omission of a correction for secular change in the observations combined in this survey, the greater part of which differ not more than one or two years from a mean epoch, must be within the limits of the ordinary errors of observation, including of course those of station error.

The method of computing the direction of the isoclinal lines, and the geographical distance between adjacent isoclinals representing certain differences in the amount of the Inclination, by a combination of the observations distributed over a limited district of the earth's surface, was first proposed by Dr. Lloyd in the Magnetic Survey of Ireland: it is simple and convenient when the lines conform to the conditions of being straight, parallel, and equidistant; but the problem becomes complicated and the calculation laborious in proportion as these conditions are departed from, and the number of indeterminate constants increases; until at length both complication and labour become excessive. In the parts of the continent of North America under consideration in this memoir, the variation of the isoclinal lines from the simple form above described is considerable: they are not straight lines on any projection; they are not parallel, nor are they equidistant. I endeavoured, nevertheless, to make the method of calculation answer, by breaking up the whole survey into several districts, and computing for each the coefficients of latitude and longitude, together with a central dip: but when districts were taken sufficiently small to satisfy approximately the required conditions of straightness, parallelism and equidistance, irregularities of observation arising from station error and other causes became significant, and materially influenced the results of the combination. I found myself obliged therefore finally to revert to the graphical method which I employed for the isoclinal lines of the British Survey, and which may be described as follows.

The observations are first entered in a Mercator's map on a sufficiently large scale, a small cross being made to mark the spot of observation in its proper latitude and longitude, with the value of the Inclination written by its side. The isoclinal lines corresponding to degrees are then drawn roughly by the eye as the observations appear to direct. Lines are next drawn through each place of observation perpendicular to the direction of the isoclinal lines at the spot, and distances are set off on them corresponding to the value in geographical miles of the number of minutes which the observed dip is either above or below the full degree to which it is nearest. The value in geographical miles corresponding to the odd minutes is computed proportionally to the distance between the two isoclinals on either side of the place of observation; and it is set off, from the cross which marked the station, towards the isoclinal of the full degree which is nearest to the observation. A cross is then made in a different coloured ink, to mark the spot where the observation places its nearest isoclinal line; it is obvious that if there were no irregularities in the observations, the isoclinal lines would run continuously through these new points. Finally, the original rough draft of the lines is revised in reference to these points, and such

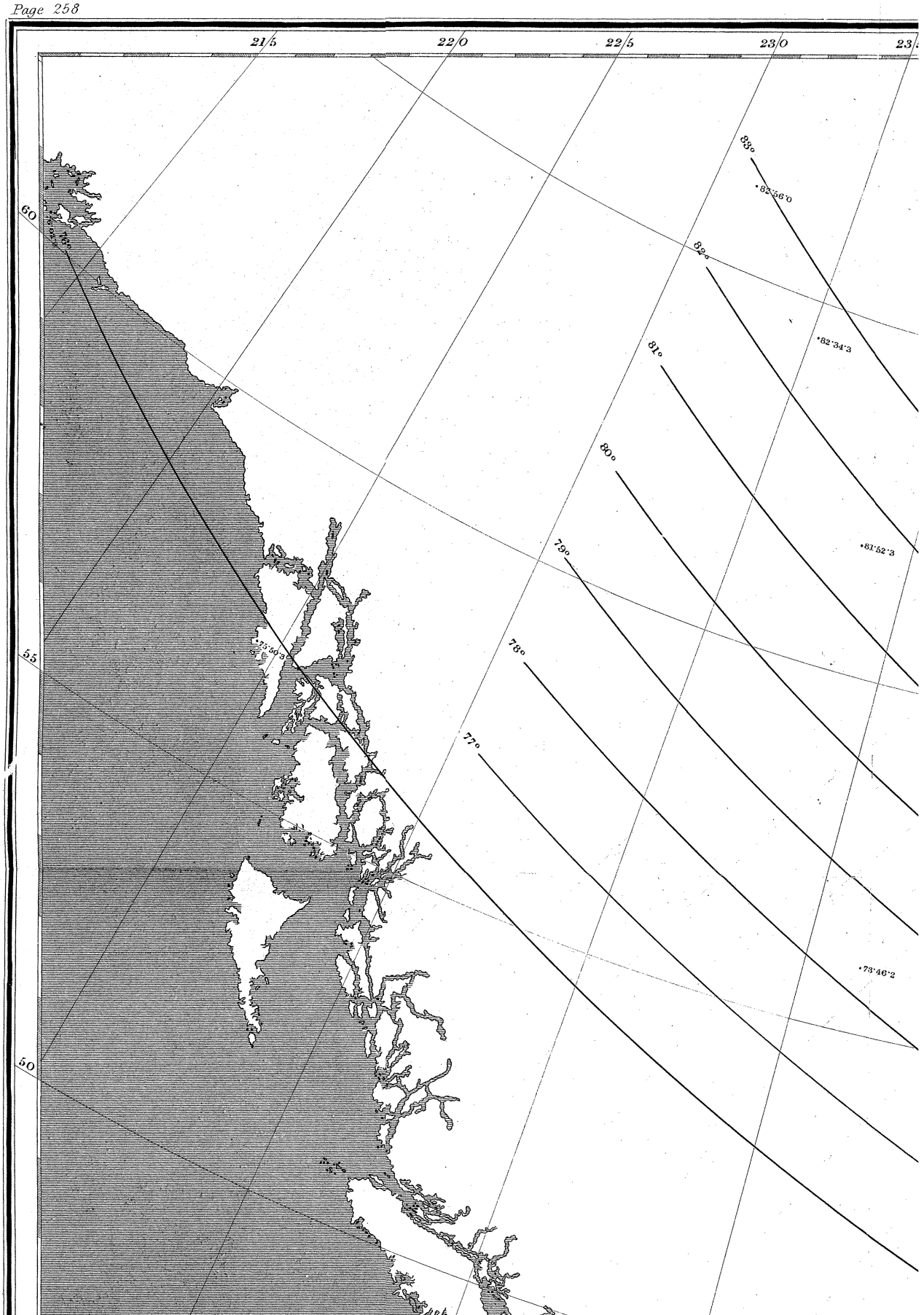
corrections are made in the tracing of the lines as may appear to be required. Observations which, from station error or otherwise, cause their mark to fall amongst those of a different degree from themselves, are given a distinctive sign, so that they do not mislead, whilst at the same time they are kept in view. The number of stations where local influences of this magnitude were found to prevail, amounts to eleven in the 335 stations at which the Inclination is determined in this memoir.

By this process each isoclinal line is deduced independently of those on either side of it, and distinctive features in each are shown, whether resulting from the general system or from district anomalies.

The northern observations of Lieut. Lefroy extend so far to the westward that they overlap the meridians of some of the stations of Sir Edward Belcher, reported in the IVth Number of these Contributions. I have therefore included the four following stations of Sir Edward Belcher in this Map, and the isoclinal lines of 70° and 76° are thus carried across the whole continent of America from sea to sea.

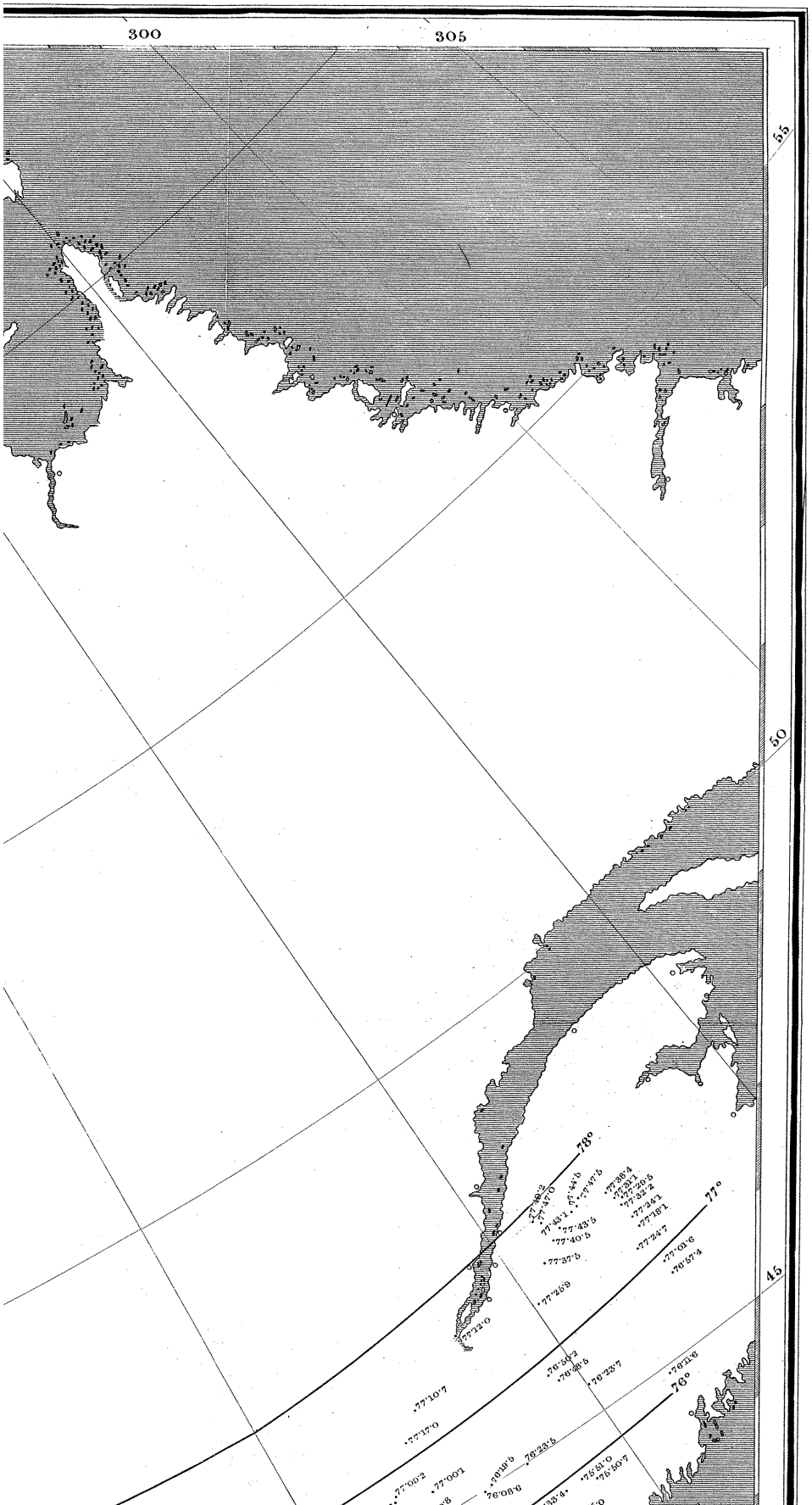
	Latitude.	Longitude.	Inclination.
Port Etches	60° 21′	213° 19′	76° 02′·9
Sitka	57 03	224 36	75 49·1
Baker's Bay	46 17	235 58	69 26·7
Fort Vancouver . . .	45 37	237 24	69 22·2

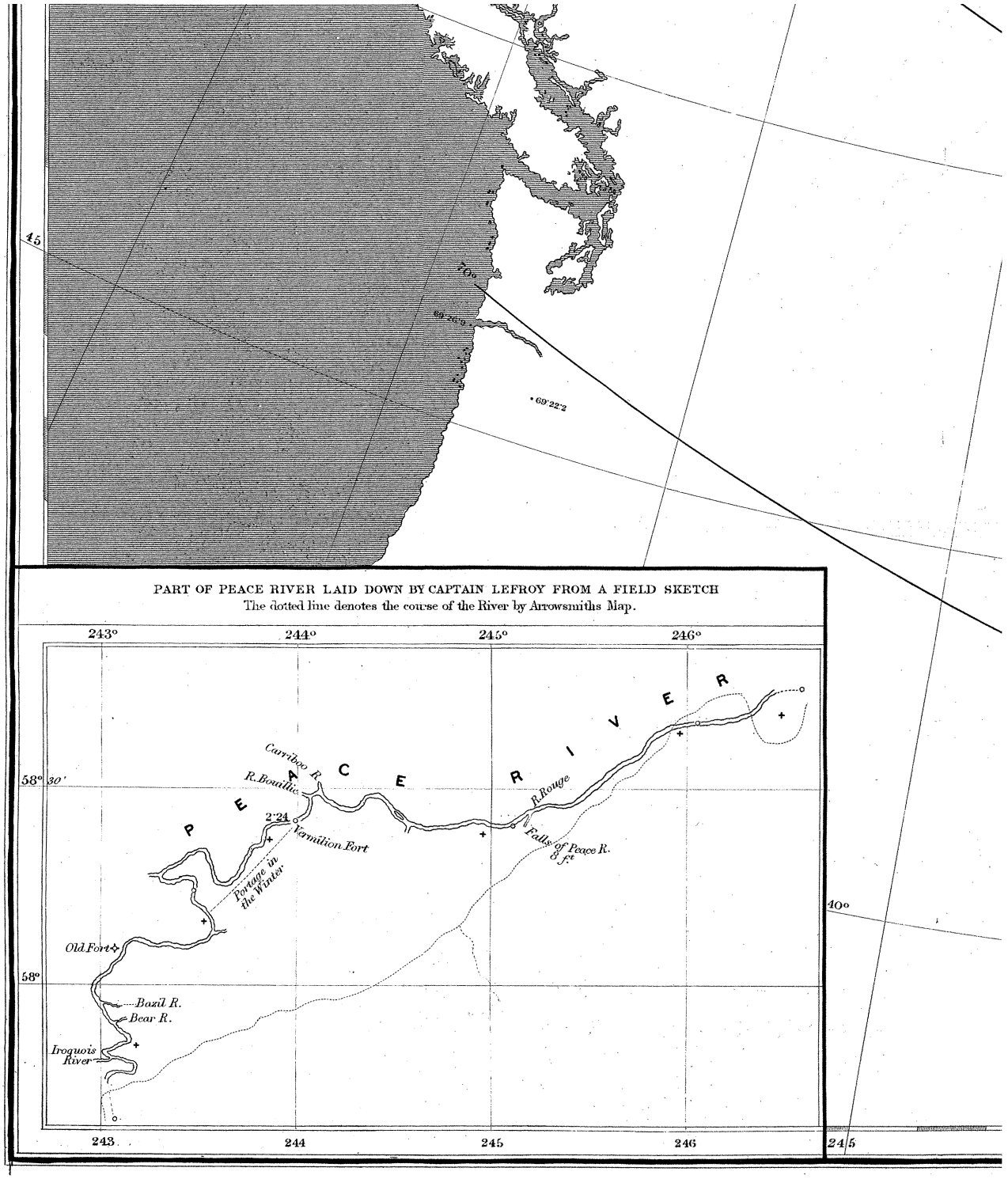
The lines drawn on the Mercator's map have been transferred to the map on the polar projection which accompanies this memoir; and for the purpose of more readily computing the inclination at any geographical position within the limits of the survey, corresponding to the observations combined in drawing the lines, the following Tables have been formed, which show the value of the Inclination at the intersection of every degree of latitude, with every fifth degree of longitude between the longitudes of 231° and 261°, and with every $2\frac{1}{2}$ degrees between those of 261° and 291°. The use of these Tables seems too obvious to need an explanation; by the usual process of interpolation, the Inclination due to any geographical locality within the bounds of the survey may be obtained by a very light calculation: a formula which should give the same result would necessarily consist of a considerable number of terms, and would therefore be of less practical utility.

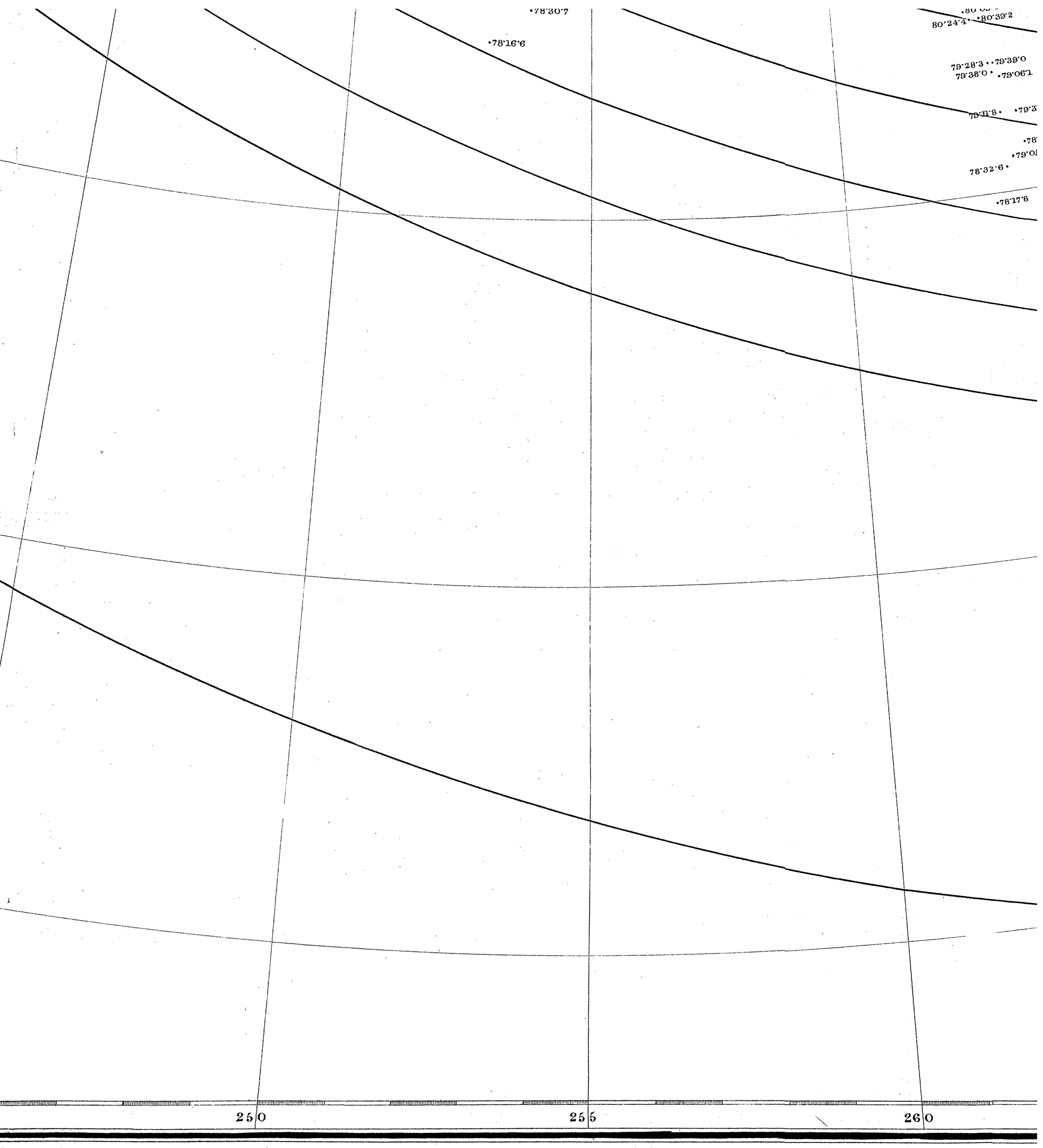

21/5
22/0
22/5
23/0
60
55
50
83°
82°
81°
80°
79°
78°
77°
82·56·0
82·34·3
81·52·3
73·46·2
75·50·3

Map of the Isoclinal lines or lines of equal Magnetu

gnetic Inclination in North America.

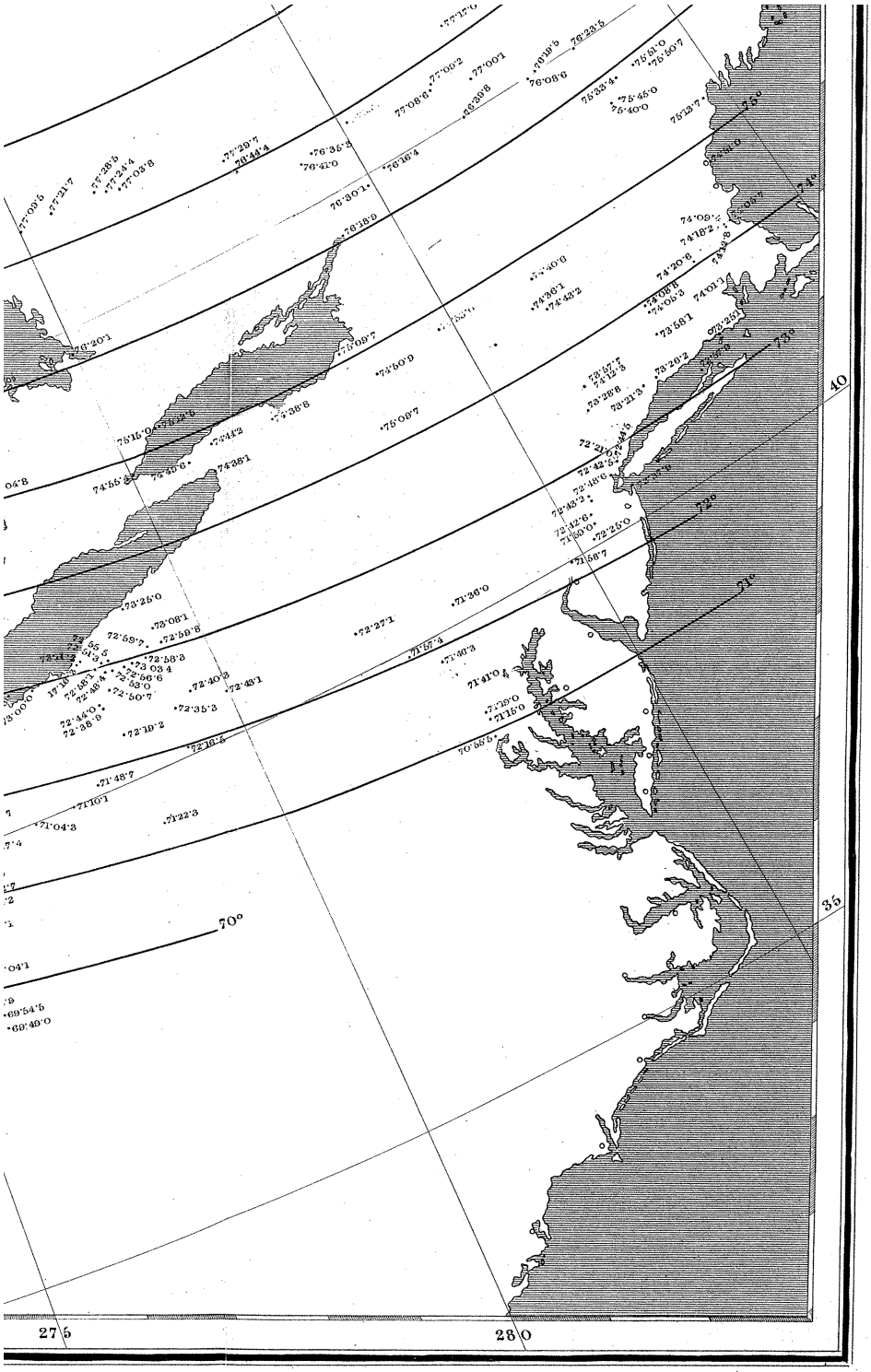

300
305
55
50
45
78°
77°
78°
77·40·2
77·43·0
77·44·5
77·47·5
77·43·1
77·43·5
77·40·5
77·37·5
77·36·4
77·33·1
77·30·5
77·30·2
77·24·1
77·18·1
77·24·7
77·01·6
76·57·4
77·25·9
77·32·0
77·10·7
77·15·0
77·00·2
77·00·1
76·38·2
76·36·6
76·23·7
76·23·5
76·01·6
76·01·0
76·00·7


45
70°
69°26·0
69°22·2
PART OF PEACE RIVER LAID DOWN BY CAPTAIN LEFROY FROM A FIELD SKETCH
The dotted line denotes the course of the River by Arrowsmiths Map.
243°
244°
245°
246°
58° 30'
58°
40°
24/5
PEACE RIVER
Carriboo R.
R. Boullie
2·24
Vermilion Fort
Portage in the Winter
R. Rouge
Falls of Peace R. 8 f.t
Old Fort
Basil R.
Bear R.
Iroquois River

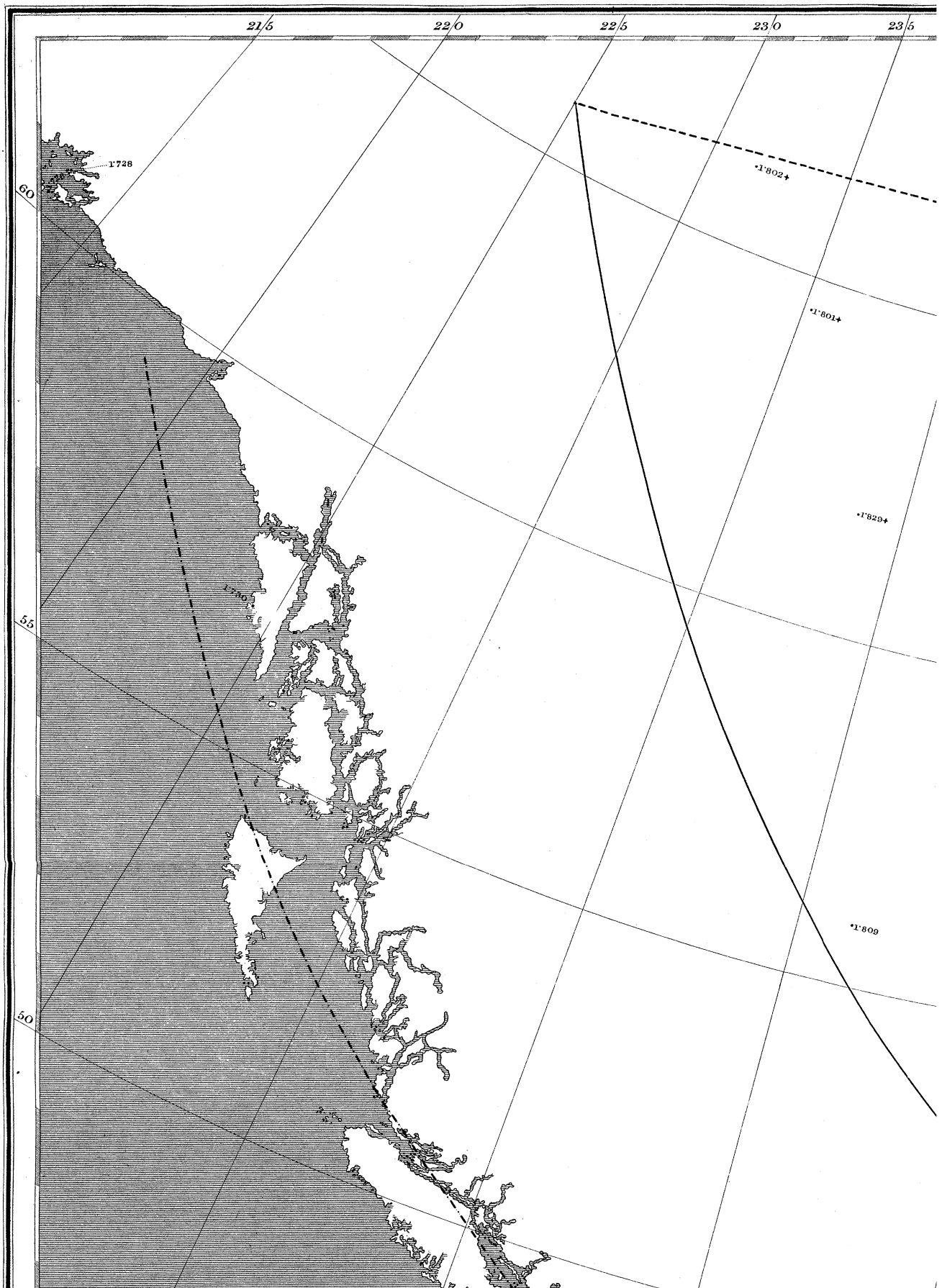


•78·30·7
•78·16·6
80·24·4
•80·39·2
79·28·3
•79·39·0
79·38·0
•79·06·1
79·11·8
78·32·6
•78·17·8
250
255
260


80°
79°
78°
77°
76°
75°
74°
73°
72°
71°
70°
69°
26·5
27·0
27·5

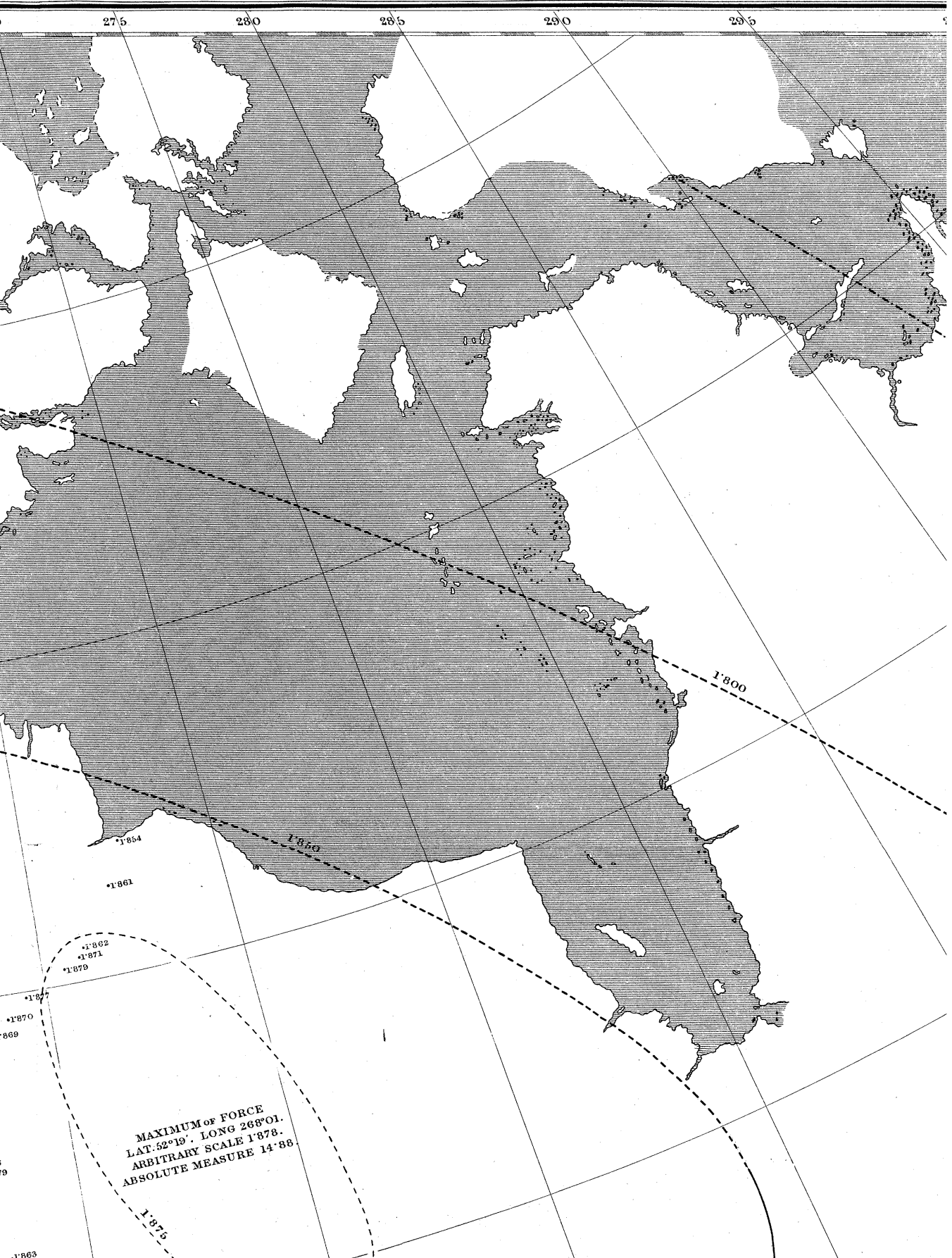


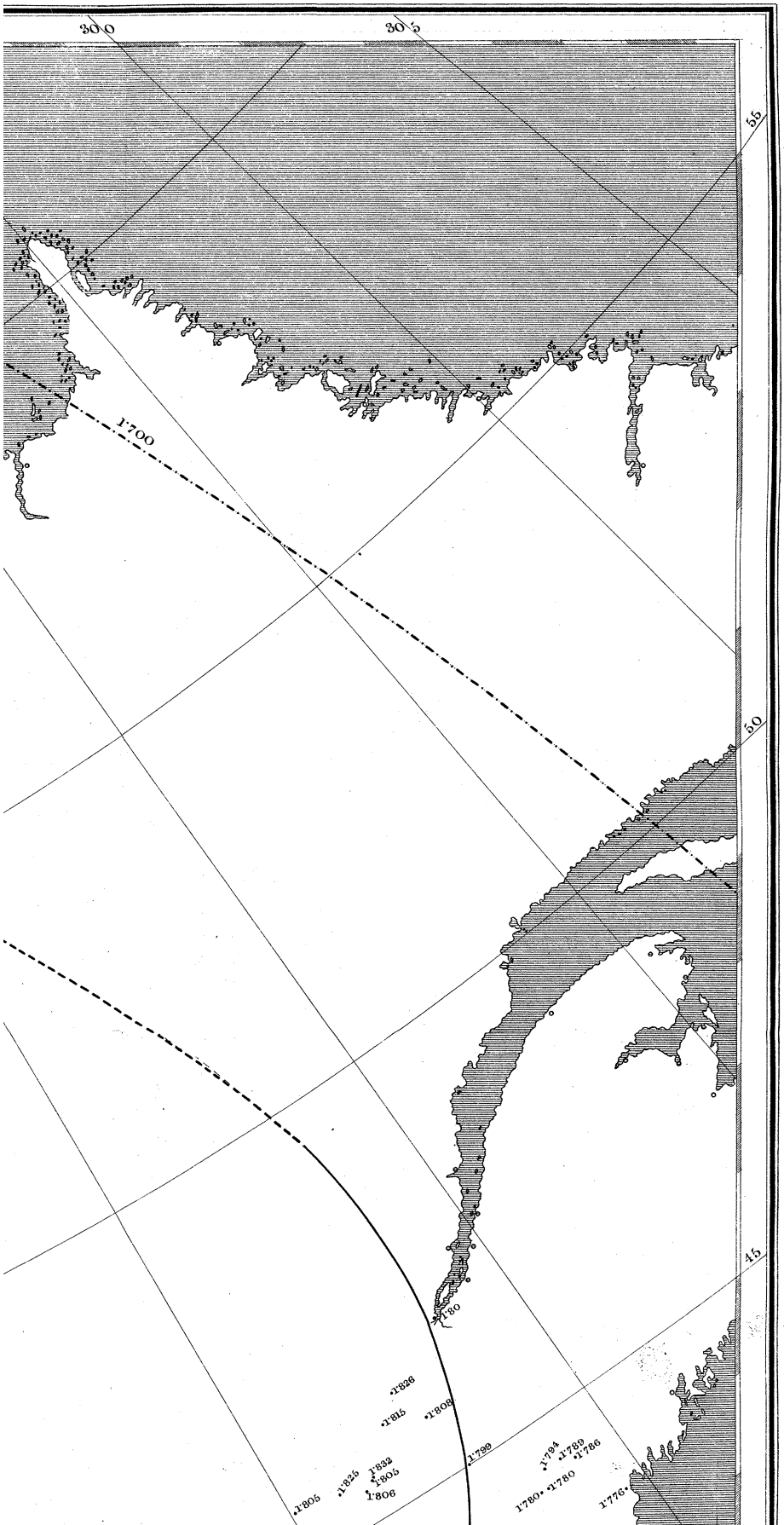
Engraved by J. & C. Walker.

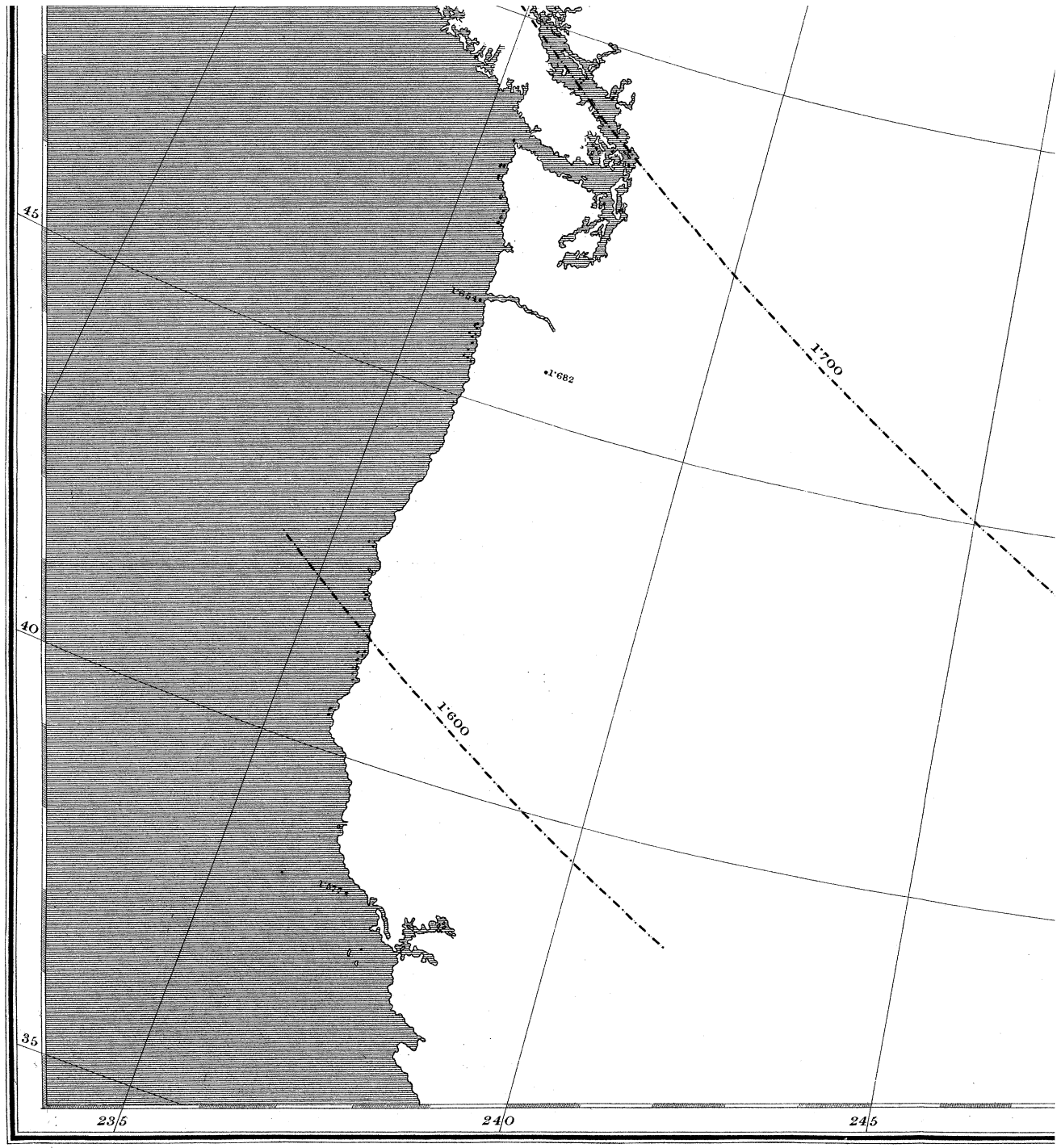

21/5
22/0
22/5
23/0
23/5
60
55
50
1·728
1·802+
1·801+
1·629+
1·809

Map of the Isodynamic lines or lines of equal M

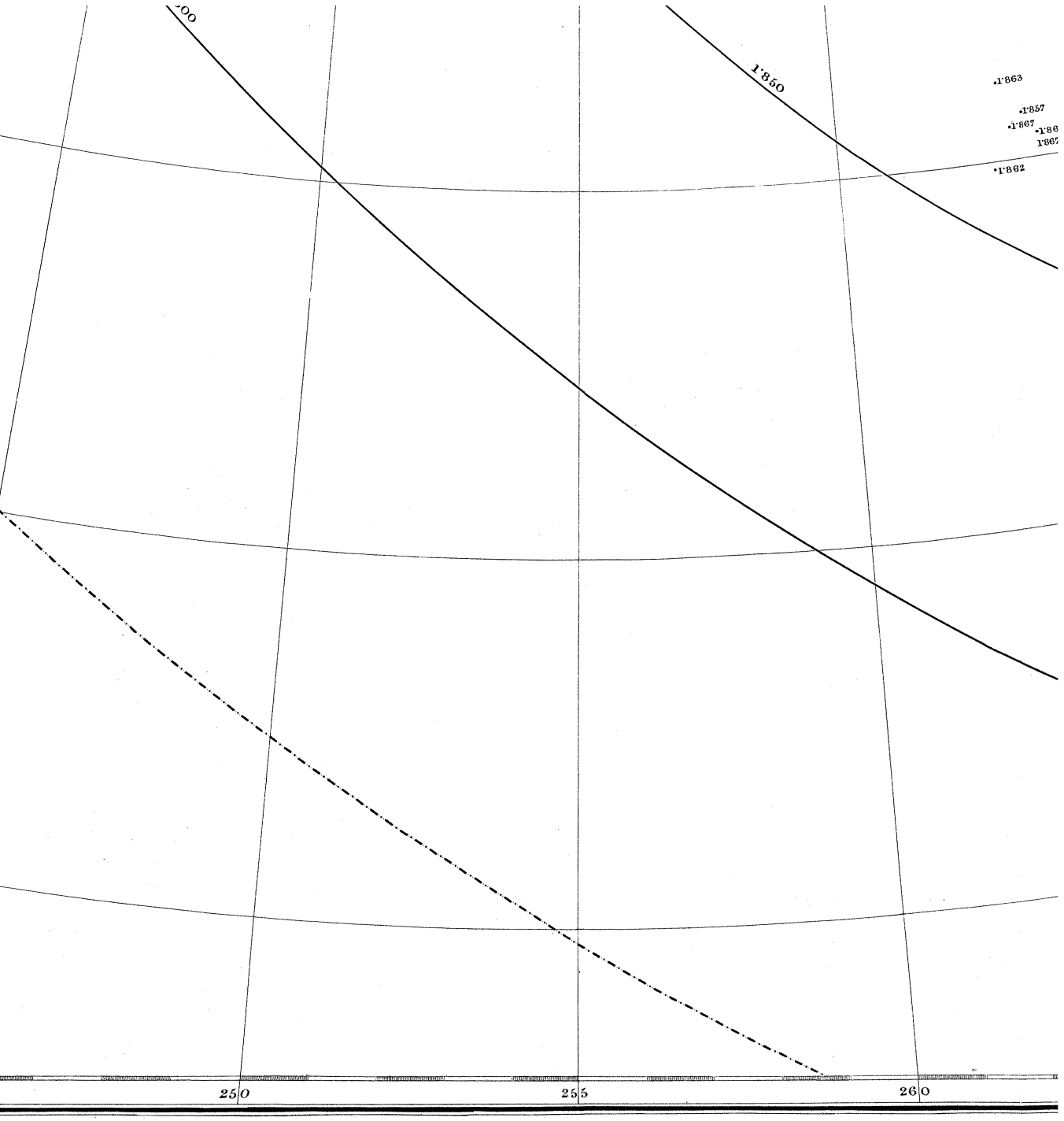
Magnetic Force in North America.




30·0
30·5
55
1·700
50
45
1·80
1·826
1·815
1·808
1·799
1·794
1·789
1·786
1·805
1·825
1·832
1·805
1·808
1·780
1·780
1·776



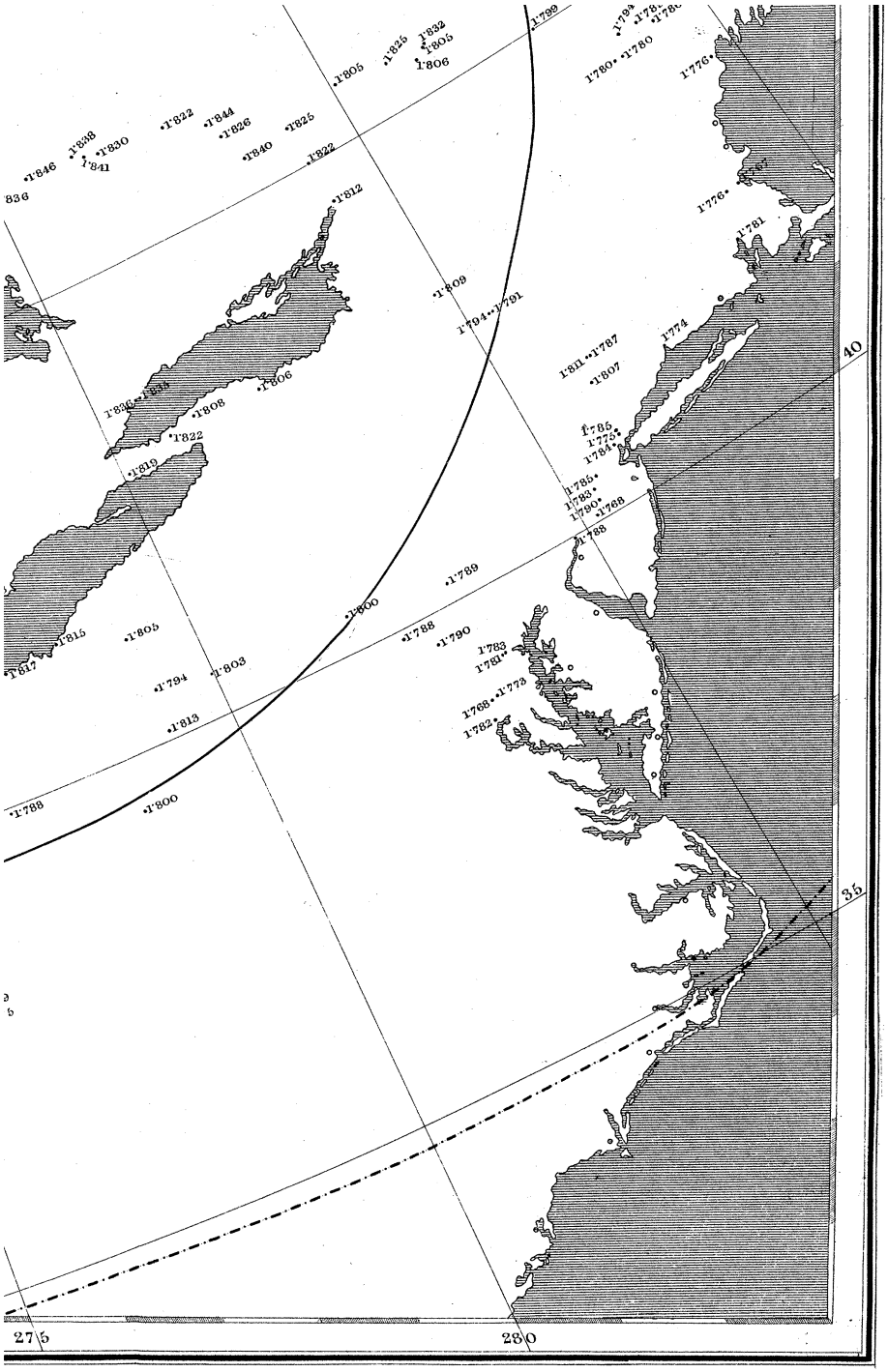
The Isodynamic lines of 1·850 and 1·800
The Isodynamic lines of 1·700 and 1·6



nd 1·800 are drawn from the observations inserted in the Map, the point of Maximum of Forc
nd 1·600 are from earlier observations than those now given, and are taken from the Map a

The Force at the 4 stations marked thus + was determined by the absolute method;

of Force is from the calculation in pp. 250, 251; the dotted ellipse of 1·875 is from the same calcula
Map accompanying Lieut. Col. Sabine's memoir on the variations of the magnetic Force Brit. A
ethod; at all the other stations by relative methods.—



Engraved by J. & C. Walker.

alculation.

Brit. Assoc. 1837.

TABLE VI.—Showing the values of the Inclination at the intersection of each degree of latitude from 38° to 48°, with every 2½° of longitude from 268° 30′ to 291.

Lat.	Longitudes.										Lat.
	268° 30′.	271°.	273° 30′.	276°.	278° 30′.	281°.	283° 30′.	286°.	288° 30′.	291°.	
38°	68° 46′	69° 01′	69° 21′	69° 40′	69° 57′	70° 14′	70° 22′	° ′	° ′	° ′	38°
39	69 43	69 57	70 17	70 36	70 52	71 09	71 16	71 18			39
40	70 39	70 53	71 13	71 31	71 47	72 03	72 09	72 11			40
41	71 34	71 48	72 08	72 26	72 42	72 57	73 01	73 03	73 08		41
42	72 28	72 43	73 03	73 21	73 36	73 50	73 53	73 54	73 58		42
43	73 21	73 37	73 57	74 15	74 30	74 42	74 44	74 45	74 47		43
44	74 13	74 30	74 51	75 09	75 22	75 32	75 34	75 34	75 34		44
45	75 04	75 22	75 44	76 02	76 13	76 21	76 22	76 21	76 20	76 12	45
46	75 54	76 13	76 36	76 50	77 02	77 07	77 06	77 09	77 06	76 57	46
47	76 43	77 03	77 23	77 37	77 45	77 49	77 50	77 53	77 44	77 36	47
48	77 32	77 54	78 08	78 22							48

TABLE VII.—Showing the values of the Inclination at the intersection of each degree of latitude from 47° to 66°, with every 5° of longitude from 231° to 261°, and with every 2½° of longitude from 261° to 268° 30′.

Lat.	Longitudes.										Lat.
	231°.	236°.	241°.	246°.	251°.	256°.	261°.	263° 30′.	266°.	268° 30′.	
47°	70° 09′	° ′	° ′	° ′	° ′	° ′	75° 33′	75° 59′	76° 22′	76° 43′	47°
48						75 26	76 20	76 47	77 10	77 32	48
49					75 15	76 12	77 08	77 34	77 58	78 20	49
50				75 00	76 00	76 58	77 54	78 21	78 44	79 07	50
51				75 45	76 44	77 43	78 40	79 06	79 29		51
52			75 26	76 29	77 29	78 27	79 25	79 50	80 14		52
53		75 08	76 09	77 12	78 13	79 11	80 09	80 34	80 56		53
54	74 53	75 50	76 51	77 54	78 56	79 54	80 48	81 17	81 39		54
55	75 36	76 32	77 33	78 37	79 38	80 37	81 27	81 59	82 21		55
56	76 18	77 14	78 15	79 19	80 20	81 19	82 12	82 40	83 04		56
57	76 59	77 55	78 56	79 59	81 01	81 56	82 51				57
58	77 40	78 35	79 36	80 40	81 42	82 35					58
59	78 19	79 14	80 15	81 20	82 22						59
60	78 58	79 53	80 54	81 59	83 01						60
61	79 36	80 31	81 32	82 38	83 39						61
62	80 14	81 09	82 10	83 16							62
63	80 51	81 36	82 48	83 53							63
64	81 28	82 23	83 24								64
65	82 05	83 00									65
66	83 31										66

To give some idea of the degree of correctness with which these tables (particularly in the portion of the survey which is most likely to be referred to) may be considered to represent the observations from which they are derived, and to give consequently the true Inclinations corresponding to geographical positions, I have formed groups in localities where observations are much clustered, and have compared the tabular Inclination corresponding to the mean latitude and longitude, with that re-

sulting from the mean of the observed Inclinations: the comparison shows as follows:—

TABLE VIII.

Group.	Long.	Lat.	No. of observations.	Mean of the observed Inclinations.	Computed tabular Inclinations.	Tabular in excess or defect.
	° ′	° ′		° ′	° ′	′
1.	269 26	42 28	14.	73 00·1	72 59	−1
2.	269 59	38 49	8.	69 38·7	69 41	+2
3.	275 36	38 30	6.	70 06·1	70 05	−1
4.	275 19	46 21	10.	77 05·2	77 06	+1
5.	278 30	41 18	15.	72 59·0	72 59	0
6.	285 58	40 59	11.	73 01·3	73 02	+1
7.	288 49	42 13	11.	74 11·1	74 09	−2
8.	291 20	46 06	12.	77 01·4	77 00	−1

The tabular inclination corresponding to the geographical position of Toronto is 75° 13′·5. Dr. LOCKE's observation in 1843 was 75° 13′·4. The needles of the observatory gave a mean inclination for that year amounting to 75° 16′. The mean of the last year (1845) is 75° 15′·5. So far as the absence of station error is an object in the choice of a situation for a magnetic Observatory, the site of the Toronto Observatory appears to have been happily chosen.

Taking single stations, there are seven at which the tabular dip differs more than 1° from the observed; at five of these the observed is in excess of the tabular, and at two in defect. The five are,—Kingston in Canada; Otter Island on Lake Superior; two stations 500 feet distant from each other in the Magnetic Inlet, and one on the adjacent isthmus on the south side of Lake Superior. The two in defect are Chat Falls on the Ottawa River; and the Portage Ecarté, near Lake Superior, towards the height of land which separates the waters which flow into Lake Superior from those which flow towards Lake Winnipeg. At all these stations the observations of the magnetic Force, as well as those of the Inclination, manifest the existence of local disturbing influence. At Chat Falls the Inclination is in defect and the Force in excess; at Otter Island the contrary is the case, the Inclination being in excess and the Force in defect. At Portage Ecarté, both Inclination and Force are in defect; and at the three other stations both elements are in excess. Besides the seven stations where the station error appears to exceed 1°, there are four (Isle d'Urval and Kingsey in Canada; Pierre au Calumet on the Elk River; and the Eagle River, in the same mineral district on the south side of Lake Superior as the magnetic inlet) at which the observations appear to be affected by station error to an amount which is less than 1°, but is still considerable. At each of these four stations the observed dip is in excess. The Inclinations at the eleven stations which have been thus named, are omitted in the map accompanying this memoir: they are eleven out of 335 stations. Of the remaining 324 stations there are some at which local disturbance of a less amount may be inferred; but all these are inserted in

the map. Four of the eleven omitted stations are in a district, rich in minerals, on the south side of Lake Superior, near the 272nd geographical meridian: in each of these four instances the effect of the disturbance has been to increase the Inclination, but there are other stations in the same district where the observed Inclination does not materially differ from that which is due to the geographical position; and there is one station (United States Agency) where it is some minutes in defect. In the cases referred to, the influence of the disturbing causes is rather to produce irregularity at individual stations, than a systematic derangement of the general direction of the magnetic lines, similar to the highly interesting phenomenon in the northern part of Bohemia, recently investigated by M. KREIL*; from which investigation we learn that a more systematic relation may exist in some localities between geological and magnetical phenomena than had been previously apprehended. But instances of disturbance even at individual stations in the countries included in this survey are so unusually rare, that we should the less expect to find districts exhibiting a systematic affection: of such I can perceive no traces; the direction of the lines conforms to the general magnetic system of the globe, and appears to suffer no material interruption; such district anomalies either do not exist, or the observations have not brought them to light.

Determinations of Latitude and Longitude.

The geographical positions of the stations visited by Lieut. LEFROY in 1843 and 1844 are given in Table IX., with the authorities on which they depend: the latitudes and longitudes entered in the column headed 'observed' were either determined by his own observations, or reduced by himself by courses and distances from neighbouring stations of observation: to distinguish those stations at which the latitude or longitude was observed on the spot, a mark is inserted in the adjoining column: the mark ⊙ indicates latitude observed by meridian altitude of the sun; the mark * by altitudes of Polaris: in the column of longitudes, the mark ⊙ indicates chronometrical longitudes deduced from observations of the sun's altitude; and the mark * from altitudes of a star: where no mark is inserted, the latitude or longitude was deduced by observation of courses and distances from the adjacent stations. The chronometrical longitudes are dependent upon the longitudes of the following principal stations, as given by Sir JOHN FRANKLIN, Captain BAYFIELD, and others: viz.

Fort William	89° 27′	BAYFIELD.
	89 16	FRANKLIN.
	89 23	TIARKS.
	89 22	Mean
Sault St. Mary . . .	84 34	BAYFIELD.

* Magnetische und Geographische Ortsbestimmungen in Böhmen; Prag. 1846.

Fort Frances	93°	28·6	FRANKLIN.	
Fort Alexander . . .	96	21·4	FRANKLIN.	
Norway House . . .	98	7·1	TAYLOR*.	
York Factory . . .	92	26·0	FRANKLIN.	
Cumberland House .	102	19·4	FRANKLIN.	Mean of two determinations.
Carlton House . . .	106	12·7	FRANKLIN.	
Isle à la Crosse . . .	107	53·8	FRANKLIN.	Mean of two determinations.
Athabasca	111	18·7	FRANKLIN.	Mean of two determinations.
Fort Simpson . . .	121	25·0	FRANKLIN.	Mean of two determinations.

These longitudes were determined with a greater number of chronometers than were carried by Lieut. LEFROY, and in some instances are the mean of determinations made by Sir JOHN FRANKLIN in his two journeys; the stations were selected therefore as points of departure; observations were made there with peculiar care, and the longitudes of intermediate stations, taken en route, were calculated from them successively. From July 1843 to September 1844 Lieut. LEFROY had the use of one chronometer only, (the other having met with an accident,) and it was found too irregular in its going to be relied on for long periods. The longitude was determined by lunar distances at certain stations, which are given in the Table.

Wherever a station of observation is common to Sir JOHN FRANKLIN and Lieut. LEFROY, the latitude or longitude determined by the former officer is inserted for comparison in the column headed "from other determinations," which also contains values taken by measurement from the maps which accompany the narrative of his journeys. Lieut. LEFROY's observations along Peace River, and from thence by Lesser Slave Lake to the Saskatchawan, a line which was not taken by Sir JOHN FRANKLIN, are the first, it is believed, that have been published since those of Sir ALEX. MACKENZIE, and materially correct the course of that river, as laid down on the best maps.

* Late Hudson's Bay Company's surveyor. This longitude is the mean of five observations of Jupiter's satellites, the extreme difference amongst them being 11′ 10″.

TABLE IX.

General Table of the Latitudes and Longitudes of the Stations visited by Lieut. LEFROY in 1843 and 1844.

Station.	Observed.				From other determinations.		Remarks.
	Latitude.		Longitude.		Latitude.	Longitude.	
	° ′		° ′		° ′	° ′	
Montreal	.....	....	.....	....	45 31 (*a.*)	286 25 (*a.*)	(*a.*) From a map in the Quart.-Master General's office in Canada.
Isle d'Urval	.....	....	.....	....	45 24 (*a.*)	286 14 (*a.*)	
La Combes	.....	....	.....	....	45 32 (*a.*)	285 51 (*a.*)	
Island in the Ottawa River	45 36·4	*	285 38	⊙			
Entrance of Grenville Canal	45 36·0	....	285 28	⊙			
Chatham	45 36·2	⊙					
Pte aux Chênes	.....	....	.....		45 37 (*b.*)	285 05 (*b.*)	(*b.*) from a map published for the Canada Company in 1829.
Alfred Township	.....	....	284 48	⊙	45 37 (*b.*)		
Foxes Point	.....	....	.....	....	45 32 (*b.*)	284 26 (*b.*)	
Templeton's Farm	.....	....	284 48	⊙	45 29 (*b.*)		
Point Aylmer	45 15	*	284 02	⊙			
Chat Portage	.....	....	.....	....	45 26 (*b.*)	283 28 (*b.*)	
Fort Portage	45 36	....	283 07	⊙			
Décharge d'Argile	45 39·6	⊙					
Grand Calumet	45 45	....	283 20				
Fort Coulange	45 54·9	⊙	282 56	⊙			
Pointe Baptême	.....	....	.....	....	46 06 (*c.*)	282 34 (*c.*)	(*c.*) From WYLDE's Map, 1843.
Portage des deux Joachims	46 12	⊙	281 41				
Roche Capitaine	46 17·2	*	281 42	⊙			
Trou Portage	46 15·0	....	281 27				
Matawa	46 18·0	....	281 20	⊙			
Little River, 1st Portage	46 18·5	....	281 17				
Lake Temisique	46 18·0	⊙					
Lac du Grand Vase, South side	46 18·5	....	280 34	⊙			
Portage du Grand Vase	46 19·5	....	280 26	⊙			
Lake Nipissing	46 14·0	⊙	280 01				
French River	45 58·0	⊙	279 25				
Ricolet Falls	45 57·0	....	278 59				
Pte au Croix	45 55·5	⊙	278 42	....	.....	.....	Mouth of French River.
Lake Huron	46 00	....	278 10				
La Cloche	46 07	*	277 32	*			
Snake Island	46 10	....	277 10				
Cranberry Bay	46 11	....	276 57				
Near Mississauga	46 08	*	276 50	*			
Tessalon Point	46 16	....	276 29				
St. Mary's River	46 20	*	276 04	*	.....	275 30 (B.)	Campment d'Ours.
Sault St. Mary	46 30·7	⊙	.....	....	46 31 (B.)	275 26 (B.)	(B.) Capt. BAYFIELD, R.N.
Pointe aux Pins	46 29·3	*	.....	....	.....	275 19 (B.)	
Pointe au Crêpe	.....	....	275 02	⊙	46 58 (B.)	275 07 (B.)	Near Mamainse.
Gargantua	47 37·2	⊙	274 49	⊙	.....	274 45 (B.)	
Fort Michipicoton	47 56·0	*	274 53	⊙	.....	274 55 (B.)	
Near Chienne River, one mile E.	47 52·0	....	274 36	⊙	.....	274 35 (B.)	
Otter Island	.....	....	.....	....	48 07 (B.)	373 45 (B.)	
One mile below White River	48 31·6	⊙	273 27	⊙			
White River	48 33·3	⊙	273 27	⊙	.....	273 33 (B.)	
Fort Pic	48 38·0	⊙	273 29	⊙	.....	273 31 (B.)	
Terreplatte	48 49·0	⊙	272 15	⊙			
Near Thunder Bay	48 20·3	⊙					
Near Pointe Tonnerre	.....	....	.....	....	48 19·0 (B.)	270 58 (B.)	(*d.*) BAYFIELD 270 33
Fort William	48 23·6	⊙	.....	....	.....	270 38 (*d.*)	FRANKLIN 270 44
Portage Ecarté	.....	....	.....	....	48 25 (B.)	270 15 (B.)	TIARKS 270 37
Portage de l'Isle	.....	....	270 22	⊙	48 26 (F.)		
Bad Portage	.....	....	270 20	⊙	48 29 (F.)		Mean 270 38

TABLE IX. (Continued.)

Station.	Observed.				From other determinations.		Remarks.
	Latitude.		Longitude.		Latitude.	Longitude.	
	° ′		° ′				
Chien Portage	.....	....	.....	....	48° 39′(F.)	270° 26′(F.)	
Chien Lake	48 47·0	....	270 20				
Chien Lake	48 50·9	⊙					
Prairie Portage	.....	....	.....	....	48 57(F.)	269 59(F.)	(F.) Captain Sir
Savannah Portage	.....	....	269 52	⊙	48 53(F.)	269 57(F.)	JOHN FRANKLIN,
French Portage	48 35·0	....	.....	....	.....	268 53(F.)	R.N.
Portage des Morts	48 35·0	....	268 27	⊙			
Portage des deux Rivières	48 34·5	⊙	.....	....	.....	268 33(F.)	
Lac à la Crosse	48 24·0	....	267 50	⊙			
Lac à la Crosse	48 21·3	⊙					
2nd Portage from Lac à la Crosse	48 14·6	⊙	267 33	⊙	.....	267 36(F.)	
Sturgeon Lake	48 27	⊙					
Sturgeon Lake	48 28	....	267 27	....	.....	267 26(F.)	
Portage	48 29	....	267 19	⊙			
Lac la Pluie	48 32·5	⊙	267 04	⊙			
Fort Francis	48 37·2	⊙	.....	....	48 36(F.)	266 31(F.)	
Rainy River	48 47·7	⊙	265 29	⊙			
Lake of the Woods	49 05·0	*	264 59	⊙			
Lake of the Woods	49 19·0	....	265 18	⊙			
Lake of the Woods	49 28·7	⊙					
Lake of the Woods	49 28·0	....	265 20				
Rat Portage	49 46·5	⊙	265 21	⊙	49 45(F.)	265 33(F.)	
Winnipeg River	50 10·1	⊙	264 50	⊙			
Burnt Portage	50 19·0	*	264 24	*	.....	264 20(F.)	
Slave Portage	50 10·6	⊙	264 23	....	.....	264 18(F.)	
Barrier Portage	50 06·0	....	264 27	⊙	.....	264 16(F.)	
Portage in Pinnaway River	50 12·0	....	263 57	⊙			
Cap Lake	50 20·8	⊙					
Fort Alexander	50 37·1	⊙	.....	....	.....	263 39(F.)	
Lake Winnipeg	50 27·3	⊙	263 22	⊙			
Upper Fort Garry	49 53·1	⊙	262 57	⊙			
Mouth of Red River	50 19·0	*	263 19	⊙			
Lake Winnipeg, West side	51 03·6	....	263 15	⊙			
Lake Winnipeg, East side	51 04·0	⊙	263 39				
Ox Island	51 16·5	*	263 32	*			
Lake Winnipeg	51 34·0	*	263 18	*			
Lake Winnipeg	51 38·0	*	263 12	⊙			
Lake Winnipeg	51 44·5	....	263 12	⊙	.....	.....	Nearly opposite
Lake Winnipeg	51 45·3	⊙	263 07				Tête du Chien.
Lake Winnipeg	52 21·0	⊙	262 51	⊙	.....	.....	Near Berens River.
Lake Winnipeg	52 22·6	*	262 51				
Lake Winnipeg	52 29·0	....	262 47				
Poplar Point	52 56·0	⊙					
Old Norway House	.....	....	.....	....	53 41·6(F.)	261 59(F.)	
Norway House	53 58·9	⊙	.....	....	.....	261 53(*e.*)	(*e.*) From five ob-
Blackwater River	54 18·8	*					servations of Ju-
Carpenter's Lake	54 14·0	....	262 22	⊙			piter's satellites
Hairy Lake	54 20·0	....	262 50	⊙	.....	262 36(F.)	by the late Mr.
Echiamamis	54 21·0	....	262 55	⊙			TAYLOR.
Painted Stone Portage	54 22·3	*					
Whitefall Portage	.....	....	263 34	....	54 24(F.)	263 29(F.)	
Holey Lake, East side	54 56·0	....	264 18	⊙			
Half mile below the Crooked Spout	54 43·9	⊙					
Oxford House	54 56·4	*	264 30	....	.....	264 32(F.)	
Rapid below Oxford House	54 52·8	⊙					
Knife Portage	54 53·2	⊙					
North side of Knee Lake	.....	....	264 49	⊙	54 51(F.)		

TABLE IX. (Continued.)

Station.	Observed.				From other determinations.		Remarks.
	Latitude.		Longitude.		Latitude.	Longitude.	
Long Portage, Jack's River	55° 15·0	⊙	265° 35′	⊙	55° 14′(F.)	265° 38′(F.)	
Creek Portage	55 24·6	⊙					
Morgan's Portage	55 29·0	....	266 08				
White Earth Portage	55 26·0	....	265 57	⊙	.....	265 57(F.)	Station of July 21.
White Earth Portage	.....	....	266 10	⊙	55 33(F.)	.....	Station of July 31.
Shamatawa	56 21·0	....	267 04	....	.....	267 00(F.)	
Five miles below Shamatawa	56 25·7	⊙					
York Factory	57 00·1	⊙	.....	....	57 00·1	267 34(F.)	
Lake Winnipeg	.....	....	260 55	⊙	.....	.....	M^{c}Intosh's Island.
Ditto, near first Rocky Point	53 31	⊙	260 48	⊙			
Saskatchawan River	53 11	⊙	.....	....	.....	.....	Mouth of the River.
Grand Rapid	.....	....	260 32	⊙	53 08(F.)	260 32(F.)	
Cross Lake, East side	53 10·2	⊙	260 28	⊙	.....	260 23(F.)	
Hare Island, Cedar Lake	53 12·0	⊙					
Island in Cedar Lake	53 18·0	....	259 48	⊙			
Devil's Drum Island	.....	....	259 15	⊙	53 19(F.)	259 20(F.)	Or Isle à Festins.
Four miles above the Pas	53 48	*	258 32	⊙	.....	258 37(F.)	
Cumberland House	.....	....	.....	....	53 57(F.)	257 41(F.)	
Pine Island Lake	54 14·3	⊙					
Crooked Rapid	54 24·7	⊙					
Beaver Lake	54 26·0	....	257 50	....	.....	.....	Limestone Point,
Half a mile north of Haye's River	54 44·0	⊙					at the S. entrance.
Carp Portage	54 47·2	....	257 21	⊙			
Pine Portage	.....	....	.....	....	55 04(F.)	257 18(F.)	
Frog Portage	.....	....	.....	....	55 27(F.)	256 30(F.)	
Little Rock Portage	55 34·3	....	255 26	⊙	.....	255 27(F.)	
Great Devil's Portage, East end.	55 40·1	⊙	254 55	....	.....	255 12(F.)	
Portage des Eçores	55 43·0	*					
Trout Portage	55 42·5	....	254 31	⊙			
Harrier Portage	55 35·8	⊙					
Half a mile above Cardinal Rapid	55 39·1	*					
Half a mile below Rapide qui ne parle pas	55 43·5	....	254 10	⊙			
Canoe Portage	55 42·7	⊙					
Pine Portage	55 43·2	....	.....	....	.....	254 04(F.)	
Snake Point	55 51·0	....	253 15	⊙			
Snake Rapid	55 45·7	⊙	.....	....	.....	253 30(F.)	
Portage Sonnante	.....	....	252 34	⊙	55 54(F.)	252 24(F.)	
Isle à la Crosse	.....	....	.....	....	55 25(F.)	252 06(F.)	
Buffaloe Lake	56 04	....	.....	....	.....	251 20(F.)	
Long Portage on River de la Loche	56 14·9	⊙	250 42	⊙	.....	250 55(F.)	
Portage de la Loche, East end.	56 34·5	*	250 16	*	.....	250 23(F.)	
Portage de la Loche, West end.	56 43·4	*	250 08	⊙	56 43(F.)	250 08(F.)	
Portage Terre Blanche	56 41·7	⊙					
Portage Gros Roche	56 43·5	....	249 51	⊙			
Cascade Portage	56 42·5	....	249 41	⊙	56 42(F.)	249 46(F.)	
Clearwater River	.....	....	.....	....	56 39(F.)	249 09(F.)	
Pine Island, Elk River	56 58·0	*	.....	....	.....	248 54(F.)	
Pierre au Calumet	.....	....	248 13	⊙	57 24(F.)	248 25(F.)	
P^{te} Brulée	.....	....	.....	....	58 07(F.)	248 35(F.)	
Athabasca	.....	....	.....	....	58 43(F.)	248 42(F.)	
Fort Good Hope	.....	....	.....	....	66 16(S.)	231 30(F.)	(S.) Observed by SIMPSON.
Rapide sans Sault	65 48	⊙					
Fort Norman	.....	....	.....	....	64 31(F.)	235 16(F.)	
Fort Simpson	61 51·7	⊙	.....	....	.....	238 45(F.)	
P^{te} Brulée	61 10·0	....	240 51	⊙			

Table IX. (Continued.)

Station.	Observed.				From other determinations.		Remarks.
	Latitude.		Longitude.		Latitude.	Longitude.	
	° ′		° ′		° ′	° ′	
Yellow Knife River	61 12·3	⊙					
Sandy Point	61 20·0	....	242 00	⊙			
Little Lake	61 25·7	⊙					
Big Island (Fishery)	61 11·7	....	243 22	⊙			
Big Island, East end	61 07·7	⊙					
Hay River	60 48	....	244 49	⊙	60 51(F.)	244 42(F.)	
Near Hay River	60 49	⊙					
Fort Resolution	61 10	⊙	.....	....	.....	246 15(F.)	
Buffaloe River	60 34	....	246 48	⊙			
Portage Grand Detour	60 22	....	247 00	⊙			
In ditto, First Lake	60 20·6	⊙					
Salt River (Slave River)	.....	....	247 45	⊙	60 06(F.)	247 38(F.)	
Slave River	60 02·2	⊙					
Pelican Portage	.....	....	248 09	⊙	59 58(F.)	248 09(F.)	
Peace River	58 55	⊙					
Point Providence	58 58	....	247 50	⊙			
Peace River	59 10·1	⊙	.....	....	.....	.....	Amongst the Gypsum Islands.
Peace River	58 58	....	247 01	⊙			
Poplar Island	58 39	⊙	246 03				
Falls of Peace River	58 24·2	⊙	245 06				
Fort Vermilion	58 24·7	⊙	243 55	⊙			
Peace River	57 57·0	....	243 00	⊙			
Peace River	57 50·7	⊙					
Peace River	57 19·0	....	243 32	⊙			
Peace River	57 12·3	⊙					
Opposite River Cadotte	56 47·0	....	242 58	⊙			
Peace River	56 42·0	⊙					
Fort Dunvegan	55 55·6	⊙	241 35	⊙	.....	.....	By 2 sets of lunar distances, ☾ from sun west 241° 41′.
Riviere de Prairie	55 50·1	⊙					
Fort at Lesser Slave Lake	55 32·8	⊙	244 07	....	.....	.....	By 4 sets of lunar distances, 2 ☾ from ✳E., and 2 ☾ from ⊙ W. 244° 06′.
Cranberry Point	55 29·5	✳	244 54	✳			
Point Dejala	55 26·5	⊙	244 59	⊙			
On Lesser Slave Lake	55 15·6	⊙					
Junction of the Slave and Elk R.	55 13·0	....	246 10	⊙			
Elk River, opposite Pembina River	54 45·7	✳					
Elk River	54 43·0	....	246 00	⊙			
Fort Assiniboine	54 19·7	⊙	245 32	⊙			
Paddle River	54 09·8	✳	245 59	✳			
Pembina River	54 08·0	....	246 06				
Edmonton	53 31·1	⊙	247 08	⊙			
Saskatchawan River	54 04·8	⊙	248 16	⊙			
Saskatchawan River	53 50·0	⊙	249 30	⊙			
Fort Pitt	53 34·0	✳	250 41	✳			
Saskatchawan River	53 07·0	⊙	251 30	⊙			
Saskatchawan River	52 23·2	⊙	252 56	⊙			
Carlton House	.....	....	.....	....	52 51(F.)	253 47(F.)	
Saskatchawan River	.....	....	255 12	....	53 16(F.)		

§ 11. *Lieut.* LEFROY's *Observations of the Magnetic Force.*

These observations were of two kinds; those which were designed to determine the *absolute* value of the *horizontal component* of the force; and those which had for their object to determine the *ratio* of the *total* force at different stations. For the absolute determinations magnets of small dimensions were employed in portable apparatus, which will be hereafter described. The observations to determine the relative values of the total force were made with two needles on Dr. LLOYD's statical principle, used in GAMBEY's circle, and with two needles on Mr. Fox's principle, used in a circle of seven inches diameter. The LLOYD's needles were distinguished as L. A. and L. B.: the Fox's as F. A. and F. C. Experiments to determine the coefficient in the temperature corrections of these needles were made at Toronto in the first three months of 1843. The observations at high temperatures were made in the detached building of the observatory, which was heated for the purpose by a copper stove: those at low temperatures were made partly in the same room and partly in the open air outside the building. In Tables X. and XI., in which these experiments are recorded, v denotes the angle of deflection with a constant weight at the temperature t, in the experiments at low temperatures; θ the inclination; and φ the total force, which is $\frac{\cos v}{\sin(\theta - v)}$ with Dr. LLOYD's needles, and $\sin v$ with Mr. Fox's; v', θ' and φ' denote the corresponding values in the experiments at high temperatures. Then, q being the coefficient, $\varphi = \varphi'(1 - q(t - t'))$; and $q = \frac{\varphi - \varphi'}{\varphi'(t - t')}$.

TABLE X.

Abstract of the Observations made at Toronto to ascertain the value of q for the needles L. A. and L. B.

L. A..

Low temperatures.					High temperatures.				
1842 and 1843.	t.	v.	θ.	φ.	1843.	t'.	v'.	θ'.	φ'.
Dec. 10.	29·0	−36° 37′·0	75° 17′·2	0·86509	Jan. 9.	66·9	−36° 45′·9	75° 15′·4	0·86414
Jan. 13.	31·8	−36 41·9	75 13·9	0·86433	13.	54·4	−36 33·5	75 13·9	0·86506
13.	32·0	−36 34·5	75 13·9	0·86497					
17.	35·0	−37 17·2	75 13·4	0·86123	17.	61·8	−36 36·8	75 13·4	0·86472
30.	38·0	−36 38·8	75 16·5	0·86487	30.	65·4	−37 02·3	75 16·5	0·86284
Feb. 1.	25·6	−36 24·2	75 15·7	0·86604	Feb. 1.	62·3	−36 41·1	75 15·7	0·86459
2.	25·8	−36 31·7	75 15·7	0·86542	2.	79·0	−36 36·8	75 15·7	0·86499
3.	27·4	−36 39·5	75 15·6	0·86470	3.	80·2	−36 58·7	75 15·6	0·86311
4.	37·0	−36 54·9	75 15·6	0·86337	4.	76·4	−36 44·6	75 15·6	0·86431
10.	25·3	−36 37·0	75 14·7	0·86479	11.	71·9	−36 47·6	75 14·7	0·86387
10.	27·5	−36 37·0	75 14·7	0·86479	11.	64·5	−37 08·3	75 14·7	0·86215
	30·4	−36 41·2	75 15·2	0·86451		68·3			0·86398

Hence for L. A. $q = ·000016$.

L. B..

Low temperatures.					High temperatures.				
1843.	t.	v.	θ.	φ.	1843.	t'.	v'.	θ'.	φ'.
Jan. 17.	34·4	−33° 45′·1	75° 13′·4	0·87923	Jan. 17.	62·9	−33° 58′·2	75° 13′·4	0·87814
Feb. 1.	26·2	−33 35·1	75 15·7	0·88026	Feb. 1.	63·9	−34 12·5	75 15·7	0·87715
2.	25·8	−33 41·1	75 15·7	0·87976	2.	85·1	−34 18·7	75 15·7	0·87661
3.	27·8	−33 30·6	75 15·6	0·88062	3.	80·4	−34 14·6	75 15·6	0·87697
4.	37·5	−34 05·9	75 15·6	0·87765	4.	88·6	−34 20·1	75 15·6	0·87651
10.	27·7	−34 04·2	75 14·7	0·87776	11.	66·1	−34 04·3	75 14·7	0·87775
	29·9	−33 47·0	75 15·1	0·87921		74·5			0·87719

Hence for L. B. q=·00005.

Table XI.

Abstract of the Observations made with Needle F. A. and F. C. to determine the Coefficient for the temperature correction.

Needle F. A.

Weight.	1843.	Low temperatures.		High temperatures.		Weight.	1843.	Low temperatures.		High temperatures.	
		t.	v.	t'.	v'.			t.	v.	t'.	v'.
2·0 grs.	Jan. 4.	26°·0	21° 09′·9	60°·8	21° 17′·2	2·5 grs.	Jan. 4.	26°·2	26° 52′·2	61°·5	27° 11′·8
	4.	28·0	21 08·9	56·8	21 20·3		4.	27·4	26 45·9	57·1	27 18·1
	12.	35·2	21 12·3	74·2	21 19·5		12.	35·5	27 04·2	74·8	27 05·7
	12.	35·5	21 21·8	82·4	21 25·6		12.	35·4	27 00·3	80·0	27 11·3
	14.	30·6	21 09·5	71·5	21 32·1		14.	29·5	26 53·1	70·5	27 12·9
	14.	27·0	21 12·6	61·2	21 20·8		14.	26·0	26 58·8	62·1	27 02·1
	16.	33·5	21 10·0	72·7	21 25·9		16.	32·5	27 08·4	74·8	27 18·1
	Means..	30·8	21 12·1	67·4	21 23·1		Means..	30·4	26 57·6	68·7	27 11·4
3·0 grs.	Jan. 4.	26·7	33 05·0	61·2	33 17·2						
	4.	26·2	33 02·8	58·8	33 18·5						
	12.	35·5	33 21·6	75·9	33 26·0						
	12.	35·0	33 15·2	83·4	33 25·8	4·0 grs.	Jan. 12.	34·9	46 45·4	74·4	46 52·5
	12.	34·2	33 14·8				12.	34·0	46 42·1	80·3	47 05·6
	16.	32·5	33 07·4	78·2	33 15·6		16.	34·5	46 41·4	82·0	47 15·4
	Means..	31·7	33 11·1	71·5	33 20·6		Means..	34·4	46 43·0	78·9	47 04·5

Hence, giving the observations with 4·0 grains, half the weight of the observations with each of the other three weights, we have q=·000164.

Needle F. C.

Weights.	1843.	Low temperatures.		High temparatures.		Weights.	1843.	Low temperatures.		High temperatures.	
		t.	v.	t'.	v'.			t.	v.	t'.	v'.
2·0 grs.	Feb. 2.	24°·7	26° 32′	83°·0	26° 36′	2·5 grs.	Feb. 2.	28°·0	34° 06′	88°·0	34° 33′
	3.	32·7	26 47	83·5	26 49		3.	30·7	34 19	87·4	34 33
	3.	31·0	26 38	67·8	27 16		3.	29·5	33 54	70·1	34 24
	6.	29·0	26 54	82·0	26 58		6.	29·0	34 16	79·2	34 30
	6.	28·1	26 45	64·6	26 55		6.	28·2	34 15	64·0	34 30
	4.	28·2	26 42	64·5	26 42		4.	31·4	34 21	65·0	34 18
	Means..	28·9	26 43	72·9	26 52·7		Means..	29·5	34 12	75·6	34 28
3·0 grs.	Feb. 2.	24·0	42 45	89·0	42 43						
	3.	29·1	42 31	87·2	42 38						
	3.	28·5	42 37	70·5	42 35						
	6.	29·0	42 41	73·0	42 40						
	6.	28·1	42 43	62·2	42 47	1·5 gr.	Feb. 6.	28·5	19 39	82·1	20 12·0
	4.	33·7	42 42	65·0	42 56		6.	27·5	19 46	65·3	20 03·0
	Means..	28·7	42 39·8	72·8	42 43·2		Means..	28·0	19 42·5	78·7	20 07·5

Hence, giving the observations with 1·5 gr. one-third the weight of those with each of the other weights, $q = \cdot00013$; or, if we reject the observations with 3 grains, which are much more irregular than the others, $q = \cdot000175$. The value which has been employed is ·00016 for both needles F. A. and F. C.

It will perhaps be most convenient to give a brief history of each needle during the period comprised by the observations discussed in this memoir; beginning with F. A. of Mr. Fox's apparatus, as having been the most extensively employed. The observations with this needle commenced at Woolwich, as a base station, on the 7th of July 1842. In the transport in which Lieut. Lefroy made his passage to Canada in July and August, it was employed to give determinations of the Inclination and Force on all days when the weather permitted. The greater part of these determinations belong to a part of the globe which is not now under consideration, and will not therefore be discussed on the present occasion; but a continuation of the series at some stations in Lower Canada, and at several in the United States which Lieut. Lefroy visited on his way to Toronto, for the purpose of connecting the base stations of other observers with his own future base station at Toronto, will be found in Table XII. The deflections obtained with this needle at Toronto on the 26th of October 1842, with the same weights which had been used at Woolwich in July, gave for the ratio of the total force at Toronto 1·3395 to 1 at Woolwich; or 1·838 to 1·372 in terms of the usual arbitrary scale. Two subsequent determinations, one with the same apparatus in 1846, and the other derived from absolute measures of the horizontal Force at Toronto and Woolwich, gave each 1·835 to 1·372; these determinations have been discussed in the introductory remarks, pages 244 to 247, the result of the discussion being that 1·836 has been finally adopted.

On the 28th of October, the needle F. A. being put away in its case, a very powerful bar magnet was inadvertently laid on the top of the case for a few minutes. Observations made on the following day (the 29th), compared with those which had been made on the 26th, showed that the needle had sustained a sensible loss of magnetism by this accident. A new series therefore in the determinations with this needle was commenced on the 29th of October, referring to Toronto as a base station, at which the value of the force is expressed by 1·836 as before. In November 1842, F. A. was employed by Lieut. YOUNGHUSBAND, R.A. at four stations in the states of Ohio and Michigan, and was brought back to Toronto in the same month: the abstract of these observations is given in Table XIII. In the first three months of 1843 the observations were made in high and low temperatures, by which the coefficient in the temperature correction was determined; and repetitions were made on different days in natural temperatures of the angles of deflection with several weights which were afterwards employed in the countries to the north. Towards the end of April Lieut. LEFROY embarked at La Chine in the canoes of the Hudson's Bay Company, and commenced a course of observations, which was continued daily with very few intermissions until his arrival at Athabasca towards the end of September, at the conclusion of the season of navigation. The observations with F. A. were made by Lieut. LEFROY himself until the station of the 11th of May at the Trou Portage; and from thenceforward by Bombardier HENRY, unless where specially noticed in the column of remarks in Tables XIV., XV. and XVI.; towards the end of July the performance of the needle was thought to be somewhat impaired, and in consequence, at York Factory, the terminations of the axles which worked in jewels, as well as the jewels themselves, were carefully examined with a microscope; the front axle was found in admirable order, but the polish of the back axle was not good on one side. The jewels were in good order; the front jewel was scratched on the face and round the edge of the cylindrical bore, probably by the end of the axle in mounting the needle, but the scratches did not appear to enter the bore or affect the bearing points; F. A. was continued in constant use until the end of the season, but its performance was occasionally sluggish and unsatisfactory in comparison with what it had formerly been, and led to its being only occasionally employed in the following year. On the return to Toronto at the close of 1844, the observations were repeated with the weights which had been used in the north; the performance of the needle on that occasion was considered to be a decided improvement on former ones, and the angles of deflection agreed within limits of ordinary error with the angles observed in 1843, before the journey to the north; showing that the magnetism of the needle had sustained no deterioration during the interval. The abstract of the observations with this needle from 1842 to the close of 1844, are given in Tables XIV., XV. and XVI.

Needle F. C. had been kept in reserve at the different stations of the Survey whilst F. A. continued to give satisfactory results. Being examined at York Factory, the

polish of the axle was found perfectly good, but the back axle had been injured in shape. A spare axle had been furnished with the apparatus, and appearing perfect both in shape and polish, it was fitted to F. C., and observations were made with this needle at Norway House on the 11th of August 1843, and were repeated at the same spot on the 7th of September 1844. The magnetism of the needle appeared steady, but from some undiscovered cause its performance at some other stations at which it was tried was sluggish and irregular, so that no satisfactory results were obtained with it at them. On the return to Toronto, the angles of deflection were observed with the same weights which had been used at Norway House in August 1843 and September 1844. These give an identical value for the increase of the magnetic force between Toronto and Norway House, to that obtained by the other needle of the apparatus F. A.; the particulars are given in Table XVII.

In Mr. Fox's apparatus the angle of deflection with any particular weight is half the difference of the arcs shown with the weight first on the one hook, and then on the other hook. The experiment is repeated with the face of the circle both east and west, and the angle of deflection entered in the Table is the mean of the angles with the face of the circle east and west.

L. A. and L. B. were the needles on Dr. Lloyd's statical principle fitted to the Gambey's circle; at Toronto, in January and February 1843, the observations were made with them in Table X., by which the coefficient in the temperature correction was determined; and angles of deflection with weights inserted in the hole most distant from the axle were observed for the purpose of supplying a base determination. On arriving at St. Helen's, however, the angles of deflection appeared inconveniently large, and the weights were shifted in each needle into the middle hole, and a new series of relative determinations commenced. The angles of deflection having been observed on the same day at St. Helen's with the weight both in the middle and in the outer hole, the second series become thereby connected with the former; but the advantage of the frequent repetition which had been made at Toronto as a base station was impaired, inasmuch as the connection of the second series commencing at St. Helen's is established by a single observation only in each position of the weights. On arriving at Fort William at the end of May, it was found necessary again to change the weights, because the view of the part of the circle opposite to which the needle rested was interrupted by the cross bar which supports the agate planes. In the case of L. B., the weight was now replaced in the hole in which it had been used at Toronto, and the connection of the subsequent observations with the original base station was thereby fully restored. In the case of L. A., a new weight appears to have been chosen, and as observations were made at Fort William both with the old and the new weight, the two series with this needle,—viz. before and after the change of the weight at Fort William,—have that station common to both. From the time of the embarkation in the Hudson's Bay Company's canoes at La Chine,

on the 30th of April, L. A. was in constant and L. B. in occasional use. This continued until the 20th of June at Rat Portage, when the circle was accidentally thrown down, and the axle of L. A., which was mounted at the time for observation, was bent. The injury which the circle had received was repaired a few days afterwards at the Red River settlement; an endeavour was made to straighten the axle of the needle, and with so much success, that observations were occasionally made with it at subsequent stations; the same weight was used as before, but the angles of deflection were of course not comparable with the preceding ones. L. B. was now taken into daily use; and as in this needle the weight was the same as at Toronto and in the same position, the observations continued for some time forward to be directly referable to the base observations at Toronto. On arrival at York Factory the angles of deflection were again found to have become inconveniently large: a new weight was substituted, and continued in use until the 8th of August at Norway House, when the position of the weight was again changed, the angles of deflection in both positions being however observed: Norway House is thus a station common to three of the four series with this needle, and is itself directly connected with Toronto by one of the series. Observations with L. B. were continued to the close of the navigation in 1843, but were not resumed in 1844 with either of the Lloyd's needles.

Under the circumstances which have been narrated, the course which has appeared to be best suited for the deduction of the variations of the magnetic Force resulting from the observations with L. A. and L. B., has been to ascertain, in the first instance, with as much precision as possible, the ratio of the magnetic force at Norway House to that at Toronto, and to regard Norway House as a base station for those series with L. A. and L. B., which are directly connected with it. By this means the only remaining unconnected series with Lloyd's needles is that with L. A. between St. Helen's and Fort William; and this series has been connected with the others, by obtaining in a similar manner the value of the Force at Fort William as a base station from the observations with all the other needles.

For the increase therefore of the total Force between Toronto and Norway House we have the following determinations by three independent methods: viz.—

1. *By* Mr. Fox's *Method and Apparatus.*

Needle F. A.—The first and apparently the best comparison with this needle is furnished by the angles of deflection observed with weights from two to four grains in natural temperatures at Toronto, on different days in January, March and April 1843, before Lieut. Lefroy's departure to join the Hudson's Bay Company's boats, and the angles of deflection observed with the same weights at Norway House on the 13th July following; the observations will be found in Table XIV. From this comparison we have the force at Norway House = 1·0196 to 1 at Toronto.

For a second comparison with this needle we may unite the whole of the deflec-

tions observed with the weights at Toronto at different times between October 1842 and December 1844 (Tables XIII., XIV. and XVI.), and the whole of the deflections observed with the same weights at different times at Norway House, viz. on July 13, 1843; August 7, 8, 9, 1843; and September 7, 1844 (Tables XV. and XVI.). From this comparison we obtain the force at Norway House = 1·0171 to 1 at Toronto; and we may consider the mean of these two determinations, or 1·0184, as the result with F. A.

Needle F. C.—By combining the angles of deflection observed with this needle at Norway House, with weights from 1·5 to 3·5 grains, on the 11th of August 1842 after the new axle had been applied to it, and repeated on the 7th of September 1844 with very small variation in the results,—with the angles observed with the same weights and the same axle at Toronto on the 14th and 17th of December 1844,—we obtain the Force at Norway House = 1·0184 to 1 at Toronto; which is precisely the same result as that deduced by needle F. A. The observations will be found in Table XVII.

We may therefore regard 1·0184 as the ratio of the Force at Norway House to unity at Toronto by Mr. Fox's method.

2. *By* Dr. Lloyd's *Method and Needles.*

L. A.—In consequence of the accident which befel this needle on the 20th of June 1843, on the route between Toronto and Norway House, the connection of the series was broken, and we can derive no aid from it for the present purpose.

L. B.—With this needle we have the deflections in natural temperatures at Toronto, in January and February 1843, in Table X., and with the same weight at Norway House on the 12th of July in the same year, in Table XXII. From this comparison we obtain the force at Norway House = 1·0232 to 1 at Toronto. When Lieut. Lefroy visited Norway House in August of the same year, the observations with this weight do not appear to have been repeated; it had been considered expedient to change the weight employed in deflecting the needle at York Factory, and as the angles both with the old and new weights were observed at that station, and as nearly under the same circumstances as possible, we are furnished with the means of computing the equivalent value of $\frac{\cos v}{\sin (v - \theta)}$ for either weight at any other station, where one of the weights only may have been employed. If then we compute this value for the old weight, from the angles with the new one which were observed at Norway House on the 7th, 8th and 11th of August 1843 (Table XXIII.), we obtain a second comparison with the original angles of deflection at Toronto, which gives the force at Norway House = 1·0185. The indirect process by which this last determination is obtained is to a certain degree a diminution of its value. On the other hand, it represents observations repeated on three different days at Norway House, whereas the first determination is from the observations of a single day only. Not feeling confident that either determination is entitled to a decided preference over the other,

I have regarded the mean, 1·0208, as the most satisfactory result which I am able to derive from the observations with this needle at Toronto and Norway House; and therefore as the result by Dr. Lloyd's method.

3. *By absolute measures of the Horizontal Force.*

The value of the horizontal force in absolute measure at Norway House is given by Lieut. Lefroy at 2·1742, derived from the experiments with two magnets in July 1843, and with three magnets in September 1844, Table XXXVIII.

The Inclination observed at Norway House in 1843 and 1844 is 81° 09′·8. Hence the total magnetic force at Norway House =14·15 in absolute measure.

At Toronto we have the horizontal force 3·535 by the experiments with the three survey magnets in January, February and March 1845, Table XXXVIII. The Inclination at this period, taken to the nearest minute from the observations at the observatory, made twice in each week, is 75° 14′. Hence the total magnetic force at Toronto at that period was 13·87. If therefore the total force at Toronto be taken as unity, the ratio at Norway House is $\frac{14\cdot15}{13\cdot87}=1\cdot0205$. It is right to notice that the value of the total force at Norway House would be altered 0·027, and the ratio of the force at Toronto and Norway House ·0019 by a correction of 1′ only in the observed dip; and that the uncertainty which must attach to a determination of the dip made with a single instrument, even under the most favourable circumstances, taking into account both the possibility of constant errors, and the probable observation error, can scarcely be deemed so small as 1′.

Collecting then in one view the results of the three methods, we have the ratio of the total Force at Norway House as follows:—

By Mr. Fox's method . . .	1·0184 to 1 at Toronto.
By Dr. Lloyd's method . . .	1·0208 to 1 at Toronto.
By absolute measure . . .	1·0205 to 1 at Toronto.

As there do not appear sufficient grounds to assign a decided preference to any one of these results over the other two, and as, moreover, they are much more accordant with each other than might reasonably have been expected, we appear to be justified in taking 1·020 as probably a very near approximation to the true ratio of the total magnetic force at Norway House to unity at Toronto. If the Force at Toronto be taken at 1·836 in the arbitrary scale, then the value of the force at Norway House, in terms of the same scale, is 1·873: which has been considered the value whenever Norway House has been used as a base station.

For the ratio of the total Force at Fort William we have the result of the two series of observations with F. A. at that station on the 29th of May 1843, one by Lieut. Lefroy and the other by Bombardier Henry, with the same weights which had been used at Toronto in the early part of the same year (Table XIV.); these give the value

of the Force = 1·867. We have also the observations with L. B. on the same day (May 29th) at Fort William, included in the same series with the observations of the 12th of July at Norway House (Table XXII.); from these we have the Force at Fort William = 1·864. The mean of the two determinations is 1·8655; which has therefore been taken as the value whenever Fort William has been used as a base station.

Tables XVIII. to XXIV. contain the several series with needles L. A. and L. B., arranged according to the base stations to which they respectively refer. The angles of deflection in these tables are always a mean of the angles in four different positions of the needle and circle; *i. e.* with the face of the circle turned towards the east and towards the west, and with the needle reversed on its supports so that each end should rest alternately on the opposite plane.

Since Lieut. LEFROY's return to Canada from the Hudson's Bay territories, GAMBEY's circle has been supplied with a second pair of statical needles on Dr. LLOYD's principle. These needles were used in 1845 by Lieut. YOUNGHUSBAND, R.A., at four stations in Canada, and by Lieut. LEFROY at six stations in Canada and the United States; the observations are contained in Tables XXV. and XXVI.

TABLE XII.—Observations on the Magnetic Force with Fox's Needle F. A., made by Lieut. LEFROY in 1842 between Woolwich and Toronto.

Station.	1842.	Angles of deflection with weights of			Temperature.	Intensity.	Remarks.
		2·0 grs.	2·5 grs.	3·0 grs.			
Woolwich	July 7.	27° 30′·0	35° 29′·1	44° 00′·9	58°·5	1·372	Base station.
Quebec	Sept. 1.	20 20·1	25 45·8	31 34·5	74	1·829	Royal Artillery Barracks.
Three Rivers..	6.	20 23·0	25 40·8	31 31·4	66	1·828	Mr. BELL's Garden.
Sorel	8.	20 30·8	25 57·6	31 36·1	61	1·817	Bank E. of the Roman Catholic Church.
Kingsey	10.	20 35·8	26 00·3	31 47·8	60	1·810	Captain Cox's Garden.
Stanstead	12.	20 38·6	26 06·1	32 06·1	60	1·801	Garden of the Hotel near the Church.
St. Helen's....	16.	20 32·5	25 51·7	31 48·3	59	1·813	100 yards S.S.W. of the Barracks.
New York	26.	21 01·6	26 46·0	32 39·2	71	1·771	Lunatic Asylum, Manhattanville.
Providence....	28.	20 45·8	26 39·1	32 32·2	75	1·783	Steam-boat landing.
Cambridge....	Oct. 3.	20 50·7	26 34·5	32 30·1	63	1·779	Garden of the Observatory.
Philadelphia ..	6.	20 31·1	26 19·7	32 22·2	62	1·795	Girard College.
Baltimore	8.	20 51·6	26 22·2	32 26·5	62	1·784	Washington's Monument N. 42° E., distant 400 yards.
Washington ..	10.	20 54·8	26 38·1	32 41·1	63	1·774	In the grounds west of the Capitol.
Princeton	14.	20 53·0	26 23·1	32 18·0	62	1·785	Field 200 yards east of the College.
Newhaven	18.	21 00·5	26 33·5	32 39·4	67	1·775	In an open space in Grove Street.
West Point....	19.	20 32·8	26 03·6	31 44·5	54	1·809	Professor BARTLETT's Garden.
Albany	21.	20 38·9	26 12·0	32 00·5	55	1·799	Hill between Orange and Patroon Streets.
Toronto	26.	20 12·3	25 34·8	31 19·7	57	1·838	Magnetic Observatory.

Note.—The Force at Toronto having been finally taken at 1·836 (p. 244 to 247), the values given in this Table for the stations in Canada and the United States require to be diminished by ·002, and have accordingly been so diminished in Table XXVII., in which the several determinations with the statical needles are collected in one view.

Table XIII.

Observations with Needle F. A., by Lieut. Younghusband, R.A., in November 1842.

Station.	1842.	Angles of deflection with weights of 1·5 gr.	2·0 grs.	2·5 grs.	Temperature.	Intensity.	Remarks.
Toronto	Oct. 29.	21° 14′·6	27° 00′·5	33° 11′·6	53°	1·836	Base station.
	Dec. 30.	21 18·5	27 08·0	33 08·2	43		
Cleveland	Nov. 3.	21 34·4	not observed.	33 58·3	56	1·807	Inland from the Wharf.
Detroit	4.	21 23·4	27 12·3	33 25·8	47	1·826	40 yards from the Wharf.
S.ManitouIsland	7.	21 15·5	26 55·8	32 55·0	54	1·846	40 yards from the Wharf.
Chicago	15.	21 26·7	27 14·1	33 26·4	47	1·823	Dr. Eldridge's Garden.
	16.	21 29·7	27 12·7	33 25·1	47		

Table XIV.

Observations on the Magnetic Force with Fox's Needle F. A., between Toronto and Norway House, from January 1844 to July 1844.

Station.	1843.	Angles of deflection with weights of 2·0 grs.	2·5 grs.	3·0 grs.	3·5 grs.	4·0 grs.	Thermometer.	Intensity. Toronto = 1·836.	Remarks.
Toronto	Jan. 4.	21° 09′·9	26° 52′·2	33° 05′·0	.....	.....	26		
	4.	21 08·8	26 45·9	33 02·8	.....	.....	27		
	12.	21 12·3	27 04·2	33 21·6	.....	46 45·4	36		
	12.	21 21·8	27 00·3	33 15·2	.....	46 42·1	35		
	12.	.....	.....	33 14·8	.....	.....	34		
	14.	21 09·4	26 53·1	.....	.....	.....	30		
	14.	21 12·6	26 58·8	.....	.....	.....	27		
	16.	21 10·0	27 08·4	33 07·4	.....	46 41·4	34		
	March 8.	21 14·7	27 16·6	32 59·7	39 34·4	46 42·5	60		
	8.	.....	27 16·1	33 06·1	.....	46 42·1	59		
	9.	21 17·6	27 06·1	33 05·0	.....	46 42·7	60		
	April 6.	.....	26 57·6	33 06·0	39 22·0	46 57·9	46		
	7.	.....	27 08·3	33 12·0	39 24·5	46 53·0	59		
	Mean..	21 13·0	27 02·3	33 08·7	39 27·0	46 45·9	46	1·836	Base station.
St Helen's.....	April 25.	.....	27 21·9	33 21·4	39 58·9	.....	54	1·821	
Isle d'Urval	30.	.....	27 27·2	33 37·0	40 30·9	47 55·0	47	1·805	
La Combes	May 2.	.....	26 44·2	33 23·2	39 43·5	47 05·4	48	1·833	
Pte aux Chênes	3.	.....	27 47·2	33 47·7	40 43·0	47 54·8	56	1·800	
Foxes Point	4.	.....	27 10·3	32 56·0	39 35·2	46 42·2	50	1·837	
Chat Falls	6.	.....	26 49·1	33 03·8	39 15·2	46 33·6	53	1·846	
Grand Calumet	7.	.....	27 24·9	33 29·6	40 01·4	47 05·1	74	1·826	
Fort Coulonge	8.	.....	26 47·2	33 01·8	39 31·0	47 10·5	55	1·841	
Pte Baptême	9.	.....	27 22·2	33 24·1	40 00·2	47 13·4	57	1·822	
Deux Joachims Portage..	10.	.....	27 22·0	33 31·8	40 02·7	46 56·9	74	1·827	
Trou Portage.....	11.	.....	27 07·5	33 12·6	39 36·7	46 48·3	80	1·842	
Little River	12.	21 10·7	27 10·1	32 47·6	39 49·6	46 23·2	78	1·836	
L. du Grand Vase.....	13.	.....	26 44·0	33 02·9	39 53·7	47 08·6	72	1·843	
Ricolet Falls	15.	.....	26 21·0	32 55·8	38 31·4	45 44·2	61	1·871	
Pte au Croix	16.	.....	26 14·6	32 52·7	39 40·6	46 35·4	49	1·852	

Table XIV. (Continued.)

Station.	1843.	Angles of deflection with weights of					Thermometer.	Intensity.	Remarks.
		2·0 grs.	2·5 grs.	3·0 grs.	3·5 grs.	4·0 grs.		Toronto = 1·836.	
Lake Huron	May 17.	.....	27° 10′·3	33° 13′·3	39° 17′·2	46° 51′·6	59°	1·838	
Snake Island	18.	.....	27 39·5	33 13·0	39 58·2	46 33·7	68	1·829	
Tessalon Point	19.	.....	26 49·8	32 22·7	39 38·2	46 12·3	69	1·860	
Pointe aux Pins	20.	.....	26 37·2	32 09·3	39 29·2	46 16·4	70	1·867	
Pte au Crêpe	21.	.....	26 00·4	31 30·6	38 04·8	44 36·7	73	1·910	
Fort Michipicoton	23.	.....	26 29·5	32 56·9	38 57·8	46 37·1	40	1·851	
Otter Island	24.	.....	27 32·5	34 06·0	40 43·8	49 08·7	52	1·790	
Pic Fort	25.	.....	27 14·5	33 06·4	38 52·5	47 22·9	66	1·841	
Terreplatte	27.	.....	27 06·4	32 28·4	39 21·6	45 42·5	45	1·853	
Pointe Tonnerre	28.	.....	25 56·5	31 58·3	38 20·8	46 19·9	58	1·890	
Fort William	29.	.....	26 40·4	32 22·8	38 51·8	46 05·0	73	1·867	
Fort William	29.	.....	26 33·3	32 37·8	39 11·0	45 48·3	63		L.
Portage Ecarté	June 2.	.....	26 38·6	32 40·8	39 26·8	46 14·9	48	1·852	
Chien Portage	3.	.....	26 31·9	32 27·7	38 45·1	45 43·9	47	1·868	
Prairie Portage	5.	.....	26 38·2	32 43·1	39 03·6	46 09·1	56	1·859	
Savannah Portage	6.	.....	26 42·6	32 39·8	38 51·2	45 52·9	65	1·866	
French Portage	7.	.....	26 40·3	32 42·3	39 00·5	46 04·5	60	1·861	
Portage des deux Rivières	8.	.....	26 32·0	32 32·1	39 04·0	46 04·2	57	1·864	
Lac à la Crosse	10.	.....	26 39·0	32 39·0	39 16·6	46 11·1	61	1·859	
2nd Portage from ditto	11.	.....	26 53·4	32 53·9	39 07·7	46 16·3	69	1·855	L.
Sturgeon Lake	12.	.....	26 34·8	32 31·8	39 10·1	46 04·8	68	1·866	
Lac la Pluie	13.	.....	26 32·5	32 49·8	39 02·5	46 02·8	55	1·861	
Fort Francis	14.	.....	26 50·8	32 50·3	39 24·8	46 05·9	62	1·853	
Rainy River	16.	.....	26 16·3	32 03·0	38 22·0	45 26·3	64	1·890	
Lake of the Woods	17.	.....	26 36·6	32 36·8	38 59·6	45 52·2	67	1·871	
Lake of the Woods	18.	.....	26 44·4	32 48·0	38 58·8	46 20·0	82	1·864	
Rat Portage	20.	.....	26 48·2	32 47·2	39 18·5	46 07·6	67	1·858	
Winnipeg River	22.	.....	26 23·9	32 30·7	38 50·4	45 38·3	71	1·877	L.
Slave Portage	23.	.....	26 34·7	32 44·3	39 21·3	46 16·3	87	1·867	
Fort Alexander	25.	.....	26 50·5	32 47·4	39 35·3	46 05·7	78	1·857	
Lake Winnipeg	26.	.....	26 38·6	32 37·0	39 05·5	46 11·3	80	1·867	
Upper Fort Garry	29.	.....	26 39·4	32 38·9	39 17·5	46 12·2	72	1·861	L.
Upper Fort Garry	July 3.	.....	26 51·2	32 40·8	39 13·7	46 07·7	84		
Mouth of the Red River	4.	.....	26 44·6	32 42·9	39 07·0	46 06·5	66	1·861	
Lake Winnipeg	5.	.....	26 42·8	32 42·2	39 07·2	46 20·9	66	1·859	
Lake Winnipeg	6.	.....	25 53·2	31 44·2	37 56·4	44 49·8	61	1·909	
Lake Winnipeg	7.	.....	26 19·9	31 46·1	38 02·5	44 46·0	69	1·904	
Lake Winnipeg	8.	.....	26 15·4	32 20·4	38 16·6	46 25·0	66	1·880	
Lake Winnipeg	10.	.....	26 08·9	33 04·3	38 47·3	46 28·9	65	1·862	
Lake Winnipeg	10.	.....	26 45·9	33 04·2	39 28·4	45 52·5	71		
Norway House	13.	.....	26 41·0	32 14·4	39 08·3	45 36·9	70	1·872	

Commencing with the 12th of May at Little River, these observations were made by Bombardier Henry, R.A., except where L. is inserted in the column of remarks.

Table XV.

Observations on the Magnetic Force with Fox's Needle F. A., between Norway House and Athabasca, from July 1843 to October 1843; observer, Bombardier Henry, R.A.

Station.	1843.	Angles of deflection with weights of					Thermometer.	Intensity.	Remarks.
		2·0 grs.	2·5 grs.	3·0 grs.	3·5 grs.	4·0 grs.		Toronto = 1·836.	
		° ′	° ′	° ′	° ′	° ′	°		
Norway House	July 13.	.....	26 41·0	32 14·4	39 08·3	45 36·9	70		
	Aug. 7.	20 45·3	26 41·9	32 45·9	39 08·9	45 57·1	78		
	8.	20 59·8	26 39·3	33 17·6	39 20·0	45 56·7	82		
	9.	20 35·7	26 53·2	32 56·8	39 24·1	46 31·1	85		
	Mean	20 45·6	26 44·3	32 48·7	39 15·3	46 00·5	79	1·873	Base.
Long Portage	July 20.	.....	26 52·4	32 19·4	38 48·1	45 40·4	64	1·880	
Long Portage	Aug. 2.	.....	26 50·0	32 22·9	39 41·9	45 45·3	71		
White Earth Portage	July 21.	.....	26 47·0	32 00·5	39 34·2	46 58·7	81	1·869	
White Earth Portage	31.	.....	27 11·7	32 23·1	38 46·2	46 29·2	59		
Shamatawa	22.	.....	26 43·9	33 35·2	39 56·8	47 09·6	63	1·862	
Shamatawa	28.	.....	26 32·5	32 57·5	38 19·9	45 57·7	70		
York Factory	24.	.....	26 57·3	32 30·3	39 05·0	46 59·1	70	1·857	
York Factory	25.	.....	27 13·0	33 16·5	39 44·1	45 55·0	56		
Hill River	Aug. 1.	.....	26 42·0	32 31·6	39 06·1	45 57·0	66	1·875	
Oxford House	3.	.....	26 56·6	32 01·3	38 35·4	45 11·3	66	1·889	
Windy Lake	4.	.....	26 20·4	32 30·8	39 17·8	46 07·5	76	1·870	
Whitefall Portage	5.	.....	26 41·4	32 32·2	39 19·3	45 45·3	82	1·879	
Hairy Lake	6.	21 00·6	27 01·9	32 54·1	39 18·9	46 09·9	73	1·861	
Lake Winnipeg	14.	.....	26 49·7	32 51·2	38 46·0	46 05·9	70	1·872	
Grand Rapid	15.	.....	26 54·9	32 29·6	38 47·9	46 07·6	67	1·874	
Cross Lake	16.	.....	26 38·4	32 33·8	38 51·6	46 20·7	68	1·875	
Cedar Lake	18.	.....	26 51·0	32 22·6	39 29·0	46 15·0	74	1·871	
Cumberland House	23.	.....	26 56·9	32 35·4	39 24·4	46 12·7	62	1·865	
Cumberland House	24.	.....	26 45·4	32 33·6	39 22·4	46 12·8	55		
Beaver Lake	26.	.....	26 42·3	32 50·4	38 37·7	46 41·1	64	1·869	
Portage des Epinettes	27.	.....	26 33·3	32 35·0	39 02·4	46 18·8	56	1·871	
Frog Portage	29.	.....	26 28·6	33 17·1	39 23·4	46 49·4	58	1·857	
Little Rock Portage	31.	.....	24 48·0	30 28·7	35 54·1	43 01·4	64	1·995	
Great Devil's Portage	Sept. 1.	.....	26 43·2	32 39·6	39 11·9	46 57·0	72	1·875	
Great Devil's Portage	1.	.....	26 00·3	32 42·1	38 40·0	46 32·6	67		
Pine Portage	3.	.....	26 00·3	32 42·1	38 40·0	46 32·6	67	1·884	
Snake Rapid	4.	.....	26 22·0	32 43·3	38 40·4	46 40·0	54	1·874	
Portage Sonnante	7.	.....	26 39·4	33 01·2	39 12·1	46 50·1	52	1·858	
Isle à la Crosse	9.	.....	26 38·2	33 12·2	38 56·8	47 20·7	64	1·857	
Isle à la Crosse	9.	.....	26 42·5	33 18·2	38 57·0	47 18·6	70		
Buffaloe Lake	13.	.....	26 58·5	33 16·0	39 05·0	.....	54	1·854	
River de la Loche	14.	.....	27 21·7	34 04·8	40 09·0	47 20·9	70	1·826	
Portage de la Loche	16.	.....	26 54·4	33 11·8	40 02·8	48 14·8	60	1·835	
Clearwater River	19.	.....	26 56·6	33 13·6	39 12·9	46 30·3	44	1·850	
Pierre au Calumet	20.	.....	25 20·3	31 33·6	37 14·1	44 46·6	55	1·938	
Pointe Brulée	21.	.....	27 16·5	33 11·5	38 32·8	46 35·8	43	1·852	
Athabasca	25.	.....	27 06·0	33 43·4	39 53·8	47 39·1	44		
Athabasca	25.	.....	27 03·3	33 28·0	39 58·9	47 52·3	44	1·828	
Athabasca	Oct. 9.	.....	26 48·7	33 45·7	39 55·5	47 34·5	36		

TABLE XVI.

Observations on the Magnetic Force with Fox's Needle F. A., between Athabasca and Toronto, from July 12th, 1844, to December 17th, 1844: Observer, Bombardier HENRY, R.A.

Station.	1844.	Angles of deflection with weights of					Temp.	Intensity.	
		2·5 grs.	3·0 grs.	3·5 grs.	4·0 grs.	4·5 grs.		Toronto = 1·836.	
Toronto	Dec. 14.	26° 52′·6	33° 18′·4	39° 16′·6	46° 39′·2	54° 25′·6	41°		
	Dec. 17.	26 40·8	33 02·4	39 13·7	46 42·1	54 33·1	32		
	Mean..	26 46·7	33 10·4	39 15·2	46 45·5	54 29·3	36·5	1·836	
Fort Vermilion....	July 12.	27 20·1	33 51·3	40 07·0	47 44·8	56 10·7	68	1·811	
Fort Dunvegan ..	23.	27 06·6	33 47·8	40 15·5	47 57·1	56 03·4	54	1·809	
Fort Edmonton ..	Aug. 17.	27 19·7	33 47·2	40 03·0	47 21·5	55 26·0	38	1·809	
Cumberland House	30.	26 37·0	32 56·8	38 59·0	46 24·9	54 06·2	61	1·853	
Norway House....	Sept. 7.	26 22·9	32 54·3	38 53·6	46 29·2	54 09·6	60	1·858	

TABLE XVII.

Observations on the Magnetic Force with Fox's Needle F. C., between Norway House in August 1843, and Toronto in December 1844.

Station.	1844.	Angles of deflection with weights of					Temp.	Intensity.	
		1·5 gr.	2·0 grs.	2·5 grs.	3·0 grs.	3·5 grs.		Toronto = 1·836.	
Toronto	Dec. 14.	19° 43′·6	27° 23′·0	34° 48′·5	43° 42′·4	53° 56·8	40°		
	Dec. 17.	19 47·1	27 17·7	34 47·5	43 42·5	53 55·0	32		
	Mean..	19 45·3	27 20·4	34 48·0	43 42·4	53 55·9	36	1·836	Base station.
	1843.								
Norway House....	Aug. 11.	19 32·2	26 54·5	34 12·0	42 39·3	52 33·0	56		
	1844.								
Norway House....	Sept. 7.	19 33·8	26 50·3	34 20·0	43 09·4	52 11·3	56		
	Means..	19 33·0	26 52·4	34 16·0	42 54·3	52 22·1	56	1·870	

TABLE XVIII.—Observations on the Magnetic Force with LLOYD's Needle L. A., from St. Helen's (in Canada) to Fort William, in April and May 1843.

Station.	1843.	Angles of deflection.	Temp.	Inclination.	Intensity. Toronto = 1·836.	Remarks.
Fort William	May 29.	− 9 37·7	70			
	29.	− 9 41·1	56			
	Mean..	− 9 39·4	63	78 10	1·8655	Base station.
St. Helen's	April 25.	−15 06·1	60	77 05·5	1·826	
Isle d'Urval	30.	−16 26·9	45	77 21·1	1·817	
La Combes	May 2.	−14 35·6	49	76 50·6	1·829	
Pte aux Chênes	3.	−17 10·0	49	76 55·4	1·810	
Point Aylmer	5.	−15 05·8	52	76 41·0	1·825	
Fort Coulange	8.	−12 13·8	53	77 29·7	1·847	
Deux Joachims Portage	10.	−14 04·9	70	77 03·8	1·834	
Trou Portage	11.	−13 24·5	87	77 24·4	1·840	
Little River	12.	−13 12·6	69	77 28·5	1·841	
L. du Grand Vase	13.	−12 05·2	86	77 21·7	1·849	
Lake Nipissing	14.	−13 48·0	64	77 09·5	1·836	
Ricolet Falls	15.	− 9 15·7	60	76 45·4	1·870	
Pte au Croix	16.	−11 41·0	50	76 31·3	1·852	
Lake Huron	17.	−12 57·3	51	77 05·6	1·843	
Snake Island	18.	−13 41·2	68	77 05·5	1·837	
Tessalon Point	19.	−12 42·3	52	76 59·3	1·844	
Pointe aux Pins	20.	−11 02·4	70	77 13·4	1·858	
Pointe au Crêpe	21.	−12 47·4	63	77 11·5	1·844	
Michipicoton	23.	−10 26·4	46	78 06·3	1·859	
Otter Island	24.	−18 20·8	51	79 43·6	1·812	
Pic Fort	25.	−11 46·6	58	78 45·8	1·851	
Terreplatte	27.	−11 02·6	48	78 53·6	1·855	
Pointe Tonnerre	28.	−10 02·7	55	78 23·2	1·862	

TABLE XIX.—Observations on the Magnetic Force with LLOYD's Needle L. A., between Fort William and Rat Portage (where the needle met with an accident) in the months of May and June 1843.

Station.	1843.	Angles of deflection.	Temperature.	Inclination.	Intensity. Toronto = 1·836.	Remarks.
Fort William	May 29.	−17 09·6	53			
	29.	−17 09·9	53			
	Mean ..	−17 09·75	53	78 10	1·8655	Base station.
Portage Ecarté	June 2.	−18 38·2	52	77 13·5	1·852	
Chien Portage	3.	−17 41·4	47	78 26·8	1·863	
Prairie Portage	5.	−18 34·4	53	78 26·2	1·857	
Savannah Portage	6.	−16 52·4	60	78 21·8	1·869	
French Portage	8.	−18 01·6	60	78 20·4	1·860	
Portage des deux Rivières	9.	−17 41·8	58	77 49·4	1·861	
Lac à la Crosse	10.	−17 41·9	58	77 51·0	1·861	
2d Portage from the Lake	11.	−18 27·5	72	77 40·1	1·855	
Sturgeon Lake	12.	−18 08·2	66	77 44·8	1·857	
Lac la Pluie	13.	−18 12·5	60	77 47·9	1·857	
Fort Francis	14.	−17 48·3	63	77 28·0	1·859	
Rainy River	16.	−11 20·6	66	77 57·4	1·906	
Lake of the Woods	17.	−17 27·2	65	78 03·7	1·863	
Lake of the Woods	18.	−19 51·6	79	78 16·7	1·847	

TABLE XX.

Observations on the Magnetic Force with LLOYD's Needle L. A. (after the axle had been straightened), between Upper Fort Garry on the 3rd of July 1843, and Lake Winnipeg on the 14th of August 1843.

Station.	1843.	Angles of deflection.	Temperature.	Inclination.	Intensity. Toronto = 1·836.	Remarks.
Norway House	July 12.	− 9° 12′·8	68°	° ′		
	13.	− 9 31·9	76			
	Aug. 8.	−11 17·5	80			
	9.	−11 49·4	84			
	11.	−10 45·4	56			
	Mean ..	−10 31·4	73	81 09·8	1·873	Base station.
Upper Fort Garry	July 3.	−12 45·6	78	78 17·8	1·857	
Lake Winnipeg	10.	−11 36·0	69	80 05·5	1·866	
Long Portage.....	20.	− 9 18·0	87	82 13·9	1·880	
Long Portage.....	Aug. 2.	− 9 13·0	71			
York Factory.....	July 24.	−18 46·7	80	83 47·0	1·848	
York Factory.....	25.	−18 07·7	73			
Oxford House	Aug. 3.	11 48·0	60	82 38·8	1·869	
Windy Lake	4.	11 19·0	71	81 57·0	1·870	
Whitefall Portage	5.	13 47·0	79	81 47·9	1·858	
Old Norway House ..	12.	10 35·0	65	80 45·4	1·872	
Lake Winnipeg	14.	13 53·0	64	80 16·8	1·853	

TABLE XXI.

Observations on the Magnetic Force with LLOYD's Needle L. B., between St. Helen's in Canada on the 25th of April 1843, and Fort William on the 29th of May 1843.

Station.	1843.	Angles of deflection.	Temperature.	Inclination.	Intensity. Toronto = 1·836.	Remarks.
Fort William	May 29.	− 3° 25′·9	80°	78° 10′	1·8655	Base station.
St. Helen's.....	April 25.	−11 00·7	60	77 05·5	1·812	
Isle d'Urval.....	30.	−13 15·2	45	77 21·1	1·796	
Foxes Point	May 4.	− 9 05·0	51	76 35·3	1·827	
Chat Falls	6.	− 8 34·0	50	75 16·1	1·835	
Pointe aux Pins.....	20.	− 4 28·6	70	77 13·4	1·861	

Table XXII.

Observations on the Magnetic Force with Lloyd's Needle L. B., between Williamsburg in Canada on the 20th of April 1843, and York Factory on the 25th of July 1843.

Station.	1843.	Angles of deflection.	Temperature.	Inclination.	Intensity. Toronto = 1·836.	Remarks.
Norway House	July 12.	−39° 16′·0	70°	81° 09′·8	1·873	Base station.
Williamsburg.....	April 20.	−34 23·0	55	76 30·0	1·841	
St. Helen's.....	25.	−36 06·7	52	77 05·0	1·831	
Fort William.....	May 29.	−34 08·1	55	78 10·0	1·864	
Fort William.....	29.	−34 03·5	56			
Fort Francis	June 14.	−35 18·2	57	77 28·0	1·846	
Rainy River	16.	−31 08·4	68	77 57·4	1·890	
Upper Fort Garry....	July 3.	−34 18·5	78	78 17·8	1·867	
Mouth of the Red River	4.	−34 37·5	64	78 32·6	1·866	
Lake Winnipeg	5.	−35 50·3	70	79 11·8	1·866	
Lake Winnipeg	6.	−30 11·1	59	79 38·0	1·915	
Lake Winnipeg	7.	−31 26·5	67	79 28·3	1·904	
Lake Winnipeg	10.	−37 10·1	66	80 05·5	1·869	
Long Portage.....	20.	−41 15·7	87	82 13·9	1·881	
White Earth Portage..	21.	−47 17·0	84	83 03·0	1·857	
Shamatawa.....	23.	−48 22·0	64	83 36·0	1·863	
York Factory.....	24.	−50 16·6	85	83 47·0	1·853	
York Factory.....	25.	−50 44·8	47			

Table XXIII.

Observations on the Magnetic Force with Lloyd's Needle L. B., between York Factory on the 26th of July 1843, and Norway House on the 11th of August 1843.

Station.	1843.	Angles of deflection.	Temperature.	Inclination.	Intensity. Toronto = 1·836.	Remarks.
Norway House	Aug. 7.	+13° 39′·0	77°	° ′		
	8.	+12 39·0	81			
	11.	+14 45·0	58			
	Mean ..	+13 41·0	72	81 09·8	1·873	Base station.
York Factory.....	July 26.	+19 00·2	75	83 47·0	1·861	
York Factory.....	26.	+18 55·9	74			
Shamatawa.....	28.	+17 58·0	65	83 36·0	1·858	
White Earth Portage..	31.	+15 20·0	58	83 03·0	1·855	
Hill River	Aug. 1.	+17 41·0	65	82 55·0	1·867	
Long Portage.....	2.	+16 21·0	80	82 13·9	1·872	
Oxford House	3.	+18 16·8	68	82 38·8	1·874	
Whitefall Portage	5.	+14 31·8	78	81 47·9	1·870	
Hairy Lake.....	6.	+11 12·2	75	81 20·9	1·857	

TABLE XXIV.

Observations on the Magnetic Force with LLOYD's Needle L. B., between Norway House on the 11th of August 1843, and Athabasca on the 20th of October 1843.

Station.	1843.	Angles of deflection.	Temperature.	Inclination.	Intensity. Toronto = 1·836.	Remarks.
Norway House	Aug. 11.	−26° 12′·0	68°	° ′		
		−25 17·0	58			
	Mean ..	−25 44·5	63	81 09·8	1·873	Base station.
Old Norway House ..	Aug. 12.	−24 28·0	66	80 45·4	1·877	
Lake Winnipeg	14.	−26 26·0	68	80 16·8	1·860	
Grand Rapid	15.	−24 02·0	60	80 21·5	1·876	
Cross Lake.....	16.	−23 59·0	58	80 28·2	1·877	
Cumberland House ..	21.	−25 24·0	55	80 30	1·868	
Cumberland House ..	21.	−25 03·0	55			
Isle à la Crosse	Sept. 9.	−28 18·0	55	80 09·8	1·845	
Isle à la Crosse	9.	−28 20·0	51			
Athabasca	Oct. 20.	−29 33·0	50			
Athabasca	20.	−30 57·0	50			
Athabasca	20.	−30 41·0	37	81 37·7	1·849	
Athabasca	20.	−30 07·0	32			

TABLE XXV.

Observations on the Magnetic Force at Stations in Canada with LLOYD's Needles L. C. and L. D., in June and July 1845, by Lieut. YOUNGHUSBAND, R.A.

Station.	1845.	Needles.	Mean angle of deflection.	Thermometer.	Inclination.	Intensity. Toronto = 1·836.	Remarks.
Toronto	June 3.	C.	−17° 28′·2	62°	° ′		
	3.	C.	−17 38·6	68			
	4.	C.	−17 34·8	64			
	4.	C.	−17 32·7	69			
	5.	C.	−17 28·4	61			
	July 7.	C.	−17 35·0	75			
	7.	C.	−17 32·3	73			
	Mean..	C.	−17 32·9	67	75 13·0	1·836	Base station.
	June 3.	D.	−13 50·4	64			
	3.	D.	−13 58·9	67			
	4.	D.	−13 38·9	66			
	4.	D.	−13 34·7	68			
	5.	D.	−13 28·5	63			
	July 7.	D.	−13 44·9	76			
	7.	D.	−13 35·2	72			
	Mean..	D.	−13 41·8	68	75 13·0	1·836	
Brockville ..	June 13.	C.	−20 57·1	72	76 18·9	1·812	Garden at Rockfort.
	13.	D.	−16 52·1	83			
Cornwall ..	16.	C.	−19 36·6	66	76 16·4	1·822	Orchard behind Chesleys.
	16.	D.	−15 17·5	66			
Montreal....	18.	C.	−24 05·5	70	77 08·6	1·788	Garden on the mountain.
	18.	D.	−20 23·1	71			
Quebec	23.	C.	−22 39·6	70	77 08·8	1·801	Near WOLFE's monument.
	23.	D.	−18 29·9	72			

Corrections have been made for the variations of temperature; the coefficient q in these needles is ·000052 for L. C. and ·000058 for L. D.

Table XXVI.

Observations on the Magnetic Force at Stations in Canada, with Lloyd's Needles L. C. and L. D., in October and November 1845, by Lieut. Lefroy, R.A.

Station.	1845.	Needles.	Mean angle of deflection.	Thermometer.	Inclination.	Intensity. Toronto = 1·836.	Remarks.
Toronto	Oct. 17.	C.	−17° 22′·7	49°			
	17.	C.	−17 22·8	50			
	Nov. 3.	C.	−17 41·9	47			
	3.	C.	−17 28·2	48			
	3.	C.	−17 40·8	50			
	Mean..	C.	−17 31·3	49	75 14·3	1·836	Base station.
	Oct. 17.	D.	−14 17·6	49			
	17.	D.	−14 24·9	50			
	Nov. 3.	D.	−14 15·1	55			
	3.	D.	−14 18·6	49			
	Mean..	D.	−14 19·0	50	75 14·3	1·836	
Niagara	Oct. 18.	C.	−19 36·7	55	74 46·8	1·822	In a field near the Falls.
	18.	D.	−16 28·8	59			
Buffaloe	20.	C.	−20 19·0	44	74 37·0	1·814	1½ mile distant from the Lake.
	20.	D.	−17 18·9	44			
Amherstburg.	22.	C.	−19 09·1	54	73 30·0	1·822	Garden of the Hon. J. Gordon.
	22.	D.	−16 25·3	49			
Detroit	23.	C.	−20 23·9	54	73 38·8	1·814	Corner of Lafayette and Orleans Streets.
	23.	D.	−16 53·2	55			
Port Sarnia ..	25.	C.	−18 34·2	55	74 15·8	1·825	Garden near the Ferry.
	27.	C.	−18 52·5	68			
	25.	D.	−15 52·6	57			
	27.	D.	−15 44·8	68			
Goderich ..	28.	C.	−18 36·5	69	75 48·0	1·828	Garden at the foot of the Hill.
	29.	C.	−18 38·7	58			
	28.	D.	−15 30·0	75			
	29.	D.	−15 14·6	58			

Corrections have been made for the variations of temperature.

Table XXVII. contains the several determinations with the statical needles of Lloyd and Fox collected in one view, and exhibits a mean of the several statical determinations at each station.

Table XXVII.

Results of the Observations on the Magnetic Force with the Statical Needles in Canada and the Hudson's Bay Territories in 1842, 1843, 1844 and 1845.

Station.	Lat.	Long.	L. A.	L. B.	F. A.	Mean.	Remarks.
1842.							
Quebec	46° 49′	288° 44′	....	....	1·827	1·827	
Three Rivers	46 19	287 24	....	....	1·826	1·826	
Sorel	46 02	287 00	....	....	1·815	1·815	
Kingsey	45 48	287 41	....	....	1·808	1·808	
Stanstead	45 02	287 50	....	....	1·799	1·799	
St. Helen's	45 31	286 25	....	....	1·811	1·811	
New York	40 49	285 57	....	....	1·769	1·769	
Providence	41 50	288 35	....	....	1·781	1·781	
Cambridge	42 22	288 52	....	....	1·777	1·777	
Philadelphia	39 58	284 50	....	....	1·793	1·793	
Baltimore	39 17	283 23	....	....	1·782	1·782	
Washington	38 53	282 59	....	....	1·772	1·772	
Princeton	40 22	285 20	....	....	1·783	1·783	
Newhaven	41 18	287 02	....	....	1·773	1·773	
West Point	41 24	285 59	....	....	1·807	1·807	
Albany	42 39	286 15	....	....	1·797	1·797	
Cleveland	41 30	278 18	....	....	1·807	1·807	
Detroit	42 24	277 00	....	....	1·826	1·826	
South Manitou Island	45 05	274 22	....	....	1·846	1·846	
Chicago	41 53	272 16	....	....	1·823	1·823	
1843.							
Toronto	43 39	280 39	1·836	1·836	1·836	1·836	
St. Helen's	45 31	286 25	1·826	1·821	1·821	1·823	
Isle d'Urval	45 24	286 14	1·817	1·796	1·805	1·806	
La Combes	45 32	285 51	1·829	....	1·833	1·831	
Pointe aux Chênes	45 37	285 05	1·810	....	1·800	1·805	
Foxes Point	45 32	284 26	....	1·827	1·837	1·832	
Point Aylmer	45 15	284 02	1·825	....	....	1·825	
Chat Falls	45 26	283 28	....	1·835	1·846	1·840	
Grand Calumet	45 45	283 20	....	....	1·826	1·826	
Fort Coulonge	45 56	282 56	1·847	....	1·841	1·844	
Pointe Baptême	46 06	282 34	....	....	1·822	1·822	
Deux Joachim's Portage	46 12	281 41	1·834	....	1·827	1·830	
Trou Portage	46 15	281 27	1·840	....	1·842	1·841	
Little River	46 18	281 17	1·841	....	1·836	1·838	
Lac du Grand Vase	46 18	280 34	1·849	....	1·843	1·846	
Lake Nipissing	46 14	280 01	1·836	....	....	1·836	
Ricolet Falls	45 57	278 59	1·870	....	1·871	1·870	
Pointe au Croix	45 55	278 42	1·852	....	1·852	1·852	
Lake Huron	46 00	278 10	1·843	....	1·838	1·840	
Snake Island	46 10	277 10	1·837	....	1·829	1·833	
Tessalon Point	46 16	276 29	1·844	....	1·860	1·852	
Pointe aux Pins	46 29	275 19	1·858	1·861	1·867	1·862	
Pointe au Crêpe	46 58	275 02	1·844	....	1·910	1·877	
Fort Michipicoton	47 56	274 55	1·859	....	1·851	1·855	
Otter Island	48 07	273 45	1·812	....	1·790	1·801	
Pic Fort	48 38	273 31	1·851	....	1·841	1·846	
Terreplatte	48 49	272 15	1·855	....	1·853	1·854	
Pointe Tonnere	48 19	270 58	1·862	....	1·890	1·876	
Fort William	48 24	270 38	....	1·864	1·867	1·8655	
Portage Ecarté	48 25	270 15	1·852	....	1·852	1·852	
Chien Portage	48 39	270 26	1·863	....	1·868	1·865	
Prairie Portage	48 57	269 59	1·857	....	1·859	1·858	
Savannah Portage	48 53	269 57	1·869	.. .	1·866	1·867	
French Portage	48 35	268 53	1·860	....	1·861	1·860	
Portage des deux Rivières	48 35	268 33	1·861	....	1·864	1·862	
L. à la Crosse	48 24	267 50	1·861	....	1·859	1·860	
2nd Portage from ditto	48 15	267 36	1·855	....	1·855	1·855	
Sturgeon Lake	48 28	267 27	1·857	....	1·866	1·861	
Lac la Pluie	48 32	267 04	1·857	....	1·861	1·859	
Fort Francis	48 37	266 31	1·859	1·846	1·853	1·853	
Rainy River	48 48	265 29	1·906	1·890	1·890	1·895	

Table XXVII. (Continued.)

Station.	Lat.	Long.	L. A.	L. B.	F. A.	Mean.	Remarks.
1843.							
Lake of the Woods	49° 19′	265° 18′	1·863	....	1·871	1·867	
Lake of the Woods	49 28	265 20	1·847	....	1·864	1·856	
Rat Portage	49 46	265 21	....	....	1·858	1·858	
Winnipeg River	50 10	264 50	....	....	1·877	1·877	
Slave Portage	50 11	264 23	....	....	1·867	1·867	
Fort Alexander	50 37	263 39	....	....	1·857	1·857	
Lake Winnipeg	50 27	263 22	....	....	1·867	1·867	
Upper Fort Garry	49 53	262 57	1·857	1·867	1·861	1·862	
Mouth of the Red River	50 19	263 19	....	1·866	1·861	1·863	
Lake Winnipeg	51 04	263 15	....	1·866	1·859	1·862	
Lake Winnipeg	51 38	263 12	....	1·915	1·909	1·912	
Lake Winnipeg	51 45	263 07	....	1·904	1·904	1·904	
Lake Winnipeg	52 23	262 51	....	....	1·880	1·880	
Lake Winnipeg	52 29	262 47	1·866	1·869	1·862	1·865	
Norway House	53 59	261 53	1·873	....	1·873	1·873	
Long Portage	55 15	265 35	1·880	1·877	1·880	1·879	
White Earth Portage	55 26	265 57	....	1·855, 1·857 } 1·856	1·869	1·862	
Shamatawa	56 21	267 04	....	1·863, 1·858 } 1·860	1·862	1·861	
York Factory	57 00	267 34	1·848	1·853, 1·861 } 1·857	1·857	1·855	
Hill River	55 22	266 00	....	1·867	1·875	1·871	
Oxford House	54 56	264 30	1·869	1·874	1·889	1·880	
Windy Lake	54 37	263 58	1·870	....	1·870	1·870	
Whitefall Portage	54 24	263 34	1·858	1·870	1·879	1·871	
Hairy Lake	54 20	262 50	....	1·857	1·861	1·859	
Old Norway House	53 42	261 59	1·872	1·877	....	1·874	
Lake Winnipeg	53 31	260 48	1·853	1·860	1·872	1·864	
Grand Rapid	53 08	260 32	....	1·876	1·874	1·875	
Cross Lake	53 10	260 28	....	1·877	1·875	1·876	
Cedar Lake	53 18	259 48	....	....	1·871	1·871	
Cumberland House	53 57	257 41	....	1·868	1·866	1·867	
Beaver Lake	54 26	257 50	....	....	1·869	1·869	
Portage des Epinettes	55 04	257 18	....	....	1·871	1·871	
Frog Portage	55 27	256 30	....	....	1·857	1·857	
Little Rock Portage	55 34	255 26	....	....	1·995	1·995	
Great Devil's Portage	55 40	255 12	....	....	1·875	1·875	
Pine Portage	55 43	254 04	....	....	1·884	1·884	
Snake Rapid	55 46	253 30	....	....	1·874	1·874	
Portage Sonnante	55 54	252 24	....	....	1·858	1·858	
Isle à la Crosse	55 25	252 06	....	1·845	1·857	1·851	
Buffaloe Lake	56 04	251 20	....	....	1·854	1·854	
River de la Loche	56 15	250 42	....	....	1·826	1·826	
Portage de la Loche	56 34	250 16	....	....	1·835	1·835	
Clearwater River	56 39	249 11	....	....	1·850	1·850	
Pierre au Calumet	57 24	248 25	....	....	1·938	1·938	
Pointe Brulée	58 07	248 35	....	....	1·852	1·852	
Athabasca	58 43	248 42	....	1·849	1·828	1·838	
1844.							
Fort Vermilion	58 55	243 55	....	....	1·811	1·811	
Fort Dunvegan	55 35	241 35	....	....	1·809	1·809	
Fort Edmonton	53 31	247 08	....	....	1·809	1·809	
Cumberland House	53 57	257 41	....	....	1·853	1·853	
1845.			L. C.	L. D.			
Brockville	44 35	284 15	1·811	1·813	....	1·812	
Cornwall	45 02	285 13	1·821	1·823	....	1·822	
Montreal	45 31	286 25	1·790	1·786	....	1·788	
Quebec	46 49	288 44	1·802	1·800	....	1·801	
Niagara	43 05	280 51	1·821	1·823	....	1·822	
Buffaloe	42 52	281 06	1·814	1·814	....	1·814	
Amherstburg	42 06	276 47	1·823	1·821	....	1·822	
Detroit	42 24	277 02	1·807	1·821	....	1·814	
Port Sarnia	42 58	277 26	1·825	1·824	....	1·825	
Goderich	43 45	278 08	1·828	1·828	....	1·828	

Report relative to the determinations of Absolute Horizontal Force, drawn up by Lieut. I. H. LEFROY, *R.A., and transmitted from Canada in* 1845.

"The measurements of the absolute horizontal force, from September 1842 to March 1843, were made with a transportable magnetometer by MEYERSTEIN of Göttingen, on the plan of Professor WEBER, described in TAYLOR's Scientific Memoirs, Part VIII. The deflecting bar in this instrument was retained at right angles to the meridian, and the angles of deflection were measured upon a long scale carried by the telescope.

"Two deflecting bars were supplied with the instrument, 0·4 inch in diameter and 3·9 and 3·75 inches in length respectively. The angle of deflection was first observed with the farthest end of the deflecting bar at the distance 1·5 foot on the deflection scale; secondly, with the same end at 1·7 foot; and finally with the nearer end at 1·7 foot, giving the following as the distances of the deflecting bar. The bars are distinguished by the letters and numbers marked upon them.

	N. IX. feet.	N. 13. feet.
r	1·3437	1·3371
r'	1·5437	1·5371
r''	1·8562	1·8629

"The third distance is as nearly in the ratio of 1·32 to the first as the graduation of the scale admitted. The angular value of one division of the scale was 1′·011.

"The following Table contains the weight and dimensions of the magnets and of the stirrup in which they were vibrated, together with those of the small cylindrical brass weights, numbered 5 and 6, used in determining the moment of inertia of the suspended mass.

TABLE XXVIII.

	Length.	Diameter.	Weight.
	ft.	ft.	grs.
Deflecting bar, N. IX.	0·3125	0·0325	1024·4
Deflecting bar, N. 13.	0·3257	0·0354	1092·4
Cylindrical weight, No. 5.	0·1243	0·0342	417·9
Cylindrical weight, No. 6.	0·1245	0·0342	418·2
Stirrup, between the points of suspension	0·3902	.....	736·0

"The moment of inertia was found by vibrating each bar with and without the cylindrical weights, and the values of the constant $\pi^2 K$ given by these experiments at various stations are included in the following Table, where

$$K' = \frac{1}{2}(l^2 + r^2)W = \log 1{\cdot}50454,$$

and

$$K = K' \frac{T^2}{T'^2 - T^2}.$$

TABLE XXIX.

1842 and 1843.	Station.	Bar No. IX.			Bar No. 13.		
		Time of vibration.		π^2K.	Time of vibration.		π^2K.
		Without weights.	With weights.		Without weights.	With weights.	
		s	s		s	s	
September	Quebec....	6·929	13·616	11·024	7·137	13·420	12·465
September	New York .	Not observed.			6·286	11·862	12·314
December	Toronto ..	6·580	12·965	10·942	6·670	11·615	12·239
January ..	Toronto ..	6·617	13·049	11·193	6·728	12·689	12·333
	Means ..	log 2·04348		11·043	log 2·09124		12·338

"Subsequent experience has shown the insufficiency of so small a number of observations as the above, to determine the constant (π^2K) with the requisite degree of precision; but as an improved instrument was substituted in March 1843 for the original transportable magnetometer, and the latter was returned to England at the same time, no opportunity has been afforded for repeating the observations.

"*Experiments of Deflection.*—The observed angles of deflection, multiplied by the ratio $\left(1+\frac{H}{F}\right)$, are given for each station, without any further correction.

"*Experiments of Vibration.*—The observed times of vibration have been corrected for the arc, and for torsion. A note was made of the apparent chord of the arc of vibration as seen through the theodolite, at the beginning and ending of each series, with a few omissions. A movement of the end of the bar through a space equal to its diameter, corresponded to an arc of 12°. When the arcs were not recorded, an approximate value has been taken, viz. for the initial arc 10°, and for the terminal arc 4°. The ratio of the torsion force $\frac{H}{F}$ was observed at one station only, viz. Philadelphia. The same value has been applied at other stations slightly modified for differences of intensity.

"*Temperature.*—The value of the coefficient for changes of temperature was not ascertained. The experiments of vibration and deflection were usually made at short intervals apart, and when both bars were employed, as was generally the case, one was vibrated during the time that the other was in use as a deflector; consequently the correction will generally have been unimportant or counterbalanced on the mean of the two results.

"*Induced Magnetism.*—No correction has been applied for changes in the magnetic moment of the bars, due to their different positions with respect to the earth's inducing force during the two parts of the experiment. This correction was not determined for the bars here employed.

"GAUSS's formula for three or more distances* has been employed for the calcula-

* Scientific Memoirs, Part V. Art. II.

tion of m and X (the values of the magnetic moment of the deflecting magnet and of the horizontal component of the force). The values of the absolute horizontal force are expressed in the units directed in the Report of the Committee of Physics of the Royal Society, 1840, pp. 21, 22. These values may be converted into their equivalents in the scale more frequently employed by the continental magneticians, by being multiplied by the factor 0·4609.

TABLE XXX.—Abstract of the observations to determine the absolute value of the horizontal component of the Magnetic Force with a German transportable magnetometer.

Date.	Station.	Bar.	Angles of deflection. u.	Angles of deflection. u'.	Angles of deflection. u''.	Corrected time of one vibration.	Temperature. Deflection.	Temperature. Vibration.	Values of m. N. 13.	Values of m. N. IX.	X. Observed.	X. Mean.	
1842.			° ′	° ′	° ′	s	°						
Sept. 7.	Quebec ...	N. IX.	11 38·0	7 42·6	4 27·6	6·929	62	62	„	·756	3·045	3·040	Near the R.A. Barracks
		N. 13.	12 30·3	8 16·9	4 40·6	7·137	62	63	·798	„	3·035		
16.	Montreal ...	N. 13.	11 54·9	7 48·1	4 23·0	7·201	62	62	·776	„	3·064	3·064	St. Helen's. [tanville.
25.	New York ...	N. 13.	9 17·8	6 08·2	3 27·3	6·286	55	58	·779	„	4·008	4·008	Lun. Asylum, Manhat-
Oct. 1.	Cambridge	N. 13.	10 02·2	6 38·1	3 44·8	6·598	72	65	·774	„	3·662	3·665	Magnetic observatory.
		N. IX.	9 30·3	6 16·7	3 38·7	6·364	65	72	„	·744	3·669		
13.	Philadelphia	N. 13.	8 48·3	5 49·5	3 17·5	6·163	55	51	·778	.....	4·176	4·176	Magnetic observatory.
Nov. 12.	Chicago*	N. 13.	9 04·3	6 00·3	3 23·5	6·765	29	43	·788	.....	4·106	4·106	
		N. IX.	8 29·8	5 35·1	3 15·4	6·752	35	28	„	·731	4·105		
Oct. 28.	Toronto†	N. 13.	10 23·8	6 52·8	3 53·4	6·718	50	50	·775	„	3·529	3·532	
		N. IX.	9 38·6	6 27·3	3 44·2	6·509	50	51	„	·745	3·501		
Dec. 19.	Toronto ...	N. 13.	10 22·5	6 52·6	3 53·1	6·680	33	32	·779	„	3·547		
		N. IX.	9 44·7	6 27·9	3 44·2	6·492	32	33	„	·738	3·552		Magnetic observatory. Mean 3·5365.
1843.													
Mar. 25.	Toronto	N. IX.	9 17·3	6 11·3	3 34·6	6·633	46	45	„	·712	3·526	3·541	
27.	Toronto	N. IX.	9 21·9	6 12·4	3 35·3	6·621	42	42	„	·711	3·545		
28.	Toronto	N. IX.	9 19·0	6 10·7	3 34·2	6·623	49	46	„	·710	3·551		
Mar. 25.	Toronto	N. 13.	10 15·4	6 47·4	3 50·1	6·730	46	45	·768	„	3·546		
27.	Toronto	N. 13.	10 15·9	6 47·9	3 50·4	6·725	42	41	·772	„	3·536		
28.	Toronto	N. 13.	10 18·0	6 49·1	3 50·8	6·722	48	47	·770	„	3·541		

"I proceed to the observations of absolute horizontal force made subsequently to March 1833 with a portable unifilar magnetometer, constructed on the principle proposed by Dr. LAMONT, in which the deflecting bar is retained at right angles to the suspended bar, and the angles of deflection are read off upon the graduated circle of the base. The lengths of the suspended and deflecting bars were in the ratio of 1

* The observations at this station were made by Lieut. YOUNGHUSBAND, R.A. The bar was vibrated in a different stirrup from that commonly employed, and its moment of inertia was afterwards ascertained at Toronto, by vibration of each bar with and without weights: the following were the dimensions; $l=3·755$ inches; $r=0·4095$ inches; $p=418·0$ grains; whence $K'=(\frac{1}{2}l^2+r^2)p=20·594$; and the following were the resulting values of log $\pi^2 K$, by a single set of vibrations with each bar: N. IX. $=2·13194$; N. 13. $=2·17200$.

† The observations at Toronto in 1842 have been already published in the Toronto volume for 1840–42. The series in March 1843 was observed by Lieut. YOUNGHUSBAND. The horizontal intensity at Toronto having since been determined with superior instruments, these results are principally interesting for comparison with those obtained at other stations.

to 1·224, being 2·45 inches and 3·00 inches respectively; but in order to secure an independent check upon the results by these bars, a third deflector of 3·6 inches in length, was also employed, at one distance of deflection only, at many of the stations of observation. It was found that the values of the absolute intensity given by the 3·6 inch bar agreed very satisfactorily with those given by the 3·0 inch bars, and in taking the general mean at each station, an equal weight has been allowed to the results by each bar. The observations were made in the manner described in the instructions for the use of portable instruments by Lieut. C. J. B. Riddell, R.A. The separate parts of each experiment were reduced to a common value of the horizontal force by corresponding observations with a portable bifilar magnetometer, which was previously placed in adjustment at all the stations where it is not otherwise stated; but as a small instrument mounted in the open air is exposed to accidents, and to be much affected by atmospheric changes, it has happened in some instances that breaks and interruptions have occurred in the series, and when the several parts of the experiments were not completed at once, (as at Dunvegan and Isle à la Crosse,) they could not be reduced to a common scale division; at some few stations, where time did not permit of the adjustment of a differential instrument, or other circumstances rendered it inconvenient, the bifilar was not employed.

"Table XXXVIII. contains the corrected data of each experiment, viz.—

"1. The angles of deflection at each distance, corrected to a temperature of the deflecting bar of 50°, and reduced to a mean value of the differential instrument.

"2. The time of one vibration corrected for the rate of the chronometer, for torsion, and for arc, reduced to a common temperature of 50°, and to the mean value of the differential instrument. The uncorrected data are given in a separate Table, No. XXXIX.

"*Corrections for Temperature.*—The following Table contains the values of the coefficient (q) for changes of temperature for each bar, as obtained by different experiments at Toronto.

Table XXXI.

1845.	No. 30.	No. 31.	No. 17.
January and February	·000226 ·000267 ·000218 ·000225 ·000205	·000254 ·000218 ·000224 ·000266 ·000226 ·000218	·000362 ·000378 ·000371 ·000374
Means..	·000228	·000234	·000371

"For bars 20, 23 and 29, employed at Athabasca and McKenzie's River, I have assumed a value for q, viz. ·00023.

"*Experiments of Deflection.*—If the lengths of the magnets are in the proportion of 1 to 1·224, each observed angle of deflection furnishes an approximate value of the ratio $\frac{m}{X}$ by the formula $\frac{m}{X}=\frac{1}{2}r^3\sin u$; but as in the great majority of these observations, the value resulting from the larger distances is greater than that given by the lesser distances, it appears that the correction depending on the distribution of free magnetism in the deflected and suspended bars was not wholly inappreciable. The approximate results have therefore been divided by the coefficient $\left(1+\frac{P}{r^2}\right)$; the values of the constant P having been derived for each bar from observations at two distances of deflection by the approximate formula $P=-\frac{r^2r'^5\sin u'-r'^2r^5\sin u}{r'^5\sin u'-r^5\sin u}$. These values of P are contained in Table XXXII., in which the values deduced from the observed angles of deflection at some of the latter stations of observation have been included, as well as those resulting from observations made for the purpose at Toronto.

TABLE XXXII.—*Values of* P.

Date.	Station.	No. 30.	No. 31.	No. 17.
1844. September 25.	Rat Portage ..	....	−·0060	
29.	Fort Francis ..	....	−·0038	
October 11.	Fort William ..	−·0054	−·0052	
November 4.	Sault St. Mary..	−·0076	−·0034	
1845. January and February ..	Toronto	−·0011	−·0063	+·0010
	Toronto	−·0019	−·0035	+·0004
	Toronto	−·0063	−·0045	+·0026
	Toronto	−·0068	....	+·0026
	Means....	−·0048	−·0048	+·0016

"The angle of deflection was first observed with the deflecting bar to the east of the suspended magnet, and then to the west; four reversals were commonly made in each position with bars 30 and 31, and five with bar 17, which was employed at one distance only; the mean angle is given in the general table; an intermediate distance was employed at Fort Simpson, viz. 1·1757 foot for each of the two bars, 30 and 31; the distances employed at all the other stations, including those for the spare bars 20, 23 and 29, and for the bars 30, 31 and 17, in the experiments at Toronto in January and March 1845, are contained in the following Table:

Table XXXIII.

Bar.	Length.	r.	r'.	r''.	r'''.
	in.	ft.	ft.	ft.	ft.
30	3·0	1·0257	1·3257		
31	3·0	1·0257	1·3257		
17	3·6	1·2514			
20	3·6 hollow.	1·2530			
33	2·45	1·1019	1·4019		
29	2·0	0·9328	1·0828	1·3828	
		Experiments at Toronto.			
30	3·0	1·0257	1·1757	1·3257	
31	3·0	1·0257	1·1257	1·2257	1·3257
17	3·6	1·1514	1·4514		

"*Experiments of Vibration.*—The bars were vibrated in the series of 1843 in a stirrup weighing 322 grains, and similar to the one employed in the observations with the German magnetometer: the moment of inertia was ascertained by vibration with and without cylindrical weights; it has since been re-determined in the method proposed by Dr. Lamont, employing accurately turned brass rings instead of weights, and the values obtained by the latter method have been applied in preference. The bars were vibrated throughout 1844, and at some of the stations of 1843, without any appendage, the suspension thread being attached by a very light wooden pin, set into the hole which is made in the centre of each for the purpose of fixing it in the stirrup: this method had the advantage of diminishing the time of vibration, and allowing the use of a suspension silk of almost insignificant torsion force; it was found to give greater regularity to the results.

"The moment of inertia of each bar, when vibrated without any appendage, is given by the formula $k=\frac{a^2+b^2}{12}\mathrm{M}$: it has also been determined by vibration with the brass rings, the results agreeing very nearly with those determined by measurement.

"The dimensions and weights of the different magnets were as follows:—

Table XXXIV.

	Length.	Diameter.	Weight.	Breadth.	Thickness.
	in.	in.	gr.	in.	in.
Bar 30	3·017	0·292	415·3		
31	3·017	0·300	416·7		
17	3·635	0·314	572·5		
20 hollow.	3·672	0·320	252·3		
23	2·446	0·300	337·0		
29	1·977	0·290	271·2		
Ring No. 1	....	2·986[a]	289·19	0·195	0·078
3	....	3·644[a]	358·78	0·195	0·078
Stirrup.	2·970	Between the points of suspension.			
Weight 5	1·199	0·315	419·9		
6	1·197	0·315			

[a] Outer diameter.

"From these data we have the following values of K′:—

For ring No. 1. $K' = \frac{1}{2}(r^2+r'^2)W = \log 0{\cdot}87111.$

No. 3. $K' = \frac{1}{2}(r^2+r'^2)W = \log 0{\cdot}59442.$

For the stirrup with weights 5 and 6. $K' = \frac{1}{2}(l^2+r^2)W = \log 0{\cdot}80974.$

The values of $K\left(=K'\frac{T^2}{T'^2-T^2}\right)$ for each magnet, determined by vibration with Dr. Lamont's rings, were as follows:—

Table XXXV.

With the stirrup.		Without the stirrup.			
No. 30.	No. 31.	No. 30.	No. 31.	No. 17.	No. 20.
3·2091	3·2375	2·1867[b]	2·2154[b]	4·3866[a]	1·9806[b]
3·2220	3·2477	2·1867[b]	2·2141[b]	4·3827[b]	1·9804[a]
3·2169	3·2477	2·1866[b]	2·2128[b]	4·3880[b]	1·9805[a]
3·2127	3·2371	2·1866[b]	2·2145[b]	4·3803[b]	1·9831[b]
3·2212	3·2437				
3·2163	3·2427	2·1867	2·2142	4·3844	1·9812

[a] Observed with ring No. 1. [b] Observed with ring No. 3.

"The mean values of K in Table XXV. give the following values of the constant log π^2K, which are compared with the approximate values previously obtained by vibration with weights, and by measurement.

Table XXXVI.

Vibration.	Bars.	Log π^2K.	
		With rings.	With weights.
With the stirrup.....	No. 30	1·50167	1·49830
With the stirrup.....	31	1·50521	1·50387
			By measurement.
Without the stirrup ..	30	1·33408*	1·33826
Without the stirrup ..	31	1·33952	1·33995
Without the stirrup ..	17	1·63621	1·63872
Without the stirrup ..	20	1·29122	1·29176

"Both methods of vibration, with the stirrup and without, were employed at several stations, for the sake of comparison, and the horizontal intensity has been deduced from the values of m X resulting from each. In the following Table these stations

* As this value differs materially from the value given by measurement, the bar was again vibrated Sept. 9, 1845, for the purpose of verification: the resulting value of π^2K was however nearly the same, viz. 1·33442.

are brought together for the purpose of showing by the agreement in the resulting values of X, the general accuracy of the constants, whether the bar was vibrated in the stirrup, or without it.

TABLE XXXVII.

Date.	Station.	No. 30.				No. 31.			
		Values of X.		Diff. ΔX.	$\frac{\Delta X}{X}$.	Values of X.		Diff. ΔX.	$\frac{\Delta X}{X}$.
		With stirrup.	Without stirrup.			With stirrup.	Without stirrup.		
1843.									
August 16.	Cross Lake	2·348	2·361	+·013	+·006	2·348	2·349	+·001	+·001
23.	Cumberland....	2·345	2·345	·000	·000	2·337	2·337	·000	·000
September 9.	Isle à la Crosse..	2·387	2·397	+·010	+·004	2·387	2·386	—·001	·000
October 12.	Athabasca	2·021	2·025	+·004	+·002	2·027	2·030	+·003	+·001
1844.									
March 2.	Athabasca	2·018	2·025	+·007	+·003	2·020	2·008	—·012	—·006
May 2.	Fort Simpson ..	1·936	1·961	+·025	+·013	1·946	1·966	+·020	+·011
29.	Fort Good Hope.	1·666	1·675	+·009	+·005	1·680	1·680	·000	·000
1845.									
Jan. and Feb.	Toronto	3·528	3·522	—·006	—·002	3·539	3·539	·000	·000
September ..	Toronto	3·510	3·511	—·001	·000	3·514	3·518	·004	—·001

"If we omit the observations at Fort Simpson, at which the difference between the values of X by the two methods of suspension is considerable with both bars, and must have been due to some other cause than a discrepancy between the constants, the mean difference in the values of X, irrespective of signs, is for

$$\text{No. 30.} \quad \cdot0029 = \frac{1}{345} \text{ of X,}$$

$$\text{No. 31.} \quad \cdot0012 = \frac{1}{833} \text{ of X.}$$

"*Experiments of Vibration.*—Each time of vibration has been corrected for the rate of the chronometer, which was generally large, 10^s to 20^s; and as the chronometer was usually worn in the pocket, under circumstances not favourable to its performance, the actual rate on any given day may have sometimes differed to a sensible amount from the mean rate applied. The arc of vibration was not recorded; but as a general rule it was reduced at the commencement to an apparent value of one diameter of the end of the magnet as seen through the theodolite, which is equivalent to 12°. As the magnet carried no reflector, and there were no direct means of measuring the exact amount of the arc, an approximate correction has been applied, by assuming the mean value of the initial semi-arc 360′, and of the terminal semi-arc as 200′. The same circumstances prevented any direct measurement of the value of $\frac{H}{F}$, but a mean value for each mode of suspension employed was ascertained at Toronto, by trying several suspension threads of the same number of fibres, and of the same silk, as were employed on the Survey.

"The following were the mean values of $\frac{H}{F}$ so obtained:—

	With stirrup.	Without stirrup.
No. 30.	·0022	·00024.
31.	·0028	·00030.
17.	. . . . .	·00031.

"From the above mean values at Toronto, an approximate value has been obtained for each of the other stations by multiplying them by the ratio $\frac{T'^2}{T^2}$ at each station. Thus the value applied at Fort Good Hope for the vibration in the stirrup, was for bar 30, ·0046, and for bar 31, ·0058.

"Table XXXVIII. contains the particulars of all the experiments by which a complete determination of the absolute horizontal force was made; these have been corrected for the various circumstances referred to; and in Table XXXIX. the data are given which have been employed for the corrections in each experiment. Table XXXIX. is followed by a notice of such additional circumstances at any of the stations as may seem to require explanation.

Table XXXVIII.

Exhibiting the corrected data of each experiment for determining the Absolute Horizontal Force. The letter *s* affixed to the time of vibration signifies that the bar was suspended in the stirrup.

Date.	Station.	Bar.	Angles of deflection.	Time of one vibration.	Values of *m*.	Values of X.		
			° ′	s.				
Nov. 4, 1844.	Sault St. Mary	30	13 52·5	4·2527	0·394	3·030	3·029	
4, 1844.	Sault St. Mary	30	6 23·8		0·394	3·028		
4, 1844.	Sault St. Mary	31	12 22·0	not observed	....	3·030	3·031	3·032
4, 1844.	Sault St. Mary	31	5 42·1			3·033		
4, 1844.	Sault St. Mary	17	12 24·8	4·7196	0·639	3·039	3·039	
May 31, 1843.	Fort William	30	17 01·7	4·9311 (*s.*)	0·455	2·868	2·869	
31, 1843.	Fort William	30	7 47·6		0·455	2·871		
31, 1843.	Fort William	31	15 39·8	5·1537 (*s.*)	0·420	2·870	2·872	
31, 1843.	Fort William	31	7 10·4		0·419	2·874		
Oct. 11, 1844.	Fort William	30	14 42·7	4·3471	0·396	2·880	2·880	2·879
11, 1844.	Fort William	30	6 47·1		0·396	2·880		
11, 1844.	Fort William	31	13 00·9	4·6387	0·352	2·882	2·878	
11, 1844.	Fort William	31	6 01·0		0·353	2·874		
11, 1844.	Fort William	17	13 13·0	4·8517	0·640	2·862	2·862	
June 14, 1843.	Fort Francis	30	15 59·3	4·7821	0·455	3·049	3·048	
14, 1843.	Fort Francis	30	7 21·4		0·456	3·046		
14, 1843.	Fort Francis	31	14 38·0	5·0102	0·418	3·051	3·049	
14, 1843.	Fort Francis	31	6 45·1		0·418	3·047		
Sept. 29, 1844.	Fort Francis	30	13 55·6	4·2395	0·396	3·034	3·031	3·041
29, 1844.	Fort Francis	30	6 26·4		0·397	3·027		

TABLE XXXVIII. (Continued.)

Date.	Station.	Bar.	Angles of deflection.	Time of one vibration.	Values of *m*.	Values of X.		
			° ′	s.				
Sept. 29, 1844.	Fort Francis	31	12 16·3	4·5242	0·351	3·044	3·045	3·041
29, 1844.	Fort Francis	31	5 39·5		0·351	3·045		
29, 1844.	Fort Francis	17	12 23·9	4·7110	0·640	3·046	3·046	
25, 1844.	Rat Portage	30	14 48·7	4·3592	0·397	2·863	2·864	
25, 1844.	Rat Portage	30	6 48·1		0·396	2·865		
25, 1844.	Rat Portage	31	13 00·7	4·6466	0·352	2·880	2·880	2·873
25, 1844.	Rat Portage	31	6 00·0		0·351	2·879		
25, 1844.	Rat Portage	17	13 11·1	4·8392	0·642	2·877	2·877	
June 21, 1843.	River Winnipeg....	30	16 34·9	not observed	0·395	2·941	2·938	2·938
21, 1843.	River Winnipeg....	30	7 36·6			2·935		
Sept. 19, 1844.	Fort Alexander	30	15 36·3	4·4898	0·397	2·710	2·702	
19, 1844.	Fort Alexander	30	7 15·2			2·694		
19, 1844.	Fort Alexander	31	13 51·8	4·7943	0·351	2·706	2·704	2·700
19, 1844.	Fort Alexander	31	8 23·7		0·352	2·703		
19, 1844.	Fort Alexander	17	14 06·4	5·0090	0·641	2·689	2·689	
June 30, 1843.	Upper Fort Garry ..	30	16 55·2	4·9748 (*s.*)	0·450	2·851	2·849	
30, 1843.	Upper Fort Garry ..	30	7 47·4		0·451	2·846		2·849
30, 1843.	Upper Fort Garry ..	31	15 35·1	5·1938	0·416	2·851	2·849	
30, 1843.	Upper Fort Garry ..	31	7 11·7		0·417	2·848		
July 14, 1843.	Norway House	30	19 20·0	6·1351 (*s.*)	0·439	2·179	2·174	
14, 1843.	Norway House	30	8 50·2		0·441	2·169		
14, 1843.	Norway House	31	21 49·6	5·7609 (*s.*)	0·391	2·177	2·178	
14, 1843.	Norway House	31	10 01·4		0·390	2·179		
Sept. 6, 1844.	Norway House	30	19 37·7	5·0058	0·396	2·176	2·173	2·174
6, 1844.	Norway House	30	9 00·7		0·397	2·171		
6, 1844.	Norway House	31	17 23·6	5·3569	0·351	2·168	2·170	
6, 1844.	Norway House	31	7 57·5		0·351	2·170		
6, 1844.	Norway House	17	17 34·0	5·5516	0·644	2·180	2·180	
July 26, 1843.	York Factory.....	30	32 09·9	6·9613 (*s.*)	0·435	1·507	1·509	
26, 1843.	York Factory.....	30	14 13·7		0·434	1·510		1·523
26, 1843.	York Factory.....	31	28 45·5	7·2275 (*s.*)	0·400	1·533	1·537	
26, 1843.	York Factory.....	31	12 48·2		0·398	1·538		
Aug. 16, 1843.	Cross Lake.....	31	17 52·7	5·8808 (*s.*)	0·391	2·348	2·348	
16, 1843.	Cross Lake.....	31	8 11·9		0·391	2·347		
16, 1843.	Cross Lake.....	30	19 45·6	5·6034 (*s.*)	0·430	2·349	2·348	
16, 1843.	Cross Lake.....	30	9 02·5		0·431	2·347		2·352
16, 1843.	Cross Lake.....	31	17 52·7	4·8516	0·393	2·351	2·349	
16, 1843.	Cross Lake.....	31	8 11·9		0·393	2·348		
16, 1843.	Cross Lake.....	30	19 45·6	4·6167	0·431	2·362	2·361	
16, 1843.	Cross Lake.....	30	9 02·3		0·431	2·361		
23, 1843.	Cumberland House	30	19 46·3	5·5994 (*s.*)	0·431	2·347	2·345	
23, 1843.	Cumberland House	30	9 05·0		0·432	2·343		
23, 1843.	Cumberland House	31	18 12·1	5·9089 (*s.*)	0·394	2·327	2·337	
23, 1843.	Cumberland House	31	8 10·7		0·390	2·348		2·341
23, 1843.	Cumberland House	30	19 46·3	4·6163	0·431	2·347	2·345	
23, 1843.	Cumberland House	30	8 05·0		0·432	2·343		
23, 1843.	Cumberland House	31	18 12·1	4·8845	0·394	2·326	2·337	
23, 1843.	Cumberland House	31	8 10·7		0·390	2·348		
26, 1844.	Carlton House	30	15 28·1	4·4542	0·396	2·743	2·743	
26, 1844.	Carlton House	30	7 06·5		0·397	2·743		2·746
26, 1844.	Carlton House	31	13 33·8	4·7654	0·350	2·751	2·750	
26, 1844.	Carlton House	31	6 15·7		0·350	2·748		
17, 1844.	Edmonton House ..	30	14 25·7	4·2948	0·397	2·943	2·941	
17, 1844.	Edmonton House ..	30	6 39·6		0·398	2·939		
17, 1844.	Edmonton House ..	31	12 20·1	4·5935	0·350	2·956		2·945
17, 1844.	Edmonton House ..	31	5 51·1		0·351	2·949	2·953	
17, 1844.	Edmonton House ..	17	13 28·5	4·6876	0·670	2·938	2·938	
Sept. 9, 1843.	Isle à la Crosse	30	18 46·8	5·6434 (*s.*)	0·417	2·390	2·387	
9, 1843.	Isle à la Crosse	30	8 38·8		0·418	2·382		
9, 1843.	Isle à la Crosse	31	17 16·5	5·9081 (*s.*)	0·384	2·386	2·387	
9, 1843.	Isle à la Crosse	31	7 55·1		0·384	2·387		2·386

Table XXXVIII. (Continued.)

Date.	Station.	Bar.	Angles of deflection.	Time of one vibration.	Values of *m*.	Values of X.		
			° ′	s.				
Sept. 9, 1843.	Isle à la Crosse	30	18 46·8	4·6589	0·419	2·402	2·397	2·386
9, 1843.	Isle à la Crosse	30	8 38·8		0·420	2·392		
9, 1843.	Isle à la Crosse	31	17 16·5	4·8838	0·384	2·386	2·386	
9, 1843.	Isle à la Crosse	31	7 55·1		0·384	2·386		
Oct. 13, 1843.	Athabasca	30	22 26·8	6·1381 (*s.*)	0·418	2·018	2·021	
13, 1843.	Athabasca	30	10 08·6		0·416	2·024		
13, 1843.	Athabasca	31	20 26·7	6·4017 (*s.*)	0·385	2·031	2·027	
13, 1843.	Athabasca	31	9 34·8		0·386	2·023		
13, 1843.	Athabasca	30	22 26·8	5·0514	0·418	2·022	2·025	
13, 1843.	Athabasca	30	10 08·6		0·417	2·028		
13, 1843.	Athabasca	31	20 26·7	5·2816	0·385	2·034	2·030	
13, 1843.	Athabasca	31	9 34·8		0·387	2·026		
March 1, 1844.	Athabasca	30	22 32·1	6·1234 (*s.*)	0·419	2·019	2·018	2·022
1, 1844.	Athabasca	30	10 15·0		0·419	2·018		
1, 1844.	Athabasca	31	20 13·6	6·4728 (*s.*)	0·378	2·019	2·020	
1, 1844.	Athabasca	31	9 12·6		0·378	2·021		
1, 1844.	Athabasca	30	22 32·1	5·0328	0·421	2·025	2·025	
1, 1844.	Athabasca	30	10 15·0		0·421	2·025		
1, 1844.	Athabasca	31	20 13·6	5·3740	0·376	2·009	2·008	
1, 1844.	Athabasca	31	9 12·6		0·376	2·007		
July 2, 1844.	Athabasca	30	20 10·0	5·1507	0·399	2·039	2·040	
2, 1844.	Athabasca	30	9 37·4		0·399	2·041		
2, 1844.	Athabasca	31	18 44·7	5·4725	0·356	2·044	2·040	2·040
2, 1844.	Athabasca	31	8 38·6		0·357	2·036		
2, 1844.	Athabasca	17	19 36·0	5·6326	0·669	2·038	2·038	
Oct. 14, 1843.	Athabasca	20	15 05·5	4·3373	0·515	2·017	2·017	2·017
14, 1843.	Athabasca	23	8 40·6	5·2689	0·206	2·042	2·038	2·038
14, 1843.	Athabasca	23	4 14·2		0·207	2·034		
14, 1843.	Athabasca	29	10 51·3	4·4147	0·155	2·034	2·029	2·029
14, 1843.	Athabasca	29	6 57·3		0·156	2·025		
14, 1843.	Athabasca	29	3 20·0		0·156	2·028		
July 12, 1844.	Fort Vermilion	30	19 17·6	4·9000	0·401	2·240	2·244	
12, 1844.	Fort Vermilion	30	8 45·4		0·400	2·248		
12, 1844.	Fort Vermilion	31	17 01·5	5·1890	0·359	2·261	2·259	2·250
12, 1844.	Fort Vermilion	31	7 50·5		0·360	2·257		
12, 1844.	Fort Vermilion	17	17 43·4	5·3771	0·668	2·241	2·241	
23, 1844.	Fort Dunvegan	30	15 39·8	4·4557	0·399	2·725	2·722	
23, 1844.	Fort Dunvegan	30	7 13·8		0·400	2·719		
23, 1844.	Fort Dunvegan	31	13 49·1	4·7671	0·353	2·725	2·725	2·724
23, 1844.	Fort Dunvegan	31	6 21·7		0·353	2·725		
23, 1844.	Fort Dunvegan	17	14 36·5	4·8589	0·673	2·725	2·725	
June 22, 1844.	Fort Resolution	30	24 46·9	5·5320	0·400	1·761	1·762	
22, 1844.	Fort Resolution	30	11 12·5		0·400	1·762		
22, 1844.	Fort Resolution	31	22 04·0	5·8714	0·359	1·764	1·765	1·763
22, 1844.	Fort Resolution	31	10 01·9		0·359	1·765		
22, 1844.	Fort Resolution	17	22 51·3	6·0479	0·671	1·764	1·764	
20, 1844.	Big Island	30	23 00·3	....	....	1·894	1·891	1·891
20, 1844.	Big Island	31	20 32·4	....	....	1·888		
May 2, 1844.	Fort Simpson	30	23 06·5	6·3133 (*s.*)	1·412	1·935	1·936	
2, 1844.	Fort Simpson	30	15 6·7		1·412	1·936		
2, 1844.	Fort Simpson	30	10 27·0		1·411	1·939		
2, 1844.	Fort Simpson	31	20 27·6	6·6867 (*s.*)	0·368	1·944	1·946	
2, 1844.	Fort Simpson	31	13 22·9		0·367	1·948		
2, 1844.	Fort Simpson	31	9 19·1		0·368	1·945		
2, 1844.	Fort Simpson	30	23 06·5	5·1393	0·417	1·960	1·961	
2, 1844.	Fort Simpson	30	15 06·7		0·417	1·960		
2, 1844.	Fort Simpson	30	10 27·0		0·416	1·964		
2, 1844.	Fort Simpson	31	20 27·6	5·4691	0·372	1·961	1·966	
2, 1844.	Fort Simpson	31	13 22·9		0·372	1·970		
2, 1844.	Fort Simpson	31	9 19·1		0·372	1·968		
2, 1844.	Fort Simpson	17	20 57·3	5·6751	0·686	1·959	1·959	1·952

Table XXXVIII. (Continued.)

Date.	Station.	Bar.	Angles of deflection.	Time of one vibration.	Values of *m*.	Values of X.		
			° ′	s.				
June 12, 1844.	Fort Simpson.....	30	22 26·9	5·2323	0·401	1·952	1·954	1·952
12, 1844.	Fort Simpson.....	30	10 10·3		0·403	1·957		
12, 1844.	Fort Simpson.....	31	20 03·3	5·5993	0·360	1·936	1·943	
12, 1844.	Fort Simpson.....	31	9 02·2		0·358	1·949		
12, 1844.	Fort Simpson.....	17	20 36·6	5·7305	0·674	1·956	1·956	
12, 1844.	Fort Simpson.....	20	13 55·2	4·6155	0·465	1·972	1·972	
12, 1844.	Fort Simpson.....	23	8 35·1	5·5003	0·196	1·967	1·947	
12, 1844.	Fort Simpson.....	23	4 19·3		0·200	1·928		
May 28, 1844.	Fort Norman.....	30	25 36·5	5·4832	0·409	1·753	1·760	1·760
June 2, 1844.	Fort Norman.....	31	22 10·5	5·8403	0·362	1·768		
May 29, 1844.	Fort Good Hope ..	30	26 44·2	6·8206 (*s.*)	0·408	1·669	1·666	
29, 1844.	Fort Good Hope ..	30	12 10·7		0·410	1·664		
29, 1844.	Fort Good Hope ..	31	23 31·0	7·2323 (*s.*)	0·364	1·682	1·680	
29, 1844.	Fort Good Hope ..	31	10 42·4		0·364	1·679		
29, 1844.	Fort Good Hope ..	30	26 44·2	5·6013	0·409	1·679	1·675	1·676
29, 1844.	Fort Good Hope ..	30	12 10·7		0·412	1·671		
29, 1844.	Fort Good Hope ..	31	23 31·0	5·9763	0·364	1·682	1·680	
29, 1844.	Fort Good Hope ..	31	10 42·4		0·364	1·679		
Jan. 22, 1845.	Toronto.....	30	11 56·0	4·7712 (*s.*)	0·395	3·527	3·528	
22, 1845.	Toronto.....	30	7 54·2		0·395	3·526		
22, 1845.	Toronto.....	30	5 29·9		0·395	3·530		
23, 1845.	Toronto.....	30	11 56·1	4·7699 (*s.*)	0·395	3·528	3·529	
23, 1845.	Toronto.....	30	7 53·9		0·395	3·529		
23, 1845.	Toronto.....	30	5 30·1		0·395	3·530		
25, 1845.	Toronto.....	30	11 53·7	4·7735 (*s.*)	0·395	3·531	3·529	3·528
25, 1845.	Toronto.....	30	7 52·7		0·395	3·530		
25, 1845.	Toronto.....	30	5 29·4		0·395	3·526		
29, 1845.	Toronto.....	30	11 53·0	4·7809 (*s.*)	0·394	3·525	3·525	
29, 1845.	Toronto.....	30	7 51·6	3·9463	0·394	3·527		
29, 1845.	Toronto.....	30	5 29·2		0·394	3·522		
Feb. 3, 1845.	Toronto.....	31	10 32·4	5·0857 (*s.*)	0·350	3·533	3·535	
3, 1845.	Toronto.....	31	7 56·9		0·350	3·535		
3, 1845.	Toronto.....	31	6 09·2		0·350	3·536		
3, 1845.	Toronto.....	31	4 51·4		0·350	3·537		
6, 1845.	Toronto.....	31	10 28·9	5·0850 (*s.*)	0·349	3·543	3.543	3·539
6, 1845.	Toronto.....	31	7 55·1		0·349	3·542		
6, 1845.	Toronto.....	31	6 07·7		0·349	3·543		
6, 1845.	Toronto.....	31	4 50·7		0·350	3·543		
8, 1845.	Toronto.....	31	10 29·2	5·0925 (*s.*)	0·349	3·537	3·538	
8, 1845.	Toronto.....	31	7 54·9		0·349	3·538		
8, 1845.	Toronto.....	31	6 07·5		0·349	3·538		
8, 1845.	Toronto.....	31	4 50·5		0·348	3·538		
3, 1845.	Toronto.....	31	10 32·4	4·2031	0·350	3·533	3·535	
3, 1845.	Toronto.....	31	7 56·9		0·350	3·535		
3, 1845.	Toronto.....	31	6 09·2		0·350	3·535		
3, 1845.	Toronto.....	31	4 51·4		0·350	3·537		
8, 1845.	Toronto.....	31	10 29·2	4·2051	0·349	3·539	3·540	3·539
8, 1845.	Toronto.....	31	7 54·9		0·349	3·540		
8, 1845.	Toronto.....	31	6 07·5		0·349	3·541		
8, 1845.	Toronto.....	31	4 50·5		0·349	3·540		
March 11, 1845.	Toronto.....	31	10 27·9	4·2051	0·349	3·543	3·543	
11, 1845.	Toronto.....	31	4 50·1		0·348	3·543		
4, 1845.	Toronto.....	17	13 43·7	4·3815	0·639	3·533	3·533	
4, 1845.	Toronto.....	17	6 48·0		0·639	3·533		
8, 1845.	Toronto.....	17	13 39·3	4·3879	0·636	3·534	3·534	
8, 1845.	Toronto.....	17	6 46·1		0·636	3·533		
10, 1845.	Toronto.....	17	13 38·6	4·3841	0·636	3·539	3·539	3·535
10, 1845.	Toronto.....	17	6 45·2		0·636	3·540		
11, 1845.	Toronto.....	17	13 39·5	4·3897	0·636	3·532	3·533	
11, 1845.	Toronto.....	17	6 46·4		0·636	3·533		

TABLE XXXIX.; exhibiting the uncorrected particulars of each experiment in Table XXXVIII.

Date.	Station.	Bifilar Magnetometer. Mean readings. Scale.	Therm.	Value of 1 sc. div. in parts of H. F.	Bar.	Experiments of Deflection. u'.	Therm.	Bifilar. Scale.	Therm.	u'.	Therm.	Bifilar. Scale.	Therm.	Experiments of Vibration. Time of one vibration.	Number.	Temperature.	Bifilar. Scale.	Therm.	Rate of chronometer.
														s					s
Nov. 4, 1844.	Sault St. Mary	170·7	40·4	·00025	30	13° 50′·3	45°·0	178·9	45°·0	6° 22′·1	44°·6	183·8	44°·6	4·2524	5×200	45°	261·8	45°·0	−17
4, 1844.	Sault St. Mary				31	12 14·8	47·0	196·5	47·6	5 39·2	47·0	193·2	46·8						
4, 1844.	Sault St. Mary				17	12 24·3	47·0	183·2	47·0					4·7081	11×200	42	175·1	42·0	
May 31, 1843.	Fort William	254·0	55·0	·00057	30	17 01·9	55·0	231·8	55·0	7 47·4	55·0	252·6	55·0	4·9331(s.)	476	55·0	253·0	54·0	− 6
31, 1843.	Fort William				31	15 33·6	50·0	265·2	55·0	7 10·6	50·0	253·8	54·0	5·1600(s.)	360	55·0	247·3	55·0	
Oct. 11, 1844.	Fort William				30	14 41·8	55·0			6 46·7	55·0			4·3470	10×200	40·0			−10
11, 1844.	Fort William				31	13 00·8	51·0			6 01·2	47·0			4·6370	11×202	38·0			
11, 1844.	Fort William				17	13 08·3	65·5							4·8462	11×200	36·0			
June 14, 1843.	Fort Francis	203·0	60·0	·00044	30	15 56·3	62·0	203·8	60·3	7 20·2	61·0	202·7	61·0	4·7865(s.)	206	62·0			− 6
14, 1843.	Fort Francis				31	14 36·5	60·0	202·5	58·0	6 44·3	60·0	203·6	57·0	5·0094(s.)	470	62·0	203·8	62·0	
Sept. 29, 1844.	Fort Francis				30	13 57·1	42·0			6 27·1	42·0			4·2423	11×200	55·0			−11
29, 1844.	Fort Francis				31	12 15·4	55·0			5 39·1	55·0			4·5272	11×200	55·0			
29, 1844.	Fort Francis				17	12 22·5	55·0							4·7201	11×200	60·0			
25, 1844.	Rat Portage				30	14 50·0	43·5			6 48·7	43·5			4·3572	11×196	45·0			−11
25, 1844.	Rat Portage				31	13 01·6	44·0			6 00·5	44·0			4·6442	11×196	45·0			
25, 1844.	Rat Portage				17	13 12·6	45·0							4·8350	9×200	45·0			
June 21, 1843.	River Winnipeg				30	16 30·8	68·0			7 34·8	68·0								
Sept. 19, 1844.	Fort Alexander	208·0	49·0	−·00064	30	15 39·2	55·0	216·6	55·0	7 12·4	55·0	202·0	55·0	4·4958	11×200	49·3	212·0	49·0	− 8
19, 1844.	Fort Alexander				31	13 49·8	49·0	204·1	49·0	6 23·4	46·0	204·1	46·0	4·7930	10×226	53·0	207·2	53·0	
19, 1844.	Fort Alexander				17	14 06·6	42·6	201·8	42·6					4·9997	11×200	45·0	214·6	45·0	
June 30, 1843.	Upper Fort Garry	203·3	69·5	·00041	30	16 50·4	73·4	199·3	73·4	7 45·7	73·0	199·0	70·2	8·6026(s.)	206	61·7	201·3	61·7	−12
30, 1843.	Upper Fort Garry				31	15 26·8	72·0	209·4	74·0	7 07·6	74·4	208·7	76·4	5·1960(s.)	330	66·0	203·2	66·0	
July 14, 1843.	Norway House	235·0	83·0	·00086	30	21 29·7	85·0	242·0	85·1	9 48·0	86·0	250·6	86·3	5·7957(s.)	6×100	79·0	226·4	79·5	−12
14, 1843.	Norway House				31	19 22·0	83·0	224·1	83·0	8 52·7	82·5	227·8	82·5	6·1230(s.)	7×100	85·0	245·5	85·0	
Sept. 6, 1844.	Norway House	237·0	49·5	·00018	30	19 37·2	56·0	220·2	56·0	8 59·9	56·0	229·2	56·0	4·9995	11×200	53·8	249·4	53·8	−11
6, 1844.	Norway House				31	17 14·5	58·0	249·2	58·0	7 54·5	61·0	242·1	61·0	5·3575	10×200	53·5	235·5	53·5	
6, 1844.	Norway House				17	17 34·7	54·5	236·4	54·5					5·5884	11×200	56·0	193·6	56·1	
July 26, 1843.	York Factory	222·0	74·0	·00083	30	32 05·6	72·5	218·9	72·3	14 11·3	76·0	218·3	74·3	6·9628(s.)	6×100	74·5	221·1	74·5	−12
26, 1843.	York Factory				31	28 32·1	74·3	223·7	74·3	12 42·6	74·0	230·8	74·0	7·2244(s.)	11×102	73·0			
Aug. 16, 1843.	Cross Lake				31	} 17 49·2	63·5			8 10·2	64·5			5·6076(s.)	9×100	68·0			−10
16, 1843.	Cross Lake				31									4·6261	10×100	67·0			
16, 1843.	Cross Lake				30	} 19 41·7	64·0			9 00·8	64·0			5·8784(s.)	8×100	60·0			
16, 1843.	Cross Lake				30									4·8605	8×100	65·0			
23, 1843.	Cumberland House	216·0	63·0	·00034	30	} 19 45·8	64·0	213·8	64·0	9 03·5	64·0	213·7	64·0	5·6038(s.)	4×166	60·0	212·2	60·0	−15
23, 1843.	Cumberland House				30									4·6202	10×200	61·5	221·3	61·5	
23, 1843.	Cumberland House				31	} 18 09·4	68·0	206·8	68·5	8 08·8	66·5	213·4	66·5	5·9056(s.)	10×200	60·5	219·0	60·5	
23, 1843.	Cumberland House				31									4·8819	11×200	58·3	228·1	58·3	
26, 1844.	Carlton House				30	15 26·4	57·5			7 05·7	58·5			4·4645	11×200	70·0			−17
26, 1844.	Carlton House				31	13 31·9	60·0			6 14·6	62·0			4·7767	11×200	70·0			
17, 1844.	Fort Edmonton	193·0	52·0	·00041	30	14 29·0	53·2	181·8	53·2	6 40·6	55·6	181·8	55·6	4·2947	10×200	47·7	195·4	47·1	−12
17, 1844.	Fort Edmonton				31	12 34·7	61·0	190·5	61·0	5 49·0	59·2	198·0	59·2	4·5938	11×196	46·8	193·8	46·8	
17, 1844.	Fort Edmonton				17	13 24·4	55·0	199·0	55·0					4·6859	10×200	45·6	194·7	45·6	
Sept. 9, 1843.	Isle à la Crosse	248·2	69·2	·00037	30	18 46·1	73·0	233·2	73·0	8 34·5	73·5	253·2	73·5	5·6378(s.)	11×200	54·0			−22
9, 1843.	Isle à la Crosse													4·6655	11×300	66·5	252·2	66·5	
9, 1843.	Isle à la Crosse				31	17 11·2	72·7	245·8	72·7	7 52·3	72·0	247·8	72·0	5·8993	10×200	64·0			
9, 1843.	Isle à la Crosse													4·8900	10×250	64·0	252·8	64·0	
Oct. 13, 1843.	Athabasca	176·0	64·6	·00037	30	22 28·2	38·0	185·2	57·2	10 13·0	38·0	166·2	57·7	6·0943(s.)	11×200	34·0	277·2	50·4	+10
13, 1843.	Athabasca													5·0354	11×200	38·0	267·4	55·0	
13, 1843.	Athabasca				31	20 31·0	36·6	175·0	65·2	9 23·7	36·4	186·1	66·5	6·3767(s.)	11×200	34·0	258·1	48·3	
13, 1843.	Athabasca													5·2409	10×234	37·0	294·4	51·4	
13, 1843.	Athabasca				20	15 05·9	36·8	178·6	73·0					4·3302	4×200	40·0	286·5	50·4	
14, 1843.	Athabasca	254·4	50·4	·00037	23	8 42·9	37·0	244·0	61·0	4 15·5	36·0	241·3	60·0	5·2606	11×160	40·0			+10
14, 1843.	Athabasca				29	10 54·7	37·0	243·5	58·6	6 59·5	37·0	243·2	58·0	4·4067	11×200	40·0			
14, 1843.	Athabasca									3 21·0	37·0	243·5	59·0						−34*

* Watch 5240.

TABLE XXXIX.; exhibiting the uncorrected particulars of each experiment in Table XXXVIII. (Continued.)

Date.	Station.	Bifilar Magnetometer. Mean readings. Scale.	Therm.	Value of 1 sc. div. in parts of H. F.	Bar.	Experiments of Deflection. u.	Therm.	Bifilar. Scale.	Therm.	u'.	Therm.	Bifilar. Scale.	Therm.	Experiments of Vibration. Time of one vibration.	Number.	Temperature.	Bifilar. Scale.	Therm.	Rate of chronometer.
						° ′	°		°	°	°		°	s		°		°	
March 1, 1844.	Athabasca				30	22 34·8	41·8			10 15·8	43·8			6·1011(*s.*)	10×100	29·0			+15°
1, 1844.	Athabasca													5·0258	11×200	34·5			
1, 1844.	Athabasca				31	20 14·9	45·4			9 13·5	45·4			6·4381(*s.*)	10×100	29·0			
1, 1844.	Athabasca													5·3643	11×200	31·8			
July 2, 1844.	Athabasca	232·0	58·3	·00043	30	21 14·5	57·0	220·8	57·0	9 39·3	57·0	221·3	57·0	5·1569	11×200	61·0	232·6	59·0	− 3
2, 1844.	Athabasca				31	18 45·5	59·0	224·8	59·0	8 38·2	59·0	227·5	59·0	5·4781	11×200	63·0	233·8	59·0	
2, 1844.	Athabasca				17	19 34·7	59·0	226·2	59·0					5·6496	9×200	65·0	231·4	59·0	
12, 1844.	Fort Vermilion	174·2	90·0	·00048	30	19 04·8	78·0	181·2	94·0	8 41·9	78·0	172·8	94·0	4·9238	11×234	77·0	169·8	85·0	− 3
12, 1844.	Fort Vermilion				31	16 57·3	78·0	166·8	98·0	7 47·8	77·0	173·1	95·0	5·2116	11×206	78·0	173·6	80·0	
12, 1844.	Fort Vermilion				17	17 31·6	79·0	174·7	92·0					5·4065	10×100	75·0	181·7	80·0	
23, 1844.	Dunvegan	167·4	77·0	−·00044	30	15 33·3	79·0	170·7	84·0	7 09·7	79·0	163·8	82·0	4·4496	10×200	48·0	153·2	48·0	− 3
24, 1844.	Dunvegan	166·1	60·0		31	13 40·8	74·0	157·2	76·0	6 18·3	74·0	159·0	76·0	4·7630	11×200	50·5	156·3	50·5	
24, 1844.	Dunvegan				17	14 31·2	63·0	157·6	63·0					4·8658	11×196	58·0	164·4	58·0	
June 22, 1844.	Fort Resolution	226·0	60·0	·00031	30	24 50·0	51·0	221·4	57·0	11 14·7	51·0	215·0	57·0	5·5218	11×200	51·0	238·0	62·0	− 1
22, 1844.	Fort Resolution				31	22 04·6	51·0	226·1	57·0	10 03·3	51·0	229·7	57·0	5·8695	6×220	51·0	227·0	63·0	
22, 1844.	Fort Resolution				17	22 49·8	51·0	230·8	57·0					6·0505	7×200	51·0	221·3	64·4	
20, 1844.	Big Island				30	22 52·0	75·0												
20, 1844.	Big Island				31	20 25·1	75·0												
May 2, 1844.	Fort Simpson	246·0	64·6	−·00028	30	23 09·8	37·5	240·5	60·5	10 28·8	37·5	244·7	62·6	6·3020(*s.*)	11×200	47·0	245·6	64·6	+15
2, 1844.	Fort Simpson									15 07·8	38·0	242·0	66·2	5·1307	11×200	39·0	240·2	64·0	
2, 1844.	Fort Simpson				31	20 14·2	48·5	209·1	69·0	9 12·5	48·5	204·7	67·0	6·6707(*s.*)	11×200	46·0	245·6	65·0	
2, 1844.	Fort Simpson									13 14·4	44·0	201·8	65·8	5·4616	11×200	42·0	241·3	63·0	
2, 1844.	Fort Simpson				17	20 43·3	40·0	194·3	64·0					5·6680	11×222	43·0	243·7	65·0	
June 12, 1844.	Fort Simpson	140·0	57·8	−·00055	30	22 30·6	57·5	147·3	56·4	10 12·0	57·5	147·5	56·4	5·2357	11×200	57·8	138·9	57·8	− 8
12, 1844.	Fort Simpson				31	20 05·1	56·0	144·4	56·0	9 01·8	57·0	141·4	57·0	5·5845	11×200	58·8	127·6	60·4	
12, 1844.	Fort Simpson				17	20 34·8	56·0	141·2	57·0					5·7256	11×200	58·0	130·8	60·6	
14, 1844.	Fort Simpson	133·4	61·9	−·00055	20	13 57·2	68·5	126·9	65·0					4·6234	11×200	67·0	130·4	57·0	− 8
14, 1844.	Fort Simpson				23	8 32·6	70·0	134·2	65·0	4 18·1	70·0	134·3	65·6	5·5088	10×160	67·0	131·5	57·0	
May 28, 1844.	Fort Norman				30	25 39·2	43·0							5·4752	11×200	36·0			− 3
June 2, 1844.	Fort Norman				31	22 15·2	36·0							5·8379	11×200	36·0			
May 29, 1844.	Fort Good Hope	211·5	46·0	−·00027	30	26 53·6	44·0	227·0	47·0	12 14·2	44·0	221·4	43·5	6·8015(*s.*)	550	37·0	208·2	37·0	− 3
29, 1844.	Fort Good Hope													5·5961	10×152	37·0	207·3	37·0	
29, 1844.	Fort Good Hope				31	23 36·0	41·5	212·6	41·5	10 42·0	41·5	197·1	41·5	7·2046(*s.*)	10×202	37·5	205·0	37·5	
29, 1844.	Fort Good Hope													5·9640	10×100	36·6	200·3	36·6	
Jan. 22, 1845.	Toronto	574·6	46·6	·000087	30	11 54·4	55·4	570·8	45·6	7 52·2	62·5	572·7	47·1	4·7638(*s.*)	382	54·5	577·9	47·9	−14
22, 1845.	Toronto									5 28·7	61·2	572·8	45·8						
23, 1845.	Toronto	570·4	46·4			11 54·8	50·2	573·3	47·3	7 53·7	45·8	570·8	46·2	4·7621(*s.*)	350	50·0	573·0	47·0	−85
23, 1845.	Toronto									5 30·1	44·0	567·6	46·9						
25, 1845.	Toronto	574·0	41·1			11 52·9	58·2	563·4	42·1	7 51·9	54·1	577·8	42·2	4·7653(*s.*)	400	45·0	576·7	42·8	−9·0
25, 1845.	Toronto									5 29·0	52·6	574·4	43·2						
29, 1845.	Toronto	570·0	43·9			11 51·3	60·7	561·1	45·2	7 50·0	65·5	562·2	45·3	4·7741(*s.*)	320	56·0	564·2	46·3	−10·0
29, 1845.	Toronto									5 27·2	67·3	562·6	45·3	3·9460	348	56·0	562·8	45·9	−10·0
Feb. 3, 1845.	Toronto	593·5	34·7		31	10 32·8	47·1	591·2	34·3	7 56·8	49·9	596·7	34·9	5·0787(*s.*)	350	47·3	592·2	39·0	− 7·3
3, 1845.	Toronto					6 08·6	53·4	598·0	34·8	4 50·8	55·5	598·1	34·9	4·2043	350	54·0	592·6	37·5	− 7·3
6, 1845.	Toronto	594·7	33·1			10 29·5	46·7	596·5	32·6	7 55·4	47·0	597·3	33·2	5·0730(*s.*)	356	34·8	591·3	31·4	− 6·7
6, 1845.	Toronto					6 07·9	46·8	597·8	33·1	4 50·9	46·8	599·5	33·0						
8, 1845.	Toronto	575·0	40·3			10 27·9	55·6	582·9	40·9	7 53·9	56·7	581·0	41·0	5·0870(*s.*)	340	55·4	592·1	36·7	− 7·3
8, 1845.	Toronto					6 06·9	57·9	578·1	40·1	4 50·0	57·4	578·4	40·1	4·2067	316	59·3	598·1	38·0	− 7·3
March 4, 1845.	Toronto	575·5	47·4		17	13 42·2	53·0	563·5	46·3	6 47·1	54·5	562·7	46·5	4·3792	370	54·0	565·3	46·8	− 8·0
8, 1845.	Toronto	567·0	51·1			13 34·7	59·9	554·6	53·5	6 43·7	61·7	553·7	53·5	4·3870	294	55·4	562·4	54·5	− 8·0
10, 1845.	Toronto	573·8	46·1			13 36·1	56·2	564·0	46·2	6 44·0	57·1	563·8	46·0	4·3805	376	47·0	566·5	45·3	− 8·0
11, 1845.	Toronto	574·0	47·8			13 34·7	59·1	567·8	49·1	6 43·6	59·0	566·2	49·2	4·3836	312	46·4	566·6	49·3	− 8·0
11, 1845.	Toronto	574·0	47·8		31	10 25·2	61·0	570·4	48·1	4 48·8	63·9	570·0	48·2	4·2000	324	46·8	569·1	49·5	− 8·0

"*Remarks referring to* TABLE XXXIX.

"*Sault St. Mary*, November 4, 1844.—The observations of vibration of No. 31 were accidentally omitted at this station, by the interruption occasioned by the sudden death of one of the voyageurs; the value of X given in the table was deduced from the experiments of deflection, by applying to the observed value of the ratio $\frac{m}{X}$ the known values of m, as given by the observations of September 6, 19, 25 and 29, and October 11, 1844, viz. 0·3; in the general mean it is allowed only half the weight of the complete observations.

"*Fort William*, May 31, 1843, and October 11, 1844.—The reduction of the observed values of X to the mean of the bifilar readings is omitted in the observations of October 11, 1844: the magnetometer was observed, but the connection of the readings did not appear satisfactory.

"*Fort Francis*, June 14, 1843, and September 29, 1844.—The bifilar was not adjusted for the observations of 1844; the value of X by No. 30 in 1844 differs considerably from the mean values by the two other bars, but not to a greater extent than might have been caused by actual changes of the force.

"*Rat Portage*, September 25, 1844.—The unfavourable state of the weather obliged the observations to be made in a dwelling-house, which like all the dwelling-houses in that part of the north of America was constructed of wood, with scarcely any iron whatever; the floor was laid with trenails, and the lock on the door was a wooden one; hence it is considered that the observation is as unexceptionable as if made in the open air: the bifilar was not in adjustment.

"*Winnipeg River*, June 21, 1843.—The value of X is deduced from observations of deflection only, employing the mean values of m given by the complete observations of June 14 and June 30.

"*Upper Fort Garry*, June 30, 1843.—The time of vibration of No. 30 was observed with the weights 5 and 6 attached*, but the second set without the weights could not be taken. The observed value of T'^2 has been multiplied by 0·338, the value of the ratio $\frac{K}{K+K'}$ to obtain the value of T^2, and the square root of the product (4·9748) inserted in table No. XXXVIII.; a few vibrations (22) which were observed as a check, gave a mean value of 4·912.

"*Norway House*, July 14, 1843, and September 6, 1844.—The value of m of bar 31 in 1843, appears too small, being 0·012 less than the mean at the preceding and following stations; the value of X is slightly in excess of the mean of the other two bars (2·178 instead of 2·174), indicating the error to be probably in the experiment of deflection. The observations of 1843 are reduced to the mean of corresponding readings of the bifilar; those of 1844 are reduced to the mean of hourly readings continued for twenty-one hours.

"*York Factory*.—The day of observation at this station, the 26th of July 1843, was one of very considerable magnetic disturbance, and in other respects unfavourable, being windy and showery; the tent which sheltered the bifilar magnetometer was blown down, and the glass tube of the instrument broken, rendering it for the time unserviceable. In consequence of this accident the time of vibration of No. 31 is not reduced to the same value of the horizontal force as the other parts of the experiments; and the mean values of X, by bars 30 and 31, differ to an amount which is very large, when compared with the small value of the horizontal component at the station, *i. e.* $\frac{1}{54}$th its whole amount.

"*Cross Lake*, August 16, 1843.—This was the first occasion on which the bars were vibrated without the stirrup. The bifilar was not in adjustment.

"*Cumberland House*.—The bars were vibrated in 1843, both with and without the stirrup, and the mean horizontal intensity is deduced from all the resulting values of X. The bars were vibrated again in August 1844 with the same mode of suspension, but the experiments of deflection were not made.

"*Carlton House*, August 26, 1844.—The bifilar was not adjusted at this station; and as the experiments of deflection with No. 17 were omitted, the mean value of X is deduced from the observations with bars 30 and 31 only.

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* This was done at several of the stations; but the values of K so obtained have been superseded by the more accurate determination with the brass rings.

"*Edmonton*, August 17, 1844.—The bifilar was adjusted, but the state of the weather prevented the continuance of the readings for so long as twenty-four hours, and the value of X is reduced to the mean of twelve hourly readings only.

"*Athabasca*.—There are three separate determinations at this station with bars 30, 31 and 17, viz. in October 1843, and in March and July 1844; the two former at the beginning and termination of a series of hourly observations of the bifilar, &c., made during the winter of 1843, and the latter after my return to Athabasca, from Mackenzie's river. Three spare bars of various lengths, No. 23, 29 and 20, were also employed in October 1843; but as the results obtained from them were calculated with an assumed temperature coefficient, and their moments of inertia are less accurately known than those of bars 30, 31 and 17, to introduce the values of X given by them into the general mean would only vitiate more accurate results, and they are added for purposes of illustration only; the general mean at the station is the mean by all the observations with bars 30, 31 and 17, except one of bar 17, in which the accuracy of the observed times of vibration appeared doubtful, and which is not included in the Table.

"*Vermilion*, July 12, 1844.—The bifilar was placed in adjustment, and the several parts of the observation are reduced to the mean of the corresponding readings.

"*Dunvegan*, July 23, 1844.—The bifilar was placed in adjustment, and hourly readings taken on the 23rd and 24th of July, the term day of the month. The absolute intensity is reduced to the mean reading of the bifilar on the 23rd, which differs but little from the mean of thirty-two hourly observations.

"*Big Island*, June 20, 1844.—The place of observation was a small fishing-station near the Big Island on Great Slave Lake, and named after it, but not actually upon it. The values of X are deduced from experiments of deflection only, applying the mean values of m given by the observations of June 12 and 23. The bifilar was not observed.

"*Fort Simpson*, May 2 and June 12, 1844.—The experiments of May are reduced to the mean reading of the bifilar given by the hourly observations of nine days, from April 27 to May 8. Those of June are reduced to the mean of the readings taken during the experiments; the values of X obtained from the experiments with the spare bars 20 and 23 have not been included in the mean, for the reason given in the remarks on the observations at Athabasca.

"*Fort Good Hope*.—The observation at this, the most northern station of the series, was made at midnight on the 29th and 30th of May, by the soft and beautiful twilight of that season and latitude. The night was calm, and free from any magnetic disturbance. The results are reduced to the mean of twenty hourly observations of the bifilar magnetometer. The value of X by the observation of No. 30, when vibrated in the stirrup, is apparently too small. The suspension thread broke after 100 vibrations had been observed, occupying only $11^m\ 20^s$, being too short a time to give an accurate result in so high a magnetic latitude: in taking the general mean I have allowed it only half the weight of the other results."—J. H. Lefroy.

Determination of the absolute Horizontal Force derived from the times of vibration *of the magnets of the portable unifilar magnetometer in* 1844.

It has been seen by the preceding Table, No. XXXVIII., that there were sixteen stations at which observations of deflection as well as vibration were made with the magnets of the portable unifilar in 1844, and that at three of the stations they were made at two different epochs: there were also twenty-five other stations, visited in the same year, at which the times of vibration only of the magnets are derived; and in respect to these we have in the first instance to derive the magnetic moment of each magnet, at the several periods when the vibrations only were observed, from the deflections at the stations where both processes were completed; and having thus obtained a knowledge of the variations which the magnetism of the bars may have undergone from time to time in the course of the year, we shall be enabled to derive the values of the absolute horizontal force at those stations also, or at least at a great part of them, where the vibrations alone are observed.

The observations, which include the deflections as well as vibrations, have been discussed by Captain Lefroy in the preceding pages; and we are thus furnished with nineteen determinations of the magnetic moment of No. 30, seventeen of No. 31, and fourteen of No. 17, at different times in the course of the year.

The values of m (the magnetic moment) of No. 30 at the stations at which the deflections are observed, were as follows, viz.—

Athabasca, March 2, 1844 . .	m=·4207.	Norway House, Sept. 4, 1844	m=·3967.
Fort Simpson, May 2, 1844 .	m=·4166.	Fort Alexander, Sept. 20, 1844	m=·3962.
Fort Good Hope, May 29, 1844	m=·4106.	Rat Portage, Sept. 25, 1844.	m=·3964.
Fort Norman, June 2, 1844 .	m=·4091.	Fort Francis, Sept. 29, 1844.	m=·3962.
Fort Simpson, June 12, 1844	m=·4018.	Fort William, Oct. 10, 1844.	m=·3962.
Fort Resolution, June 24, 1844	m=·4002.	Sault St. Mary, Nov. 5, 1844.	m=·3940.
Athabasca, July 2, 1844 . .	m=·3988.	Toronto (with the stirrup), January 1845	m=·3947.
Fort Vermilion, July 11, 1844	m=·4005.		
Fort Dunvegan, July 24, 1844	m=·3992.	Toronto (without the stirrup), Jan. 29, 1845 . . .	m=·3931.
Fort Edmonton, Aug. 18, 1844	m=·3978.		
Carlton House, Aug. 26, 1844	m=·3965.		

An inspection of these values shows that the magnetism of No. 30 was not constant during the period under consideration, but that a progressive loss took place, which was considerable in amount between March and June, but became much smaller and more regular between June 1844 and January 1845.

The whole of the twenty-five stations at which the times of vibration only were observed, are comprised between Fort Dunvegan on the 24th of July, 1844, and Toronto on January 29, 1845, or during the period when the loss of magnetism of No. 30 was small and tolerably regular; we may therefore assume for this portion of

the year the most simple hypothesis of an uniform loss in equal intervals of time, without incurring the risk of any material error. If x be the magnetic moment at Toronto on January 29, 1845, a the interval of time in days between the date of the observations at any anterior station and the 29th of January, and y the change of m corresponding to a single day, each of the stations where observations of deflection were made will furnish an equation of the form,

$$\text{observed value of } m = x + ay;$$

and by the method of least squares we shall obtain the most probable values of m on the hypothesis of uniform loss. There are fifteen such equations furnished by No. 30, between June 12, 1844, and January 29, 1845; from these we obtain $m = \cdot 3928$, and $y = \cdot 0000317$. Hence we have m at Toronto on January 29 $= \cdot 3928$; and on any earlier day between June 12, 1844, and January 29, 1845, $m = \cdot 3928 + \cdot 0000317a$.

By the experiments with Dr. LAMONT's rings, p. 293, the values of $\pi^2 K$, or the moment of inertia of each of the magnets 30, 31 and 17, multiplied by the square of the ratio of the circumference of a circle to its diameter, were determined as follows, viz.—

No. 30.	21·581.
No. 31.	21·853.
No. 17.	43·272.

The absolute horizontal force at the stations where the observations of vibration only were made, are then deducible from the following expression,

$$X = \frac{\pi^2 K}{m T^2},$$

in which T is the time of vibration and m computed as above.

The values of m with magnet No. 31 at the stations where the deflections were observed were as follows:—

Athabasca, March 2, 1844 . .	·3763.	Fort Edmonton, Aug. 18, 1844.	·3507.
Fort Simpson, May 2, 1844 . .	·3721.	Carlton House, Aug. 26, 1844 .	·3499.
Fort Good Hope, May 29, 1844.	·3641.	Norway House, Sept. 4, 1844 .	·3512.
Fort Norman, June 2, 1844 . .	·3616.	Fort Alexander, Sept. 20, 1844 .	·3517.
Fort Simpson, June 12, 1844 .	·3587.	Rat Portage, Sept. 25, 1844 . .	·3515.
Fort Resolution, June 24, 1844.	·3592.	Fort Francis, Sept. 29, 1844 . .	·3506.
Athabasca, July 2, 1844 . . .	·3568.	Fort William, October 10, 1844.	·3522.
Fort Vermilion, July 11, 1844 .	·3592.	Toronto(with stirrup),Feb.5,1845.	·3494.
Fort Dunvegan, July 24, 1844 .	·3528.	Toronto (without stirrup), Feb. 5.	·3494.

In this case also the twenty-five stations at which the times of vibration only were observed, were all comprised in the interval between the 24th of July 1844 at Dunvegan, and the 5th of February 1845 at Toronto. The loss of magnetism of No. 31 in this interval appears to have been very small; and to have been progressive,

although the evidence on this point is obscured by the occasional irregularities of observation. If we treat the observed values between Dunvegan and Toronto in the manner already described in discussing the observations with No. 30, we obtain ·3495 as the value of m at Toronto on the 5th of February 1845, and $\cdot3495+\cdot000012a$ as its value on any anterior day in that interval.

The values of m with No. 17, derived from the deflections, are as follows:—

Fort Simpson, May 2, 1844 . .	·6858.	Norway House, Sept. 4, 1844 .	·6441.
Fort Simpson, June 12, 1844 .	·6738.	Fort Alexander, Sept. 20, 1844.	·6414.
Fort Resolution, June 24, 1844.	·6707.	Rat Portage, Sept. 25, 1844 . .	·6423.
Athabasca, July 2, 1844 . . .	·6691.	Fort Francis, Sept. 29, 1844. .	·6401.
Fort Vermilion, July 11, 1844 .	·6678.	Fort William, October 10, 1844.	·6405.
Fort Dunvegan, July 24, 1844 .	·6727.	Sault St. Mary, Nov. 5, 1845 .	·6393.
Fort Edmonton, Aug. 18, 1844.	·6702.	Toronto, March 8, 1845 . . .	·6368.

A cursory examination of these values suffices to show, that between September 4, 1844, at Norway House, and March 8, 1845, at Toronto, a small and progressive loss of magnetism was sustained; but that between the observations at Fort Edmonton on the 18th of August, and those at Norway House on the 4th of September, an irregular and very considerable loss occurred. A more careful examination of the times of vibration of this magnet, in comparison with those of No. 30 and 31, show that the period at which this loss took place was, after the observations at Devil's Drum Island on September 1, and before those at Norway House on the 4th of the same month. The stations therefore at which the observations of deflection were made with this magnet may be divided into two series; one antecedent to the loss thus sustained, and the other subsequent to it. For the latter series, viz. between Norway House on the 4th of September and Toronto in February 1845, the most probable values of m have been obtained by the method of least squares in the manner already described; which gives for m at Toronto, on the 8th of March 1845, $=\cdot6363$, and on anterior days $\cdot6363+\cdot000032a$. But we have still to provide for the observations of vibration made in July and August, and for this period the arithmetical mean of the observed values of m between June 24 at Fort Resolution, and August 18 at Fort Edmonton, viz. ·6700, is perhaps the least exceptionable value that can be taken; the irregularities of the observed values during the period would scarcely justify a more precise deduction.

When the values of m, resulting from the observations made with a magnet at several stations of a survey, give reason to infer that its magnetism has remained constant, it is obviously preferable to employ at each station a mean value of m derived from the whole body of the observations, as irregularities of individual determinations afford a mutual compensation. When the loss of magnetism during the whole or a part of the survey has been small and progressive, a probable value of m, computed for the period of the loss in the manner described, may continue to be

preferable at the stations where the individual values were observed. For other portions of a survey where the observed discrepancies are considerable, and where they present an alternation of increasing and decreasing values, an arithmetical mean may furnish the most probable value: but when the observed values at successive stations have varied to an amount which considerably exceeds what may reasonably be ascribed to observation error,—and whilst they manifest a progressive loss, afford no very decided indication of its regularity in correspondence with intervals of time,—a satisfactory combination may not be possible, and it may be safer to employ the individual values furnished at each station of observation. Thus the arithmetical mean of the four values obtained with No. 31, from June 12 at Fort Simpson to July 11 at Fort Vermilion, appears preferable to the values themselves, or to any other deduction that might be made for that period; and in the case of No. 17, the values observed on May 2 and June 12 are probably preferable to any others which could be assigned for the respective epochs, but their differences are too great to permit a value to be derived from them for any intermediate or an earlier period.

The following Table contains the times of vibration of the three magnets, Nos. 30, 31 and 17, at the whole of the stations in 1844, with the values of m either observed or deduced in the manner which has been described, and the absolute horizontal force computed by $X = \frac{\pi^2 K}{m T^2}$.

TABLE XL.

Station.	Date.	Magnet.	Time of vibration.	Magnetic moment.	Horizontal force in absolute measure.	
			s			
Athabasca	March 1844.	30	5·0328	·4207	2·025	2·018
		31	5·3740	·3763	2·011	
		17	5·5204	*	*	
Fort Simpson	May 2, 1844.	30	5·1393	·4166	1·961	1·961
		31	5·4691	·3721	1·963	
		17	5·6751	·6858	1·959	
Fort Good Hope	29, 1844.	30	5·6013	·4106	1·67	1·678
		31	5·9763	·3641	1·68	
		17	6·1109	*	*	
Fort Norman	June 2, 1844.	30	5·4832	·4091	1·755	1·763
		31	5·4803	·3616	1·772	
		17	5·9717	*	*	
Fort Simpson	12, 1844.	30	5·2323	·4018	1·962	1·954
		31	5·5993	·3587	1·943	
		17	5·7305	·6738	1·956	
Fort Resolution	24, 1844.	30	5·5320	·3998	1·767	1·767
		31	5·8714	·3585	1·768	
		17	6·0479	·6700	1·766	
Athabasca	July 2, 1844.	30	5·1507	·3995	2·036	2·036
		31	5·4725	·3585	2·035	
		17	5·6326	·6700	2·036	
Fort Vermilion	11, 1844.	30	4·9000	·3992	2·251	2·250
		31	5·1890	·3585	2·264	
		17	5·3771	·6700	2·234	

* Values uncertain.

TABLE XL. (Continued.)

Station.	Date.	Magnet.	Time of vibration.	Magnetic moment.	Horizontal force in absolute measure.	
			s			
Fort Dunvegan	July 24, 1844.	30	4·4557	·3988	2·726	2·732
		31	4·7671	·3519	2·733	
		17	4·8589	·6700	2·736	
Lesser Slave Lake	Aug. 5, 1844.	30	4·4449	·3985	2·744	2·731
		31	4·7706	·3517	2·730	
		17	4·8741	·6700	2·718	
Fort Edmonton	18, 1844.	30	4·2948	·3989	2·940	2·942
		31	4·5939	·3515	2·946	
		17	4·6876	·6700	2·939	
Saskatchawan	20, 1844.	30	4·3747	·3979	2·834	2·829
		31	4·6908	·3515	2·826	
		17	4·7792	·6700	2·828	
Saskatchawan	21, 1844.	30	4·4348	·3979	2·758	2·746
		31	4·7706	·3515	2·732	
		17	4·8472	·6700	2·749	
Fort Pitt	22, 1844.	30	4·4167	·3979	2·781	2·778
		31	4·7334	·3515	2·775	
		17	4·8223	·6700	2·777	
Saskatchawan	23, 1844.	30	4·3646	·3978	2·848	2·847
		31	4·6798	·3515	2·839	
		17	4·7562	·6700	2·855	
Saskatchawan	24, 1844.	30	4·3520	·3978	2·865	2·865
		31	4·6534	·3515	2·871	
		17	4·7525	·6700	2·860	
Carlton House	26, 1844.	30	4·4542	·3977	2·735	2·737
		31	4·7654	·3515	2·738	
		17	4·8565	·6700	2·738	
Saskatchawan	27, 1844.	30	4·5560	·3977	2·614	2·615
		31	4·8791	·3515	2·612	
		17	4·9668	·6700	2·618	
Cumberland House	29, 1844.	30	4·7775	·3976	2·378	2·376
		31	5·1080	·3515	2·383	
		17	5·2235	·6700	2·367	
Near the Pas	31, 1844.	30	4·7705	·3975	2·385	2·386
		31	5·1090	·3514	2·383	
		17	5·1978	·6700	2·391	
Devil's Drum Island	Sept. 1, 1844.	30	4·7485	·3975	2·408	2·399
		31	5·0968	·3514	2·394	
		17	5·1934	·6700	2·395	
Grand Rapid	Sept. 2, 1844.	30	4·8097	·3975	2·347	2·343
		31	5·1558	·3514	2·340	
		17	5·3157	*	....	
Norway House	4, 1844.	30	5·0058	·3974	2·166	2·171
		31	5·3569	·3513	2·168	
		17	5·5516	·6441	2·180	
Lake Winnipeg	14, 1844.	30	4·7613	·3971	2·397	2·398
		31	5·2045	·3512	2·397	
		17	5·2997	·6419	2·400	
Lake Winnipeg	16, 1844.	30	4·4437	·3971	2·754	2·763
		31	4·7457	·3512	2·763	
		17	4·9326	·6418	2·771	
Lake Winnipeg	17, 1844.	30	4·4662	·3970	2·725	2·721
		31	4·7866	·3512	2·716	
		17	4·9768	·6418	2·722	
Lake Winnipeg	18, 1844.	30	4·5414	·3970	2·636	2·639
		31	4·8576	·3512	2·637	
		17	5·0498	·6418	2·644	

* Value uncertain.

TABLE XL. (Continued.)

Station.	Date.	Magnet.	Time of vibration.	Magnetic moment.	Horizontal force in absolute measure.	
			s			
Fort Alexander	Sept. 20, 1844.	30	4·4898	·3970	2·697	2·698
		31	4·7943	·3511	2·708	
		17	5·0090	·6417	2·688	
Rat Portage	25, 1844.	30	4·3592	·3969	2·864	2·876
		31	4·6466	·3511	2·883	
		17	4·8392	·6415	2·880	
Fort Francis	29, 1844.	30	4·2395	·3967	3·027	3·040
		31	4·5242	·3510	3·042	
		17	4·7110	·6414	3·040	
Portage des 2 Rivières	Oct. 4, 1844.	30	4·3170	·3965	2·921	2·930
		31	4·6034	·3510	2·938	
		17	4·7976	·6413	2·932	
Prairie Portage	7, 1844.	30	4·3838	·3964	2·834	2·844
		31	4·6720	·3510	2·853	
		17	4·8705	·6412	2·845	
Chien Portage	9, 1844.	30	4·3888	·3964	2·826	2·836
		31	4·6840	·3510	2·838	
		17	4·8717	·6411	2·844	
Fort William	10, 1844.	30	4·3474	·3963	2·882	2·881
		31	4·6387	·3509	2·894	
		17	4·8517	·6411	2·868	
Lake Superior	14, 1844.	30	4·1192	·3962	3·211	3·213
		31	4·3988	·3509	3·219	
		17	4·5875	·6409	3·208	
Fort Pic	17, 1844.	30	4·4726	·3961	2·724	2·725
		31	4·7741	·3508	2·733	
		17	4·9833	·6408	2·719	
White River	21, 1844.	30	4·4104	·3960	2·804	2·803
		31	4·7096	·3508	2·809	
		17	4·9150	·6407	2·796	
Fort Michipicoton	30, 1844.	30	4·3598	·3957	2·869	2·870
		31	4·6507	·3507	2·881	
		17	4·8606	·6404	2·860	
Gargantua	31, 1844.	30	4·1408	·3956	3·182	3·190
		31	4·4156	·3507	3·196	
		17	4·6015	·6404	3·191	
Sault St. Mary	Nov. 5, 1844	30	4·2527	·3954	3·018	3·026
		31	not observed.	....	....	
		17	4·7196	·6403	3·034	
La Cloche	8, 1844.	30	4·2058	·3953	3·087	3·108
		31	4·4774	·3506	3·109	
		17	4·6495	·6401	3·127	
Penetanguishene	15, 1844.	30	4·0551	·3951	3·323	3·326
		31	4·3324	·3505	3·322	
		17	4·5047	·6397	3·333	
Toronto	Jan. 29, 1845.	30	3·9463	·3928	3·528	3·537
	Feb. 5, 1845.	31	4·2041	·3495	3·538	
	Mar. 8, 1845.	17	4·3858	·6363	3·536	

Determination of the absolute Horizontal Force derived from the times of vibration *of the magnets of the portable unifilar magnetometer in* 1843.

Besides the ten stations at which observations both of deflection and of vibration were made with Nos. 30 and 31 in 1843, which have been discussed in pp. 289–302, there were also thirteen stations at which the times of vibration only were observed, unaccompanied by observations of deflection: these stations were all comprised between Cumberland House on the 22nd of August and Athabasca on the 13th of October. The deflections observed at Cross Lake and Cumberland House on the 16th and 22nd of August, and at Athabasca on the 13th of October, indicate that the magnetic moment of both magnets sustained a considerable diminution in the interval; and from the only intermediate determination, made at Isle à la Crosse on the 9th of September, we may infer that the greater part at least, if not the whole of the loss, occurred in both magnets between August 23 and September 9. For the second portion of the interval therefore, or from September 9 to October 23, the arithmetical mean of the determinations at Isle à la Crosse and at Athabasca have been taken for the values of m, viz. ·4138 for No. 30, and ·3841 for No. 31. In regard to the previous interval, or that comprised between August 22 and September 9, the observations at Cumberland House and at Isle à la Crosse manifest that a very considerable change took place in the magnetic moment of both bars, but as intermediate observations of deflection are wholly wanting we have no direct evidence of the particular time when it occurred. A careful examination and comparison of the times of vibration at the intermediate stations makes it probable that the greater portion at least of the loss occurred in No. 31 between Cumberland House and Beaver Lake, and in No. 30 between Beaver Lake and the Portage des Epinettes; but as there is necessarily much uncertainty involved in any conclusion on this point, it has appeared the safest course to record the times of vibration at the stations between Cumberland House and Isle à la Crosse without an attempt to deduce the horizontal force from them.

The times of vibration of No. 17 were also observed at the stations between Cumberland House and Athabasca, but no deflection experiments were made with it before the arrival at Athabasca; it appears by the observations of vibration that this bar unquestionably lost magnetism in the interval, but as there is no independent evidence to show at what particular time the loss took place, or whether it was of a sudden or of a progressive character, the times of vibration with this magnet have also been recorded, but no conclusion has been drawn from them in regard to the values of the horizontal force at any earlier station than at Athabasca.

Table XLI.

Absolute Horizontal Force deduced from the times of vibration of Nos. 30 and 31 in 1843.

Station.	Date.	Magnet.	Time of vibration.	Magnetic moment.	Horizontal force in absolute measure.	
			s.			
Isle à la Crosse	Sept. 9.	30	4·6589	·4138	2·403	2·394
		31	4·8838	·3841	2·386	
Buffaloe Lake.....	13.	30	4·7694	·4138	2·283	2·278
		31	4·9986	·3841	2·273	
River de la Loche	14.	30	4·7101	·4138	2·341	2·336
		31	4·9345	·3841	2·332	
Portage de la Loche	16.	30	4·7725	·4138	2·280	2·278
		31	4·9968	·3841	2·275	
Clearwater River	19.	30	4·7822	·4138	2·271	2·262
		31	5·0201	·3841	2·253	
Pierre au Calumet	20.	30	4·8867	·4138	2·175	2·172
		31	5·1162	·3841	2·170	
Pointe Brulée.....	21.	30	5·0054	·4138	2·073	2·067
		31	5·2482	·3841	2·062	
Athabasca	Oct. 13.	30	5·0514	·4138	2·035	2·036
		31	5·2816	·3841	2·036	

Table XLII.

Times of Vibration of Nos. 30, 31 and 17, between August 22 and October 13, recorded but not employed.

Station.	1843.	No. 30.	No. 31.	No. 17.	Station.	Date.	No. 17.
Cumberland House	Aug. 22.	....	....	5·126	Isle à la Crosse	Sept. 9.	5·116
Beaver Lake	26.	4·667	4·945	5·205	Buffaloe Lake.....	13.	5·236
Portage des Epinettes ..	28.	4·689	5·007	5·272	River de la Loche	14.	5·169
Frog Portage	29.	4·786	5·049	5·318	Portage de la Loche	16.	5·231
Great Devil Portage	Sept. 1.	4·765	4·937	5·286	Clearwater River	19.	5·253
Pine Portage	3.	4·786	5·011	....	Pierre au Calumet.....	20.	5·364
Snake Rapid	4.	4·760	4·983	5·231	Pointe Brulée.....	21.	5·493
Portage Sonnante	7.	4·644	4·879	5·097			

Collecting then in one view the results obtained by Lieut. Lefroy with the magnets of the German and unifilar magnetometers, and employing the Inclinations observed at the stations which will be found in the general table at the close of § 12, we have the values of the horizontal component, and of the total Force, severally as follows:—*a.* signifies by the German magnetometer; *b.* by the unifilar, where both deflections and vibrations have been observed; and *c.* when the times of vibration only of the magnets of the unifilar were observed.

Table XLIII.

Station.	Date.	Horizontal component.	Mean horizontal component.	Total force in absolute measure.	Remarks.
Quebec	1842.	3·040 *a*.	3·040	13·78	
Montreal	1842.	3·064 *a*.	3·064	13·78	
New York	1842.	4·008 *a*.	4·008	13·49	Lunatic Asylum.
Cambridge	1842.	3·665 *a*.	3·665	13·55	Lunatic Asylum.
Philadelphia	1842.	4·176 *a*.	4·176	13·50	Observed by Lieut. Young-husband, R.A.
Chicago	1842.	4·106 *a*.	4·106	13·77	Observed by Lieut. Young-husband, R.A.
Fort William	1843.	2·869 *b*.	2·875	13·91	Observed by Lieut. Young-husband, R.A.
Fort William	1844.	2·881 *b*.			Observed by Lieut. Young-husband, R.A.
Fort Francis	1843.	3·048 *b*.	3·044	14·18	Observed by Lieut. Young-husband, R.A.
Fort Francis	1844.	3·040 *b*.			Observed by Lieut. Young-husband, R.A.
Upper Fort Garry	1843.	2·849 *b*.	2·849	14·05	
Norway House	1843.	2·176 *b*.	2·173	14·18	
Norway House	1844.	2·171 *b*.			
York Factory	1843.	1·523 *b*.	1·523	14·07	
Cross Lake	1843.	2·352 *b*.	2·352	14·21	
Cumberland House	1843.	2·341 *b*.	2·358	14·12	
Cumberland House	1844.	2·376 *b*.			
Isle à la Crosse	1843.	2·394 *c*.	2·394	14·01	
Buffaloe Lake	1843.	2·278 *c*.	2·278	13·97	
River de la Loche	1843.	2·336 *c*.	2·336	13·90	
Portage de la Loche	1843.	2·278 *c*.	2·278	13·95	
Clearwater River	1843.	2·262 *c*.	2·262	13·85	
Pierre au Calumet	1843.	2·172 *c*.	2·172	14·33	
Pointe Brulée	1843.	2·067 *c*.	2·067	14·00	
Athabasca	1843.	2·036 *b*.	2·030	13·94	
Athabasca	1844.	2·018 *b*.			
Athabasca	1844.	2·036 *b*.			
Fort Simpson	1844.	1·961 *b*.	1·957	13·84	
Fort Simpson	1844.	1·954 *b*.			
Fort Good Hope	1844.	1·678 *b*.	1·678	13·64	
Fort Norman	1844.	1·763 *b*.	1·763	13·63	
Fort Resolution	1844.	1·767 *b*.	1·767	13·99	
Fort Vermilion	1844.	2·250 *b*.	2·250	14·07	
Fort Dunvegan	1844.	2·732 *b*.	2·732	14·03	
Lesser Slave Lake	1844.	2·731 *b*.	2·731	13·87	
Fort Edmonton	1844.	2·942 *b*.	2·942	14·04	
On the Saskatchawan	1844.	2·829 *c*.	2·829	13·71	
On the Saskatchawan	1844.	2·746 *c*.	2·746	13·84	
Fort Pitt	1844.	2·778 *c*.	2·778	14·15	
On the Saskatchawan	1844.	2·847 *c*.	2·847	14·24	
On the Saskatchawan	1844.	2·865 *c*.	2·865	14·09	
Carlton House	1844.	2·737 *c*.	2·737	13·74	
On the Saskatchawan	1844.	2·615 *c*.	2·615	13·94	
Near the Pas	1844.	2·386 *c*.	2·386	14·32	
Devil's Drum Island	1844.	2·399 *c*.	2·399	13·82	
Grand Rapid	1844.	2·343 *c*.	2·343	14·11	
Lake Winnipeg	1844.	2·365 *c*.	2·398	14·38	
Lake Winnipeg	1844.	2·763 *c*.	2·763	15·37	
Lake Winnipeg	1844.	2·721 *c*.	2·721	14·40	
Lake Winnipeg	1844.	2·639 *c*.	2·639	14·51	

TABLE XLIII. (Continued).

Station.	Date.	Horizontal component.	Mean horizontal component.	Total force in absolute measure.	Remarks.
Fort Alexander	1844.	2·698 *b.*	2·698	14·08	
Rat Portage	1844.	2·876 *b.*	2·876	13·97	
Portage des deux Rivières	1844.	2·930 *c.*	2·930	13·89	
Prairie Portage	1844.	2·844 *c.*	2·844	14·18	
Portage du Chien	1844.	2·836 *c.*	2·836	14·17	
Lake Superior	1844.	3·213 *c.*	3·213	15·89	
Pic Fort.....	1844.	2·725 *c.*	2·725	13·84	
White River	1844.	2·803 *c.*	2·803	14·12	
Fort Michipicoton	1844.	2·870 *c.*	2·870	13·93	
Gargantua	1844.	3·190 *c.*	3·190	15·26	
Sault St. Mary	1844.	3·026 *c.*	3·026	13·98	
La Cloche	1844.	3·108 *c.*	3·108	13·64	
Penetanguishene	1844.	3·326 *c.*	3·326	14·08	
Toronto	1842. 1843.	3·537 *a.*			
Toronto	1845.	3·537 *b.*	3·535	13·90	
Toronto	1845.	3·535 *b.*			
Toronto	1846.	3·533 *b.*			
Woolwich	1846.	3·729 *b.*	3·729	10·39	

Values of the Magnetic Force at Dr. LOCKE's *stations.*

Dr. LOCKE's determinations were of the ratios of the horizontal component of the Force to its value at Cincinnati taken as a base station: it is therefore requisite to establish, in the first instance, the relative values of the magnetic Force at Cincinnati and Toronto on the best evidence that the observations furnish. For this comparison we have—1°. Dr. LOCKE's observations with HANSTEEN's apparatus, at Toronto on the 20th of June, and at Cincinnati on the 4th of July 1844, combined with observations of the Inclination on the same days. The observations of horizontal Force give the ratio ·7784 at Toronto to unity at Cincinnati, and those of Inclination 70° 25′·0 at Cincinnati, and 75° 13′·4 at Toronto. Whence, if we take the total Force at Toronto in the arbitrary scale as 1·836, its value at Cincinnati is 1·795.

2°. Dr. LOCKE's determination of the ratios of the horizontal force at New York, Cambridge, and Philadelphia, to unity at Cincinnati, with the Inclination at each station, combined with Lieut. LEFROY's determination of the ratios of the horizontal force at the same three stations to the force at Toronto, all which were observed with the magnets of the German transportable magnetometer. The place of observation at New York, Cambridge and Philadelphia, was the same with both observers; viz. the Lunatic Asylum at Manhattanville near New York, and the magnetic observatories at Cambridge and Philadelphia.

The particulars of this comparison are as follows:—

TABLE XLIV.

Station.	Date.	Dr. Locke.		Lieut. Lefroy.	Horizontal force deduced at Cincinnati.	Lieut. Lefroy.		Total force at Cincinnati to 1·836 at Toronto.
		Ratio of the horizontal force to 1 at Cincinnati.	Inclination observed at Cincinnati.	Horizontal force observed at the stations in the first column.		Horizontal force observed at Toronto.	Inclination observed at Toronto.	
				(1842.)		(1842.)	(1842.)	
New York	1841.	·8828	70° 26′·2					
	1844.	·8811	70 25·0					
	Mean	·8819	70 25·6	4·008	4·544	3·537	75 16·0	1·791
Cambridge.....	1842.	·8040	70 26·2	3·665	4·558	3·537	75 16·0	1·797
Philadelphia ..	1841.	·9175	70 26·2					
	1842.	·9178	70 26·2					
	1844.	·9151	70 25·2					
	Mean	·9168	70 25·8	4·168	4·546	3·537	75 16·0	1·792
							Mean	1·794

Whence we have the total force at Cincinnati = 1·794.

3°. Dr. Locke's determination of the ratios of the horizontal force at Baltimore, Washington, Princeton, Newhaven, Albany and Sault St. Mary, to unity at Cincinnati, and his observations of the Inclination at those stations, combined with the ratios of the total force to 1·836 at Toronto, determined by Lieut. Lefroy at the same six stations. The particulars of the comparison are as follows:—

TABLE XLV.

Station.	Dates.	Ratio of the horizontal force to 1 at Cincinnati.	Inclination observed at		Total force at Cincinnati to 1·836 at Toronto.	
			the stations in column 1.	Cincinnati.	By observations at the stations in column 1.	Deduced for Cincinnati.
		Dr. Locke.	Dr. Locke.	Dr. Locke.	Lieut. Lefroy.	
Baltimore	1841.	·9370	71° 34′·1	70° 26′·2	1·782	1·796
Washington	1844.	·9483	71 13·4	70 25·0	1·772	1·795
Princeton	1844.	·8833	72 40·4	70 25·0	1·783	1·794
Newhaven	1842.	·8385	73 29·8	70 26·2	1·773	1·794
Albany	1844.	·7876	74 40·2	70 25·0	1·797	1·800
Sault St. Mary	1843.	·6695	77 30·2	70 25·5	1·862	1·796
					Mean	1·796

Whence we have the total force at Cincinnati = 1·796. Collecting in 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

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 Lieut. 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 Lieut. Lefroy . . . . 1·796

The total force at Cincinnati, the base station of Dr. Locke's survey, has therefore been taken = 1·795; and the final column in the following Table has been computed accordingly; employing for that purpose the Inclinations observed at the same stations by Dr. Locke, contained in § 12, where also the geographical positions of the stations are given.

Table XLVI.—Values of the Magnetic Force at the stations of Dr. Locke's survey.

Station.	Date.	Ratios of the horizontal force to unity at Cincinnati.	Ratios of the total force.	
			To unity at Cincinnati.	To 1·836 at Toronto.
Cincinnati	.....	1·0000	1·0000	1·795
Dayton	1838.	·9582	1·0032	1·797
Dayton	1840.	·9544	·9991	
Springfield	1838.	·9494	·9978	1·791
Urbana	1838.	·9533	1·0122	1·816
Columbus	1838.	·9666	·9967	1·788
Columbus	1845.	·9644	·9957	
St. Louis	1839.	1·0430	·9973	1·790
Davenport	1839.	·9385	1·0120	1·816
Lostgrove	1839.	·9360	1·0154	1·822
Wabisepinnecon River	1839.	·9302	1·0206	1·832
Iron Ore Bed	1839.	·9085	1·0302	1·849
Brown's Settlement	1839.	·9181	1·0129	1·818
Mahoqueta River	1839.	·9034	1·0178	1·818
Farmer's Creek	1839.	·9144	1·0228	1·836
White Water River	1839.	·8927	1·0165	1·824
Mahoqueta River *	1839.	·8897	1·0093	1·811
Dubugues Town	1839.	·8805	1·0130	1·818
Little Mahoqueta	1839.	·8813	1·0160	1·823
Turkey River	1839.	·8732	1·0091	1·811
Prairie du Chien	1839.	·8763	1·0187	1·828
Blue Mound	1839.	·8540	1·0174	1·826
Madison	1839.	·8521	1·0378	1·862
Mineral Point	1839.	·8686	1·0137	1·819
Hamilton	1840.	·9383	1·0035	1·801
Piqua	1840.	·9461	1·0026	1·799
Lebanon	1840.	·9720	1·0011	1·797
Mason	1840.	·9770	·9989	1·793
Williamstown	1840.	1·0122	·9932	1·783
Lexington	1840.	1·0120	·9854	1·769
Clay's Ferry	1840.	1·0203	·9893	1·775
Frankfort	1840.	1·0151	·9887	1·774
Louisville	1840.	1·0234	·9965	1·788
Mount Vernon	1840.	1·0646	·9913	1·779
New Harmony	1840.	1·0581	·9908	1·778
Princeton	1840.	1·0447	·9923	1·781
Vincennes	1840.	1·0260	·9985	1·792
Paoli	1840.	1·0313	·9880	1·775
Philadelphia	1841.	·9174	·9943	1·784
Philadelphia	1842.	·9178	·9955	
Philadelphia	1844.	·9151	·9918	
Pittsburg	1841.	·8915	1·0052	1·803
Pittsburg	1842.	·8907	1·0041	
Pittsburg	1845.	·8869	1·0034	
Chambersburgh	1842.	·9216	·9964	1·788
Mount St. Mary's	1842.	·9319	·9977	1·790
Baltimore	1841.	·9370	·9935	1·784
Baltimore †	1841.	·9319	·9914	1·779
Trenton	1841.	·9246	·9978	1·790
Newark	1841.	·8785	·9957	1·784
Newark	1844.	·8756	·9925	
New York ‡	1841.	·8835	·9943	1·785
New York ‡	1844.	·8817	·9944	
New York §	1841.	·8828	·9918	1·781
New York §	1844.	·8811	·9924	
New York ‖	1841.	·9003	·9942	1·784
Newhaven	1842.	·8385	·9884	1·774
Boston	1842.	·8057	·9845	1·767
Cambridge	1842.	·8040	·9917	1·774
Cambridge ¶	1845.	·7955	·9860	
Bristol	1842.	·8885	·9850	1·768
Huron	1843.	·8834	1·0123	1·817
Detroit	1843.	·8552	1·0111	1·815
Ann Arbor	1843.	·8771	1·0184	1·828
Machinac	1843.	·7159	1·0387	1·864
Sault St. Mary	1843.	·6695	1·0366	1·861
Encampment	1843.	·6959	1·0341	1·856
Houghton's River	1843.	·6713	1·0266	1·842
Magnetic Inlet	1843.	·6199	1·0652	1·910**
Isthmus	1843.	·6298	1·0555	1·895**
United States Agency	1843.	·7171	1·0866	1·950**
Eagle River	1843.	·6482	1·0367	1·861
Lapointe	1843.	·7047	1·0445	1·875
Ontanogon River	1843.	·6862	1·0393	1·865
Isle Royale	1843.	·6464	1·0526	1·889
Cleveland	1843.	·8802	1·0163	1·824
Wheeling	1844.	·9167	1·0129	1·813
Wheeling	4845.	·9182	1·0070	
Cumberland	1844.	·9390	·9967	1·789
Washington ††	1844.	·9414	1·0026	1·800
Washington ‡‡	1844.	·9483	·9879	1·773
Georgetown	1844.	·9413	·9849	1·768
Mount Vernon	1844.	·9685	·9933	1·782
Princeton	1844.	·8833	·9940	1·783
Princeton §§	1844.	·8815	·9927	1·781
Princeton ‖‖	1844.	·8905	·9973	1·790
New Brunswick	1844.	·8814	·9946	1·785
Powkeepsie	1844.	·8808	·9959	1·787
Opposite Powkeepsie	1844.	·8197	1·0094	1·811
Greenbush	1844.	·7867	·9978	1·791
Albany	1844.	·7876	·9985	1·792
Utica	1844.	·7876	1·0078	1·809
Rochester	1844.	·7948	1·0061	1·806
Lockport	1844.	·7913	1·0073	1·808
Buffaloe	1844.	·8054	1·0170	1·825
Ashtabula	1844.	·8600	1·0335	1·855
Warren	1844.	·8806	1·0056	1·805
Wellsville	1844.	·8927	·9999	1·794
Toronto ¶¶	1844.	·7784	1·0229	1·836
Near Toronto ***	1844.	·7789	1·0220	1·835
Marietta	1845.	·9566	1·0025	1·800
Near Marietta	1845.	·9507	·9999	1·795
Allegheny Summit	1845.	·9026	1·0025	1·800
Portland	1845.	·7535	·9897	1·776
Locke's Mills	1845.	·7265	·9950	1·786
Bethel	1845.	·7274	·9965	1·789
Goreham	1845.	·7442	·9993	1·794
Mount Washington	1845.	·7287	·9915	1·780
Near Mount Washington	1845.	·7334	·9914	1·780
Oxford	1845.	·9732	1·0056	1·805
Richmond	1845.	·9574	1·0020	1·799
St. Mary's	1845.	·9255	1·0056	1·805
Carrolton	1845.	·9662	1·0024	1·800

* North Branch. † St. Mary's College. ‡ Columbia College.
§ Lunatic Asylum, Manhattanville. ‖ New Asylum. ¶ Mr. Bond's Magnetic Observatory.
** At these four stations, which are all within one mile of each other, considerable local disturbance obviously exists. †† Magnetic Observatory. ‡‡ Grounds of the Capitol, mean of the east and west sides.
§§ Pott's Wood. ‖‖ Rock Hills (trap). ¶¶ Magnetic Observatory. *** In the woods.

Values of the Magnetic Force at Mr. RENWICK's *Stations.*

Mr. RENWICK's observations consisted partly of determinations of the absolute horizontal force with a portable unifilar magnetometer, and partly of determinations of its ratios, by means of the times of vibrations of the magnet of the unifilar, of which the magnetism is assumed to have been constant. The absolute values of the total force are derived from the horizontal component obtained by both classes of observations, by applying the Inclinations observed at the same stations, which will be found in the General Table of Inclinations in the sequel, where also the geographical positions of Mr. RENWICK's stations are given. The particulars of the magnetic determinations will be contained in the official publication of the United States Government: the results now communicated have been computed by Mr. RENWICK.

TABLE XLVII.

Results of the Observations on the Magnetic Force made by Mr. RENWICK in 1844.

Station.	Absolute horizontal force.	Absolute total force.	Remarks.
Stonington	3·7479	13·133	Vibrations and deflections.
Bridgeport	3·7380	13·050	
Greenport	3·8501	13·142	
Saybrook	3·5636	13·388	
New York (Columbia College)	4·1317	13·883	Vibrations only.
New York (Old Lunatic Asylum)	4·0913	13·849	
Sandy Hook	4·1270	13·824	
Yale College	3·8758	13·514	
Stamford	3·9429	13·512	
Oyster Bay	3·9526	13·506	

The determinations of the magnetic force which have been discussed in the preceding pages, are collected in one view in the following General Table, No. XLVIII.; which exhibits the names of the stations, their geographical positions, the observers, and the intensities of the Force; the latter are placed in separate columns according to the nature of the determination in each case, the relative values of the total Force being placed in the one column, and the absolute values of the horizontal component in another; the former are expressed in the arbitrary scale, and are dependent on 1·836 as the force at Toronto; the latter are expressed in British units. A final column is added for the purpose of showing the total Force in absolute measure corresponding to the determinations in the two preceding columns: when the deduction is from the horizontal component, the values in the final column are the horizontal force multiplied by the secant of the observed Inclination; when from the ratios of the total Force, they have been computed by multiplying the respective ratios by $\frac{13\cdot896}{1\cdot836}$. The number of separate results in the Table is 289, of which 222 are relative, and 67 are absolute determinations. The number of stations at which the force has been obtained by these observations is 234. Seventeen of the results at fifteen

stations present discordances much exceeding the ordinary limits; in most of these cases similar discrepancies occur in the observations of the Inclination also, whence it may be inferred that they are occasioned by station-error. Setting aside these seventeen results, there remain 272 independent determinations at 219 stations distributed over a portion of the earth's surface, extending in latitude above twenty-eight degrees, and in longitude above fifty degrees.

At thirty-five of Captain Lefroy's stations, results were obtained both by the magnets of the unifilar magnetometer, and by the statical needles. Omitting Pierre au Calumet, where much local disturbance prevailed, there are thirty-four stations at which the values of the total Force in absolute measure derived from the two methods admit of being compared; when this is done it is found that the values obtained by the horizontal method are in excess at fifteen stations, and in defect at an equal number, the results being identical at the remaining four stations. The sum of the differences in excess is 1·95, and in defect 1·22; the difference of these two numbers divided by 34 (the number of stations), gives ·0215 as the average excess of the absolute determinations, or about ·0015 of the whole force. As the two methods of experimenting are perfectly independent of each other, having no single element in common, such an agreement is a very satisfactory confirmation of the general merits of both, and testifies, far more than any verbal expressions, in praise of the unremitting care with which the observations were conducted and executed. The sum of the differences in excess and defect, taken without reference to signs, is 3·17, which divided by 34 gives an average difference at each station of 0·09 between the two methods. As in all probability the differences which appear in the results of the two methods in such very high magnetic latitudes are chiefly attributable to observation-error in the *Inclinations*, of which the secants are employed in the deduction of the total Force from the horizontal components, it may be proper to notice that an error of 0·09 in the total Force is equivalent, when the Inclination is 80°, to an observation-error of less than 4′ in the Inclination: and when all the circumstances are considered under which the observations of Inclination were made, an average error of 4′ in determinations, which rarely admitted of confirmation on a second day, will by no means appear an extraordinary amount.

As a considerable portion of the statical determinations of the Force, and of the observations of Inclination, were entrusted to Bombardier Henry, I may take this occasion to insert, as I have great pleasure in doing, the following extract from a communication from Captain Lefroy:—"During the twenty months which I passed in the Hudson's Bay Territories, Bombardier Henry was my only English assistant: his excellent conduct and cheerful endurance at times of considerable inconvenience and hardships, did as much credit to his character as a non-commissioned officer of artillery, as the interest with which he devoted himself to the observations entrusted to him did to his zeal and intelligence."

TABLE XLVIII. General Table of the Observations of the Magnetic Force.

Station.	Lat.	Long.	Observer.	Magnetic force.		
				Relative scale. Toronto = 1·836.	In absolute measure.	
					Horizontal.	Total.
	Between the latitudes of 38° and 40°.					
St. Louis	38° 38′	269° 56′	LOCKE.	1·790	....	13·55
New Harmony	38 11	272 12	LOCKE.	1·778	....	13·46
Mount Vernon	37 59	272 13	LOCKE.	1·779	....	13·47
Princeton	38 23	272 30	LOCKE.	1·781	....	13·48
Vincennes	38 43	272 35	LOCKE.	1·792	....	13·56
Paoli	38 05	273 25	LOCKE.	1·775	....	13·44
Louisville	38 03	274 30	LOCKE.	1·788	....	13·53
Richmond	39 49	275 13	LOCKE.	1·799	....	13·61
Frankfort	38 14	275 20	LOCKE.	1·774	....	13·43
Oxford	39 30	275 22	LOCKE.	1·805	....	13·66
Hamilton	39 23	275 28	LOCKE.	1·801	....	13·63
Williamstown	38 36	275 38	LOCKE.	1·783	....	13·50
Cincinnati	39 06	275 38	LOCKE.	1·795	....	13·59
Dayton	39 44	275 43	LOCKE.	1·797	....	13·60
Clay's Ferry	37 54	275 42	LOCKE.	1·775	....	13·43
Lexington	38 06	275 42	LOCKE.	1·769	....	13·38
Mason	39 22	275 47	LOCKE.	1·793	....	13·57
Carrolton	39 38	275 51	LOCKE.	1·800	....	13·62
Lebanon	39 26	275 54	LOCKE.	1·797	....	13·60
Springfield	39 54	276 09	LOCKE.	1·791	....	13·55
Columbus	39 57	276 57	LOCKE.	1·788	....	13·53
Marietta Island	39 25	278 32	LOCKE.	1·800	....	13·62
Near Marietta Island	?	?	LOCKE.	1·795	....	13·58
Chambersburg	39 55	282 20	LOCKE.	1·788	....	13·53
Mount St. Mary's	39 41	282 42	LOCKE.	1·790	....	13·55
Mount Vernon	38 41	282 53	LOCKE.	1·782	....	13·49
Georgetown	38 53	282 57	LOCKE.	1·768	....	13·38
Washington	38 53	282 59	LOCKE.	1·773*	....	13·42
Washington	38 53	282 59	LEFROY.	1·772*	....	13·41
Washington	38 54	282 59	LOCKE.	1·800†	....	13·62
Washington	38 54	282 59	LEFROY.	1·798†	....	13·61
Baltimore	39 17	283 22	LOCKE.	1·779	....	13·47
Baltimore	39 17	283 23	LOCKE.	1·784	....	13·50
Baltimore	39 17	283 23	LEFROY.	1·782	....	13·49
Philadelphia	39 58	284 50	LOCKE.	1·784‡	....	13·50
Philadelphia	39 58	284 50	LEFROY.	1·793‡	....	13·57
Philadelphia	39 58	284 50	LEFROY.	....	4·176‡	13·50
	Between the latitudes of 40° and 45°.					
Prairie du Chien	43 01	268 51	LOCKE.	1·828	....	13·83
Brown's Settlement	42 02	268 54	LOCKE.	1·818	....	13·76
Mahoqueta River	42 14	269 03	LOCKE.	1·818	....	13·76
North branch of ditto	42 23	269 08	LOCKE.	1·811	....	13·71
Turkey River	42 42	269 12	LOCKE.	1·811	....	13·71
Iron Ore Bed	41 55	269 20	LOCKE.	1·849§	....	13·99
White Water River	42 18	269 22	LOCKE.	1·824	....	13·80

* Grounds of the Capitol.

† Magnetic Observatory. The Inclinations observed at the Magnetic Observatory and in the grounds of the Capitol, differ also about one-third of a degree; the results at the observatory are omitted in the map.

‡ Magnetic Observatory.

§ Local influence; omitted in the map.

TABLE XLVIII. (Continued.)

Station.	Lat.	Long.	Observer.	Magnetic force.		
				Relative scale. Toronto = 1·836.	In absolute measure.	
					Horizontal.	Total.
	Between the latitudes of 40° and 45° (continued).					
Little Mahoqueta River..	42° 31′	269° 29′	LOCKE.	1·823	....	13·80
Davenport	41 30	269 34	LOCKE.	1·818	....	13·76
Wabisepinnecon River ..	41 44	269 37	LOCKE.	1·832	....	13·86
Dubuques Town	42 29	269 37	LOCKE.	1·818	....	13·76
Farmer's Creek	42 13	269 37	LOCKE.	1·836	....	13·90
Lostgrove	41 39	269 51	LOCKE.	1·822	....	13·79
Mineral Point.....	42 50	270 06	LOCKE.	1·819	....	13·76
Blue Mound	43 01	270 22	LOCKE.	1·826	....	13·82
Madison.....	43 04	270 54	LOCKE.	1·862‡	....	14·09
Chicago	41 53	272 16	YOUNGHUSBAND.	1·823	....	13·80
Chicago	41 53	272 16	YOUNGHUSBAND.	....	4·106	13·77
St. Mary's	40 32	275 41	LOCKE.	1·805	....	13·66
Piqua	40 06	275 47	LOCKE.	1·799	....	13·61
Urbana	40 05	276 12	LOCKE.	1·816	....	13·74
Ann Arbor.....	42 18	276 15	LOCKE.	1·828	....	13·84
Amherstburg.....	42 06	276 47	LEFROY.	1·822	....	13·79
Detroit	42 25	277 04	LEFROY.	1·814	....	13·72
Detroit	42 25	277 04	LOCKE.	1·815	....	13·73
Detroit	42 25	277 04	YOUNGHUSBAND.	1·826	....	13·82
Port Sarnia.....	42 58	277 26	LEFROY.	1·825	....	13·81
Huron	41 26	277 33	LOCKE.	1·817	....	13·75
Goderich	43 45	278 03	LEFROY.	1·828	....	13·84
Cleveland	41 30	278 18	LOCKE.	1·824	....	13·80
Cleveland	41 30	278 18	YOUNGHUSBAND.	1·807	....	13·67
Ashtabula	41 52	279 08	LOCKE.	1·855‡	....	14·04
Warren	41 16	279 11	LOCKE.	1·805	....	13·66
Wheeling	40 08	279 13	LOCKE.	1·813	....	13·72
Wellsville	40 38	279 16	LOCKE.	1·794	....	13·58
Pittsburg	40 32	279 58	LOCKE.	1·803	....	13·65
Penetanguishene	44 49	279 59	LEFROY.	....	3·326	14·08
Toronto	43 39	280 39	LEFROY.	1·836	....	13·90
Toronto	43 39	280 39	LOCKE.	1·836	....	13·90
Toronto	43 39	280 39	LEFROY.	....	3·535	13·90
Near Toronto.....	43 39	280 41	LOCKE.	1·835	....	13·89
Niagara	43 05	280 51	LEFROY.	1·822	....	13·79
Buffaloe	42 53	281 06	LEFROY.	1·814	....	13·73
Buffaloe	42 53	281 06	LOCKE.	1·825	....	13·81
Lockport	43 11	281 14	LOCKE.	1·808	....	13·68
Allegheny Summit	40 27	281 50	LOCKE.	1·800	....	13·62
Rochester	43 08	282 09	LOCKE.	1·806	....	13·67
Cumberland	40 13	283 10	LOCKE.	1·789	....	13·54
Brockville	44 35	284 15	YOUNGHUSBAND.	1·812	....	13·71
Utica	43 07	284 47	LOCKE.	1·809	....	13·69
Bristol.....	40 06	285 13	LOCKE.	1·768	...	13·38
Trenton	40 13	285 20	LOCKE.	1·790	....	13·55
Princeton	40 22	285 20	LOCKE.	1·783	....	13·50
Princeton	40 22	285 20	LEFROY.	1·783	....	13·50
Princeton*.....	40 22	285 20	LOCKE.	1·781	....	13·48
Princeton†.....	40 22	285 20	LOCKE.	1·790	....	13·55
New Brunswick.....	40 30	285 25	LOCKE.	1·785	....	13·51
Newark	40 43	285 50	LOCKE.	1·784	....	13·50

* Pott's Woods. † Rock Hills (trap). ‡ Apparent local influence; omitted in the map.

Table XLVIII. (Continued.)

Station.	Lat.	Long.	Observer.	Magnetic force. Relative scale. Toronto = 1·836.	Magnetic force. In absolute measure. Horizontal.	Magnetic force. In absolute measure. Total.
	Between the latitudes of 40° and 45° (continued).					
New York*	40° 49′	285° 57′	Locke.	1·781	....	13·48
New York*	40 49	285 57	Lefroy.	1·769	....	13·39
Yew York*	40 49	285 57	Lefroy.	....	4·008	13·49
New York*	40 49	285 57	Renwick.	....	4·091	13·85
New York†	40 48	285 58	Locke.	1·784	....	13·50
Sandy Hook	40 27	285 58	Renwick.	....	4·127	13·82
New York‡	40 43	285 59	Locke.	1·785	....	13·51
New York‡	40 43	285 59	Renwick.	....	4·132	13·88
West Point	41 24	285 59	Lefroy.	1·807	....	13·67
Opposite Powkeepsie	41 41	286 04	Locke.	1·811	....	13·71
Powkeepsie	41 41	286 05	Locke.	1·787	....	13·52
Albany	42 39	286 14	Locke.	1·792	....	13·56
Albany	42 39	286 14	Lefroy.	1·797	....	13·60
Greenbush	42 39	286 16	Locke.	1·791	....	13·55
Oyster Bay	40 52	.....	Renwick.	....	3·953	13·51
Bridgeport	41 11	286 48	Renwick.	....	3·738	13·05
Newhaven	41 18	287 02	Locke.	1·774	....	13·42
Newhaven	41 18	287 02	Lefroy.	1·773	....	13·42
Newhaven	41 18	287 02	Renwick.	....	3·876	13·51
Greenport	41 06	287 38	Renwick.	....	3·850	13·14
Stamford	41 03	.....	Renwick.	....	3·943	13·51
Saybrook	41 17	287 39	Renwick.	....	3·564	13·39
Stonington	41 20	288 05	Renwick.	....	3·749	13·13
Mount Washington	44 17	288 31	Locke.	1·780	....	13·47
Providence	41 50	288 35	Lefroy.	1·781	....	13·48
Near Mount Washington.	44 16	288 31	Locke.	1·780	....	13·47
Goreham	44 27	288 47	Locke.	1·794	....	13·58
Cambridge	42 22	288 52	Locke.	1·774	....	13·42
Cambridge	42 22	288 52	Lefroy.	1·777	....	13·45
Cambridge	42 22	288 52	Lefroy.	....	3·665	13·55
Boston	42 22	289 01	Locke.	1·767	....	13·37
Bethel	44 27	289 09	Locke.	1·789	....	13·54
Locke's Mills	44 24	289 16	Locke.	1·786	....	13·52
Portland	43 41	289 40	Locke.	1·776	....	13·44
	Between the latitudes of 45° and 50°.					
Upper Fort Garry	49 53	262 58	Lefroy.	1·862	....	14·09
Upper Fort Garry	49 53	262 58	Lefroy.	....	2·849	14·05
Lake of the Woods	49 19	265 18	Lefroy.	1·867	....	14·13
Lake of the Woods	49 28	265 20	Lefroy.	1·856	....	14·05
Rat Portage	49 46	265 21	Lefroy.	1·858	....	14·06
Rat Portage	49 46	265 21	Lefroy.	....	2·876	13·97
Rainy River	48 48	265 29	Lefroy.	1·895§	....	14·34
Fort Francis	48 37	266 31	Lefroy.	1·853	....	14·03
Fort Francis	48 37	266 31	Lefroy.	....	3·044	14·18
Lac de la Pluie	48 32	267 04	Lefroy.	1·859	....	14·07
Sturgeon Lake	48 27	267 19	Lefroy.	1·861	....	14·08
2nd Pe. from L. à la Crosse	48 15	267 33	Lefroy.	1·855	....	14·04
Lac à la Crosse	48 24	267 50	Lefroy.	1·860	....	14·08
Portage des deux Rivières	48 35	268 33	Lefroy.	1·862	....	14·09

* Lunatic Asylum, Manhattanville.

† New Lunatic Asylum.

‡ Columbia College.

§ Apparent local disturbance; omitted in the map.

TABLE XLVIII. (Continued.)

Station.	Lat.	Long.	Observer.	Magnetic force.		
				Relative force. Toronto = 1·836.	In absolute measure.	
					Horizontal.	Total.
	Between the latitudes of 45° and 50° (continued).					
Portage des deux Rivières	48° 35′	268° 33′	LEFROY.	....	2·930	13·89
French Portage	48 35	268 53	LEFROY.	1·860	....	14·08
La Pointe	46 47	269 02	LOCKE.	1·875	....	14·19
Savannah Portage	48 53	269 57	LEFROY.	1·867	....	14·13
Prairie Portage	48 58	269 59	LEFROY.	1·858	....	14·06
Prairie Portage	48 58	269 59	LEFROY.	....	2·844	14·18
Portage Ecarté	48 25	270 15	LEFROY.	1·852	....	14·02
Portage du Chien	48 39	270 26	LEFROY.	1·865	....	14·12
Portage du Chien	48 39	270 26	LEFROY.	....	2·836	14·17
Ontanogon River	46 52	270 29	LOCKE.	1·865	....	14·12
Fort William	48 24	270 37	LEFROY.	1·866	....	14·12
Fort William	48 24	270 37	LEFROY.	....	2·875	13·91
Pointe Tonnerre	48 19	270 58	LEFROY.	1·876	....	14·20
Isle Royale	48 06	271 13	LOCKE.	1·889*	....	14·30
Eagle River	47 27	271 37	LOCKE.	1·861	....	14·08
United States Agency	47 28	271 59	LOCKE.	1·950*	....	14·76
Houghton's River	47 28	271 59	LOCKE.	1·842	....	13·94
Magnetic Inlet	47 29	271 59	LOCKE.	1·910*	....	14·46
Isthmus	47 28	272 00	LOCKE.	1·895*	....	14·34
Terreplatte	48 49	272 15	LEFROY.	1·854	....	14·03
Encampment	46 44	272 17	LOCKE.	1·856	....	14·05
Lake Superior	48 46	272 20	LEFROY.	....	3·213	15·89
Pic Fort	48 38	273 29	LEFROY.	....	2·725	13·84
Pic Fort	48 38	273 29	LEFROY.	1·846	....	13·97
White River	48 33	273 33	LEFROY.	....	2·803	14·12
Otter Island	48 06	273 43	LEFROY.	1·801*	....	13·63
South Manitou Island	45 05	274 22	YOUNGHUSBAND.	1·846	....	13·97
Gargantua	47 37	274 49	LEFROY.	....	3·190	15·26
Michipicoton	47 56	274 55	LEFROY.	1·855	....	14·04
Michipicoton	47 56	274 55	LEFROY.	....	2·870	13·93
Pointe au Crêpe	46 58	275 02	LEFROY.	1·877	....	14·21
Pointe aux Pins	46 29	275 19	LEFROY.	1·862	....	14·09
Machinac	45 52	275 19	LOCKE.	1·864	....	14·10
Sault St. Mary	46 31	275 26	LEFROY.	....	3·026	13·98
Sault St. Mary	46 31	275 26	LOCKE.	1·861	....	14·08
Tessalon Point	46 16	276 29	LEFROY.	1·852	....	14·02
Snake Island	46 10	277 10	LEFROY.	1·833	....	13·87
Fort la Cloche	46 07	277 35	LEFROY.	....	3·108	13·64
Lake Huron	46 00	278 10	LEFROY.	1·840	....	13·93
Pointe au Croix	45 55	278 42	LEFROY.	1·852	....	14·02
Ricolet Falls	45 57	278 59	LEFROY.	1·870	....	14·15
Lake Nipissing	46 13	280 01	LEFROY.	1·836	....	13·90
Lake du Grand Vase	46 18	280 34	LEFROY.	1·846	....	13·97
Little River	46 18	281 17	LEFROY.	1·838	....	13·91
Trou Portage	46 15	281 27	LEFROY.	1·841	....	13·93
Deux Joachim's Point	46 12	281 41	LEFROY.	1·830	....	13·85
Pointe Baptême	46 06	282 34	LEFROY.	1·822	....	13·79
Fort Coulange	45 56	282 56	LEFROY.	1·844	....	13·95
Grand Calumet	45 45	283 20	LEFROY.	1·826	....	13·82
Chat Falls	45 26	283 28	LEFROY.	1·840	....	13·93
Point Aylmer	45 29	284 12	LEFROY.	1·825	....	13·81
Cornwall	45 02	284 13	YOUNGHUSBAND.	1·822	....	13·79
Pointe aux Chênes	45 37	285 05	LEFROY.	1·805	....	13·66
La Combes	45 32	285 51	LEFROY.	1·825	....	13·81

* Apparent local disturbance; these are omitted in the map.

TABLE XLVIII. (Continued.)

Station.	Lat.	Long.	Observer.	Magnetic force.		
				Relative scale. Toronto = 1·836.	In absolute measure.	
					Horizontal.	Total.
	Between the latitudes of 45° and 50° (continued).					
Foxes Point	45° 32′	286° 26′	LEFROY.	1·832	....	13·86
Isle d'Urval	45 24	286 14	LEFROY.	1·806	....	13·67
Montreal*	45 30	286 24	YOUNGHUSBAND.	1·788	....	13·53
St. Helen's	45 30	286 24	LEFROY.	1·823	....	13·79
St. Helen's	45 30	286 24	LEFROY.	....	3·064	13·78
Sorel	46 02	287 00	LEFROY.	1·815	....	13·74
Three Rivers	46 19	287 24	LEFROY.	1·826	....	13·82
Kingsey	45 48	287 41	LEFROY.	1·808	....	13·69
Stanstead	45 02	287 50	LEFROY.	1·799	....	13·61
Quebec	46 49	288 44	LEFROY.	....	3·040†	13·78
Quebec	46 49	288 44	LEFROY.	1·827†	....	13·83
Quebec	46 49	288 44	YOUNGHUSBAND.	1·801‡	....	13·63
	Between the latitudes of 50° and 55°.					
Fort Edmonton	53 31	247 08	LEFROY.	1·809	....	13·69
Fort Edmonton	53 31	247 08	LEFROY.	....	2·942	14·04
Saskatchawan River	54 05	248 16	LEFROY.	....	2·829	13·71
Saskatchawan River	53 50	249 30	LEFROY.	....	2·746	13·84
Fort Pitt	53 34	250 41	LEFROY.	....	2·778	14·15
Saskatchawan River	53 07	251 30	LEFROY.	....	2·847	14·24
Saskatchawan River	52 23	252 56	LEFROY.	....	2·865	14·09
Carlton House	52 51	253 47	LEFROY.	....	2·737	13·74
Saskatchawan River	53 16	255 12	LEFROY.	....	2·615	13·94
Cumberland House	53 57	257 41	LEFROY.	1·866	....	14·12
Cumberland House	53 57	257 41	LEFROY.	....	2·358	14·12
Beaver Lake	54 32	257 50	LEFROY.	1·869	....	14·14
Near the Pas	53 48	258 32	LEFROY.	....	2·386	14·32
Devil's Drum Island	53 19	259 15	LEFROY.	....	2·399	13·82
Cedar Lake	53 12	259 30	LEFROY.	1·871	....	14·16
Cross Lake	53 10	260 28	LEFROY.	1·876	....	14·20
Cross Lake	53 10	260 28	LEFROY.	....	2·352	14·21
Grand Rapid	53 08	260 32	LEFROY.	1·875	....	14·19
Grand Rapid	53 08	260 34	LEFROY.	....	2·343	14·11
Lake Winnipeg	53 31	260 48	LEFROY.	1·862	....	14·09
Norway House	53 59	261 53	LEFROY.	1·873	....	14·18
Norway House	53 59	261 53	LEFROY.	....	2·173	14·18
Old Norway House	53 42	261 59	LEFROY.	1·874	....	14·18
Lake Winnipeg	52 29	262 47	LEFROY.	1·866	....	14·12
Hairy Lake	54 21	262 50	LEFROY.	1·859	....	14·07
Lake Winnipeg	52 23	262 51	LEFROY.	1·879	....	14·22
Lake Winnipeg	52 21	262 51	LEFROY.	....	2·398	14·38
Lake Winnipeg	51 45	263 07	LEFROY.	1·904§	....	14·42
Lake Winnipeg	51 44	263 12	LEFROY.	....	2·763§	15·37
Lake Winnipeg	51 38	263 12	LEFROY.	1·912§	....	14·47
Lake Winnipeg	51 04	263 15	LEFROY.	1·863	....	14·10
Lake Winnipeg	51 34	263 20	LEFROY.	....	2·721	14·40
Lake Winnipeg	50 27	263 22	LEFROY.	1·867	....	14·13

* Garden on the Mountain.

† At the Royal Artillery Barracks, apparent local disturbance; omitted in the map.

‡ Near WOLFE'S Monument.

§ Apparent local disturbance; these are omitted in the map.

TABLE XLVIII. (Continued.)

Station.	Lat.	Long.	Observer.	Magnetic force.		
				Relative scale. Toronto = 1·836.	In absolute measure.	
					Horizontal.	Total.
	Between the latitudes of 50° and 55° (continued).					
White Fall Portage	54° 24′	263° 34′	LEFROY.	1·869	....	14·15
Fort Alexander	50 37	263 39	LEFROY.	1·857	....	14·05
Fort Alexander	50 37	263 39	LEFROY.	....	2·698	14·08
Lake Winnipeg	51 04	263 39	LEFROY.	....	2·640	14·52
Mouth of the Red River.	50 19	263 19	LEFROY.	1·864	....	14·11
Windy Lake	54 37	263 58	LEFROY.	1·870	....	14·15
Slave Portage.....	50 11	264 23	LEFROY.	1·867	....	14·13
Oxford House	54 56	264 30	LEFROY.	1·877	....	14·21
Winnipeg River.....	50 10	264 51	LEFROY.	1·877	....	14·21
	Between the latitudes of 55° and 60°.					
Fort Dunvegan	55 56	241 35	LEFROY.	1·809	....	13·69
Fort Dunvegan	55 56	241 35	LEFROY.	....	2·732	14·03
Fort Vermilion	58 25	243 55	LEFROY.	1·811	....	13·71
Fort Vermilion	58 25	243 55	LEFROY.	....	2·250	14·07
Lesser Slave Lake.....	55 33	244 07	LEFROY.	....	2·731	13·87
Pierre au Calumet.....	57 24	248 25	LEFROY.	1·938*	....	14·66
Pierre au Calumet.....	57 24	248 25	LEFROY.	....	2·172*	14·33
Pointe Brulée	58 07	248 35	LEFROY.	1·852	....	14·02
Pointe Brulée	58 07	248 35	LEFROY.	...	2·067	14·00
Athabasca	58 43	248 42	LEFROY.	1·838	....	13·91
Athabasca	58 43	248 42	LEFROY.	....	2·030	13·94
Clearwater River	56 39	249 11	LEFROY.	1·850	....	14·00
Clearwater River	56 39	249 11	LEFROY.	....	2·262	13·85
Portage de la Loche	56 34	250 23	LEFROY.	1·835	....	13·89
Portage de la Loche	56 34	250 23	LEFROY.	....	2·278	13·95
River de la Loche.....	56 15	250 37	LEFROY.	1·826	....	13·82
River de la Loche.....	56 15	250 37	LEFROY.	....	2·336	13·90
Buffaloe Lake	56 05	251 19	LEFROY.	1·854	....	14·03
Buffaloe Lake	56 05	251 19	LEFROY.	....	2·278	13·97
Isle à la Crosse	55 27	252 06	LEFROY.	1·851	....	14·01
Isle à la Crosse	55 27	252 06	LEFROY.	....	2·394	14·01
Portage Sonnante	55 54	252 34	LEFROY.	1·858	....	14·06
Snake Rapid	55 46	253 30	LEFROY.	1·874	....	14·18
Pine Portage	55 43	254 10	LEFROY.	1·884	....	14·26
Great Devil's Portage ..	55 40	255 11	LEFROY.	1·875	....	14·19
Little Rock Portage	55 34	255 27	LEFROY.	1·995*	....	15·10
Frog Portage	55 28	256 30	LEFROY.	1·857	....	14·06
Portage des Epinettes ..	55 04	257 18	LEFROY.	1·871	....	14·16
Long Portage.....	55 15	265 35	LEFROY.	1·879	....	14·22
Hill River	55 22	266 00	LEFROY.	1·871	....	14·16
White Earth Portage....	55 32	266 10	LEFROY.	1·862	....	14·09
Shamatawa.....	56 21	267 04	LEFROY.	1·861	....	14·08
York Factory.....	57 00	267 34	LEFROY.	1·854	....	14·03
York Factory.....	57 00	267 34	LEFROY.	....	1·523	14·07
	Between the latitudes of 60° and 67°.					
Fort Good Hope	66 16	231 30	LEFROY.	....	1·678	13·64
Fort Norman	64 31	235 16	LEFROY.	....	1·763	13·63
Fort Resolution	61 10	246 15	LEFROY.	....	1·767	13·99
Fort Simpson.....	61 51	238 35	LEFROY.	....	1·957	13·84

* Local disturbance; omitted in the map.

§ 12. *Observations of the Inclination.*

With Mr. Fox's *apparatus.*—The Inclinations obtained with needle F. A. of Mr. Fox's apparatus were observed with the face of the circle successively to the east and to the west; the mean of the arcs read in the two positions and at both ends of the needle is the result entered in the Table. The observations were made either direct, *i. e.* without the employment of deflectors, or with a deflector placed successively at the same angle on either side of the Inclination, and deflecting the needle to the opposite side: half the sum of the arcs read in the two deflected positions is the result in the Table. The poles of the needle F. A. were at no time reversed. When received in England from the maker in the spring of 1842, the mean of the two arcs with the face east and face west were found to give the true Inclination without sensible index error. At Sorel, in September of the same year, the Inclination obtained with needle F. C. of the same apparatus, of which the poles were on that occasion reversed, was found to agree with that shown by needle F. A. within the usual limits of observation error; and at Toronto in October 1842, the Inclination observed with needle F. A. agreed within the same limits with that observed with GAMBEY's needles of which the poles were reversed. This needle is therefore considered to have had no index error.

With GAMBEY's *Inclinometer.*—This instrument is the property of Captain ROBERT FITZROY of the Royal Navy, by whom it has been kindly lent for general magnetic service. It is the same instrument which was employed by that officer in his voyage of circumnavigation, and was afterwards used by myself in the magnetic survey of the British Islands. It has since travelled with Lieut. LEFROY over the continent of America to the Arctic Circle and back, having been used at more than 100 stations during that journey; and it should be recorded, to the credit of the excellent artist by whom it was made, that it is still in use apparently quite unimpaired.

The observations made with the needles of this instrument in different azimuths, and recorded in the Memoir of the Magnetic Survey of the British Islands*, have shown that the curvature of the axles is without sensible fault, and consequently that there is no index error, whatever may be the Inclination.

The Inclination with GAMBEY's circle and needles entered in the Tables are the mean of the arcs in the sixteen positions of the circle and needle; viz. eight positions with the poles direct, and the same number with the poles reversed.

* Report of the British Association, 1838, pages 59 and 60.

TABLE XLIX.

Inclinations observed with the Needles of Fox's Apparatus in Canada and the United States in 1842. Needle F. A. was always employed except when otherwise noticed.

Station.	1842.	Direct or with deflectors.	Inclination.		Station.	1842.	Direct or with deflectors.	Inclination.	
			° ′	° ′				° ′	° ′
Quebec[a]	Sept. 1.	Direct.	77 23·0		Cambridge[n]	Oct. 3.	Direct.	74 23·1	
Quebec[a]	1.	Def. N. at 40°	77 08·5	77 15·3	Cambridge[n]	3.	Def. S. at 40°	74 16·7	74 19·5
Quebec[a]	1.	Def. N. at 50°	77 14·3		Cambridge[n]	3.	Def. S. at 50°	74 18·7	
Three Rivers[b]	6.	Direct.	77 13·2		Philadelphia[o]	6.	Direct.	72 00·9	
Three Rivers[b]	6.	Def. N. at 40°	77 09·9	77 10·7	Philadelphia[o]	6.	Def. N. at 40°	71 58·1	71 59·0
Three Rivers[b]	6.	Def. N. at 50°	77 09·0		Philadelphia[o]	6.	Def. N. at 50°	71 58·0	
Sorel[c]	8.	Direct.	77 22·6		Baltimore[p]	8.	Direct.	71 34·0	
Sorel[c]	8.	Def. S. at 40°	77 14·3	77 17·7	Baltimore[p]	8.	Def. N. at 40°	71 35·4	71 36·0
Sorel[c]	8.	Def. S. at 50°	77 16·1		Baltimore[p]	8.	Def. N. at 50°	71 38·5	
Sorel[d]	8.	Direct.	77 13·9		Baltimore[q]	8.	Direct.	71 47·5	
Sorel[d]	8.	Def. S. at 40°	77 18·0	77 16·8	Baltimore[q]	8.	Def. S. at 40°	71 46·7	71 47·5
Sorel[d]	8.	Def. S. at 50°	77 17·4		Baltimore[q]	8.	Def. S. at 50°	71 49·2	
Sorel[e]	8.	Direct.	77 21·6		Baltimore[r]	8.	Direct.	71 41·1	
Sorel[e]	8.	Def. S. at 40°	77 23·3	77 16·3	Baltimore[r]	8.	Def. N. at 40°	71 40·4	71 40·7
Sorel[e]	8.	Def. S. at 50°	77 04·1		Washington[s]	10.	Direct.	71 13·7	
Kingsey[f]	10.	Direct.	77 46·0		Washington[s]	10.	Def. N. at 40°	71 13·8	71 13·8
Kingsey[f]	10.	Def. N. at 40°	77 39·3	77 40·0	Washington[s]	10.	Def. N. at 50°	71 13·9	
Kingsey[f]	10.	Def. N. at 50°	77 34·4		Princeton[t]	14.	Direct.	72 46·4	
Stanstead[g]	12.	Direct.	76 27·9		Princeton[t]	14.	Def. N. at 40°	72 40·0	72 43·5
Stanstead[g]	12.	Def. N. at 40°	76 14·0	76 19·5	Princeton[t]	14.	Def. N. at 50°	72 44·0	
Stanstead[g]	12.	Def. N. at 50°	76 16·7		Newhaven[u]	18.	Direct.	73 31·4	
St. John's[h]	14.	Direct.	77 09·1		Newhaven[u]	18.	Def. N. at 40°	73 24·7	73 27·4
St. John's[h]	14.	Def. N. at 40°	76 56·0	77 00·1	Newhaven[u]	18.	Def. N. at 50°	73 26·2	
St. John's[h]	14.	Def. N. at 50°	76 55·1		West Point[v]	19.	Direct.	73 33·3	
St. Helen's[i] (Montreal).	16.	Direct.	77 20·4		West Point[v]	19.	Def. N. at 40°	73 30·1	73 30·4
St. Helen's[i] (Montreal).	16.	Def. N. at 40°	77 08·1	77 13·1	West Point[v]	19.	Def. N. at 50°	73 27·6	
St. Helen's[i] (Montreal).	16.	Def. N. at 50°	77 10·7		Albany[w]	21.	Direct.	74 51·0	
New York[k]	26.	Direct.	72 40·1		Albany[w]	21.	Def. N. at 40°	74 38·7	74 44·6
New York[k]	26.	Def. N. at 40°	72 35·5	72 39·5	Albany[w]	21.	Def. N. at 50°	74 44·2	
New York[k]	26.	Def. N. at 50°	72 44·5		Toronto[x]	26.	Direct.	75 19·2	
Providence[l]	28.	Direct.	74 02·3		Toronto[x]	26.	Def. S. at 40°	75 14·9	75 16·3
Providence[l]	28.	Def. S. at 40°	73 59·3	73 59·9	Toronto[x]	26.	Def. S. at 50°	75 14·8	
Providence[l]	28.	Def. S. at 50°	73 58·1						
Dorchester[m]	Oct. 1.	Direct.	74 18·6						
Dorchester[m]	1.	Def. N. at 40°	74 05·0	74 12·8					
Dorchester[m]	1.	Def. N. at 50°	74 14·9						

Observations made with the same Instrument by Lieut. YOUNGHUSBAND, R.A.

Station.	1842.	Direct or with deflectors.	Inclination.		Station.	1842.	Direct or with deflectors.	Inclination.	
			° ′	° ′				° ′	° ′
Toronto[x]	Oct. 29.	Direct.	75 17·9		Chicago[a']	Nov. 15.	Direct.	72 37·6	
Toronto[x]	29.	Def. N. at 40°	75 19·3	75 17·1	Chicago[a']	15.	Def. N. at 40°	72 38·8	72 39·3
Toronto[x]	29.	Def. N. at 50°	75 14·0		Chicago[a']	15.	Def. N. at 50°	72 41·6	
Cleveland[y]	Nov. 3.		73 03·8	73 03·8	Toronto	Dec. 30.	Direct.	75 16·0	
Detroit[y]	4.		73 28·7	73 28·7	Toronto	30.	Def. N. at 40°	75 15·9	75 16·6
South Manitou Island[z]	7.	Direct.	75 55·8		Toronto	30.	Def. N. at 50°	75 17·8	
South Manitou Island[z]	7.	Def. N. at 40°	75 56·5	75 56·6					
South Manitou Island[z]	7.	Def. N. at 50°	75 57·8						

[a] In front of the Artillery Barracks.
[b] Mr. BELL's garden.
[c] East of the Roman Catholic Church.
[d] Needle C., poles direct α.
[e] Needle C., poles reversed β.
[f] Captain Cox's garden.
[g] Hotel garden.
[h] A quarter of a mile above the bridge.
[i] 100 yards S.S.W. of barracks.
[k] Lunatic Asylum, Manhattanville.
[l] At the Steam-boat landing.
[m] Near Grove Hall.
[n] Garden of Observatory.
[o] Magnetic Observatory.
[p] 400 yards N. 42° E. from Washington's Monument.
[q] 600 yards north of Monument.
[r] St. Mary's College.
[s] In the grounds of the Capitol, west front.
[t] 200 yards east of the College.
[u] Near the Cemetery.
[v] Professor BARTLETT's garden.
[w] N. 39° W. from north tower of the North Dutch Church.
[x] Magnetic Observatory. Inclination observed on the same day with GAMBEY's needles, poles direct and reversed, 75° 17′·6.
[y] By the angles of deflection with weights.
[z] Inland from the wharf.
[a'] Dr. ELDRIDGE's inclosure.

TABLE L.—Observations of the Inclination made with Captain FITZROY's Gambey in 1842, 1843, 1844 and 1845. A large portion of the observations in the countries north of Canada were made by Bombardier HENRY.

Station.	Date.	Needle.	Poles. α Direct. β Reversed.	Inclination.		Station.	Date.	Needle.	Poles. α Direct. β Reversed.	Inclination.	
	1842.			° ′			1843.			° ′	
Kingston	Nov. 11.	1	α 77 17·1	77 18·8		Terreplatte	May 27.	1	α 78 52·3	78 53·6	
Kingston	11.	1	β 77 20·5			Terreplatte	27.	1	β 78 54·8		
Kingston	14.	2	α 77 14·7	77 19·1	77 18·7	Pointe Tonnerre	28.	1	α 78 19·8	78 23·2	
Kingston	14.	2	β 77 23·6			Pointe Tonnerre	28.	1	β 78 26·7		
	1843.					Fort William	29.	1	α 78 09·4	78 09·7	78 10·0
Kingston	April 18.	1	α 77 18·0	77 18·1		Fort William	29.	1	β 78 10·0		
Kingston	18.	1	β 77 18·2			Fort William	29.	2	α 78 06·8	78 10·4	
	1842.					Fort William	29.	2	β 78 14·0		
Toronto	Dec. .	1	α	75 14·0	75 14·0	Portage Ecarté	June 2.	1	α 77 13·2	77 13·5	
Toronto	.	1	β			Portage Ecarté	2.	1	β 77 13·7		
Hamilton	29.	1	α 74 54·7	74 55·3	74 56·7	Chien Portage	3.	1	α β 78 26·8	78 26·8	
Hamilton	29.	1	β 74 56·0			Prairie Portage	5.	1	α 78 26·2	78 26·2	
Hamilton	29.	2	α 74 52·5	74 58·1		Prairie Portage	5.	1	β 78 26·2		
Hamilton	29.	2	β 75 03·6			Savannah Portage	7.	1	α 78 19·3	78 21·8	
	1843.					Savannah Portage	7.	1	β 78 24·3		
Williamsburg	April 20.	1	α 76 30·8	76 31·2	76 30·1	French Portage	8.	1	α 78 19·0	78 20·4	
Williamsburg	20.	1	β 76 31·7			French Portage	8.	1	β 78 21·8		
Williamsburg	20.	1	α 76 26·8	76 29·0		Portage des deux Rivières	9.	1	α 77 49·3	77 49·4	
Williamsburg	20.	1	β 76 31·2			Portage des deux Rivières	9.	1	β 77 49·5		
St. Helen's	25.	1	α 76 59·2	77 02·1	77 05·3	Lac à la Crosse	10.	1	α 77 50·6	77 51·0	
St. Helen's	25.	1	β 77 05·1			Lac à la Crosse	10.	1	β 77 51·5		
St. Helen's	29.	2	α 77 03·6	77 08·6		2nd Portage from do.	11.	1	α 77 39·8	77 40·1	
St. Helen's	29.	2	β 77 13·7			2nd Portage from do.	11.	1	β 77 40·4		
Isle d'Urval*	30.	1	α	77 21·1	77 21·1	Sturgeon Lake	12.	1	α 77 44·4	77 44·8	
Isle d'Urval	30.	1	β 77 21·1			Sturgeon Lake	12.	1	β 77 45·3		
La Combes*	May 2.	1	α	76 50·6	76 50·6	Lac la Pluie	13.	1	α 77 46·5	77 47·9	
La Combes	2.	1	β 76 50·6			Lac la Pluie	13.	1	β 77 49·3		
Pointe aux Chênes*	3.	1	α	76 55·4	76 55·4	Fort Francis	14.	1	α 77 26·9	77 27·5	
Pointe aux Chênes	3.	1	β 76 55·4			Fort Francis	14.	1	β 77 28·1		
Foxes Point*	4.	1	α	76 35·3	76 35·3	Rainy River	16.	1	α 77 57·3	77 57·4	
Foxes Point	4.	1	β 76 35·3			Rainy River	16.	1	β 77 57·5		
Point Aylmer	5.	1	α 76 37·2	76 41·0		Lake of the Woods	17.	1	α 78 02·2	78 03·7	
Point Aylmer	5.	1	β 76 44·9			Lake of the Woods	17.	1	β 78 05·2		
Chat Falls	6.	1	α 75 11·6	75 16·1		Lake of the Woods	18.	1	α 78 15·8	78 16·7	
Chat Falls	6.	1	β 75 20·6			Lake of the Woods	18.	1	β 78 17·6		
Grand Calumet	7.	1	α 76 42·4	76 44·4		Rat Portage	20.	1	α 78 07·0	78 07·5	
Grand Calumet	7.	1	β 76 46·4			Rat Portage	20.	1	β 78 08·0		
Fort Coulonge	8.	1	α 77 28·8	77 29·7		Upper Fort Garry	July 3.	1	α 78 17·0	78 19·4	78 17·8
Fort Coulonge	8.	1	β 77 30·6			Upper Fort Garry	3.	1	β 78 21·3		
Pointe Baptême	9.	1	α 77 18·9	77 26·6		Upper Fort Garry	3.	2	α 78 11·4	78 16·3	
Pointe Baptême	9.	1	β 77 34·3			Upper Fort Garry	3.	2	β 78 21·2		
2 Joachim's Portage	10.	1	α 77 03·8	77 03·8		Mouth of the Red River	4.	1	α β 78 32·6	78 32·6	
2 Joachim's Portage	10.	1	β 77 03·9			Lake Winnipeg	5.	1	α 79 09·9	79 11·8	
Trou Portage	11.	1	α 77 24·0	77 24·4		Lake Winnipeg	5.	1	β 79 13·8		
Trou Portage	11.	1	β 77 24·9			Lake Winnipeg	6.	1	α 79 37·9	79 38·0	
Little River	12.	1	α 77 26·7	77 28·5		Lake Winnipeg	6.	1	β 79 38·0		
Little River	12.	1	β 77 30·4			Lake Winnipeg	7.	1	α 79 27·1	79 28·3	
Lac du Grand Vase	13.	1	α 77 21·5	77 21·7		Lake Winnipeg	7.	1	β 79 29·6		
Lac du Grand Vase	13.	1	β 77 22·0			Lake Winnipeg	8.	1	α 80 38·6	80 39·2	
Lake Nipissing	14.	1	α 77 06·2	77 09·5		Lake Winnipeg	8.	1	β 80 39·8		
Lake Nipissing	14.	1	β 77 12·8			Lake Winnipeg	10.	1	α 80 01·9	80 03·7	80 05·4
Ricolet Falls	15.	1	α 76 43·6	76 45·4		Lake Winnipeg	10.	1	β 80 05·6		
Ricolet Falls	15.	1	β 76 47·3			Lake Winnipeg	10.	2	α 80 00·8	80 07·2	
Pointe au Croix	16.	1	α 76 30·2	76 31·3		Lake Winnipeg	10.	2	β 80 13·7		
Pointe au Croix	16.	1	β 76 32·5			Norway House	12.	1	α 81 10·5	81 11·0	81 08·8
Lake Huron	17.	1	α 77 05·6	77 05·6		Norway House	12.	1	β 81 11·6		
Lake Huron	17.	1	β 77 05·7			Norway House	13.	1	α 81 05·8	81 06·2	
Snake Island	18.	1	α 77 04·7	77 05·5		Norway House	13.	1	β 81 06·6		
Snake Island	18.	1	β 77 06·2			Norway House	Aug. 9.	1	α 81 08·9	81 09·4	
Tessalon Point	19.	1	α 76 59·2	76 59·3		Norway House	9.	1	β 81 09·8		
Tessalon Point	19.	1	β 76 59·4			Long Portage (Jack River)	19.	1	α 82 13·2	82 13·9	
Pointe au Pins	20.	1	α 77 12·0	77 13·4		Long Portage (Jack River)	19.	1	β 82 14·6		
Pointe au Pins	20.	1	β 77 14·8			White Earth Portage	21.	1	α 83 02·1	83 02·9	
Pointe au Crêpe	21.	1	α 77 10·3	77 11·5		White Earth Portage	21.	1	β 83 03·6		
Pointe au Crêpe	21.	1	β 77 12·6								
Fort Michipicoton	23.	1	α 78 04·6	78 06·3							
Fort Michipicoton	23.	1	β 78 08·0								
Otter Island	24.	1	α 79 43·6	79 43·6							
Otter Island	24.	1	β 79 43·6								
Pic Fort	25.	1	α 78 45·5	78 45·8							
Pic Fort	25.	1	β 78 46·2								

* The poles were not reversed at these four stations.

TABLE L. (Continued.)

Station.	Date.	Needle.	Poles. α Direct. β Reversed.	Inclination.			Station.	Date.	Needle.	Poles. α Direct. β Reversed.	Inclination.		
	1843.		° ′	° ′				1844.		° ′	° ′		
Shamatawa	Aug. 22.	1	α 83 35·6	83 36·2			Athabasca	Feb.		α	81 35·4	81 37·0	
Shamatawa	22.	1	β 83 36·7				Athabasca			β			
York Factory	24.	1	α 83 50·1	83 50·5	83 47·2		Near Big Island	Mar. 18.	1	α 82 02·5	82 08·7		
York Factory	24.	1	β 83 50·9				Near Big Island	18.	1	β 82 14·9			
York Factory	24.	2	α 83 40·3	83 44·0			Fort Simpson	28.	1	α 81 52·9	81 54·0	81 52·3	
York Factory	24.	2	β 83 47·6				Fort Simpson	28.	1	β 81 55·2			
Hill River	1.	1	α 82 54·5	82 55·0			Fort Simpson	May 10.	2	α 81 47·7	81 50·7		
Hill River	1.	1	β 82 55·4				Fort Simpson	10.	2	β 81 53·8			
Oxford House	3.	1	α 82 37·7	82 38·8			Fort Norman	28.	1	α 82 32·2	82 34·3		
Oxford House	3.	1	β 82 39·8				Fort Norman	28.	1	β 82 36·5			
Windy Lake	4.	1	α 81 56·8	81 57·0			Fort Good Hope	29.	1	α 82 54·7	82 55·8	82 55·9	
Windy Lake	4.	1	β 81 57·2				Fort Good Hope	29.	1	β 82 57·0			
White Fall Portage	5.	1	α 81 46·6	81 47·9			Fort Good Hope	29.	2	α 82 52·3	82 56·1		
White Fall Portage	5.	1	β 81 49·2				Fort Good Hope	29.	2	β 82 59·9			
Hairy Lake	6.	1	α 81 20·4	81 20·9			Fort Resolution	June 22.	1	α 82 41·8	82 43·5	82 44·4	
Hairy Lake	6.	1	β 81 21·3				Fort Resolution	22.	1	β 82 45·2			
Old Norway House	12.	1	α 80 43·8	80 45·4			Fort Resolution	22.	2	α 82 39·4	82 45·4		
Old Norway House	12.	1	β 80 47·0				Fort Resolution	22.	2	β 82 51·5			
Lake Winnipeg	14.	1	α 80 16·7	80 16·8			Portage Gr. Detour	25.	1	α 82 31·6	82 33·6		
Lake Winnipeg	14.	1	β 80 16·9				Portage Gr. Detour	25.	1	β 82 35·6			
Grand Rapid	15.	1	α 80 19·5	80 21·5			Pelican Portage	27.	1	α 82 24·4	82 26·8		
Grand Rapid	15.	1	β 80 23·5				Pelican Portage	27.	1	β 82 29·2			
Cross Lake	16.	1	α 80 27·1	80 28·2			Point Providence	July 5.	1	α 81 42·9	81 46·1		
Cross Lake	16.	1	β 80 29·4				Point Providence	5.	1	β 81 49·3			
Cedar Lake	18.	1	α 80 06·5	80 07·1			Peace River	7.	1	α 81 34·2	81 36·9		
Cedar Lake	18.	1	β 80 07·7				Peace River	7.	1	β 81 39·6			
Cumberland House	24.	1	α 80 28·4	80 28·7	80 30·2		Poplar Island	9.	1	α 81 04·5	81 04·8		
Cumberland House	24.	1	β 80 29·1				Poplar Island	9.	1	β 81 05·2			
Cumberland House	24.	2	α 80 31·1	80 31·8			Falls of Peace River	10.	1	α 80 50·5	80 50·8		
Cumberland House	24.	2	β 80 32·4				Falls of Peace River	10.	1	β 80 51·2			
Beaver Lake	26.	1	α 80 33·3	80 34·2			Fort Vermilion	11.	1	α 80 46·9	80 48·4	80 48·0	
Beaver Lake	26.	1	β 80 35·2				Fort Vermilion	11.	1	β 80 50·0			
Carp Portage	27.	1	α 80 39·0	80 39·6			Fort Vermilion	11.	2	α 80 44·7	80 47·6		
Carp Portage	27.	1	β 80 40·1				Fort Vermilion	11.	2	β 80 50·6			
Portage des Epinettes	28.	1	α 80 52·1	80 52·6			Peace River	17.	1	α 79 26·4	79 27·0		
Portage des Epinettes	28.	1	β 80 53·2				Peace River	17.	1	β 79 27·7			
Frog Portage	29.	1	α 80 57·0	80 59·3			Peace River	15.	1	α 79 59·2	80 00·7		
Frog Portage	29.	1	β 81 01·6				Peace River	15.	1	β 80 02·3			
Little Rock Portage	31.	1	α 80 15·0	80 16·5			Peace River, opp. River Cadotte	19.	1	α 79 20·1	79 20·7		
Little Rock Portage	31.	1	β 80 17·9				Peace River, opp. River Cadotte	19.	1	β 79 21·4			
Great Devil's Portage	Sept. 1.	1	α 80 29·8	80 30·9			Fort Dunvegan	22.	1	α 78 43·8	78 45·7	78 46·2	
Great Devil's Portage	1.	1	β 80 31·9				Fort Dunvegan	22.	1	β 78 47·6			
Pine Portage	3.	1	α 80 40·0	80 40·3			Fort Dunvegan	22.	2	α 78 45·8	78 46·8		
Pine Portage	3.	1	β 80 40·6				Fort Dunvegan	22.	2	β 78 47·8			
Snake Rapid	4.	1	α 80 38·4	80 38·7			Lesser Slave Lake F.	Aug. 3.	1	α 78 34·5	78 36·2	78 39·0	
Snake Rapid	4.	1	β 80 39·1				Lesser Slave Lake F.	3.	1	β 78 37·9			
Portage Sonnante	7.	1	α 80 09·7	80 11·2			Lesser Slave Lake F.	3.	2	α 78 39·3	78 41·9		
Portage Sonnante	7.	1	β 80 12·7				Lesser Slave Lake F.	3.	2	β 78 44·5			
Isle à la Crosse	9.	1	α 80 08·1	80 09·1	80 09·8		Point Dejala, Lesser Slave L.	6.	1	α 78 28·7	78 29·9		
Isle à la Crosse	9.	1	β 80 10·1				Point Dejala, Lesser Slave L.	6.	1	β 78 31·1			
Isle à la Crosse	9.	2	α 80 08·5	80 10·5			Forks of Athabasca and Slave River	7.	1	α 78 53·3	78 55·2		
Isle à la Crosse	9.	2	β 80 12·5				Forks of Athabasca and Slave River	7.	1	β 78 57·1			
Buffaloe Lake	13.	1	α 80 36·7	80 37·0			Athabasca River	9.	1	α 78 33·7	78 34·1		
Buffaloe Lake	13.	1	β 80 37·2				Athabasca River	9.	1	β 78 34·6			
River de la Loche	14.	1	α 80 18·7	80 19·7			Fort Assiniboine	12.	1	α 78 15·6	78 16·9	78 15·2	
River de la Loche	14.	1	β 80 20·6				Fort Assiniboine	12.	1	β 78 18·3			
Portage de la Loche, S. end	16.	1	α 80 35·9	80 36·4			Fort Assiniboine	12.	2	α 78 13·2	78 13·5		
Portage de la Loche, S. end	16.	1	β 80 36·8				Fort Assiniboine	12.	2	β 78 13·8			
Portage de la Loche, N. end	17.	1	α 80 36·7	80 38·0			Pembina River	14.	1	α 77 53·8	77 54·0		
Portage de la Loche, N. end	17.	1	β 80 40·0				Pembina River	14.	1	β 77 54·3			
Clearwater River	19.	1	α 80 35·8	80 36·2			Fort Edmonton	17.	1	α 77 52·2	77 53·4	77 54·2	
Clearwater River	19.	1	β 80 36·6				Fort Edmonton	17.	1	β 77 54·7			
Pierre au Calumet	20.	1	α 81 16·1	81 16·8			Fort Edmonton	17.	2	α 77 54·4	77 55·1		
Pierre au Calumet	20.	1	β 81 17·5				Fort Edmonton	17.	2	β 77 55·8			
Pointe Brulée	21.	1	α 81 30·2	81 30·6			Saskatchawan River	20.	1	α 78 04·8	78 05·2		
Pointe Brulée	21.	1	β 81 31·1				Saskatchawan River	20.	1	β 78 05·7			
Athabasca	30.	1	α 81 36·9	81 37·7	81 37·0		Saskatchawan River	21.	1	α 78 33·3	78 33·5		
Athabasca	30.	1	β 81 38·4				Saskatchawan River	21.	1	β 78 33·7			
Athabasca	30.	2	α 81 37·1	81 37·6									
Athabasca	30.	2	β 81 37·9										

TABLE L. (Continued.)

Station.	Date.	Needle.	Poles. α Direct. β Reversed.	Inclination.		Station.	Date.	Needle.	Poles. α Direct. β Reversed.	Inclination.	
	1844.		° ′	° ′			1844.		° ′	° ′	
Fort Pitt.....	Aug. 22.	1	α 78 42·2	78 43·0	78 41·0	Fort Michipicoton ..	Oct. 30.	1	α 78 07·8	78 08·1	78 08·2
Fort Pitt.....	22.	1	β 78 43·8			Fort Michipicoton ..	30.	1	β 78 08·4		
Fort Pitt.....	22.	2	α 78 38·9	78 39·1		Fort Michipicoton ..	30.	2	α 78 08·4	78 08·3	
Fort Pitt.....	22.	2	β 78 40·4			Fort Michipicoton ..	30.	2	β 78 08·5		
Saskatchawan River	23.	1	α 78 28·1	78 28·1		Gargantua	31.	1	α 77 56·1	77 56·1	
Saskatchawan River	23.	1	β 78 28·1			Gargantua	31.	1	β 77 56·1		
Saskatchawan River	24.	1	α 78 16·1	78 16·6		Fort la Cloche	8.	1	α 76 50·7	76 50·7	76 50·2
Saskatchawan River	24.	1	β 78 17·1			Fort la Cloche	8.	1	β 76 50·8		
Carlton House	26.	1	α 78 30·1	78 30·2	78 30·7	Fort la Cloche	8.	2	α 76 49·2	76 49·7	
Carlton House	26.	1	β 78 30·3			Fort la Cloche	8.	2	β 76 50·3		
Carlton House	26.	2	α 78 30·5	78 31·2		Penetanguishene ..	14.	1	α 76 18·9	76 19·2	76 20·1
Carlton House	26.	2	β 78 31·9			Penetanguishene ..	14.	1	β 76 19·5		
Saskatchawan River[a]	27.	1	α 79 11·2	79 11·2		Penetanguishene ..	14.	2	α 76 21·0	76 21·0	
Saskatchawan River[a]	27.	1	β 79 11·2			Penetanguishene ..	14.	2	β 76 21·1		
Cumberland House .	29.	1	α 80 19·6	80 20·5	80 19·7		1845.				
Cumberland House .	29.	1	β 80 21·5			Kingston*[b]	June 10.	1	α 77 11·1	77 14·2	77 14·4
Cumberland House .	29.	2	α 80 18·1	80 19·0		Kingston*[b]	10.	1	β 77 17·3		
Cumberland House .	29.	2	β 80 19·9			Kingston*[b]	10.	2	α 77 09·9	77 14·7	
Above the Pas	31.	1	α 80 24·4	80 24·4		Kingston*[b]	10.	2	β 77 19·5		
Above the Pas	31.	1	β 80 24·4			Brockville*[c]	13.	1	α 76 17·7	76 19·8	76 18·9
Devil's Drum Island	Sept. 1.	1	α 79 59·2	80 00·0		Brockville*[c]	13.	1	β 76 21·9		
Devil's Drum Island	1.	1	β 80 00·8			Brockville*[c]	13.	2	α 76 12·7	76 18·0	
Grand Rapid	2.	1	α 80 30·6	80 31·6		Brockville*[c]	13.	2	β 76 23·4		
Grand Rapid	2.	1	β 80 32·7			Cornwall*[d].....	16.	1	α 76 14·7	76 16·5	76 16·4
Norway House	7.	1	α 81 10·5	81 11·1	81 11·2	Cornwall*[d].....	16.	1	β 76 18·3		
Norway House	7.	1	β 81 11·7			Cornwall*[d].....	16.	2	α 76 10·2	76 16·3	
Norway House	7.	2	α 81 10·8	81 11·4		Cornwall*[d].....	16.	2	β 76 22·4		
Norway House	7.	2	β 81 12·0			Montreal*[e].....	18.	1	α 77 03·0	77 06·7	77 08·6
Lake Winnipeg	14.	1	α 80 24·4	80 24·4		Montreal*[e].....	18.	1	β 77 10·5		
Lake Winnipeg	14.	1	β 80 24·4			Montreal*[e].....	20.	2	α 77 05·9	77 10·3	
Lake Winnipeg	16.	1	α 79 38·9	79 39·0		Montreal*[e].....	20.	2	β 77 14·7		
Lake Winnipeg	16.	1	β 79 39·1			Montreal*[e].....	20.	1	α 77 03·7	77 08·9	
Lake Winnipeg	17.	1	α 79 05·9	79 06·1		Montreal*[e].....	20.	1	β 77 14·1		
Lake Winnipeg	17.	1	β 79 06·4			Quebec*[f]	23.	1	α 77 04·7	77 08·8	
Lake Winnipeg	18.	1	α 79 31·2	79 31·5		Quebec*[f]	23.	1	β 77 12·9		
Lake Winnipeg	18.	1	β 79 31·8			Niagara[g].....	Oct. 18.	1	α 74 46·3	74 46·8	
Fort Alexander	19.	1	α 79 03·2	79 03·4	79 02·9	Niagara[g].....	18.	1	β 74 47·3		
Fort Alexander	19.	1	β 79 03·7			Buffaloe[h]	20.	1	α 74 35·6	74 37·8	74 37·0
Fort Alexander	19.	2	α 79 02·5	79 02·5		Buffaloe[h]	20.	1	β 74 42·2		
Fort Alexander	19.	2	β 79 02·5			Buffaloe[h]	20.	2	α 74 31·8	74 36·2	
Fort Francis	30.	1	α 77 38·2	77 41·4	77 42·9	Buffaloe[h]	20.	2	β 74 40·6		
Fort Francis	30.	1	β 77 44·7			Amherstburg[i].....	22.	1	α 73 26·1	73 32·7	73 29·9
Fort Francis	30.	2	α 77 44·0	77 44·5		Amherstburg[i].....	22.	1	β 73 39·2		
Fort Francis	30.	2	β 77 45·1			Amherstburg[i].....	22.	2	α 73 21·5	73 27·2	
Fort William	Oct. 1	1	α 78 07·2	78 07·5	77 59·5	Amherstburg[i].....	22.	2	β 73 32·9		
Fort William	1	1	β 78 07·9			Detroit[k].....	23.	1	α 73 34·5	73 40·6	73 38·8
Fort William	1	2	α 77 55·2	77 55·5		Detroit[k].....	23.	1	β 73 46·8		
Fort William	1	2	β 77 55·8			Detroit[k].....	23.	2	α 73 31·5	73 37·0	
Fort William	1*	1	α 77 54·9	77 55·5		Detroit[k].....	23.	2	β 73 42·5		
Fort William	1	1	β 77 56·1			Port Sarnia[l]	25.	1	α 74 14·7	74 18·6	74 15·7
S. shore Lake Superior	14.	1	α 78 23·2	78 24·0		Port Sarnia[l]	25.	1	β 74 22·6		
S. shore Lake Superior	14.	1	β 78 24·8			Port Sarnia[l]	26.	2	α 74 07·8	74 12·9	
Pic Fort	17.	1	α 78 32·0	78 32·8	78 31·4	Port Sarnia[l]	26.	2	β 74 18·0		
Pic Fort	17.	1	β 78 33·6			Goderich[m]	28.	1	α 75 03·9	75 04·4	75 04·8
Pic Fort	17.	2	α 78 29·9	78 30·1		Goderich[m]	28.	1	β 75 05·0		
Pic Fort	17.	2	β 78 30·4			Goderich[m]	28.	2	α 75 03·4	75 05·3	
White River	21.	1	α 78 33·4	78 33·7	78 33·1	Goderich[m]	28.	2	β 75 07·3		
White River	21.	1	β 78 34·1			Hamilton	31.	1	α 74 51·9	74 54·1	
White River	21.	2	α 78 31·2	78 32·5		Hamilton	31.	1	β 74 56·3		
White River	21.	2	β 78 33·8								

[a] Below the forks of the north and south branches.

* The observation with Needle No. 1 was repeated in consequence of the difference between the results with Nos. 1 and 2.

* Observed by Lieut. YOUNGHUSBAND, R.A.

[b] Royal Artillery Barracks.

[c] Garden at Rockfort.

[d] Orchard behind Chesleys.

[e] Garden on the Mountain.

[f] Near WOLFE'S Monument.

[g] Near the Clifton Hotel.

[h] Behind the High School.

[i] Garden of the Hon. J. GORDON.

[k] North-west corner of Lafayette and Orleans Straits.

[l] Garden near the Ferry.

[m] Garden at the foot of the hill.

TABLE LI. General Table of the Observations of the Magnetic Inclination.

Station.	Lat.	Long.	Year.	Observer.	Inclination.	
	Between 68° 30′ and 69° 30′.					
	° ′	° ′			° ′	° ′
Princeton	38 23	272 30	1840.	LOCKE.	69 22·8	
Mount Vernon	37 59	272 13	1840.	LOCKE.	68 56·3	
New Harmony	38 11	272 12	1840.	LOCKE.	69 03·6	
St. Louis	38 38	269 56	1839.	LOCKE.	69 31·4	69 27·9
St. Louis	38 38	269 56	1841.	LOOMIS.	69 25·5	
St. Louis	38 38	269 56	1841.	NICOLLET.	69 26·9	
	69° 30′ to 70° 30′.					
Lexington	38 06	275 42	1840.	LOCKE.	69 54·5	
Clay's Ferry	37 54	275 42	1840.	LOCKE.	69 49·0	
Cincinnati	39 06	275 38	1838 to 1844.	LOCKE.	70 26·5	70 27·1
Cincinnati	39 06	275 38	1841.	LOOMIS.	70 27·7	
Williamstown	38 36	275 38	1840.	LOCKE.	70 04·1	
Frankfort	38 14	275 20	1840.	LOCKE.	69 54·9	
Louisville	38 03	274 30	1840.	LOCKE.	69 54·4	
Paoli	38 05	273 35	1840.	LOCKE.	69 33·8	
Vincennes	38 43	272 35	1840.	LOCKE.	69 51·0	69 51·9
Vincennes	38 43	272 31	1841.	LOOMIS.	69 52·8	
Edwardsville	38 50	270 07	1841.	LOOMIS.	69 57·7	
Bunker's Hill	39 04	270 07	1841.	LOOMIS.	69 49·1	
Upper Alton	38 55	269 57	1841.	LOOMIS.	69 45·7	
Alton	38 54	269 56	1841.	LOOMIS.	69 34·8	
Monticello	38 57	269 55	1841.	LOOMIS.	69 38·9	
	70° 30′ to 71° 30′.					
Washington[a]	38 53	282 59	1839.	LOOMIS.	71 21·4	
Washington[a]	38 53	282 59	1841.	GRAHAM.	71 15·9	
Washington[a]	38 53	282 59	1844.	GRAHAM.	71 10·5	71 15·0
Washington[a]	38 53	282 59	1841.	NICOLLET.	71 14·8	
Washington[a]	38 53	282 59	1842.	LEFROY.	71 13·8	
Washington[a]	38 53	282 59	1844.	LOCKE.	71 13·4	
Washington[b]	38 53	282 59	1844.	LOCKE.	71 39·3	
Washington[c]	38 53	282 59	1844.	LOCKE.	71 34·8	
Washington[d]	38 53	282 59	1844.	LOCKE.	71 14·9	
Washington[e]	38 53	282 59	1844.	LOCKE.	71 20·5	
Georgetown	38 53	282 57	1844.	LOCKE.	71 19·0	
Mount Vernon	38 41	282 53	1844.	LOCKE.	70 55·5	
Marietta Island	39 25	278 32	1845.	LOCKE.	71 22·3	
Hebron	39 59	277 31	1841.	LOOMIS.	71 10·1	
Columbus	39 57	276 57	1840.	LOCKE.	71 04·9	71 04·3
Columbus	39 57	276 57	1841.	LOOMIS.	71 03·7	
Columbus	39 57	276 57	1845.	LOCKE.	71 04·3	
Springfield	39 54	276 09	1840.	LOCKE.	71 27·4	
Lebanon	39 26	275 54	1840.	LOCKE.	71 02·7	
Carrolton	39 38	275 51	1845.	LOCKE.	71 10·0	
Mason	39 22	275 47	1840.	LOCKE.	70 54·2	
Dayton	39 44	275 43	1838.	LOCKE.	71 22·7	71 22·3
Dayton	39 44	275 43	1840.	LOCKE.	71 22·0	
Hamilton	39 23	275 28	1840.	LOCKE.	70 58·0	
Oxford	39 30	275 22	1845.	LOCKE.	71 10·0	
Richmond	39 49	275 13	1845.	LOCKE.	71 20·3	
Pekin	40 35	270 24	1841.	LOOMIS.	71 13·2	

[a] Grounds East or West or in front of the Capitol. [b] Magnetic Observatory.
[c] Old Depôt near Georgetown. [d] Near the Patent Office. [e] Near the War Office.

Table LI. (Continued.)

Station.	Lat.	Long.	Year.	Observer.	Inclination.	
	71° 30′ to 72° 30′.					
	° ′	° ′			° ′	
New York (New Asylum)..	40 48	285 58	1841.	Locke.	72 21·0	
Trenton	40 13	285 20	1841.	Locke.	71 59·0	
Bristol	40 06	285 13	1842.	Locke.	72 25·0	
Philadelphia[a].....	39 58	284 50	1844.	Graham.	72 09·2	
Philadelphia[b].....	39 58	284 50	1839.	Loomis.	72 07·1	
Philadelphia[c].....	39 58	284 50	1841.	Graham. / Bache.	71 54·5	
Philadelphia	39 58	284 50	1841.	Bache.	71 58·2	
Philadelphia	39 58	284 50	1841.	Locke.	72 00·2	71 58·7
Philadelphia	39 58	284 50	1842.	Lefroy.	71 59·0	
Philadelphia	39 58	284 50	1842.	Locke.	72 01·0	
Philadelphia	39 58	284 50	1844.	Locke.	71 59·3	
Cumberland	40 13	283 10	1844.	Locke.	71 36·0	
Baltimore[d].....	39 17	283 23	1839.	Loomis.	71 50·3	
Baltimore[d].....	39 17	283 23	1841.	Graham.	71 47·2	71 48·8
Baltimore[d].....	39 17	283 23	1841.	Nicollet.	71 50·1	
Baltimore[d].....	39 17	283 23	1842.	Lefroy.	71 47·5	
Baltimore[e].....	39 17	283 23	1840.	Bache.	71 34·4	
Baltimore[e].....	39 17	283 23	1841.	Nicollet.	71 35·4	
Baltimore[e].....	39 17	283 23	1841.	Graham.	71 32·0	71 34·1
Baltimore[e].....	39 17	283 23	1842.	Lefroy.	71 36·0	
Baltimore[e].....	39 17	283 23	1844.	Graham.	71 32·5	
Baltimore[e].....	39 17	283 23	1841.	Locke.	71 34·1	
Baltimore[f].....	39 17	283 23	1841.	Graham.	71 48·2	71 49·5
Baltimore[f].....	39 17	283 23	1841.	Graham.	71 50·7	
Baltimore[g].....	39 17	283 22	1841.	Nicollet.	71 39·7	
Baltimore[g].....	39 17	283 22	1841.	Locke.	71 39·2	
Baltimore[g].....	39 17	283 22	1841.	Graham.	71 38·9	71 39·6
Baltimore[g].....	39 17	283 22	1842.	Lefroy.	71 40·7	
Baltimore[g].....	39 17	283 22	1844.	Graham.	71 39·5	
Mount St. Mary's	39 41	282 42	1842.	Locke.	71 46·3	
Chambersburg	39 55	282 20	1842.	Locke.	71 57·4	
Allegheny Summit.....	40 27	281 50	1845.	Locke.	72 27·1	
Wheeling	40 08	279 13	1844.	Locke.	72 19·3	72 16·5
Wheeling	40 08	279 13	1845.	Locke.	72 13·7	
Dover.....	40 33	278 30	1841.	Loomis.	72 19·2	
Frazerburg.....	40 09	277 52	1841.	Loomis.	71 48·7	
Urbana	40 05	276 12	1840.	Locke.	71 39·7	
Piqua.....	40 06	275 47	1840.	Locke.	71 35·8	
St. Mary's	40 32	275 41	1845.	Locke.	72 00·3	
Ottawa	41 15	271 10	1841.	Nicollet.	72 20·2	
Juliet.....	41 30	271 09	1841.	Nicollet.	72 16·0	
Peru	41 23	270 55	1841.	Loomis.	71 51·1	71 50·3
Peru	41 23	270 55	1841.	Nicollet.	71 49·6	
Lostgrove	41 39	269 51	1839.	Locke.	72 02·4	
Wabisepinnecon River	41 44	269 37	1839.	Locke.	72 15·0	
Davenport.....	41 30	269 34	1839.	Locke.	71 55·1	
Brown's Settlement	42 02	268 54	1839.	Locke.	72 21·0	
	72° 30′ to 73° 30′.					
Stonington.....	41 20	288 05	1845.	Renwick.	73 25·1	
Greenport	41 06	287 38	1845.	Renwick.	72 57·9	
Newhaven	41 18	287 02	1839.	Loomis.	73 26·7	73 26·2
Newhaven	41 18	287 02	1842.	Lefroy.	73 27·4	
Newhaven	41 18	287 02	1842.	Locke.	73 29·8	
Newhaven	41 18	287 02	1844.	Renwick.	73 20·9	

[a] Rittenhouse Square. [b] In front of Dr. Bache's House. [c] Girard College.

[d e f] are three stations in the grove which extends N. and E. of the Washington Monument.

[g] St. Mary's College

TABLE LI. (Continued.)

Station.	Lat.	Long.	Year.	Observer.	Inclination.	
	72° 30′ to 73° 30′ (continued).					
Bridgeport	41° 11′	286° 48′	1845.	RENWICK.	73° 21·3	° ′
West Point	41 24	285 59	1839.	LOOMIS.	73 27·4	
West Point	41 24	285 59	1840.	GRAHAM	73 20·1	73 28·8
West Point	41 24	285 59	1841.	BACHE.	73 37·2	
West Point	41 24	285 59	1842.	LEFROY.	73 30·4	
New York, Columbia College	40 43	285 59	1834.	BACHE.	72 51·7	
New York, Columbia College	40 43	285 59	1844.	RENWICK.	72 38·0	
New York, Columbia College	40 43	285 59	1839.	LOOMIS.	72 52·2	72 44·5
New York, Columbia College	40 43	285 59	1841.	LOCKE.	72 41·0	
New York, Columbia College	40 43	285 59	1844.	LOCKE.	72 42·6	
New York, Columbia College	40 43	285 59	1845.	RENWICK.	72 40·6	
Sandy Hook	40 27	285 58	1844.	RENWICK.	72 37·9	
Lunatic Asylum, Manhattanville	40 49	285 57	1841.	LOCKE.	72 39·6	
Lunatic Asylum, Manhattanville	40 49	285 57	1844.	LOCKE.	72 41·7	72 42·5
Lunatic Asylum, Manhattanville	40 49	285 57	1842.	LEFROY.	72 39·5	
Lunatic Asylum, Manhattanville	40 49	285 57	1844.	RENWICK.	72 49·0	
Newark	40 43	285 50	1841.	LOCKE.	72 49·0	72 48·6
Newark	40 43	285 50	1844.	LOCKE.	72 48·3	
New Brunswick	40 30	285 25	1844.	LOCKE.	72 43·2	
Princeton[a]	40 30	285 25	1844.	LOCKE.	72 41·4	
Princeton[b]	40 30	285 25	1844.	LOCKE.	72 35·9	
Princeton	40 22	285 20	1839.	LOOMIS.	72 47·1	
Princeton	40 22	285 20	1842.	LEFROY.	72 43·5	72 42·6
Princeton	40 22	285 20	1844.	LOOMIS.	72 39·5	
Princeton	40 22	285 20	1844.	LOCKE.	72 40·4	
Pittsburg	40 32	279 58	1839.	LOOMIS.	72 38·9	
Pittsburg	40 32	279 58	1841.	LOCKE.	72 43·5	72 43·1
Pittsburg	40 32	279 58	1842.	LOCKE.	72 43·2	
Pittsburg	40 32	279 58	1845.	LOCKE.	72 46·7	
Beaver	40 44	279 33	1839.	LOOMIS.	72 40·3	
Hartford	41 19	279 26	1840.	LOOMIS.	72 59·8	
Kinsman	41 30	279 26	1840.	LOOMIS.	73 08·1	
Wellsville	40 38	279 16	1844.	LOCKE.	72 35·3	
Bazetta	41 20	279 15	1840.	LOOMIS.	72 59·7	
Warren	41 16	279 11	1840.	LOOMIS.	73 00·7	72 58·3
Warren	41 16	279 11	1844.	LOCKE.	72 55·9	
Ashtabula	41 52	279 08	1844.	LOCKE.	73 25·0	
Windham	41 15	278 57	1840.	LOOMIS.	73 03·4	
Shakersville	41 15	278 47	1840.	LOOMIS.	72 56·6	
Streetsboro	41 15	278 40	1840.	LOOMIS.	72 53·0	
Aurora	41 20	278 40	1840.	LOOMIS.	72 55·5	
Twinsburgh	41 20	278 34	1840.	LOOMIS.	72 51·3	
Hudson	41 15	278 34	1838 to 1842.	LOOMIS.	72 48·4	
Tallmadge	41 06	278 33	1840. 1841.	LOOMIS.	72 50·7	
Bedford	41 24	278 28	1840.	LOOMIS,	72 58·1	
Fulton	40 55	278 22	1841.	LOOMIS.	72 38·9	
Clinton	40 58	278 20	1841.	LOOMIS.	72 44·0	
Cleveland	41 30	278 18	1839.	LOOMIS.	73 26·0	
Cleveland	41 30	278 18	1840.	LOOMIS.	73 14·1	
Cleveland	41 30	278 18	1841.	LOOMIS.	73 04·3	73 11·2
Cleveland	41 30	278 18	1842.	YOUNGHUSBAND.	73 03·8	
Cleveland	41 30	278 18	1843.	LOCKE.	73 08·0	
Brooklyn	41 30	278 17	1841.	LOOMIS.	73 16·3	
Huron	41 26	277 33	1843.	LOCKE.	73 00·0	
Sandusky	41 29	277 13	1839.	LOOMIS.	72 57·8	
Amherstburg	42 06	276 47	1845.	LEFROY.	73 29·9	

[a] Pott's Wood.

[b] Rock Hills (trap).

TABLE LI. (Continued.)

Station.	Lat.	Long.	Year.	Observer.	Inclination.	
	72° 30′ to 73° 30′ (continued).					
Munroe	41° 55′	276° 32′	1839.	LOOMIS.	73° 32′·3	73° 25′·6
Munroe	41 55	276 32	1841.	LOOMIS.	73 19·0	
Toledo	41 41	276 28	1839.	LOOMIS.	73 06·1	
Maumee	41 34	276 23	1839.	LOOMIS.	72 49·1	
Ypsilanti	42 14	276 22	1839.	LOOMIS.	73 18·0	73 18·4
Ypsilanti	42 14	276 22	1841.	LOOMIS.	73 18·8	
Ann Arbor	42 18	276 15	1839.	LOOMIS.	73 13·9	
Ann Arbor	42 18	276 15	1841.	LOOMIS.	73 16·5	73 14·7
Ann Arbor	42 18	276 15	1843.	LOCKE.	73 13·6	
Chicago	41 53	272 16	1841.	LOOMIS.	72 47·8	
Chicago	41 53	272 16	1841.	NICOLLET.	72 45·8	72 44·3
Chicago	41 53	272 16	1842.	YOUNGHUSBAND.	72 39·3	
Campbells	43 01	270 34	1841.	LOOMIS.	73 28·1	
Mineral Point	42 50	270 02	1839.	LOCKE.	73 20·6	73 21·8
Mineral Point	42 50	270 02	1841.	LOOMIS.	73 23·0	
Galena	42 28	269 47	1841.	LOOMIS.	73 03·0	
Platteville	42 43	269 46	1841.	LOOMIS.	73 17·2	
Farmer's Creek	42 13	269 37	1839.	LOCKE.	72 36·0	
Dubuques Town	42 29	269 37	1839.	LOCKE.	73 05·0	
Little Mahoqueta	42 31	269 29	1839.	LOCKE.	73 08·0	
White Water River	42 18	269 22	1839.	LOCKE.	72 55·0	
Iron Ore Bed	41 55	269 20	1839.	LOCKE.	72 50·5	
Turkey River	42 42	269 12	1839.	LOCKE.	73 11·0	
Mahoqueta, North Branch	42 23	269 08	1839.	LOCKE.	72 51·0	
Mahoqueta River	42 14	269 05	1839.	LOCKE.	72 43·6	
Prairie du Chien	43 01	268 51	1839.	LOCKE.	73 16·6	
	73° 30′ to 74° 30′.					
Boston	42 22	289 01	1842.	LOCKE.	74 05·7	
Boston	42 21	288 56	1841.	GRAHAM.	74 09·4	
Dorchester	42 19	288 55	1842.	LEFROY.	74 12·8	
Cambridge	42 22	288 52	1839.	LOOMIS.	74 20·1	74 18·2
Cambridge	42 22	288 52	1841.	GRAHAM and BOND.*	74 17·3	
Cambridge	42 22	288 52	1842.	LOCKE.	74 14·8	
Cambridge	42 22	288 52	1842.	LEFROY.	74 19·5	
Cambridge	42 22	288 52	1845.	LOCKE.	74 19·4	
Cambridge, New Observatory	42 23	288 52	1844.	GRAHAM.	74 18·2	
Providence	41 50	288 35	1839.	LOOMIS.	73 59·6	74 01·1
Providence	41 50	288 35	1841.	BACHE.	74 02·8	
Providence	41 49	288 35	1842.	LEFROY.	74 00·0	
Worcester	42 16	288 12	1839.	LOOMIS.	74 20·6	
Springfield	42 06	287 24	1839.	LOOMIS.	74 06·9	74 08·8
Springfield	42 06	287 24	1841.	BACHE.	74 10·7	
Longmeadow	42 02	287 24	1839.	LOOMIS.	74 05·3	
Harford	41 46	287 19	1839.	LOOMIS.	73 58·1	
Powkeepsie	41 41	286 05	1844.	LOCKE.	73 57·7	
Opposite Powkeepsie	41 41	286 04	1844.	LOCKE.	74 12·3	
Port Sarnia	42 58	277 26	1845.	LEFROY.	74 15·7	
Detroit	42 24	277 00	1845.	LEFROY.	73 38·8	73 35·0
Detroit	42 25	277 00	1839.	LOOMIS.	73 42·6	
Detroit	42 25	277 00	1841.	LOOMIS.	73 35·2	
Detroit	42 25	277 00	1841.	NICOLLET.	73 32·7	
Detroit	42 25	277 00	1842.	YOUNGHUSBAND.	73 28·7	
Detroit	42 25	277 00	1843.	LOCKE.	73 32·2	

* Mr. WILLIAM CRANCH BOND, Director of the Cambridge Observatory. This result is the mean of 288 observations with two needles.

TABLE LI. (Continued.)

Station.	Lat.	Long.	Year.	Observer.	Inclination.	
	73° 30′ to 74° 30′ (continued).					
Madison	43° 04′	270° 54′	1839.	LOCKE.	74° 03·0	74° 04·7
Madison	43 03	270 54	1841.	LOOMIS.	74 06·5	
Blue Mound	43 01	270 22	1839.	LOCKE.	73 41·0	73 38·0
Blue Mound	43 00	270 22	1841.	LOOMIS.	73 34·9	
Hickoks	42 58	270 13	1841.	LOOMIS.	73 39·5	
	74° 30′ to 75° 30′.					
Portland	43 41	289 40	1845.	LOCKE.	75 13·7	
Portsmouth	43 05	289 16	1844.	GRAHAM and WHIPPLE.*	74 47·7	74 51·0
Portsmouth	43 03	289 16	1844.		74 38·0	
Portsmouth	43 04	289 13	1844.		74 53·7	
Portsmouth	43 04	289 15	1844.		74 58·2	
Portsmouth	43 05	289 15	1844.		74 57·4	
Greenbush	42 39	286 16	1844.	LOCKE.	74 40·6	
Albany	42 39	286 15	1839.	LOOMIS.	74 51·3	74 43·2
Albany	42 39	286 15	1841.	BACHE.	74 40·1	
Albany	42 39	286 15	1841.	NICOLLET.	74 39·9	
Albany	42 39	286 15	1842.	LEFROY.	74 44·6	
Albany	42 39	286 15	1844.	LOCKE.	74 40·2	
Schenectady	42 48	286 05	1839.	LOOMIS.	74 36·1	
Utica	43 07	284 47	1839.	LOOMIS.	74 57·2	74 53·0
Utica	43 07	284 47	1844.	LOCKE.	74 48·8	
Syracuse	43 00	283 46	1839.	LOOMIS.	74 50·9	
Chat Falls	45 26	283 28	1843.	LEFROY.	75 16·1†	
Oswego	43 26	283 24	1839.	LOOMIS.	75 11·3	75 09·7
Oswego	43 26	283 24	1841.	NICOLLET.	75 08·1	
Rochester	43 08	282 09	1844.	LOCKE.	74 38·8	
Lockport	43 11	281 14	1844.	LOCKE.	74 44·2	
Buffaloe	42 53	281 06	1839.	LOOMIS.	74 40·8	74 38·1
Buffaloe	42 53	281 06	1844.	LOCKE.	74 36·5	
Buffaloe	42 52	281 06	1845.	LEFROY.	74 37·0	
Niagara	43 05	280 51	1841.	NICOLLET.	74 52·4	74 49·6
Niagara	43 05	280 51	1845.	LEFROY.	74 46·8	
Toronto Observatory	43 39	280 39	1841. 1845.	LEFROY and YOUNGHUSBAND.	75 15·5	75 15·0
Toronto Observatory	43 39	280 39	1844.	LOCKE.	75 13·4	
Near Toronto	43 39	280 41	1844.	LOCKE.	75 12·5	
Hamilton	43 16	280 04	1842.	LEFROY.	74 56·7	74 55·4
Hamilton	43 16	280 04	1845.	LEFROY.	74 54·1	
Goderich	43 45	278 08	1845.	LEFROY.	75 04·8	
	75° 30′ to 76° 30′.					
Bangor	44 48	291 13	1841.	GRAHAM.	76 11·6	
Forks of the Kennebec	45 20	290 02	1844.	GRAHAM.	76 23·7	
Locke's Mills	44 24	289 16	1845.	LOCKE.	75 50·7	
Bethel	44 27	289 09	1845.	LOCKE.	75 51·0	
Goreham	44 27	288 47	1845.	LOCKE.	75 33·4	
Hall's Stream	45 01	288 30	1845.	GRAHAM.	76 23·5	
Mount Washington	44 17	288 41	1845.	LOCKE.	75 45·0	
Near Mount Washington	44 16	288 31	1845.	LOCKE.	75 40·0	
Stanstead	45 02	287 50	1842.	LEFROY.	76 19·5	
L. Memphremagog, East shore	45 01	287 41	1845.	WHIPPLE.	76 08·6	
Cornwall	45 02	285 13	1845.	YOUNGHUSBAND.	76 16·4	
Brockville	44 35	284 15	1845.	YOUNGHUSBAND.	76 18·9	
Penetanguishene	44 49	279 59	1844.	LEFROY.	76 20·1	
South Manitou Island	45 05	274 22	1841.	LOOMIS.	75 59·3	75 57·9
South Manitou Island	45 05	274 22	1842.	YOUNGHUSBAND.	75 56·6	

* Lieut. A. W. WHIPPLE, of the United States Corps of Topographical Engineers. The observations at Portsmouth were made at five different stations, which are named in order of succession corresponding with the entries in the Table; Jamaica Island; near the north extremity of the base line of the Trigonometrical Survey of the harbour; Mr. SHELLIBY's field; Shapley's Point; One Tree Island.

† Local disturbance; omitted in the map.

TABLE LI. (Continued.)

Station.	Lat.	Long.	Year.	Observer.	Inclination.	
	76° 30′ to 77° 30′.					
	° ′	° ′			° ′	° ′
Grand Falls of the St. John.	47 03	292 15	1843.	GRAHAM.	77 29·5	
Aroostook Hill	46 47	292 13	1841.	GRAHAM.	77 24·1	
Blue Hill.....	46 38	292 13	1841.	GRAHAM.	77 18·1	
Park's Hill	46 07	292 13	1840.	GRAHAM.	77 02·5	77 01·6
Park's Hill	46 07	292 13	1841.	GRAHAM.	77 00·7	
N.E. Boundary Station, No. 1. ..	45 57	292 13	1840.	GRAHAM.	76 57·4	
Near the Grand Forks of the St. John	46 35	290 07	1844.	GRAHAM.	77 25·9	
S.W. branch of the River St. John	46 25	289 56	1844.	GRAHAM.	77 24·7	
Moose River	45 39	289 44	1844.	GRAHAM.	76 48·5	
Taschereau's	45 49	289 36	1844.	GRAHAM.	76 50·4	
Quebec.....	46 49	288 44	1842.	LEFROY.	77 15·3	77 12·0
Quebec.....	46 49	288 44	1845.	YOUNGHUSBAND.	77 08·8	
Three Rivers	46 19	287 24	1842.	LEFROY.	77 10·7	
St. John's.....	45 20	287 00	1842.	LEFROY.	77 00·1	
Sorel.....	46 02	287 00	1842.	LEFROY.	77 17·0	
Rouse's Point	45 00	286 37	1845.	GRAHAM and WHIPPLE.	76 39·8	
St. Helen's	45 31	286 25	1842.	LEFROY.	77 13·1	77 09·2
St. Helen's	45 31	286 25	1843.	LEFROY.	77 05·3	
Montreal	45 30	286 24	1845.	YOUNGHUSBAND.	77 08·6	
Isle d'Urval	45 24	286 14	1843.	LEFROY.	77 21·1*	
La Combes	45 32	285 51	1843.	LEFROY.	76 50·6	
Pointe aux Chênes	45 37	285 05	1843.	LEFROY.	76 55·4	
Williamsburg	44 55	284 53	1843.	LEFROY.	76 30·1	
Fox's Point	45 32	284 26	1843.	LEFROY.	76 35·3	
Point Aylmer	45 29	284 12	1843.	LEFROY.	76 41·0	
Kingston	44 13	283 25	1842. / 1843.	LEFROY.	77 18·7	77 16·5*
Kingston	44 13	283 25	1845.	YOUNGHUSBAND.	77 14·4	
Grand Calumet	45 45	283 20	1843.	LEFROY.	76 44·4	
Fort Coulange.....	45 56	283 13	1843.	LEFROY.	77 29·7	
Point Baptême.....	46 06	282 34	1843.	LEFROY.	77 26·6	
Deux Joachim's Portage.....	46 12	281 41	1843.	LEFROY.	77 03·8	
Trou Portage	46 15	281 27	1843.	LEFROY.	77 24·4	
Little River.....	46 18	281 17	1843.	LEFROY.	77 28·5	
Lac du Grand Vase.....	46 18	280 34	1843.	LEFROY.	77 21·7	
Lake Nipissing.....	46 13	280 01	1843.	LEFROY.	77 09·5	
Ricolet Falls	45 57	278 59	1843.	LEFROY.	76 45·4	
Pointe au Croix	45 55	278 42	1843.	LEFROY.	76 31·3	
Lake Huron.....	46 00	278 10	1843.	LEFROY.	77 05·6	
Fort la Cloche.....	46 07	277 35	1844.	LEFROY.	76 50·2	
Snake Island	46 07	277 00	1843.	LEFROY.	77 05·5	
Tessalon Point.....	46 16	276 29	1843.	LEFROY.	76 59·3	
Fort Brady	46 30	275 36	1841.	LOOMIS.	77 29·7	
Sault St. Mary.....	46 30	275 26	1843.	LOCKE.	77 30·3	77 24·9
Sault St. Mary.....	46 30	275 26	1845.	RAE.	77 19·5	
Mackinac.....	45 51	275 19	1841.	NICOLLET.	76 34·5	
Mackinac.....	45 51	275 19	1841.	LOOMIS.	76 37·5	76 37·0
Mackinac.....	45 51	275 19	1843.	LOCKE.	76 38·9	
Gross Cap	46 32	275 17	1841.	LOOMIS.	77 05·3	
Point aux Pins.....	46 29	275 19	1843.	LEFROY.	77 13·4	77 14·7
Point aux Pins.....	46 29	275 19	1845.	RAE.	77 16·0	
Point au Crêpe	46 58	275 02	1843.	LEFROY.	77 11·5	
Encampment	46 44	272 17	1843.	LOCKE.	76 58·3	
Houghton's River	47 28	271 59	1843.	LOCKE.	77 20·7	
United States' Agency	47 28	271 59	1843.	LOCKE.	77 13·5	
Ontanogon River.....	46 52	270 29	1843.	LOCKE.	77 13·2	
Portage Ecarté	48 25	270 15	1843.	LEFROY.	77 13·5*	
Lapointe	46 47	269 02	1843.	LOCKE.	76 56·0	

* Local disturbance; omitted in the map.

TABLE LI. (Continued.)

Station.	Lat.	Long.	Year.	Observer.	Inclination.
	77° 30′ to 78° 30′.				
North bank of the St. John River	47° 04′	292° 13′	1843.	GRAHAM.	77° 31·1′
Peconk Hill	46 59	292 13	1841.	GRAHAM.	77 32·2
Mouth of the Grand River	47 11	292 03	1844.	GRAHAM.	77 38·4
Mouth of the Madawaska	47 22	291 41	1843.	GRAHAM.	77 47·5
Albert's Inn	47 17	291 32	1843.	GRAHAM.	77 44·5
Fort Kent	47 15	291 25	1843.	GRAHAM.	77 43·1
St. Francis River	47 11	291 06	1843.	GRAHAM and ROBINSON*.	77 43·5
Head of Beau Lac	47 23	290 57	1843.	GRAHAM.	77 47·0
Mouth of the Passa-ooe-tuc.	47 07	290 55	1844.	GRAHAM.	77 40·5
Outlet of Lake Pohenagamook	47 28	290 47	1843.	GRAHAM.	77 49·2
M. of the Chimpassaooetuc	46 57	290 33	1843.	GRAHAM.	77 37·5
Kingsey	45 48	287 41	1842.	LEFROY.	77 40·0†
Fort Michipicoton	47 56	274 55	1843.	LEFROY.	78 06·0
Fort Michipicoton	47 56	274 55	1844.	LEFROY.	78 08·2 } 78 06·4
Fort Michipicoton	47 56	274 55	1845.	RAE.	78 05·0
Gargantua	47 37	274 49	1844.	LEFROY.	77 56·1
Lake Superior	48 46	272 20	1844.	LEFROY.	78 24·0
Isthmus	47 28	272 00	1843.	LOCKE.	78 28·0†
Eagle River	47 27	271 37	1843.	LOCKE.	77 54·5†
Isle Royale	48 06	271 13	1843.	LOCKE.	78 07·5
Pointe Tonnerre	48 19	270 58	1843.	LEFROY.	78 23·2
Fort William	48 24	270 37	1843.	LEFROY.	78 10·0
Fort William	48 24	270 37	1844.	LEFROY.	77 59·5 } 78 06·8
Fort William	48 24	270 37	1845.	RAE.	78 11·0
Chien Portage	48 39	270 26	1843.	LEFROY.	78 26·8
Prairie Portage	48 58	269 59	1843.	LEFROY.	78 26·2
Savannah Portage	48 53	269 52	1843.	LEFROY.	78 21·8
French Portage	48 35	268 53	1843.	LEFROY.	78 20·4
Deux Rivières Portage	48 35	268 33	1843.	LEFROY.	77 49·4
Lac à la Crosse	48 24	267 50	1843.	LEFROY.	77 51·0
Second Portage from Lac à la Crosse	48 15	267 33	1843.	LEFROY.	77 40·1
Sturgeon Lake	48 27	267 19	1843.	LEFROY.	77 44·8
Lac la Pluie	48 32	267 04	1843.	LEFROY.	77 47·9
Fort Francis	48 37	266 31	1843.	LEFROY.	77 27·5
Fort Francis	48 37	266 31	1844.	LEFROY.	77 43·0 } 77 34·2
Fort Francis	48 37	266 31	1845.	RAE.	77 32·0
Rainy River	48 48	265 29	1843.	LEFROY.	77 57·4
Rat Portage	49 46	265 21	1843.	LEFROY.	78 07·5
Lake of the Woods	49 28	265 20	1843.	LEFROY.	78 16·7
Lake of the Woods	49 19	265 18	1843.	LEFROY.	78 03·7
Upper Fort Garry	49 53	262 58	1843.	LEFROY.	78 17·8
Saskatchawan River	52 23	252 56	1844.	LEFROY.	78 16·6
Saskatchawan River	53 07	251 30	1844.	LEFROY.	78 28·1
Saskatchawan River	54 05	248 16	1844.	LEFROY.	78 05·2
Fort Edmonton	53 31	247 03	1844.	LEFROY.	77 54·2
Pembina River	54 08	246 06	1844.	LEFROY.	77 54·5
Fort Assiniboine	54 20	245 32	1844.	LEFROY.	78 15·2
Point Dejala	55 26	244 59	1844.	LEFROY.	78 29·9
	78° 30′ to 79° 30′.				
White River	48 33	273 33	1844.	LEFROY.	78 33·1
Fort Pic	48 38	273 21	1843.	LEFROY.	78 45·8
Fort Pic	48 38	273 21	1844.	LEFROY.	78 31·5 } 78 37·1
Fort Pic	48 38	273 21	1845.	RAE.	78 34·0

* Captain WILLIAM ROBINSON, Royal British Engineers, attached to the Survey and Boundary Commission.

† Local disturbance; omitted in the map.

TABLE LI. (Continued.)

Station.	Lat.	Long.	Year.	Observer.	Inclination.	
	78° 30′ to 79° 30′.					
Terreplatte	48° 40′	272° 15′	1843.	LEFROY.	78° 53·6	
Magnetic Inlet	47 28	271 59	1843.	LOCKE.	78 44·3*	
500 feet East of Ditto	47 28	271 59	1843.	LOCKE.	78 37·5*	
Slave Portage	50 11	264 23	1843.	LEFROY.	78 57·1	
Fort Alexander	50 37	263 39	1843.	LEFROY.	78 51·8	78 57·4
Fort Alexander	50 37	263 39	1844.	LEFROY.	79 03·0	
Lake Winnipeg	50 27	263 22	1843.	LEFROY.	79 05·2	
Lake Winnipeg	51 34	263 20	1844.	LEFROY.	79 06·1	
Mouth of Red River	50 19	263 15	1843.	LEFROY.	78 32·6	
Lake Winnipeg	51 04	263 15	1843.	LEFROY.	79 11·8	
Lake Winnipeg	51 45	263 07	1843.	LEFROY.	79 28·3	
Saskatchawan River	53 16	255 12	1844.	LEFROY.	79 11·2	
Carlton House	52 51	253 47	1844.	LEFROY.	78 30·7	
Fort Pitt	53 34	250 41	1844.	LEFROY.	78 41·0	
Saskatchawan River	53 50	249 30	1844.	LEFROY.	78 33·5	
Forks of Athabasca River	55 13	246 10	1844.	LEFROY.	78 55·2	
Athabasca River	54 43	246 00	1844.	LEFROY.	78 34·1	
Lesser Slave Lake	55 33	244 07	1844.	LEFROY.	78 39·0	
Peace River	57 19	243 32	1844.	LEFROY.	79 27·0	
Opposite River Cadotte	56 47	242 58	1844.	LEFROY.	79 20·7	
Fort Dunvegan	55 56	241 26	1844.	LEFROY.	78 46·2	
	79° 30′ to 80° 30′.					
Otter Island	48 06	273 43	1843.	LEFROY.	79 43·6*	
Lake Winnipeg	51 04	263 39	1844.	LEFROY.	79 31·5	
Lake Winnipeg	51 44	263 12	1844.	LEFROY.	79 39·0	
Lake Winnipeg	51 38	263 11	1843.	LEFROY.	79 38·0	
Lake Winnipeg	52 21	262 51	1844.	LEFROY.	80 24·4	
Lake Winnipeg	52 29	262 47	1843.	LEFROY.	80 05·4	
Lake Winnipeg	53 31	260 48	1843.	LEFROY.	80 16·8	
Grand Rapid	53 08	260 32	1843.	LEFROY.	80 21·5	80 26·5
Grand Rapid	53 08	260 32	1844.	LEFROY.	80 31·6	
Cross Lake	53 10	260 28	1843.	LEFROY.	80 28·2	
Cedar Lake	53 12	259 30	1843.	LEFROY.	80 07·1	
Devil's Drum Island	53 19	259 20	1844.	LEFROY.	80 00·0	
Above the Pas	53 48	258 32	1844.	LEFROY.	80 24·4	
Cumberland House	53 57	257 41	1843.	LEFROY.	80 30·2	80 24·9
Cumberland House	53 57	257 41	1844.	LEFROY.	80 19·7	
Little Rock Portage	55 34	255 27	1843.	LEFROY.	80 16·5	
Portage Sonnante	55 54	252 13	1843.	LEFROY.	80 11·2	
Isle à la Crosse	55 27	252 06	1843.	LEFROY.	80 09·8	
Buffaloe Lake	56 05	251 09	1843.	LEFROY.	80 37·0	
River de la Loche	56 15	250 37	1843.	LEFROY.	80 19·7	
Peace River	57 57	243 00	1844.	LEFROY.	80 00·7	
	80° 30′ to 81° 30′.					
Lake Winnipeg	52 23	263 07	1843.	LEFROY.	80 39·2	
Hairy Lake	54 21	262 49	1843.	LEFROY.	81 20·9	
Old Norway House	53 42	261 59	1843.	LEFROY.	80 45·4	
Norway House	53 59	261 53	1843.	LEFROY.	81 08·9	81 10·0
Norway House	53 59	261 53	1844.	LEFROY.	81 11·2	
Beaver Lake	54 32	257 50	1843.	LEFROY.	80 34·2	
Carp Portage	54 47	257 21	1843.	LEFROY.	80 39·6	
Portage des Epinettes	55 06	257 18	1843.	LEFROY.	80 52·6	
Frog Portage	55 28	256 30	1843.	LEFROY.	80 59·3	
Great Devil's Portage	55 40	255 11	1843.	LEFROY.	80 30·9	

* Local disturbance; omitted in the map.

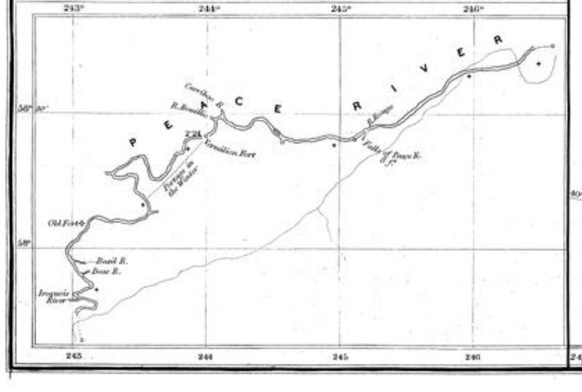
TABLE LI. (Continued.)

Station.	Lat.	Long.	Year.	Observer.	Inclination.
	80° 30′ to 81° 30′ (continued).				
Pine Portage	55° 43′	254° 10′	1843.	LEFROY.	80° 40·3′
Snake Rapid	55 46	253 30	1843.	LEFROY.	80 38·7
Portage de la Loche, South end	56 34	250 16	1843.	LEFROY.	80 36·4
Portage de la Loche, North end	56 43	250 08	1843.	LEFROY.	80 38·0
Clearwater River	56 39	249 11	1843.	LEFROY.	80 36·2
Pierre au Calumet	57 24	248 25	1843.	LEFROY.	81 16·8*
Poplar Island	58 38	246 03	1844.	LEFROY.	81 04·8
Falls of Peace River	58 24	245 06	1844.	LEFROY.	80 50·8
Fort Vermilion	58 25	243 45	1844.	LEFROY.	80 48·0
	81° 30′ to 82° 30′.				
Long Portage	55 15	265 35	1843.	LEFROY.	82 13·9
Windy Lake	54 37	263 58	1843.	LEFROY.	81 57·0
Whitefall Portage	54 24	263 34	1843.	LEFROY.	81 47·9
Athabasca	58 43	248 42	1843.	LEFROY.	81 37·0
Pointe Brulée	58 07	248 35	1843.	LEFROY.	81 30·6
Pelican Portage	59 58	248 09	1844.	LEFROY.	82 26·8
Point Providence	58 58	247 50	1844.	LEFROY.	81 46·1
Peace River	58 58	247 01	1844.	LEFROY.	81 36·9
Big Island	61 12	243 22	1844.	LEFROY.	82 08·7
Fort Simpson	61 51	238 35	1844.	LEFROY.	81 52·3
	82° 30′ to 83° 30′.				
White Earth Portage	55 32	266 10	1843.	LEFROY.	83 02·9
Hill River	55 25	266 00	1843.	LEFROY.	82 55·0
Oxford House	54 56	264 30	1843.	LEFROY.	82 38·8
Portage Grand Detour	60 22	247 00	1844.	LEFROY.	82 33·6
Fort Resolution	61 10	246 15	1844.	LEFROY.	82 44·5
Fort Norman	64 31	235 16	1844.	LEFROY.	82 34·3
Fort Good Hope	66 16	231 30	1844.	LEFROY.	82 56·0
	83° 30′ to 84° 30′.				
York Factory	57 00	267 34	1843.	LEFROY.	83 47·2
Shamatawa	56 21	267 04	1843.	LEFROY.	83 36·2

* Local disturbance; omitted in the map.

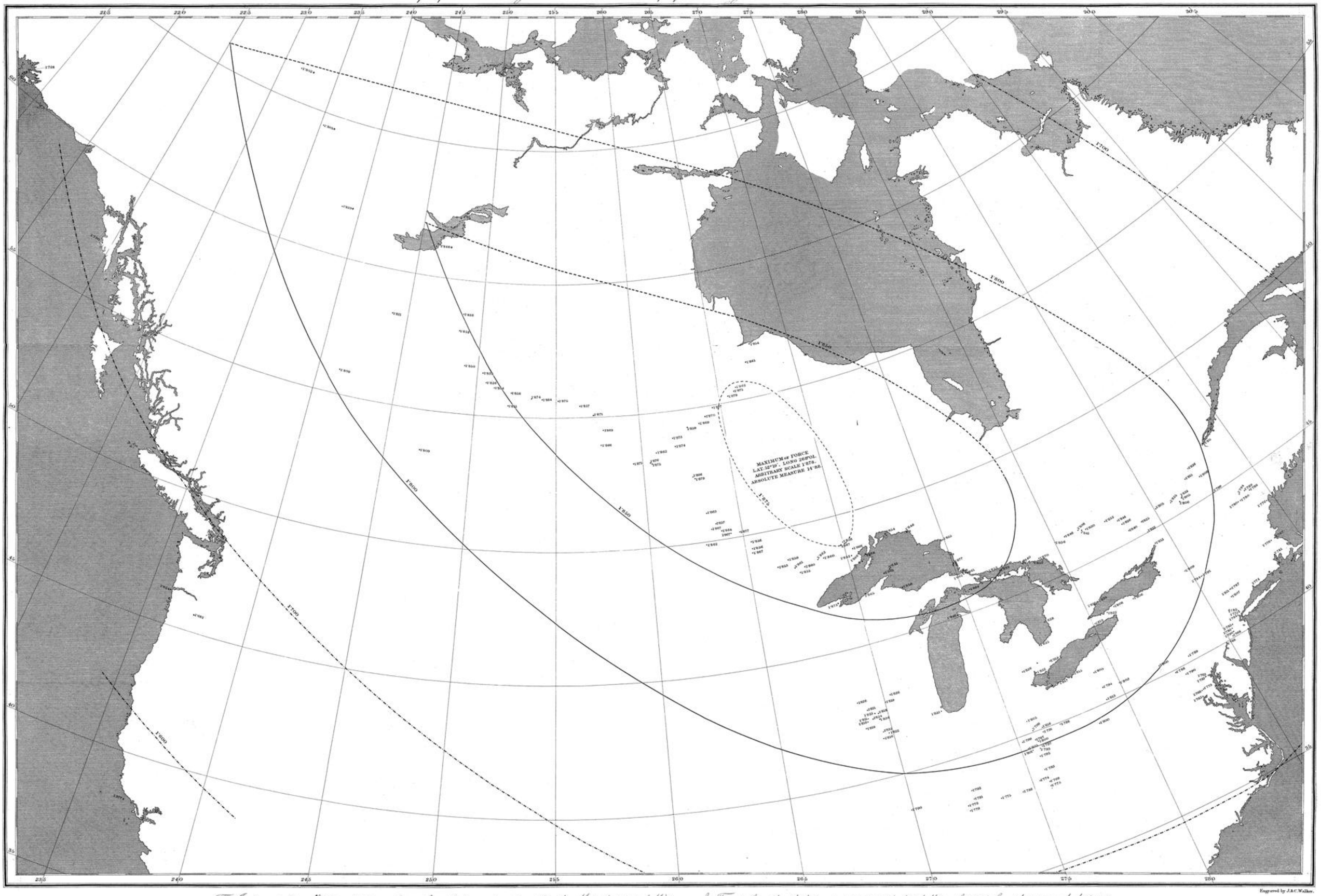
Map of the Isoclinal lines or lines of equal Magnetic Inclination in North America

PART OF PEACE RIVER LAID DOWN BY CAPTAIN LEFROY FROM A FIELD SKETCH
The dotted line denotes the course of the River by Arrowsmiths Map.



Engraved by J.& C.Walker.

Map of the Isodynamic lines or lines of equal Magnetic Force in North America.



Engraved by J.& C. Walker.

The Isodynamic lines of 1850 and 1800 are drawn from the observations inserted in the Map, the point of Maximum of Force is from the calculation in pp. 250, 251; the dotted ellipse of 1875 is from the same calculation.
The Isodynamic lines of 1700 and 1600 are from earlier observations than those now given, and are taken from the Map accompanying Lieut.-Col. Sabine's memoir on the variations of the magnetic Force, Brit. Assoc. 1837.
The Force at the 4 stations marked thus • was determined by the absolute method; at all the other stations by relative methods.