PHILOSOPHICAL TRANSACTIONS.

The Magnetic Re-survey of the British Isles for the Epoch January 1, 1915.

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[Plates 1–5 and Diagrams 1–6.]

The first Magnetic Survey of the British Isles by Rücker and Thorpe was reduced to epoch January 1, 1886, and their more extended survey was reduced to epoch January 1, 1891. For some years a revision of the original survey had been contemplated by Sir Arthur Rücker, but for various reasons did not mature. In the summer of 1913 the Royal Society decided to repeat the survey of the main magnetic features of the British Isles obtained by Rücker and Thorpe, and invited me to undertake the work.

It would in any case have been an honour to carry out this work, but to me the honour was increased by the fact that I was a pupil of Sir Arthur Rücker and Sir Edward Thorpe, at the Royal College of Science, when their great undertaking was nearing its completion. The Royal Society desired that I should consult Sir Arthur Rücker with regard to the general scope of the new survey; and, fortunately, Sir Arthur was able at the time to enter into the matter both by correspondence and by personal interview. His view was that the original 200 points used by him and Sir Edward Thorpe should be re-determined and, if possible, marked in some permanent way. He further desired that about 40 new points along the Yorkshire "ridge line" should be chosen.

We discussed the question of apparatus, and the strongest arguments were in favour of using the same type of apparatus as before, viz., a Kew Unifilar and a Dover Dip-Circle. I proposed to reduce all values to Greenwich Observatory as theoretical base station, but to have my working base at Cambridge Observatory. In surveying parlance Cambridge Observatory was thus to be a satellite station referred to Greenwich Observatory. Sir Arthur warmly approved of this proposal, and it was most cordially entertained by the Astronomer Royal, Sir Frank Dyson, and by Prof. H. F. Newall, who was then acting for Sir Robert Ball.

On many preliminary points I received much invaluable advice from Sir Arthur Rücker, and I had looked forward to having his help and guidance throughout the work which is now (May, 1917) nearly complete. Alas, my interview with him in 1913 proved to be the last, as soon after he was struck down by serious illness. Although I know from Lady Rücker that he retained a lively interest in the

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re-survey until the time of his death in 1915, yet he was not equal to the exertion of writing to me about it. It is thus seemly that I should record the loss to the re-survey, and my own sense of personal grief, occasioned by the death of my revered teacher.

The first step taken in 1913 with regard to the work was to procure a suitable set of instruments. The instruments used by RÜCKER and THORPE were not available, and several belonging to the Royal Society could not without great inconvenience be obtained. It was only after much delay and trouble that Unifilar Elliott, No. 66, and Dip Circle, Dover, No. 86, belonging to the Society, and hitherto in use at Falmouth Observatory, were placed at my disposal. I draw attention to this in order that like trouble may not occur again. In my opinion, the present apparatus, when returned to the Royal Society, should be preserved solely for, or for comparison with instruments used in, future magnetic surveys of the British Isles.

The Unifilar required some overhauling and, as the certificate with it was rather old, I decided to have the more important constants re-determined. The inertia bar and deflexion bar were sent to the National Physical Laboratory for measurement. I made a series of observations to determine the moment of inertia of the Magnet 66A, and special experiments were made to determine the temperature coefficient of its magnetic moment. These latter were made in the Cavendish Laboratory by a compensation method which I had devised at Eskdalemuir Observatory, and I am greatly indebted to Sir JOSEPH THOMSON for giving me the special facilities required.

Concurrently with this a point was selected in a paddock belonging to Cambridge Observatory, and a concrete base about 1 metre square and $\frac{1}{2}$ metre deep was prepared in the ground. The exact centre is marked permanently on the surface of the cement, and the azimuths of two suitable reference objects have been determined (1) by myself using the Unifilar 66 for Sun observations; (2) by Mr. HARTLEY, chief assistant at the observatory, from observation of the Pole Star; (3) by the Ordnance Survey Department from the Trigonometrical Survey of Great Britain. The agreement was as close as could be desired. Magnetic observations were made on this concrete base and compared with values supplied by Greenwich Observatory. The results are given in detail later, and while the differences are perhaps not as constant as one could wish, the divergences are within the limits of experimental error. Accordingly, I have used corrections supplied from the variometers at Greenwich to correct my experiments at Cambridge in obtaining the constants of the apparatus. But I admit it would have been better if neighbouring variometers had been available. This however was not possible.

It may be recalled that in determining Horizontal Force RÜCKER and THORPE used two distances, 30 cm. and 40 cm., in the deflexion experiment in the field, and deduced the distribution constant P for their magnets by means of the field observations. The determination of distribution constants requires specially careful experiments and I think field observations are hardly good enough for this purpose. Moreover, observations at two distances add considerably to the time required in the field without materially contributing to improved accuracy. I decided to use only one distance, viz., 25 cm., in the field observations, and in order to avoid personal error of setting from day to day I had fixed geometrical stops put on the bar.

Special experiments were therefore made at Cambridge to obtain the distribution constants. Three distances 25, 30 and 35 cm. were used, and assuming the formula $1+P/r^2+Q/r^4$ the deduced values were

$$P = 8{\cdot}90, \qquad Q = -2479$$

and the value of $\log(1+P/r^2+Q/r^4)$ at 25 cm. was 0·00342.

This value was used throughout the survey. It had been calculated on the reputed certificate values of the distances and temperature coefficient. When the bar had been re-measured and the temperature coefficient determined the values were re-computed and gave

$$P = 8{\cdot}4, \qquad Q = -2245$$

and

$$\log(1+P/r^2+Q/r^4) \text{ at 25 cm.} = 0{\cdot}00333.$$

Thus the observed values as recorded in the tables would require to be reduced by 2γ on this account.

It is by no means certain that one gets more accurate absolute values by using a two-constant formula. If we assume that the form $(1+P'/r^2)$ is better and that the differences obtained in the experiments are errors, I find that the least-square solution of my observations gives $P' = 2{\cdot}96$, so that

$$\log(1+P'/r^2) \text{ at 25 cm.} = 0{\cdot}00205.$$

This assigns errors in the observations of $-1{\cdot}8\gamma$ at 25 cm , $+3{\cdot}6\gamma$ at 30 cm., $-1{\cdot}8\gamma$ at 35 cm., which are by no means unreasonable. If this latter assumption is correct the observed values would have to be reduced by 25γ.

A visit was made to Greenwich in January, 1914, and while the comparison of Declination and Dip was satisfactory, my value of Force was considerably larger than that supplied by the Observatory. A re-determination of the moment of inertia of the Greenwich magnet was made by the Astronomer Royal and led to an increase of 20γ in the Observatory values.

These necessary preliminary experiments took up a good deal of time, and meanwhile an important arrangement was made. I have referred to Sir ARTHUR RÜCKER's wish that the stations should be permanently marked and the azimuths of suitable marks determined once for all. The Director-General of the Ordnance Survey, Southampton, Colonel (now Sir CHARLES) C. F. CLOSE, K.B.E., C.B., was approached on the matter, and as a result the O.S.O. undertook to mark permanently the stations and determine the azimuth of suitable reference objects. The importance of this cannot well be over-rated. Apart from the fact that it relieved me of the necessity of finding my own azimuth by sun observation, it places the magnetic survey on a permanent basis, so that in future surveys precisely the same points and reference objects will be available, and the scheme is linked up with the triangulation of the British Isles.

The general plan of campaign was worked out by Captain (now Colonel) WINTERBOTHAM, D.S.O., Captain (now Major) HENRICI, and myself. It was arranged that parties from the O.S.O. should travel in advance to select, mark, and fix a suitable point of observation and a suitable reference object for use. When a station had been so determined, maps and descriptions to enable me to find the stations were sent on.

The parties had complete instructions as to selecting points not likely to be built over in the near future, and well removed from local magnetic disturbances and more especially those that might arise from railway or tramway lines.

At first we aimed at getting the points close to the reputed points used by RÜCKER and THORPE, but a little experience showed that this was not generally possible. In many cases electric tramways had rendered the point unsuitable, in others the co-ordinates appeared incorrect, and again other points would have been very difficult for the O.S.O. to fix. It is obvious that the simplest course for the O.S.O. was to obtain a suitable "down trigonometrical point" for the magnetic station from which a suitable "up trigonometrical point," such as a spire, could be used as reference object. No reasonable objection could be taken, from a magnetic point of view, to adopting a course which simplified the work of the O.S.O. Accordingly our plan changed to selecting as observing station, if possible, a "down trigonometrical point" as near as possible to RÜCKER and THORPE'S point and free from spurious local magnetic disturbance.

The field work started in March, 1914, and after the usual slight difficulties of getting the various "staff" operations to work smoothly, the survey went well away throughout the summer. The outbreak of war found us working in the North of Scotland after having surveyed from Cornwall round the South and East of England, right up to Orkney. The O.S. parties, consisting chiefly of Royal Engineers, had to be recalled; but Colonel CLOSE kindly agreed to leave with me Surveyor Assistant YOUNG, who was greatly skilled in finding the "trig." points. We therefore worked along under considerable difficulties until the end of September, when I decided to finish up for the season. 111 stations had been completed out of a programme of 120.

The field work was resumed in April, 1915, but various circumstances arising on account of the war interrupted the work. 72 stations were completed by the end of October of that year. Thus during the summers of 1914 and 1915, 183 out of the original 200 had been completed. These included the whole mainland of Scotland, England and Wales and Ireland, along with Orkney and Skye. There remained to observe 13 points in the Hebrides, 2 in the Isle of Man, and 6 in the Channel Isles. In any case those points are somewhat inaccessible, and in war time cannot be completed without serious trouble which can hardly be justified. Accordingly it has been decided to reduce the survey with the results so far obtained.

Having now given a brief sketch of the general field work of the survey we proceed to detailed consideration of the observations.

It is first desirable to say that the survey has been carried out under the auspices of a Committee representing the Royal Society, the Ordnance Survey Office, and the British Association, as these bodies have financed the work.

My personal thanks are due to the Committee for providing a motor car for the work. This has greatly facilitated rapid progress, and the instruments were thus exposed to a minimum of disturbance in travelling from place to place. Acknowledgment is due to—

(1) H.M. King George V. for permission to observe at Windsor Castle; the Cambridge Observatory for a base station, and proprietors throughout the country for access to private grounds;
(2) The Admiralty for the use of marine chronometers;
(3) The Astronomer Royal for the vast amount of magnetic data required for reducing the field results to epoch;
(4) The police authorities for helpful protection since the war began;
(5) The Postmaster-General for permission to check chronometers at post-offices where the Greenwich 10 a.m. signal was received.

The normal procedure at each station was to set up the tripod and centre the Unifilar exactly over the brass stud imbedded in cement which marks the station. The bearing of the reference object was then determined by setting the vertical cross-wire of the telescope on the R.O. and taking the circle reading.

The magnetic meridian was then found by the readings of the circle when the vertical cross-wire of the telescope was on the centre of the scale of the collimator magnet. Two readings only were made: (1) magnet scale erect; (2) magnet scale inverted.

It is very gratifying in this connexion to be able to say that the silk suspension with which I started from Cambridge in March, 1914, has been carried without a break throughout the whole survey. It has thus travelled safely over 11,000 miles.

The Horizontal Force was next determined by making (1) a vibration experiment in the manner used at Kew; (2) a deflexion experiment using one deflexion distance 25 cm. in four positions. The setting was not made by eye, but by placing the magnet carriage against fixed geometrical stops on the bar. Here also the same silk suspension in the deflexion experiment was used throughout the survey.

In the determination of Inclination I did not consider it any advantage to make 32 readings of the azimuth circle to get the magnetic meridian. I accepted the azimuth obtained when the A point of the needle dipping with face to instrument face was on the cross-wire of the lower microscope when set at 90° in the vertical circle. (An error of 1° in azimuth means an error of 0′·2 in Inclination.) Further, I saw no adequate gain in using two needles. Accordingly I used only one needle (32 readings), but I carried a second needle in reserve so as to be fresh if the first should go wrong. I found this precaution valuable twice in 1914, viz., at King's Lynn and Portree, but unnecessary in 1915.

With regard to accuracy the azimuths given by the O.S.O. are believed to be not more than 0′·5 in error, and so I think the absolute Declinations ought not normally to be more than 1′ wrong.

In Horizontal Force I consider that the absolute values are normally not more than 15γ wrong. The unit of Force is $1\gamma = 10^{-5}$ gauss.

In Inclination it would be unsafe to suppose that the absolute values are correct to less than 1′, and from Portree to Oban I suspect they may be several minutes wrong.

The following constants were used in calculating the force :—

$$\text{Induction coefficient, } \mu \quad . \quad . \quad \log \mu = 0\cdot83793.$$

$$\text{Temperature coefficient of magnetic moment} = 0\cdot00060 \text{ per } 1^\circ \text{ C.}$$

$$\text{Moment of inertia, K} \quad . \quad . \quad \log \pi^2\text{K} = 3\cdot42610 + \log(1 + 0\cdot000022t),$$

where t = temperature centigrade.

$$\text{Deflexion distance } r = 24\cdot9977\ (1 + 0\cdot000017t).$$

$$\log(1 + \text{P}/r^2 + \text{Q}/r^4) = 0\cdot00342.$$

When a station had been "observed" the calculations were made, and a copy of the data sent to the O.S.O. for preservation and verification of my calculations. The O.S.O. then sent enquiry slips to Greenwich for the corresponding magnetic values at the times of my observations. The variation of H at Greenwich between the vibration and deflexion experiments was assumed to be applicable at all points in the British Isles, and was used to correct the observed value at the station.

We may now consider the comparative results at Greenwich. From the tables we have the following :—

Declination.	January 14, 1914.	January 15, 1914.	May 14, 1914.
Survey value	15° 11′·7	15° 11′·0	15° 8′·8
Greenwich value	15 12·3	15 12·2	15 9·4
Difference	− 0·6	− 1·2	− 0·6
Mean . . −0′·8			

In the first two the observations were made in the Magnetic Pavilion, and I determined my own azimuth by sun observation. In the third the observations were made a few yards from the Pavilion at the station selected by the O.S.O. and the azimuth was determined by the O.S.O.

Horizontal Force.	January 14, 1914.	January 15, 1914.	May 14, 1914.
Survey value	18,575	18,560	18,565
Greenwich value	18,548	18,553	18,553
Difference	+27	+7	+12
Mean . . +15			

Inclination.	January 14, 1914.	January 15, 1914.	May 14, 1914.
Survey value	66° 50′·8	66° 50′·2	66° 49′·4
Greenwich value	66 50·6	66 50·1	66 50·0
Difference	+ 0·2	+ 0·1	− 0·6
Mean . . −0′·1			

It is here of interest to examine the values at Kew and Stonyhurst Observatories where observations were made and the observatory values supplied by Dr. CHREE and Rev. Father SIDGREAVES.

KEW, May 27, 1914.

	D.	H.	I.
Survey value	15° 28′·9	18,484	66° 56′·4
Kew value	15 30·0	18,460	66 56·2
Difference	− 1·1	+24	+ 0·2

STONYHURST, September 17, 1914.

	D.	H.	I.
Survey value	16° 46′·0	17,376	68° 41′·4
Stonyhurst value	16 44·3	17,362	68 40·4
Difference	+ 1·7	+14	+ 1·0

In both these cases the observatory azimuths were used and were not determined by the O.S.O. Further, at Stonyhurst the spare dip needle was used, as No. 1 had gone out of order.

The survey values of H ought to be reduced by 2γ in view of the determination of the value of $\log(1+P/r^2+Qr^4)$ referred to, and it is possible that a further reduction might be made if the better form is $(1+P'/r^2)$. But without expressing an opinion as to whether the Greenwich values are more correct in an absolute sense than the survey values, the only rational course in reducing the survey to epoch was to adopt the Greenwich standards, so that if in the future these require change the magnetic survey as reduced will be changed in a simple and definite way.

We now compare the Cambridge observations with the corresponding Greenwich values.

Declination.	1913.					1914.		1915.	
	November 10.	November 18.	November 19.	November 24.	November 25.	May 25.	September 25.	March 24.	April 22.
Cambridge survey value . . .	15° 19′·9	19′·0	17′·8	21′·0	18′·7	13′·1	9′·9	° 6′·0	2′·4
Greenwich value	15 14·0	13·1	13·9	14·8	14·0	9·9	4·9	14 59·6	57·4
Difference	+5·9	5·9	3·9	6·2	4·7	3·2	5·0	6·4	5·0
Mean . . +5′·1									
Divergence	+0′·8	+0′·8	−1′·2	+1′·1	−0′·4	−1′·9	−0′·1	+1′·3	−0′·1

Horizontal Force.	1913.					1914.		1915.	
	November 10.	November 28.	December 2.	December 3.	December 8.	May 25.	September 25.	March 24.	April 22.
Cambridge survey value . . .	18,162	18,188	18,168	18,161	18,174	18,176	18,190	18,137	18,136
Greenwich value	18,505	18,518	18,527	18,518	18,516	18,514	18,526	18,486	18,484
Difference	343	330	359	357	342	338	336	349	348
Mean . . −345									
Divergence	+2	+15	−14	−12	+3	+7	+9	−4	−3

Inclination.	1913.					1914.		1915.
	November 10.	November 18.	November 24.	November 25.	November 26.	May 25.	September 25.	March 24.
Cambridge survey value . . .	67° 22′·2	21′·7	22′·3	21′·5	22′·4	23′·4	24′·7	26′·7
Greenwich value	66 52·4	50·6	49·4	50·5	49·0	51·4	53·1	52·4
Difference	+29·8	31·1	32·9	31·0	33·4	32·0	31·6	34·3
Mean . . +32′·0								
Divergence	− 2′·2	−0′·9	+0′·9	−1′·0	+1′·4	0′·0	−0′·4	+2′·3

I think the conclusion is that within the limits of experimental error, the magnetic elements at Cambridge vary *pari passu* with those at Greenwich.

The magnetic values obtained at any station refer to a particular day and a particular hour. Thus since the magnetic values are continually varying the observed values are subject to a correction which will reduce them all to a common standard, viz., the normal value characteristic of the stations at the same time—the epoch of the survey. The correction may be considered as made up of (1) correction to mean for the day, (2) correction for secular change to epoch.

Rücker and Thorpe regarded the correction to mean for the day as consisting of two parts (1) that due to the normal diurnal variation; (2) that due to disturbance. They assumed that the values of these obtained from the magnetograms at Kew were applicable to the whole of the British Isles, that the normal diurnal variation depended on local time, but that the disturbance depended on Greenwich time.

None of these assumptions are correct, and it is generally agreed that the only satisfactory way is to have a triangle of recording observatories within which the survey is to be carried out, so that the interpolation of variations may be made. Although we could not arrange for this, a scheme was drawn up for taking a set of magnetographs for a few weeks to the North of Scotland and the West of Ireland, so that by comparison with Greenwich, factors applicable to the various stations might be determined. This plan had, however, to be given up on account of the war and I had to depend on the data from Greenwich only.

Again the rate of secular change is not the same all over the British Isles. On the other hand, preliminary comparison of my results with those of Rücker and Thorpe showed that the average rate of change was fairly uniform all over, so that within the extent of my survey (two years) an elaborate system of correction was hardly justified.

On the whole it appeared that I had to choose between assuming (1) that the Greenwich variations are applicable to the whole of the British Isles; or (2) entering on a somewhat speculative and elaborate system of corrections. I decided to make the former assumption. While some error may thus remain in the values far North and far West, the results are left in a form such that they may be most readily corrected in the future, when the relationship between the variations at any point and those at Greenwich has been investigated.

The correction of the field results to epoch now becomes very simple. We simply have to add, to the value of the element as observed at a station, the increase in the value of that element as observed at Greenwich from the time of the observation to the epoch. In order that the final values should be expressed in terms of the Greenwich standard the difference between the Survey instrument and that at Greenwich has been incorporated in the correction.

In the table of Horizontal Force I have included the observed values of m_0, the magnet moment of magnet 66A at 0° C. These are of interest as showing how well the moment was maintained in spite of the large distance travelled and the varied conditions of temperature experienced. They are also of value as giving some indication of the degree of accuracy obtained from day to day.

All the values of H were obtained by the Unifilar with the exception of those at the five stations Drogheda, Llandudno, Birkenhead, Stoke-on-Trent and Coalville, which are starred. At these places I was unable to get the Unifilar observations carried out, and the values have been assigned from the readings of the portable variometer for measuring differences of H which I carried with me in 1915 and which has been described in 'Roy. Soc. Proc.' for 1916.

In Tables I., II. and III. the results entered as "observed" are, of course, deduced from the field observations, and in the case of Force and Inclination involve a considerable amount of computation. Such computation cannot well be reproduced in detail, but if any doubt arises in future as to the accuracy of an "observed" number, it may be stated that the original observation books are preserved in the Royal Society's archives, and that the copies and tables of Greenwich corrections are preserved by the Ordnance Survey Office, Southampton.

Table I.—Declination.

Station.	No.	Date.	Declination observed.	Greenwich value.	Difference.	Add 15° 2′·8.	Provisional value for epoch Jan. 1, 1915.
		1913.					
Cambridge	67	Nov. 10	15° 19′·9	15° 14′·0	+0° 5′·9	—	15° 8′·7
,, ...	67	,, 18	15 19·0	15 13·1	+0 5·9	—	15 8·7
,, ...	67	,, 19	15 17·8	15 13·9	+0 3·9	—	15 6·7
,, ...	67	,, 24	15 21·0	15 14·8	+0 6·2	—	15 9·0
,, ...	67	,, 25	15 18·7	15 14·0	+0 4·7	—	15 7·5
		1914.					
Greenwich	G.	Jan. 14	15 11·7	15 12·3	−0 0·6	—	15 2·2
,, ...	,,	,, 15	15 11·0	15 12·2	−0 1·2	—	15 1·6
Chichester	72	Mar. 24	15 20·7	15 11·4	+0 9·3	—	15 12·1
Salisbury	136	,, 26	15 41·5	15 12·3	+0 29·2	—	15 32·0
Southampton . . .	O.S.	,, 28	15 27·4	15 11·0	+0 16·4	—	15 19·2
Alresford	58	,, 31	15 28·7	15 13·9	+0 14·8	—	15 17·6
Weymouth	151	April 3	16 0·1	15 10·2	+0 49·9	—	15 52·7
Taunton	145	,, 6	16 26·0	15 12·4	+1 13·6	—	16 16·4
St. Cyres	134	,, 7	16 45·5	15 11·2	+1 34·3	—	16 37·1
Plymouth	124	,, 8	16 43·7	15 10·3	+1 33·4	—	16 36·2
Falmouth	80	,, 9	17 13·3	15 13·5	+1 59·8	—	17 2·6
Bude	66	,, 10	17 7·7	15 9·0	+1 58·7	—	17 1·5
Clovelly	75	,, 15	17 0·5	15 7·7	+1 52·8	—	16 55·6
Ilfracombe	93	,, 16	17 0·8	15 9·8	+1 51·0	—	16 53·8
Clifton	74	,, 18	16 26·0	15 12·5	+1 13·5	—	16 16·3
Cardiff	68	,, 21	16 34·4	15 9·5	+1 24·9	—	16 27·7
Brecon	65	,, 22	16 53·7	15 13·7	+1 40·0	—	16 42·8
Gloucester	83	,, 24	16 23·5	15 9·8	+1 13·7	—	16 16·5
Swindon	144	,, 25	15 31·1	15 10·1	+0 21·0	—	15 23·8
Wallingford	150	,, 27	15 37·4	15 12·0	+0 25·4	—	15 28·2
Reading	131	,, 29	15 28·1	15 12·1	+0 16·0	—	15 18·8
Haslemere	89	,, 30	15 26·2	15 12·3	+0 13·9	—	15 16·7
Ryde	133	May 1	15 19·4	15 12·5	+0 6·9	—	15 9·7
Horsham	91	,, 5	15 16·2	15 9·1	+0 7·1	—	15 9·9
Worthing	156	,, 6	15 16·6	15 13·3	+0 3·3	—	15 6·1
St. Leonard's . . .	135	,, 7	14 41·7	15 12·9	−0 31·2	—	14 31·6
Dover	79	,, 8	14 14·7	15 12·8	−0 58 1	—	14 4·7
Tunbridge Wells . .	149	,, 11	14 26·4	15 9·8	−0 43·4	—	14 19·4
Ranmore	130	,, 12	15 26·7	15 13·8	+0 12·9	—	15 15·7
Windsor	154	,, 13	15 41·8	15 9·8	+0 32·0	—	15 34·8
Greenwich	G.	,, 14	15 8·8	15 9·4	−0 0·6	—	15 2·2
Purfleet	127	,, 15	15 4·8	15 12·6	−0 7·8	—	14 55·0
Southend	139	,, 16	14 55·9	15 11·5	−0 15·6	—	14 47·2
Braintree	64	,, 18	15 2·8	15 8·6	−0 5·8	—	14 57·0
Colchester	77	,, 19	15 11·7	15 11·9	−0 0·2	—	15 2·6
Harwich	87	,, 21	14 34·5	15 10·8	−0 36·3	—	14 26·5
Lowestoft	110	,, 22	14 31·8	15 10·2	−0 38·4	—	14 24·4
Thetford	146	,, 23	14 58·1	15 14·4	−0 16·3	—	14 46·5
Cambridge	67	,, 25	15 13·1	15 9·9	+0 3·2	—	15 6·0
Harpenden	88	,, 26	15 35·3	15 15·4	+0 19·9	—	15 22·7
Kew	99	,, 27	15 28·9	15 9·6	+0 19·3	—	15 22·1
Oxford	122	,, 28	15 44·0	15 8·2	+0 35·8	—	15 38·6
Bedford	61	,, 29	15 35·8	15 8·7	+0 27·1	—	15 29·9
Peterborough . . .	123	,, 30	15 28·4	15 7·7	+0 20·7	—	15 23·5

TABLE I.—Declination (continued).

Station.	No.	Date.	Declination observed.	Greenwich value.	Difference.	Add 15° 2'·8.	Provisional value for epoch Jan. 1, 1915.
		1914.					
March	115	June 2	15° 14'·0	15° 12'·3	+0° 1'·7	—	15° 4'·5
Wisbech	155	„ 3	15 16·5	15 9·8	+0 6·7	—	15 9·5
Tilney	148	„ 4	15 23·0	15 9·7	+0 13·3	—	15 16·1
Clenchwarton	73	„ 4	15 16·0	15 9·3	+0 6·7	—	15 9·5
King's Lynn	100	„ 5	15 13·3	15 9·3	+0 4·0	—	15 6·8
Cromer	78	„ 8	14 41·8	15 9·6	−0 27·8	—	14 35·0
Sutton Bridge	142	„ 10	15 13·1	15 12·1	+0 1·0	—	15 3·8
Spalding	140	„ 11	15 12·2	15 9·5	+0 2·7	—	15 5·5
Mablethorpe	111	„ 12	15 27·5	15 9·1	+0 18·4	—	15 21·2
Lincoln	105	„ 12	15 30·8	15 9·0	+0 21·8	—	15 24·6
Gainsborough	81	„ 15	15 53·2	15 11·8	+0 41·4	—	15 44·2
Hull	92	„ 16	16 7·1	15 8·4	+0 58·7	—	16 1·5
Scarborough	137	„ 17	16 0·4	15 7·8	+0 52·6	—	15 55·4
Thirsk	147	„ 17	16 28·4	15 8·5	+1 19·9	—	16 22·7
Redcar	132	„ 18	16 16·3	15 11·7	+1 4·6	—	16 7·4
Newcastle	119	„ 19	16 43·1	15 12·1	+1 31·0	—	16 33·8
Alnwick	57	„ 20	16 53·5	15 10·2	+1 43·3	—	16 46·1
Berwick	8	„ 20	16 48·0	15 9·9	+1 38·1	—	16 40·9
Edinburgh	22	„ 24	17 55·3	15 10·2	+2 45·1	—	17 47·9
Dundee	21	„ 26	17 39·6	15 8·4	+2 31·2	—	17 34·0
Crieff	17	„ 27	18 23·5	15 8·2	+3 15·3	—	18 18·1
Pitlochry	41	„ 29	18 16·1	15 10·0	+3 6·1	—	18 8·9
Aberdeen	1	July 1	17 27·4	15 6·8	+2 20·6	—	17 23·4
Ballater	5	„ 2	17 36·8	15 10·8	+2 26·0	—	17 28·8
Banff	7	„ 3	18 2·5	15 11·5	+2 51·0	—	17 53·8
Elgin	23	„ 6	18 10·0	15 10·7	+2 59·3	—	18 2·1
Boat of Garten	9	„ 7	18 55·3	15 7·6	+3 47·7	—	18 50·5
Inverness	32	„ 8	18 43·5	15 8·8	+3 34·7	—	18 37·5
Lairg	36	„ 10	19 2·6	15 10·1	+3 52·5	—	18 55·3
Golspie	29	„ 13	19 4·5	15 5·4	+3 59·1	—	19 1·9
Wick	54	„ 14	18 29·2	15 6·7	+3 22·5	—	18 25·3
Kirkwall	34	„ 15	18 27·2	15 5·0	+3 22·2	—	18 25·0
Stromness	51	„ 15	18 24·0	15 5·6	+3 18·4	—	18 21·2
Thurso	53	„ 16	18 13·2	15 8·4	+3 4·8	—	18 7·6
Loch Inver	31	Aug. 5	19 40·9	15 6·5	+4 34·4	—	19 37·2
Loch Eribol	24	„ 7	19 21·5	15 9·1	+4 12·4	—	19 15·2
Gairloch	27	„ 10	19 46·2	15 7·1	+4 39·1	—	19 31·9
Kyle Akin	35	„ 11	20 5·5	15 10·2	+4 55·3	—	19 58·1
Portree	43	„ 12	18 54·5	15 7·2	+3 47·3	—	18 50·1
Fort Augustus	26	„ 13	18 54·0	15 9·5	+3 44·5	—	18 47·3
Banavie	6	„ 14	19 9·9	15 9·3	+4 0·6	—	19 3·4
Dalwhinnie	19	„ 17	18 49·4	15 5·9	+3 43·5	—	18 46·3
Crianlarich	16	„ 18	19 2·7	15 10·2	+3 52·5	—	18 55·3
Oban	40	„ 19	19 16·3	15 5·3	+4 11·0	—	19 13·8
Tarbert	52	„ 20	18 59·5	15 7·5	+3 52·0	—	18 54·8
Campbeltown	13	„ 21	19 21·8	15 7·8	+4 14·0	—	19 16·8
Strachur	49	„ 24	18 40·4	15 6·9	+3 33·5	—	18 36·3
Lochgoilhead	38	„ 25	19 22·1	15 10·3	+4 11·8	—	19 14·6
Row	44	„ 26	18 46·0	15 9·7	+3 36·3	—	18 39·1
Stirling	47	„ 31	18 46·6	15 2·6	+3 44·0	—	18 46·8
Glasgow	28	Sept. 2	19 4·4	15 9·0	+3 55·4	—	18 58·2

TABLE I.—Declination (continued).

Station.	No.	Date.	Declination observed.	Greenwich value.	Difference.	Add 15° 2′·8	Provisional value for epoch Jan. 1, 1915.
		1914.					
Carstairs	15	Sept. 3	17° 59′·3	15° 11′·9	+2° 47′·4	—	17° 50′·2
Fairlie	25	„ 4	18 29·8	15 14·3	+3 15·5	—	18 18·3
Ayr	4	„ 5	18 39·1	15 10·5	+3 28·6	—	18 31·4
Stranraer	50	„ 7	18 37·1	15 9·6	+3 27·5	—	18 30·3
Dumfries	20	„ 8	17 57·0	15 8·5	+2 48·5	—	17 51·3
Hawick	30	„ 9	17 37·0	15 9·4	+2 27·6	—	17 30·4
Carlisle	70	„ 10	17 28·4	15 7·7	+2 20·7	—	17 23·5
Appleby	59	„ 11	17 12·5	15 8·7	+2 3·8	—	17 6·6
Whitehaven	153	„ 12	17 44·1	15 8·6	+2 35·5	—	17 38·3
Barrow	60	„ 15	17 15·0	15 7·2	+2 7·8	—	17 10·6
Giggleswick	82	„ 16	16 41·9	15 6·6	+1 35·3	—	16 38·1
Stonyhurst	S.	„ 17	16 46·0	15 6·7	+1 39·3	—	16 42·1
Preston	126	„ 18	17 3·2	15 8·3	+1 54·9	—	16 57·7
Manchester	113	„ 19	16 30·0	15 10·4	+1 19·6	—	16 22·4
Leeds	103	„ 21	16 23·8	15 9·3	+1 14·5	—	16 17·3
Chesterfield	71	„ 22	16 14·6	15 10·0	+1 4·6	—	16 7·4
Newark	118	„ 23	15 49·8	15 8·3	+0 41·5	—	15 44·3
Grantham	84	„ 24	15 48·6	15 6·6	+0 42·0	—	15 44·8
Cambridge	67	„ 25	15 9·9	15 4·9	+0 5·0	—	15 7·8
		1915.					
Cambridge	67	Mar. 24	15 6·0	14 59·6	+0 6·4	—	15 9·2
Northampton	120	Apr. 2	15 47·1	14 58·8	+0 48·3	—	15 51·1
King's Sutton	101	„ 5	15 53·2	14 58·6	+0 54·6	—	15 57·4
Kenilworth	97	„ 7	15 54·7	14 56·3	+0 58·4	—	16 1·2
Malvern	112B	„ 8	16 30·4	15 2·2	+1 28·2	—	16 31·0
„	112C	„ 8	16 30·0	15 5·6	+1 24·4	—	16 27·2
„	112A	„ 9	16 9·6	15 0·4	+1 9·2	—	16 12·0
„	112D	„ 10	16 1·0	15 1·2	+0 59·8	—	16 2·6
Milford Haven	117	„ 13	17 11·0	15 2·4	+2 8·6	—	17 11·4
Swansea	143	„ 14	16 47·5	14 59·7	+1 47·8	—	16 50·6
Lampeter	102	„ 15	17 0·2	14 58·5	+2 1·7	—	17 4·5
Cardigan	69	„ 16	17 35·6	15 4·1	+2 31·5	—	17 34·3
Aberystwith	55	„ 17	16 51·8	14 59·3	+1 52·5	—	16 55·3
Llanidloes	108	„ 17	16 50·2	15 1·6	+1 48·6	—	16 51·4
Shrewsbury	138	„ 19	16 49·0	15 1·0	+1 48·0	—	16 50·8
Birmingham	63	„ 20	15 50·4	15 5·0	+0 45·4	—	15 48·2
Cambridge	67	„ 22	15 2·4	14 57·4	+0 5·0	—	15 7·8
Kettering	98	June 12	15 34·0	14 58·5	+0 35·5	—	15 38·3
Manton	114	„ 14	15 27·7	14 55·9	+0 31·8	—	15 34·6
Melton	116	„ 15	16 21·2	14 55·0	+1 26·2	—	16 29·0
Nottingham	121	„ 16	15 46·1	14 59·5	+0 46·6	—	15 49·4
Loughborough	109	„ 17	15 29·0	15 7·0	+0 22·0	—	15 24·8
Dublin	174	Aug. 9	18 44·2	15 1·0	+3 43·2	—	18 46·0
Wicklow	200	„ 10	18 17·8	14 59·9	+3 17·9	—	18 20·7
Bagenalstown	159	„ 11	18 51·6	15 1·9	+3 49·7	—	18 52·5
Kilkenny	181	„ 12	18 50·8	15 3·0	+3 47·8	—	18 50·6
Ballywilliam	161	„ 13	18 34·1	15 1·4	+3 32·7	—	18 35·5
Wexford	199	„ 14	18 10·6	14 56·9	+3 13·7	—	18 16·5
Waterford	197	„ 16	18 29·0	15 1·3	+3 27·7	—	18 30·5
Lismore	187	„ 17	19 4·5	15 1·0	+4 3·5	—	19 6·3

TABLE I.—Declination (continued).

Station.	No.	Date.	Declination observed.	Greenwich value.	Difference.	Add 15° 2′·8.	Provisional value for epoch Jan. 1, 1915.
		1915.					
Cork	171	Aug. 18	° ′ 19 20·6	° ′ 15 1·3	° ′ +4 19·3	—	° ′ 19 22·1
Bantry	163	,, 19	19 35·8	14 59·3	+4 36·5	—	19 39·3
Valencia	195	,, 20	20 7·3	14 58·1	+5 9·2	—	20 12·0
Killarney	182	,, 26	19 55·3	15 0·6	+4 54·7	—	19 57·5
Tralee	194	,, 27	20 10·7	15 2·9	+5 7·8	—	20 10·6
Charleville	167	,, 28	19 30·1	14 56·7	+4 33·4	—	19 36·2
Tipperary	193	,, 30	19 19·8	14 59·1	+4 20·7	—	19 23·5
Limerick	185	,, 31	19 49·9	15 0·4	+4 49·5	—	19 52·3
Kilrush	183	Sept. 1	20 6·8	14 58·3	+5 8·5	—	20 11·3
Lisdoonvarna	186	,, 2	19 55·5	14 59·6	+4 55·9	—	19 58·7
Gort	177	,, 3	19 46·6	14 58·8	+4 47·8	—	19 50·6
Parsonstown	190	,, 4	19 27·1	15 0·0	+4 27·1	—	19 29·9
Kildare	180	,, 6	18 56·4	14 57·4	+3 59·0	—	19 1·8
Athlone	158	,, 7	19 25·1	14 59·5	+4 25·6	—	19 28·4
Galway	176	,, 8	20 20·1	14 57·8	+5 22·3	—	20 25·1
Oughterard	189	,, 9	20 33·4	14 58·9	+5 34·5	—	20 37·3
Clifden	168	,, 10	20 27·7	14 58·2	+5 29·5	—	20 32·3
Leenane	184	,, 11	20 19·7	14 58·1	+5 21·6	—	20 24·4
Westport	198	,, 13	20 9·4	14 59·4	+5 10·0	—	20 12·8
Ballina	160	,, 14	20 10·8	14 58·3	+5 12·5	—	20 15·3
Castlereagh	165	,, 15	20 7·8	14 58·5	+5 9·3	—	20 12·1
Carrick-on-Shannon	164	,, 16	19 55·4	14 58·0	+4 57·4	—	20 0·2
Sligo	191	,, 17	20 5·2	15 2·2	+5 3·0	—	20 5·8
Enniskillen	175	,, 18	19 46·6	14 56·8	+4 49·8	—	19 52·6
Donegal	172	,, 20	19 37·2	14 55·2	+4 42·0	—	19 44·8
Strabane	192	,, 21	19 44·8	14 57·2	+4 47·6	—	19 50·4
Londonderry	188	,, 21	19 44·0	14 58·0	+4 46·0	—	19 48·8
Coleraine	169	,, 22	19 46·8	15 0·8	+4 46·0	—	19 48·8
Waterfoot	196	,, 23	19 19·6	15 0·0	+4 19·6	—	19 22·4
Cookstown Junction	170	,, 24	17 15·4	14 58·2	+2 17·2	—	17 20·0
Bangor	162	,, 28	18 30·9	14 56·7	+3 34·2	—	18 37·0
Armagh	157	,, 29	19 9·7	14 59·5	+4 10·2	—	19 13·0
Greenore	178	,, 30	19 8·0	15 0·3	+4 7·7	—	19 10·5
Cavan	166	Oct. 1	19 28·8	14 58·9	+4 29·9	—	19 32·7
Kells	179	,, 1	19 10·6	14 55·6	+4 15·0	—	19 17·8
Drogheda	173	,, 2	18 52·3	14 56·7	+3 55·6	—	18 58·4
Holyhead	90	,, 4	17 45·5	14 56·9	+2 48·6	—	17 51·4
Pwllheli	128	,, 6	17 30·3	14 54·7	+2 35·6	—	17 38·4
Llandudno	106	,, 8	17 43·6	14 58·6	+2 45·0	—	17 47·8
Llangollen	107	,, 9	17 2·7	14 58·2	+2 4·5	—	17 7·3
Birkenhead	62	,, 11	17 0·5	15 1·0	+1 59·5	—	17 2·3
Wheelock	152	,, 12	16 13·7	14 55·0	+1 18·7	—	16 21·5
Stoke-on-Trent	141	,, 13	16 14·6	14 53·6	+1 21·0	—	16 23·8
Coalville	76	,, 13	15 27·0	14 56·3	+0 30·7	—	15 33·5
Leicester	104	,, 14	15 29·0	14 57·8	+0 31·2	—	15 34·0

Table II.—Horizontal Force.

Station.	No.	Date.	Horizontal Force observed.	Greenwich value.	Difference.	Add 18,505.	Provisional value for epoch Jan. 1, 1915.	Moment of magnet at 0° C.
		1913.						
Cambridge	67	Nov. 10	18,162	18,505	− 343	—	18,162	768·3
"	67	" 28	18,188	18,518	− 330	—	18,175	761·1
"	67	Dec. 2	18,168	18,527	− 359	—	18,146	760·1
"	67	" 3	18,161	18,518	− 357	—	18,148	760·1
"	67	" 8	18,174	18,516	− 342	—	18,163	760·5
		1914.						
Greenwich	G.	Jan. 14	18,575	18,548	+ 27	—	18,532	760·3
"	"	" 15	18,560	18,553	+ 7	—	18,512	760·4
Chichester	72	Mar. 24	18,836	18,541	+ 295	—	18,800	760·4
Salisbury	136	" 26	18,638	18,536	+ 102	—	18,607	760·3
Southampton . . .	O.S.	" 28	18,704	18,513	+ 191	—	18,696	760·0
Alresford	58	" 31	18,721	18,540	+ 181	—	18,686	759·9
Weymouth . . .	151	April 3	18,815	18,513	+ 302	—	18,807	760·7
Taunton	145	" 6	18,577	18,507	+ 70	—	18,575	760·6
St. Cyres	134	" 7	18,686	18,534	+ 152	—	18,657	759·9
Plymouth	124	" 8	18,811	18,527	+ 284	—	18,789	760·2
Falmouth	80	" 9	18,832	18,523	+ 309	—	18,814	760·2
Bude	66	" 11	18,517	18,509	+ 8	—	18,513	760·4
Clovelly	75	" 15	18,461	18,515	− 54	—	18,451	760·7
Ilfracombe	93	" 16	18,390	18,501	− 111	—	18,394	760·5
Clifton	74	" 18	18,426	18,512	− 86	—	18,419	760·4
Cardiff	68	" 21	18,409	18,518	− 109	—	18,396	759·6
Brecon	65	" 22	18,143	18,532	− 389	—	18,116	760·0
Gloucester	83	" 24	18,210	18,515	− 305	—	18,200	759·5
Swindon	144	" 25	18,384	18,511	− 127	—	18,378	760·3
Wallingford . . .	150	" 27	18,432	18,519	− 87	—	18,418	759·1
Reading	131	" 29	18,504	18,520	− 16	—	18,489	759·7
Haslemere	89	" 30	18,692	18,525	+ 167	—	18,672	759·5
Ryde	133	May 1	18,794	18,497	+ 297	—	18,802	759·2
Horsham	91	" 5	18,739	18,524	+ 215	—	18,720	759·4
Worthing	156	" 6	18,835	18,531	+ 304	—	18,809	759·4
St. Leonards . . .	135	" 7	18,846	18,539	+ 307	—	18,812	759·2
Dover	79	" 8	18,771	18,536	+ 235	—	18,740	759·5
Tunbridge Wells. .	149	" 11	18,765	18,564	+ 201	—	18,706	759·2
Ranmore	130	" 12	18,705	18,516	+ 189	—	18,694	759·1
Windsor	154	" 13	18,479	18,508	− 29	—	18,476	759·4
Greenwich	G.	" 14	18,565	18,553	+ 12	—	18,517	759·2
Purfleet	127	" 15	18,563	18,565	− 2	—	18,503	758·3
Southend	139	" 16	18,535	18,541	− 8	—	18,497	759·7
Braintree	64	" 18	18,373	18,530	− 157	—	18,348	757·6
Colchester	77	" 19	18,404	18,515	− 111	—	18,394	759·2
Harwich	87	" 21	18,391	18,547	− 156	—	18,349	757·9
Lowestoft	110	" 22	18,198	18,537	− 339	—	18,166	758·7
Thetford	146	" 23	18,169	18,566	− 397	—	18,108	758·6
Cambridge. . . .	67	" 25	18,176	18,514	− 338	—	18,167	758·7
Harpenden . . .	88	" 26	18,391	18,561	− 170	—	18,335	758·7
Kew.	99	" 27	18,484	18,506	− 22	—	18,483	758·7
Oxford	122	" 28	18,241	18,489	− 248	—	18,257	758·8
Bedford.	61	" 29	18,100	18,529	− 429	—	18,076	758·4
Peterborough . . .	123	" 30	18,087	18,539	− 442	—	18,063	758·3

TABLE II.—Horizontal Force (continued).

Station.	No.	Date.	Horizontal Force observed.	Greenwich value.	Differ-ence.	Add 18,505.	Provisional value for epoch Jan. 1, 1915.	Moment of magnet at 0° C.
		1914.						
March	115	June 2	18,073	18,530	− 457	—	18,048	758·8
Wisbech	155	" 3	18,085	18,535	− 450	—	18,055	759·1
Tilney	148	" 4	18,024	18,517	− 493	—	18,012	758·4
Clenchwarton	73	" 4	18,027	18,534	− 507	—	17,998	758·5
King's Lynn	100	" 5	18,030	18,515	− 485	—	18,020	759·1
Cromer	78	" 8	17,995	18,496	− 501	—	18,004	759·1
Sutton Bridge	142	" 10	18,040	18,532	− 492	—	18,013	757·7
Spalding	140	" 11	18,016	18,519	− 503	—	18,002	759·0
Mablethorpe	111	" 12	17,733	18,529	− 796	—	17,709	758·5
Lincoln	105	" 12	17,794	18,556	− 762	—	17,743	758·2
Gainsborough	81	" 15	17,750	18,552	− 802	—	17,703	758·5
Hull	92	" 16	17,549	18,518	− 969	—	17,536	759·3
Scarborough	137	" 17	17,380	18,511	− 1131	—	17,474	758·8
Thirsk	147	" 17	17,287	18,551	− 1264	—	17,241	757·2
Redcar	132	" 18	17,209	18,522	− 1313	—	17,192	758·5
Newcastle	119	" 19	17,006	18,521	− 1517	—	16,988	758·1
Alnwick	57	" 20	16,861	18,524	− 1663	—	16,842	758·2
Berwick	8	" 20	16,834	18,550	− 1716	—	16,789	757·5
Edinburgh	22	" 24	16,556	18,509	− 1953	—	16,552	758·8
Dundee	21	" 26	16,113	18,528	− 2415	—	16,090	758·5
Crieff	17	" 27	16,353	18,521	− 2168	—	16,337	759·0
Pitlochry	41	" 29	16,215	18,522	− 2307	—	16,198	758·6
Aberdeen	1	July 1	16,015	18,513	− 2498	—	16,007	758·7
Ballater	5	" 2	16,054	18,524	− 2470	—	16,035	757·8
Banff	7	" 4	15,994	18,533	− 2539	—	15,966	758·3
Elgin	23	" 6	15,917	18,516	− 2599	—	15,906	758·3
Boat of Garten	9	" 7	16,050	18,491	− 2441	—	16,064	758·6
Inverness	32	" 8	15,924	18,505	− 2581	—	15,924	758·7
Lairg	36	" 10	15,645	18,523	− 2878	—	15,627	759·0
Golspie	29	" 13	15,684	18,518	− 2834	—	15,671	758·7
Wick	54	" 14	15,508	18,522	− 3014	—	15,491	758·4
Kirkwall	34	" 15	15,356	18,499	− 3143	—	15,362	757·8
Stromness	51	" 15	15,429	18,535	− 3106	—	15,399	757·6
Thurso	53	" 16	15,514	18,533	− 3019	—	15,486	758·7
Loch Inver	31	Aug. 5	15,219	18,516	− 3297	—	15,208	758·4
Loch Eribol	24	" 7	15,461	18,498	− 3037	—	15,468	758·8
Gairloch	27	" 10	15,648	18,543	− 2895	—	15,610	758·8
Kyle Akin	35	" 11	15,807	18,516	− 2709	—	15,796	758·4
Portree	43	" 12	16,473	18,510	− 2037	—	16,468	758·1
Fort Augustus	26	" 13	15,986	18,522	− 2536	—	15,969	758·9
Banavie	6	" 14	16,234	18,520	− 2286	—	16,219	758·9
Dalwhinnie	19	" 17	16,266	18,537	− 2271	—	16,234	757·7
Crianlarich	16	" 18	16,385	18,540	− 2155	—	16,350	757·6
Oban	40	" 19	16,436	18,526	− 2090	—	16,415	758·9
Tarbert	52	" 20	16,366	18,520	− 2154	—	16,351	758·1
Campbeltown	13	" 21	16,591	18,519	− 1928	—	16,577	757·7
Strachur	49	" 24	16,222	18,540	− 2318	—	16,187	758·0
Lochgoilhead	38	" 25	16,397	18,520	− 2123	—	16,382	758·4
Row	44	" 26	16,385	18,524	− 2139	—	16,366	758·3
Stirling	47	" 31	16,104	18,536	− 2432	—	16,073	757·7
Glasgow	28	Sept. 2	16,208	18,537	− 2329	—	16,176	758·4

TABLE II.—Horizontal Force (continued).

Station.	No.	Date.	Horizontal Force observed.	Greenwich value.	Difference.	Add 18,505.	Provisional value for epoch Jan. 1, 1915.	Moment of magnet at 0° C.
		1914.						
Carstairs	15	Sept. 3	16,775	18,537	−1762	—	16,743	758·5
Fairlie	25	,, 4	16,578	18,524	−1946	—	16,559	758·5
Ayr.	4	,, 5	16,679	18,503	−1824	—	16,681	758·8
Stranraer	50	,, 7	16,833	18,512	−1679	—	16,826	758·5
Dumfries	20	,, 8	16,943	18,532	−1589	—	16,916	757·7
Hawick	30	,, 9	16,786	18,512	−1726	—	16,779	758·1
Carlisle	70	,, 10	17,000	18,507	−1507	—	16,998	758·1
Appleby	59	,, 11	17,076	18,527	−1451	—	17,054	758·4
Whitehaven . . .	153	,, 12	17,063	18,518	−1455	—	17,050	758·9
Barrow	60	,, 15	17,237	18,493	−1256	—	17,249	758·4
Giggleswick . . .	82	,, 16	17,347	18,532	−1185	—	17,320	758·6
Stonyhurst . . .	S	,, 17	17,376	18,528	−1152	—	17,353	758·3
Preston	126	,, 18	17,430	18,527	−1097	—	17,408	758·9
Manchester . . .	113	,, 19	17,579	18,535	− 956	—	17,549	759·3
Leeds	103	,, 21	17,476	18,526	−1050	—	17,455	759·2
Chesterfield . . .	71	,, 22	17,781	18,544	− 763	—	17,742	758·4
Newark	118	,, 23	17,815	18,538	− 723	—	17,782	758·6
Grantham	84	,, 24	17,860	18,525	− 665	—	17,840	758·5
Cambridge	67	,, 25	18,190	18,526	− 336	—	18,169	758·6
		1915.						
Cambridge	67	Mar. 24	18,137	18,486	− 349	—	18,156	757·5
Northampton . . .	120	April 2	18,063	18,489	− 426	—	18,079	758·6
King's Sutton . .	101	,, 5	18,178	18,487	− 309	—	18,196	757·6
Kenilworth . . .	97	,, 7	17,971	18,492	− 521	—	17,984	758·9
Malvern	112B	,, 8	18,049	18,477	− 428	—	18,077	758·8
,, ...	112C	,, 8	18,108	18,527	− 419	—	18,086	758·4
,, ...	112A	,, 9	17,991	18,503	− 512	—	17,993	758·8
,, ...	112D	,, 10	18,072	18,507	− 435	—	18,070	758·2
Milford Haven . .	117	,, 13	18,252	18,529	− 277	—	18,228	758·3
Swansea	143	,, 14	18,335	18,512	− 177	—	18,328	757·6
Lampeter	102	,, 15	17,950	18,508	− 558	—	17,947	758·2
Cardigan	69	,, 16	17,907	18,488	− 581	—	17,924	758·2
Aberystwith . . .	55	,, 17	17,891	18,483	− 592	—	17,913	759·1
Llanidloes	108	,, 17	17,882	18,512	− 630	—	17,875	758·1
Shrewsbury . . .	138	,, 19	17,798	18,485	− 687	—	17,818	759·1
Birmingham . . .	63	,, 20	17,984	18,500	− 516	—	17,989	758·2
Cambridge	67	,, 22	18,136	18,484	− 348	—	18,157	758·3
Kettering . . .	98	June 12	18,104	18,501	− 397	—	18,108	758·2
Manton.	114	,, 14	18,064	18,478	− 414	—	18,091	758·4
Melton	116	,, 15	18,016	18,485	− 469	—	18,036	758·1
Nottingham . . .	121	,, 16	17,862	18,483	− 621	—	17,884	757·8
Loughborough . .	109	,, 17	17,715	18,300	− 585	—	17,920	757·7
Dublin	174	Aug. 9	17,461	18,492	−1031	—	17,474	757·8
Wicklow	200	,, 10	17,534	18,482	− 948	—	17,557	757·9
Bagenalstown . .	159	,, 11	17,645	18,490	− 845	—	17,660	757·2
Kilkenny	181	,, 12	17,656	18,490	− 834	—	17,671	757·7
Ballywilliam . . .	161	,, 13	17,635	18,490	− 855	—	17,650	757·1
Wexford	199	,, 14	17,761	18,488	− 727	—	17,778	758·3
Waterford	197	,, 16	17,799	18,495	− 696	—	17,809	757·7
Lismore	187	,, 17	17,809	18,491	− 682	—	17,823	757·5

TABLE II.—Horizontal Force (continued).

Station.	No.	Date.	Horizontal Force observed.	Greenwich value.	Difference.	Add 18,505.	Provisional value for epoch Jan. 1, 1915.	Moment of magnet at 0° C.
		1915.						
Cork	171	Aug. 18	17,916	18,498	– 582	—	17,923	757·4
Bantry	163	„ 19	17,994	18,482	– 488	—	18,017	757·6
Valencia	195	„ 20	17,903	18,497	– 594	—	17,911	758·4
Killarney	182	„ 26	17,879	18,476	– 597	—	17,908	757·7
Tralee	194	„ 27	17,699	18,492	– 793	—	17,712	757·8
Charleville	167	„ 28	17,701	18,501	– 800	—	17,705	757·4
Tipperary	193	„ 30	17,695	18,476	– 781	—	17,724	758·3
Limerick	185	„ 31	17,658	18,503	– 845	—	17,660	757·5
Kilrush	183	Sept. 1	17,543	18,499	– 956	—	17,549	758·1
Lisdoonvarna	186	„ 2	17,479	18,498	– 1019	—	17,486	758·3
Gort	177	„ 3	17,445	18,501	– 1056	—	17,449	756·9
Parsonstown	190	„ 4	17,410	18,493	– 1083	—	17,422	757·6
Kildare	180	„ 6	17,505	18,495	– 990	—	17,515	758·2
Athlone	158	„ 7	17,295	18,496	– 1201	—	17,304	757·0
Galway	176	„ 8	17,305	18,490	– 1185	—	17,320	757·9
Oughterard	189	„ 9	17,171	18,499	– 1328	—	17,177	757·6
Clifden	168	„ 10	17,064	18,492	– 1428	—	17,077	757·3
Leenore	184	„ 11	16,973	18,492	– 1519	—	16,986	757·5
Westport	198	„ 13	16,921	18,505	– 1684	—	16,921	757·9
Ballina	160	„ 14	16,728	18,489	– 1761	—	16,744	757·4
Castlereagh	165	„ 15	17,100	18,485	– 1385	—	17,120	757·5
Carrick-on-Shannon	164	„ 16	17,115	18,490	– 1375	—	17,130	757·1
Sligo	191	„ 17	16,798	18,474	– 1676	—	16,829	757·6
Enniskillen	175	„ 18	16,864	18,482	– 1618	—	16,887	757·3
Donegal	172	„ 20	16,919	18,476	– 1557	—	16,948	758·2
Strabane	192	„ 21	16,772	18,488	– 1716	—	16,789	757·9
Londonderry	188	„ 21	16,720	18,495	– 1775	—	16,730	757·3
Coleraine	169	„ 22	17,112	18,479	– 1367	—	17,138	757·2
Waterfoot	196	„ 23	16,719	18,469	– 1750	—	16,755	757·2
Cookstown Junction	170	„ 24	16,889	18,468	– 1579	—	16,926	757·9
Bangor	162	„ 28	16,934	18,470	– 1536	—	16,969	758·2
Armagh	157	„ 29	16,999	18,476	– 1477	—	17,028	758·0
Greenore	178	„ 30	17,181	18,466	– 1285	—	17,220	758·4
Cavan	166	Oct. 1	16,995	18,479	– 1484	—	17,021	757·7
Kells	179	„ 1	17,317	18,495	– 1178	—	17,327	757·5
Drogheda	173	„ 2	17,260*	18,488	– 1228	—	17,277	—
Holyhead	90	„ 4	17,363	18,509	– 1146	—	17,359	757·9
Pwllheli	128	„ 6	17,810	18,502	– 692	—	17,813	757·7
Llandudno	106	„ 8	17,446*	18,501	– 1055	—	17,450	—
Llangollen	107	„ 9	17,721	18,505	– 784	—	17,721	757·7
Birkenhead	62	„ 11	17,476*	18,474	– 998	—	17,507	—
Wheelock	152	„ 12	17,670	18,490	– 820	—	17,685	757·9
Stoke-on-Trent	141	„ 13	17,739*	18,488	– 749	—	17,756	—
Coalville	76	„ 13	17,944*	18,506	– 562	—	17,943	—
Leicester	104	„ 14	17,944	18,482	– 538	—	17,967	757·5

TABLE III.—Inclination.

Station.	No.	Date.	Inclination observed.	Greenwich value.	Difference.	Add 66° 52′·1.	Provisional value for epoch Jan. 1, 1915.
		1913.					
Cambridge	67	Nov. 10	67° 22′·2	66° 52′·4	+0° 29′·8	—	67° 21′·9
,, ...	67	,, 18	67 21·7	66 50·6	+0 31·1	—	67 23·2
,, ...	67	,, 24	67 22·3	66 49·4	+0 32·9	—	67 25·0
,, ...	67	,, 25	67 21·5	66 50·5	+0 31·0	—	67 23·1
,, ...	67	,, 26	67 22·4	66 49·0	+0 33·4	—	67 25·5
		1914.					
Greenwich	G.	Jan. 14	66 50·8	66 50·6	+0 0·2	—	66 52·3
,, ...	,,	,, 15	66 50·2	66 50·1	+0 0·1	—	66 52·2
Chichester	72	Mar. 24	66 24·8	66 50·0	−0 25·2	—	66 26·9
Salisbury	136	,, 26	66 41·9	66 49·8	−0 7·9	—	66 44·2
Southampton . . .	O.S.	,, 28	66 34·1	66 50·7	−0 16·6	—	66 35·5
Alresford	58	,, 31	66 37·8	66 49·1	−0 11·3	—	66 40·8
Weymouth	151	April 3	66 25·1	66 51·0	−0 25·9	—	66 26·2
Taunton	145	,, 6	66 50·1	66 53·0	−0 2·9	—	66 49·2
St. Cyres	134	,, 7	66 40·2	66 50·4	−0 10·2	—	66 41·9
Plymouth	124	,, 8	66 24·1	66 50·8	−0 26·7	—	66 25·4
Falmouth	80	,, 9	66 24·3	66 51·1	−0 26·8	—	66 25·3
Bude	66	,, 11	66 59·5	66 51·4	+0 8·1	—	67 0·2
Clovelly	75	,, 15	67 6·0	66 51·4	+0 14·6	—	67 6·7
Ilfracombe	93	,, 16	67 8·6	66 50·9	+0 17·7	—	67 9·8
Clifton	74	,, 18	67 9·6	66 50·4	+0 19·2	—	67 11·3
Cardiff	68	,, 21	67 8·9	66 51·0	+0 17·9	—	67 10·0
Brecon	65	,, 22	67 31·9	66 50·6	+0 41·3	—	67 33·4
Gloucester	83	,, 24	67 24·4	66 51·4	+0 33·0	—	67 25·1
Swindon	144	,, 25	67 8·7	66 51·2	+0 17·5	—	67 9·6
Wallingford	150	,, 27	67 2·7	66 49·6	+0 13·1	—	67 5·2
Reading	131	,, 29	66 59·3	66 49·2	+0 10·1	—	67 2·2
Haslemere	89	,, 30	66 37·2	66 49·3	−0 12·1	—	66 40·0
Ryde	133	May 1	66 24·3	66 52·0	−0 27·7	—	66 24·4
Horsham	91	,, 5	66 30·2	66 49·8	−0 19·6	—	66 32·5
Worthing	156	,, 6	66 22·2	66 49·6	−0 27·4	—	66 24·7
St. Leonards. . . .	135	,, 7	66 18·7	66 49·8	−0 31·1	—	66 21·0
Dover	79	,, 8	66 26·5	66 50·6	−0 24·1	—	66 28·0
Tunbridge Wells . .	149	,, 11	66 29·4	66 50·8	−0 21·4	—	66 30·7
Ranmore	130	,, 12	66 36·1	66 53·0	−0 16·9	—	66 35·2
Windsor	154	,, 13	66 57·3	66 53·1	+0 4·2	—	66 56·3
Greenwich	G.	,, 14	66 49·4	66 50·0	−0 0·6	—	66 51·5
Purfleet	127	,, 15	66 52·9	66 49·0	+0 3·9	—	66 56·0
Southend	139	,, 16	66 51·3	66 50·4	+0 0·9	—	66 53·0
Braintree	64	,, 18	67 4·8	66 50·2	+0 14·6	—	67 6·7
Colchester	77	,, 19	67 5·1	66 50·6	+0 4·5	—	66 56·6
Harwich	87	,, 21	67 2·2	66 48·7	+0 3·5	—	66 55·6
Lowestoft	110	,, 22	67 22·8	66 49·7	+0 33·1	—	67 25·2
Thetford	146	,, 23	67 23·0	66 48·4	+0 34·6	—	67 26·7
Cambridge	67	,, 25	67 23·4	66 51·4	+0 32·0	—	67 24·1
Harpenden	88	,, 26	67 8·6	66 50·6	+0 18·0	—	67 10·1
Kew	99	,, 27	66 56·4	66 52·4	+0 4·0	—	66 56·1
Oxford	122	,, 28	67 19·7	66 54·0	+0 25·7	—	67 17·8
Bedford	61	,, 29	67 27·4	66 50·6	+0 36·8	—	67 28·9
Peterborough . . .	123	,, 30	67 37·4	66 50·1	+0 47·3	—	67 39·4

TABLE III.—Inclination (continued).

Station.	No.	Date.	Inclination observed.	Greenwich value.	Difference.	Add 66° 52′·1.	Provisional value for epoch Jan. 1, 1915.
		1914.					
March	115	June 2	67° 33′·4	66° 51′·4	+0° 42′·0	—	67° 34′·1
Wisbech	155	„ 3	67 39·7	66 51·2	+0 48·5	—	67 40·6
Tilney	148	„ 4	67 40·9	66 52·0	+0 48·9	—	67 41·0
King's Lynn	100	„ 5	67 39·5	66 52·2	+0 47·3	—	67 39·4
Cromer	78	„ 8	67 43·3	66 52·7	+0 50·6	—	67 42·7
Clenchwarton	73	„ 10	67 41·5	66 52·8	+0 48·7	—	67 40·8
Sutton Bridge	142	„ 10	67 43·2	66 50·9	+0 52·3	—	67 44·4
Spalding	140	„ 11	67 42·6	66 50·8	+0 51·8	—	67 43·9
Mablethorpe	111	„ 12	68 7·2	66 49·8	+1 17·4	—	68 9·5
Lincoln	105	„ 12	68 1·5	66 48·4	+1 13·1	—	68 5·2
Gainsborough	81	„ 15	68 11·6	66 49·4	+1 22·2	—	68 14·3
Hull	92	„ 16	68 25·9	66 51·1	+1 34·8	—	68 26·9
Scarborough	137	„ 17	68 42·1	66 51·1	+1 51·0	—	68 43·1
Thirsk	147	„ 17	68 55·3	66 48·9	+2 6·4	—	68 58·5
Redcar	132	„ 18	69 1·8	66 50·1	+2 11·7	—	69 3·8
Newcastle	119	„ 19	69 16·7	66 50·0	+2 26·7	—	69 18·8
Alnwick	57	„ 20	69 32·6	66 48·9	+2 43·7	—	69 35·8
Berwick	8	„ 20	69 43·3	66 48·8	+2 54·5	—	69 46·6
Edinburgh	22	„ 24	70 2·9	66 51·2	+3 11·7	—	70 3·8
Dundee	21	„ 26	70 38·7	66 50·5	+3 48·2	—	70 40·3
Crieff	17	„ 27	70 20·1	66 51·1	+3 29·0	—	70 21·1
Pitlochry	41	„ 29	70 28·4	66 51·1	+3 37·3	—	70 29·4
Aberdeen	1	July 1	70 48·0	66 50·8	+3 57·2	—	70 49·3
Ballater	5	„ 2	70 44·7	66 50·3	+3 54·4	—	70 46·5
Banff	7	„ 4	70 52·7	66 50·3	+4 2·4	—	70 54·5
Elgin	23	„ 6	71 5·5	66 51·7	+4 13·8	—	71 5·9
Boat of Garten	9	„ 7	70 51·4	66 52·4	+3 59·0	—	70 51·1
Inverness	32	„ 8	71 6·5	66 51·1	+4 15·4	—	71 7·5
Lairg	36	„ 10	71 26·4	66 50·9	+4 35·5	—	71 27·6
Golspie	29	„ 13	71 24·3	66 51·0	+4 33·3	—	71 25·4
Wick	54	„ 14	71 40·7	66 50·4	+4 50·3	—	71 42·4
Kirkwall	34	„ 15	71 50·4	66 51·7	+4 58·7	—	71 50·8
Stromness	51	„ 15	71 46·5	66 50·1	+4 56·4	—	71 48·5
Thurso	53	„ 16	71 34·1	66 50·0	+4 44·1	—	71 36·2
Loch Inver	31	Aug. 5	71 51·6	66 50·7	+5 0·9	—	71 53·0
Loch Eribol	24	„ 7	71 43·6	66 52·0	+4 51·6	—	71 43·7
Gairloch	27	„ 10	71 14·7	66 48·7	+4 26·0	—	71 18·1
Kyle Akin	35	„ 11	71 10·5	66 51·0	+4 19·5	—	71 11·6
Portree	43	„ 12	70 2·8	66 51·3	+3 11·5	—	70 3·6
Fort Augustus	26	„ 13	71 5·5	66 50·7	+4 14·8	—	71 6·9
Banavie	6	„ 14	70 49·6	66 51·1	+3 58·5	—	70 50·6
Dalwhinnie	19	„ 17	70 38·7	66 51·4	+3 47·3	—	70 39·4
Crianlarich	16	„ 18	70 26·9	66 51·9	+3 35·0	—	70 27·1
Oban	40	„ 19	70 17·1	66 52·0	+3 25·1	—	70 17·2
Tarbert	52	„ 20	70 13·8	66 52·0	+3 21·8	—	70 13·9
Campbeltown	13	„ 21	69 58·0	66 53·1	+3 4·9	—	69 57·0
Strachur	49	„ 24	70 26·1	66 50·8	+3 35·3	—	70 27·4
Lochgoilhead	38	„ 25	70 14·5	66 51·6	+3 22·9	—	70 15·0
Row	44	„ 26	70 16·6	66 51·7	+3 24·9	—	70 17·0
Stirling	47	„ 31	70 40·5	66 51·0	+3 49·5	—	70 41·6
Glasgow	28	Sept. 2	70 34·5	66 49·9	+3 44·6	—	70 36·7

TABLE III.—Inclination (continued).

Station.	No.	Date.	Inclination observed.	Greenwich value.	Difference.	Add 66° 52′·1.	Provisional value for epoch Jan. 1, 1915.
		1914.					
Carstairs	15	Sept. 3	69° 49′·8	66° 50′·2	+2° 59′·6	—	69° 51′·7
Fairlie	25	„ 4	70 9·6	66 51·3	+3 18·3	—	70 10·4
Ayr	4	„ 5	70 1·1	66 50·8	+3 10·3	—	70 2·4
Stranraer	50	„ 7	69 42·4	66 49·6	+2 52·8	—	69 44·9
Dumfries	20	„ 8	69 29·8	66 48·6	+2 41·2	—	69 33·3
Hawick	30	„ 9	69 43·2	66 50·7	+2 52·5	—	69 44·6
Carlisle	70	„ 10	69 21·5	66 50·8	+2 30·7	—	69 22·8
Appleby	59	„ 11	69 7·2	66 49·9	+2 17·3	—	69 9·4
Whitehaven	153	„ 12	69 22·2	66 51·9	+2 30·3	—	69 22·4
Barrow	60	„ 15	68 52·8	66 52·2	+2 0·6	—	68 52·7
Giggleswick	82	„ 16	68 49·2	66 50·9	+1 58·3	—	68 50·4
Stonyhurst	S.	„ 17	68 41·4	66 52·0	+1 49·4	—	68 41·5
Preston	126	„ 18	68 37·8	66 51·9	+1 45·9	—	68 38·0
Manchester	113	„ 19	68 26·9	66 52·2	+1 34·7	—	68 26·8
Leeds	103	„ 21	68 36·1	66 53·0	+1 43·1	—	68 35·2
Chesterfield	71	„ 22	68 9·7	66 52·2	+1 17·5	—	68 9·6
Newark	118	„ 23	68 0·1	66 53·0	+1 7·1	—	67 59·2
Grantham	84	„ 24	67 54·7	66 53·2	+1 1·5	—	67 53·6
Cambridge	67	„ 25	67 24·7	66 53·1	+0 31·6	—	67 23·7
		1915.					
Cambridge	67	Mar. 26	67 26·7	66 52·4	+0 34·3	—	67 26·4
Northampton	120	April 2	67 27·8	66 52·1	+0 35·7	—	67 27·8
King's Sutton	101	„ 5	67 25·1	66 52·0	+0 33·1	—	67 25·2
Kenilworth	97	„ 7	67 51·7	66 51·8	+0 59·9	—	67 52·0
Malvern	112B	„ 8	67 37·4	66 53·2	+0 44·2	—	67 36·3
„	112C	„ 8	67 33·0	66 50·2	+0 42·8	—	67 34·9
„	112A	„ 9	67 41·4	66 50·6	+0 50·8	—	67 42·9
„	112D	„ 10	67 35·9	66 50·4	+0 45·5	—	67 37·6
Milford Haven	117	„ 13	67 26·7	66 50·2	+0 36·5	—	67 28·6
Swansea	143	„ 14	67 18·1	66 50·8	+0 27·3	—	67 19·4
Lampeter	102	„ 15	67 47·1	66 51·6	+0 55·5	—	67 47·6
Cardigan	69	„ 16	67 52·1	66 52·4	+0 59·7	—	67 51·8
Aberystwith	55	„ 17	67 55·2	66 52·7	+1 2·5	—	67 54·6
Llanidloes	108	„ 17	67 57·0	66 51·6	+1 5·4	—	67 57·5
Shrewsbury	138	„ 19	68 0·5	66 52·6	+1 7·9	—	68 0·0
Birmingham	63	„ 20	67 44·2	66 51·4	+0 52·8	—	67 44·9
Cambridge	67	—	—	—	—	—	—
Kettering	98	June 12	67 34·8	66 51·4	+0 43·4	—	67 35·5
Manton	114	„ 14	67 38·8	66 51·9	+0 46·9	—	67 39·0
Melton	116	„ 15	67 48·4	66 51·0	+0 57·4	—	67 49·5
Nottingham	121	„ 16	68 2·5	66 52·0	+1 10·5	—	68 2·6
Loughborough	109	„ 17	67 54·6	66 55·9	+0 58·7	—	67 50·8
Dublin	174	Aug. 9	68 41·9	66 51·7	+1 50·2	—	68 42·3
Wicklow	200	„ 10	68 29·5	66 52·0	+1 37·5	—	68 29·6
Bagenalstown	159	„ 11	68 21·9	66 51·9	+1 30·0	—	68 22·1
Kilkenny	181	„ 12	68 21·6	66 52·5	+1 29·1	—	68 21·2
Ballywilliam	161	„ 13	68 24·9	66 51·5	+1 33·4	—	68 25·5
Wexford	199	„ 14	68 13·8	66 51·7	+1 22·1	—	68 14·2
Waterford	197	„ 16	68 12·2	66 51·7	+1 20·5	—	68 12·6
Lismore	187	„ 17	68 7·9	66 51·5	+1 16·4	—	68 8·5

TABLE III.—Inclination (continued).

Station.	No.	Date.	Inclination observed.	Greenwich value.	Difference.	Add 66° 52′·1.	Provisional value for epoch Jan. 1, 1915.
		1915.					
Cork	171	Aug. 18	68° 1′·9	66° 51′·5	+1° 10′·4	—	68° 2′·5
Bantry	163	" 19	67 58·6	66 52·6	+1 6·0	—	67 58·1
Valencia	195	" 20	68 8·5	66 51·7	+1 16·8	—	68 8·9
Killarney	182	" 26	68 12·9	66 52·9	+1 20·0	—	68 12·1
Tralee	194	" 27	68 25·7	66 52·9	+1 32·8	—	68 24·9
Charleville	167	" 28	68 20·1	66 52·3	+1 27·8	—	68 19·9
Tipperary	193	" 30	68 23·2	66 53·4	+1 29·8	—	68 21·9
Limerick	185	" 31	68 31·1	66 51·9	+1 39·2	—	68 31·3
Kilrush	183	Sept. 1	68 41·7	66 51·7	+1 50·0	—	68 42·1
Lisdoonvarna	186	" 2	68 48·1	66 51·7	+1 56·4	—	68 48·5
Gort	177	" 3	68 50·0	66 52·1	+1 57·9	—	68 50·0
Parsonstown	190	" 4	68 49·1	66 52·5	+1 56·6	—	68 48·7
Kildare	180	" 6	68 37·5	66 52·4	+1 45·1	—	68 37·2
Athlone	158	" 7	69 1·3	66 52·3	+2 9·0	—	69 1·1
Galway	176	" 8	69 2·5	66 51·5	+2 11·0	—	69 3·1
Oughterard	189	" 9	69 13·9	66 52·0	+2 21·9	—	69 14·0
Clifden	168	" 10	69 18·3	66 53·1	+2 25·2	—	69 17·3
Leenane	184	" 11	69 25·7	66 53·0	+2 32·7	—	69 24·8
Westport	198	" 13	69 38·0	66 51·5	+2 46·5	—	69 38·6
Ballina	160	" 14	69 45·0	66 52·2	+2 52·8	—	69 44·9
Castlereagh	165	" 15	69 19·6	66 52·6	+2 27·0	—	69 19·1
Carrick-on-Shannon	164	" 16	69 18·7	66 52·4	+2 26·3	—	69 18·4
Sligo	191	" 17	69 43·6	66 54·7	+2 48·9	—	69 41·0
Enniskillen	175	" 18	69 37·3	66 52·1	+2 45·2	—	69 37·3
Donegal	172	" 20	69 33·5	66 52·9	+2 40·6	—	69 32·7
Strabane	192	" 21	69 47·6	66 52·1	+2 55·5	—	69 47·6
Londonderry	188	" 21	69 51·6	66 52·3	+2 59·3	—	69 51·4
Coleraine	169	" 22	69 19·9	66 53·3	+2 26·6	—	69 18·7
Waterfoot	196	" 23	69 51·9	66 56·5	+2 55·4	—	69 47·5
Cookstown Junction	170	" 24	69 32·6	66 53·7	+2 38·9	—	69 31·0
Bangor	162	" 28	69 30·7	66 53·6	+2 37·1	—	69 29·2
Armagh	157	" 29	69 23·8	66 53·3	+2 30·5	—	69 22·6
Greenore	178	" 30	69 9·4	66 54·7	+2 14·7	—	69 6·8
Cavan	166	Oct. 1	69 20·1	66 53·1	+2 27·0	—	69 19·1
Kells	179	" 1	69 1·1	66 51·9	+2 9·2	—	69 1·3
Drogheda	173	" 2	69 0·7	66 52·7	+2 8·0	—	69 0·1
Holyhead	90	" 4	68 44·5	66 51·9	+1 52·6	—	68 44·7
Pwllheli	128	" 6	68 11·9	66 51·1	+1 20·8	—	68 12·9
Llandudno	106	" 8	68 35·9	66 50·6	+1 45·3	—	68 37·4
Llangollen	107	" 9	68 11·4	66 51·4	+1 20·0	—	68 12·1
Birkenhead	62	" 11	68 31·5	66 52·8	+1 38·7	—	68 30·8
Wheelock	152	" 12	68 12·0	66 52·7	+1 19·3	—	68 11·4
Stoke-on-Trent	141	" 13	68 5·5	66 52·7	+1 12·8	—	68 4·9
Coalville	76	" 13	67 51·1	66 52·1	+0 59·0	—	67 51·1
Leicester	104	" 14	67 49·0	66 53·1	+0 55·9	—	67 48·0

Reduction of the Survey.

As already indicated, observations at several points in the Western and Channel Islands will have to be made when the war is over. Inasmuch as the Western Isles are known to be disturbed magnetically and the Channel Isles are mainly of interest in connecting up with the mainland of France, no grave objection can be taken to analysing the main features of the magnetic state of the British Isles from the results already secured. On the contrary, certain advantages may arise from such procedure.

The principle adopted for reducing the observed results to epoch has already been explained. It is, however, obvious that Greenwich Observatory could not supply final values for 1915 until some time after that year was completed. In view of the large amount of computation involved in reducing the survey, it appeared to me desirable to save time by adopting provisional Greenwich values for January 1, 1915, which might be expected to be very close to the final values.

These provisional values were

$$H = 18{,}520\gamma, \qquad D = 15^\circ\ 2'{\cdot}0\ \mathrm{W}, \qquad I = 66^\circ\ 52'{\cdot}0$$

and the Tables I., II., III., were deduced for these values.

The final values of Greenwich Observatory are

$$H = 18{,}519\gamma, \qquad D = 15^\circ\ 1'{\cdot}4\ \mathrm{W}, \qquad I = 66^\circ\ 51'{\cdot}6,$$

so that in order to obtain final values for the Survey the numbers in Tables I. to VI. require corrections—

$$\Delta H = -1\gamma, \qquad \Delta D = -0'{\cdot}6\ \mathrm{W}, \qquad \Delta I = -0'{\cdot}4$$
$$\Delta N = 0\gamma, \qquad \Delta W = -4\gamma, \qquad \Delta V = -17\gamma.$$

These corrections do not, of course, affect the values of disturbing forces.

RÜCKER and THORPE divided the British Isles into nine overlapping districts. There is no doubt that such a course tends to diminish discontinuities between the districts and in a first general conspectus it may be advantageous. But a smoothing process is always attended with some danger, and after careful consideration I decided to group the observations into non-overlapping districts. There is, in the event, no reason to think that this departure was unwise. The question at once arose as to what should be the districts. Now this is a matter of some importance. *A priori* an ideal survey would require stations forming a system of equilateral triangles. The stations were not so selected. Still it appeared to me desirable to choose districts so that they contained roughly the same number of stations, the same area, and bounded by whole degrees of latitude and longitude. Naturally we must compromise, but the division adopted appears to me quite a good compromise with the stations originally chosen by RÜCKER and THORPE.

The scheme is as follows :—

District.	Latitude.	Longitude.	Stations.	
			Observed.	Still to Observe.
I.	56°–59° N.	2°–5° W.	22	0
II.	56°–59° N.	5°–8° W.	7	10
III.	54°–56° N.	0°–5° W.	18	3
IV.	54°–56° N.	5°–10° W.	16	2
V.	52°–54° N.	2° E.–1° W.	23	0
VI.	52°–54° N.	1°–5° W.	24	0
VII.	51°–54° N.	6°–11° W.	31	0
VIII.	50°–52° N.	2° E.–1° W.	18	0
IX.	50°–52° N.	1°–6° W.	22	0

In this scheme Cavan, strictly belonging to VII., was moved to IV., and King's Sutton, strictly in VI., was moved to VIII. They are seen to lie practically on the corresponding boundaries and were moved to secure a more equable number of stations per district.

Since District II. is far from complete, it was not included in deducing the mean isomagnetics. This procedure has been deliberately adopted with a view to including District II. in the general scheme in the simplest manner when more peaceful times obtain, and the observations have been completed.

Each district was reduced separately. I examined very carefully whether the method of least squares would be of real advantage, and I came to the conclusion that RÜCKER and THORPE's method of "equations of conditions" ('Phil. Trans.,' vol. 181 (1890), p. 235) was the best and simplest procedure, and that the method of least squares gave no gain in accuracy commensurate with the extra labour involved.

But an important difference in procedure was adopted. It was evident that at some stage the geographical components would have to be calculated; and I therefore decided to convert the values of H, D and I straight away to N, W and V before reducing. This procedure is generally recognised to be rational, and it possesses the important advantage, that it enables one to deduce with little trouble the best "Potential Solution" for the district.

A slight digression from the main argument must now be introduced in order to explain this matter. It may be premised that, except close to the earth's magnetic poles, the magnetic state of any small region of the earth's surface may be regarded as due to magnetic forces from (1) causes at a considerable distance from the region, and (2) causes within the region. An analysis of a magnetic survey aims at separating these two causes.

If the first cause existed alone, the magnetic state of the region would be characterised by a potential function, and if the region is small enough the isomagnetic lines would be linear in the differences of latitude and longitude from a mean point within the region.

Thus the magnetic potential Ω is adequately expressed by

$$\Omega = A\lambda + Bl + \tfrac{1}{2}a\lambda^2 + b\lambda l + \tfrac{1}{2}cl^2,$$

where λ and l are the differences of latitude and longitude from the mean point λ_0 and l_0 as origin.

Whence

$$N = -\frac{\partial\Omega}{\partial\lambda} = -A - a\lambda - bl,$$

$$\cos(\lambda_0+\lambda)\,W = \frac{\partial\Omega}{\partial l} = B + b\lambda + cl,$$

so that

$$\frac{\partial N}{\partial l} + \frac{\partial \cos(\lambda_0+\lambda)\,W}{\partial\lambda} = 0$$

is a necessary condition.

Causes within the region may be either electric currents or magnetic poles. The known electric currents in the earth and the air are too small to produce any magnetic effects that can be measured by survey apparatus and may therefore be ignored. There remains the possibility of unknown electric currents that may not give a magnetic potential, and of local magnetic poles which would contribute terms to the magnetic potential. These latter, being effectively singularities within the region, produce effects on the isomagnetic lines that are not adequately represented by linear formulæ. Only by very numerous and properly selected stations could we expect to disentangle the terrestrial isomagnetic lines due to distant causes, which produce a potential and linear isomagnetics, from the true isomagnetics in which possible electric currents and local magnetic poles have an appreciable effect.

The number of stations is, however, limited, so that if we determine (as we may) the best linear isomagnetics that are given by the data, we get only an approximation to the terrestrial lines, while the differences between the observed and the computed values of the element give an approximation to the disturbances in the region. No other course is open, but the results suggest where more detailed survey is required to improve the approximation.

We may proceed then by determining the best linear isomagnetics (Force, Declination and Dip) or (North, West and Vertical components of force) which fit the observations. The three components are analysed independently and we may then test whether they satisfy the condition for a potential. In general they do not; and the differences are usually so great that no known electric currents will account for them. The obvious explanation lies to hand that we have local attraction, not adequately represented by a magnetic potential giving linear contributions to the isomagnetics, and hence the obvious step is to determine the best linear forms which do conform to a potential. This is very readily determined from the independent reductions of the geographical components.

Having obtained the best potential solution giving linear isomagnetics for each district, we try to find a potential solution for the whole region. We might expect to have to proceed to non-linear isomagnetics (still satisfying a potential) but in the event it appeared that no adequate improved agreement with the observed values could be so obtained.

Accordingly I have adopted the magnetic potential giving linear isomagnetics for N, W and V and the best agreement with observation as representing the terrestrial lines due to remote causes, and the differences between the observed and the calculated values are taken as the "disturbing forces." These latter may or may not have a potential.

The procedure differs from RÜCKER and THORPE'S in that I have made the terrestrial lines conform to a potential, and that I found no adequate grounds in the data to justify the introduction of higher powers than squares in the potential.

We may now return to the main argument.

If we have set out the co-ordinates of the stations in a district and the corresponding observed values of the element, say, N, we might proceed by the method of least squares to find the best linear form. But I am satisfied that RÜCKER'S method of "equations of condition" is quite adequate and much simpler.

Let

λ_0 and l_0 represent the mean co-ordinates, and

$\Delta\lambda$, Δl represent the differences for the station,

N_0 represent the mean values of the element, and

ΔN represent the difference for the station.

We then take all the stations to North (or South) of λ_0 and sum $\Delta\lambda$, Δl, and ΔN, we thus get

$$\Sigma_1 \Delta N = a\Sigma(+\Delta\lambda)+b\Sigma\Delta l.$$

Again, take all stations to East (or West) of l_0 and sum Δl, $\Delta\lambda$, and ΔN, we get another equation

$$\Sigma_2 \Delta N = a\Sigma\Delta\lambda+b\Sigma(+\Delta l).$$

Solving these for a and b we get

$$N = N_0+a\,\Delta\lambda+b\,\Delta l$$

as the best linear solution given by the observations.

The results for the different districts and different components are set out in Table V.

Next, to get the best potential solution we combine the four equations of condition for N and W. Thus

$$\Sigma_1 \Delta N = a_1 \Sigma (+\Delta\lambda) + b_1 \Sigma \Delta l$$

$$\Sigma_2 \Delta N = a_1 \Sigma \Delta\lambda + b_1 \Sigma (+\Delta l)$$

$$-W_0 \sin\lambda_0 \Sigma (+\Delta\lambda) + \cos\lambda_0 \Sigma_1 \Delta W = -b_1 \Sigma (+\Delta\lambda) + b_2 \Sigma \Delta l$$

$$-W_0 \sin\lambda_0 \Sigma \Delta\lambda + \cos\lambda_0 \Sigma_2 \Delta W = -b_1 \Sigma \Delta\lambda + b_2 \Sigma (+\Delta l)$$

and we solve for a_1, b_1, b_2 by least squares. In practice it is very easy to calculate how much these coefficients differ from those obtained in the independent reduction of N and W.

The results are entered on Table V.

The values of V obtained in the first instance by the same method do not of course require adjustment to fit a potential function.

The lines thus obtained for the districts were drawn on a large scale O.S. map, and although they did not join at the boundaries, the discrepancies were a good deal less than might have been expected, thus justifying the tentative division into non-overlapping districts.

The next step was to obtain forms for the general representation of the British Isles. I proceeded by the humble method of meaning the district potential solutions. A slight adjustment of constants proved necessary to reduce the discrepancies between the means for different districts. These were adjusted by least squares. The discrepancies tabulated in Table IV. may appear in some cases large, but they follow no simple law, as far as I can ascertain, and I prefer to attribute them (as the known iron mines suggest) to district causes.

TABLE IV.—Mean Values of Geographical Components for the Districts compared with the Values Calculated from the best Potential Solution.

District.	North.					West.			Vertical.		
	λ_0.	l_0.	O.	C.	O – C.	O.	C.	O – C.	O.	C.	O – C.
I.	57° 21′·8	–3° 44′·8	15,106	15,099	+ 7	5041	5046	– 5	46,279	46,315	– 36
II.											
III.	55 2·1	–2 45·6	16,157	16,156	+ 1	5025	5012	+13	45,284	45,199	+85
IV.	54 42·9	–6 48·6	15,906	15,890	+16	5582	5581	+ 1	45,406	45,456	– 50
V.	52 44·8	–0 4·4	17,330	17,361	– 31	4760	4743	+17	43,925	43,933	– 8
VI.	52 54·0	–2 40·2	17,011	17,043	– 32	5070	5093	– 23	44,251	44,255	– 4
VII.	52 53·1	–8 14·9	16,506	16,503	+ 3	5862	5858	+ 4	44,882	44,795	+87
VIII.	51 22·3	+0 3·2	17,943	17,940	+ 3	4803	4786	+17	43,262	43,319	– 57
IX.	51 13·2	–2 51·2	17,751	17,717	+34	5163	5191	– 28	43,518	43,538	– 20

TABLE V.

District.	λ_0.	l_0.	N.	W.	V.	$\frac{\partial N}{\partial l} + \frac{\partial W \cos\lambda}{\partial\lambda}$.	Equivalent current amps./km².
I.	57° 21′·8	$-3°$ 44′·8 P.S.	$15{,}106 - 5\cdot782\Delta\lambda + 1\cdot433\Delta l$ $15{,}106 - 5\cdot861\Delta\lambda + 1\cdot608\Delta l$	$5041 - 1\cdot014\Delta\lambda - 3\cdot037\Delta l$ $5041 - 0\cdot692\Delta\lambda - 3\cdot289\Delta l$	$46{,}279 + 7\cdot453\Delta\lambda - 1\cdot896\Delta l$	$-0\cdot349$ $0\cdot0$	$-0\cdot278$
II.							
III.	55 2·1	-2 45·6 P.S.	$16{,}157 - 6\cdot295\Delta\lambda + 1\cdot974\Delta l$ $16{,}157 - 6\cdot406\Delta\lambda + 1\cdot902\Delta l$	$5025 - 1\cdot101\Delta\lambda - 2\cdot590\Delta l$ $5025 - 1\cdot228\Delta\lambda - 2\cdot646\Delta l$	$45{,}284 + 8\cdot603\Delta\lambda - 1\cdot834\Delta l$	$+0\cdot145$ $0\cdot0$	$+0\cdot108$
IV.	54 42·9	-6 48·6 P.S.	$15{,}906 - 6\cdot114\Delta\lambda + 2\cdot296\Delta l$ $15{,}906 - 5\cdot751\Delta\lambda + 2\cdot123\Delta l$	$5582 - 1\cdot080\Delta\lambda - 1\cdot968\Delta l$ $5582 - 1\cdot381\Delta\lambda - 1\cdot863\Delta l$	$45{,}406 + 6\cdot139\Delta\lambda - 1\cdot797\Delta l$	$+0\cdot347$ $0\cdot0$	$+0\cdot258$
V.	52 44·8	-0 4·4 P.S.	$17{,}330 - 6\cdot592\Delta\lambda + 1\cdot472\Delta l$ $17{,}330 - 6\cdot563\Delta\lambda + 1\cdot506\Delta l$	$4760 - 0\cdot724\Delta\lambda - 2\cdot742\Delta l$ $4760 - 0\cdot668\Delta\lambda - 2\cdot728\Delta l$	$43{,}925 + 8\cdot515\Delta\lambda - 1\cdot204\Delta l$	$-0\cdot068$ $0\cdot0$	$-0\cdot048$
VI.	52 54·0	-2 40·2 P.S.	$17{,}011 - 7\cdot303\Delta\lambda + 1\cdot999\Delta l$ $17{,}011 - 7\cdot104\Delta\lambda + 1\cdot566\Delta l$	$5070 - 0\cdot073\Delta\lambda - 2\cdot790\Delta l$ $5070 - 0\cdot646\Delta\lambda - 2\cdot722\Delta l$	$44{,}251 + 6\cdot166\Delta\lambda - 1\cdot358\Delta l$	$+0\cdot867$ $0\cdot0$	$+0\cdot617$
VII.	52 53·1	-8 14·9 P.S.	$16{,}506 - 7\cdot513\Delta\lambda + 1\cdot740\Delta l$ $16{,}506 - 7\cdot501\Delta\lambda + 1\cdot712\Delta l$	$5862 - 0\cdot537\Delta\lambda - 2\cdot274\Delta l$ $5862 - 0\cdot583\Delta\lambda - 2\cdot279\Delta l$	$44{,}882 + 7\cdot369\Delta\lambda - 2\cdot134\Delta l$	$+0\cdot056$ $0\cdot0$	$+0\cdot040$
VIII.	51 22·3	$+0$ 3·2 P.S.	$17{,}943 - 8\cdot309\Delta\lambda + 1\cdot439\Delta l$ $17{,}943 - 7\cdot944\Delta\lambda + 1\cdot040\Delta l$	$4803 + 0\cdot722\Delta\lambda - 2\cdot872\Delta l$ $4803 + 0\cdot083\Delta\lambda - 2\cdot707\Delta l$	$43{,}262 + 8\cdot126\Delta\lambda - 2\cdot947\Delta l$	$+0\cdot798$ $0\cdot0$	$+0\cdot549$
IX.	51 13·2	-2 51·2 P.S.	$17{,}751 - 7\cdot279\Delta\lambda + 1\cdot547\Delta l$ $17{,}751 - 7\cdot240\Delta\lambda + 1\cdot514\Delta l$	$5163 - 0\cdot493\Delta\lambda - 2\cdot350\Delta l$ $5163 - 0\cdot547\Delta\lambda - 2\cdot346\Delta l$	$43{,}518 + 8\cdot972\Delta\lambda - 1\cdot575\Delta l$	$+0\cdot053$ $0\cdot0$	$+0\cdot036$
P.S. for British Isles	53 31·8	-3 23·0	$16{,}714 - 6\cdot864\Delta\lambda + 1\cdot633\Delta l$	$5163 - 0\cdot726\Delta\lambda - 2\cdot283\Delta l$	$44{,}601 + 7\cdot297\Delta\lambda - 1\cdot633\Delta l$	$0\cdot0$	

I ought to mention that in the solution adopted the mean longitude differs by $0'\cdot 3$ from the mean for the districts. This really arose from the fact that after a large amount of reduction had been done the longitude of Worthing was found to have been entered with the wrong sign. The values for District VIII. had to be re-computed, but the net result for the British Isles was as stated above. The change in no case amounts to 1γ except by the turn of the decimal point, so that the original solution has been retained. In any case it is an empirical solution. But I venture to think it cannot be substantially improved until detailed survey of clearly disturbed regions has been made.

The solution is then

$$N = 16{,}714 - 6\cdot 864\,\Delta\lambda + 1\cdot 633\,\Delta l,$$

$$W = 5{,}163 - 0\cdot 726\,\Delta\lambda - 2\cdot 283\,\Delta l,$$

$$V = 44{,}601 + 7\cdot 297\,\Delta\lambda - 1\cdot 633\,\Delta l,$$

where $\Delta\lambda$ and Δl are the differences of latitude and longitude in minutes of arc measured from

$$\lambda_0 = 53^\circ\ 31'\cdot 8\ \mathrm{N}, \qquad l_0 = 3^\circ\ 23'\cdot 0\ \mathrm{W}.$$

The charts (Nos. 1, 2 and 3) of equal values of N, W and V have been drawn at convenient intervals. In order to show how the general solution differs from the corresponding district solution, extra isomagnetics representing the mean for each district, have been drawn both from the general solution and the district solution, the latter being shown by a dotted line.

Although lines of equal Declination have little theoretical importance, yet they are of considerable practical utility, and therefore a chart (No. 4) of equal declination has been prepared.

The lines have been computed from the general potential solution by the formula

$$\tan D = W/N.$$

The approximate solution, correct to the first power of $\Delta\lambda$ and Δl, viz.,

$$D = 17^\circ\ 10' + 0\cdot 00436\,\Delta\lambda - 0\cdot 00872\,\Delta l,$$

where D is in degrees and $\Delta\lambda$ and Δl in minutes of arc from the mean co-ordinates $53^\circ\ 31'\cdot 8$ N, $3^\circ\ 23'\cdot 0$ W, is not accurate enough for the whole of the British Isles.

On the chart are shown the differences between the observed and the calculated values of D in minutes of arc. I have further indicated the probable positions of the true isogonals. At some places ambiguity arises on account of the complexity of the disturbing forces, and the line drawn is thus a personal guess at a simple solution with which others may not agree.

TABLE

District I. Longitude −5° to −2°.

Station.	No.	Latitude.	Longitude.	Provisional values for epoch January 1, 1915.					
				H.	D.	I.	N.	W.	V.
		° ′	° ′	γ	° ′	° ′	γ	γ	γ
Aberdeen	1	57 7·5	−2 4·2	16,007	17 23·4	70 49·3	15,276	4784	46,021
Ballater	5	57 2·8	−3 2·9	16,035	17 28·8	70 46·5	15,295	4816	45,982
Banff	7	57 39·5	−2 32·0	15,966	17 53·8	70 54·5	15,193	4906	46,129
Boat of Garten	9	57 15·5	−3 43·0	16,064	18 50·5	70 51·1	15,203	5188	46,264
Crianlarich	16	56 23·7	−4 37·6	16,350	18 55·3	70 27·1	15,467	5302	46,048
Crieff	17	56 22·3	−3 49·3	16,337	18 18·1	70 21·1	15,511	5130	45,757
Dalwhinnie	19	56 55·9	−4 14·4	16,234	18 46·3	70 39·4	15,371	5224	46,245
Dundee	21	56 28·6	−2 54·7	16,090	17 34·0	70 40·3	15,340	4856	45,873
Elgin	23	57 38·1	−3 19·4	15,906	18 2·1	71 5·9	15,125	4924	46,453
Loch Eribol	24	58 29·9	−4 40·0	15,468	19 15·2	71 43·7	14,603	5101	46,849
Fort Augustus	26	57 9·0	−4 40·9	15,969	18 47·3	71 6·9	15,118	5143	46,682
Golspie	29	57 58·6	−3 57·1	15,671	19 1·9	71 25·4	14,814	5110	46,628
Inverness	32	57 27·8	−4 12·6	15,924	18 37·5	71 7·5	15,090	5086	46,577
Kirkwall	34	58 59·5	−2 58·2	15,362	18 25·0	71 50·8	14,575	4853	46,852
Lairg	36	58 1·0	−4 24·8	15,627	18 55·3	71 27·6	14,783	5067	46,596
Lochgoilhead	38	56 10·0	−4 54·9	16,382	19 14·6	70 15·0	15,431	5399	45,628
Pitlochrie	41	56 41·6	−3 43·9	16,198	18 8·9	70 29·4	15,392	5045	45,716
Row	44	56 1·1	−4 45·9	16,366	18 39·1	70 17·0	15,506	5234	45,667
Stirling	47	56 7·2	−3 56·9	16,073	18 46·8	70 41·6	15,217	5174	45,880
Stromness	51	58 57·1	−3 18·3	15,399	18 21·2	71 48·5	14,616	4849	46,859
Thurso	53	58 35·3	−3 29·9	15,486	18 7·6	71 36·2	14,717	4818	46,562
Wick	54	58 26·6	−3 3·5	15,491	18 25·3	71 42·4	14,697	4895	46,859
Mean	. .	57 21·8	−3 44·8				15,106	5041	46,279

District II. Longitude −8° to −5°.

Station.	No.	Latitude.	Longitude.	Provisional values for epoch January 1, 1915.					
				H.	D.	I.	N.	W.	V.
		° ′	° ′	γ	° ′	° ′	γ	γ	γ
Arinagower	2	56 37·6	−6 31·9						
Loch Aylort	3								
Banavie	6	56 50·3	−5 6·3	16,219	19 3·4	70 50·6	15,330	5296	46,688
Loch Boisdale	10	57 9·5	−7 20·6						
Callernish	12								
Canna	14								
Gairloch	27	57 42·6	−5 41·3	15,610	19 31·9	71 18·1	14,712	5219	46,122
Loch Inver	31	58 8·9	−5 14·0	15,208	19 37·2	71 53·0	14,325	5107	46,483
Iona	33								
Kyle Akin	35	57 16·4	−5 43·1	15,796	19 58·1	71 11·6	14,846	5394	46,383
Loch Maddy	39								
Oban	40	56 25·4	−5 29·8	16,415	19 13·8	70 17·2	15,499	5406	45,812
Portree	43	57 26·6	−6 13·7	16,468	18 50·1	70 3·6	15,586	5317	45,393
Scarnish	45								
Soa	46	57 9·4	−6 12·9						
Stornoway	48	58 12·0	−6 23·5						
Strachur	49	56 10·5	−5 4·9	16,187	18 36·3	70 27·4	15,341	5164	45,601

VI.

Latitude 56° to 59°.

Calculated values.				Observed – calculated.			
N.	W.	V.	D.	N.	W.	V.	D.
γ	γ	γ	° ′	γ	γ	γ	′
15,361	4827	46,046	17 26·7	– 85	– 43	– 25	– 3·3
15,298	4964	46,111	17 58·7	– 3	–148	–129	–29·9
15,096	4867	46,325	17 52·2	+ 97	+ 39	–196	+ 1·6
15,145	5046	46,266	18 25·6	+ 58	+142	– 2	+24·9
15,412	5209	45,977	18 40·5	+ 55	+ 93	+ 71	+14·8
15,500	5099	45,888	18 12·6	+ 11	+ 31	–131	+ 5·5
15,232	5132	46,174	18 37·2	+139	+ 92	+ 71	+ 9·1
15,547	4970	45,845	17 43·7	–207	–114	+ 28	– 9·7
15,029	4976	46,392	18 19·2	+ 96	– 52	+ 61	–17·1
14,541	5123	46,902	19 24·5	+ 62	– 22	– 53	– 9·3
15,095	5183	46,313	18 57·0	+ 23	– 40	+369	– 9·7
14,826	5048	46,604	18 48·2	– 12	+ 62	+ 24	+13·7
15,012	5105	46,404	18 46·9	+ 78	– 19	+173	– 9·4
14,504	4869	46,952	18 33·4	+ 71	– 16	–100	– 8·4
14,765	5109	46,666	19 5·2	+ 18	– 42	– 70	– 9·9
15,477	5258	45,906	18 45·9	– 46	+141	–278	+28·7
15,376	5073	46,020	18 15·6	+ 16	– 28	–304	– 6·7
15,553	5244	45,826	18 38·0	– 47	– 10	–159	+ 1·1
15,591	5128	45,790	18 12·4	–374	+ 46	+ 90	+34·4
14,488	4916	46,967	18 44·6	+128	– 67	–108	–23·4
14,619	4959	46,827	18 43·8	+ 98	–141	–265	–36·2
14,722	4905	46,720	18 25·6	– 25	– 10	+139	– 0·3
15,099	5046	46,315		+ 7	– 5	– 36	

Latitude 56° to 59°.

Calculated values.				Observed – calculated.			
N.	W.	V.	D.	N.	W.	V.	D.
γ	γ	γ	° ′	γ	γ	γ	′
15,183	5255	46,218	19 5·5	+147	+ 41	+ 470	– 2·1
14,767	5297	46,660	19 44·0	– 55	– 78	– 538	– 8·1
14,636	5215	46,804	19 36·7	–311	–108	– 321	+ 0·5
14,944	5320	46,469	19 35·7	– 98	+ 74	– 86	+22·4
15,315	5326	46,075	19 10·5	+184	+ 80	– 263	+ 3·3
14,824	5382	46,593	19 57·2	+762	– 65	– 1200	–67·1
15,458	5280	45,925	18 51·5	–117	–116	– 324	–15·2

TABLE

District III. Longitude −5° to 0°.

Station.	No.	Latitude.	Longitude.	Provisional values for epoch January 1, 1915. H.	D.	I.	N.	W.	V.
		° ′	° ′	γ	° ′	° ′	γ	γ	γ
Ayr	4	55 26·9	−4 38·6	16,681	18 31·4	70 2·4	15,817	5299	45,930
Berwick	8	55 46·2	−1 59·5	16,789	16 40·9	69 46·6	16,082	4819	45,574
Carstairs	15	55 40·5	−3 41·1	16,743	17 50·2	69 51·7	15,938	5128	45,658
Cumbrae	18	55 46·7	−4 54·3						
Dumfries	20	55 1·6	−3 34·1	16,916	17 51·3	69 33·3	16,101	5187	45,377
Edinburgh	22	55 57·9	−3 12·9	16,552	17 47·9	70 3·8	15,760	5059	45,633
Fairlie	25	55 46·1	−4 50·8	16,559	18 18·3	70 10·4	15,721	5201	45,927
Glasgow	28	55 49·9	−4 21·5	16,176	18 58·2	70 36·7	15,297	5258	45,964
Hawick	30	55 26·0	−2 47·5	16,779	17 30·4	69 44·6	16,003	5047	45,465
Alnwick	57	55 25·2	−1 43·7	16,842	16 46·1	69 35·8	16,126	4859	45,279
Appleby	59	54 34·1	−2 29·3	17,054	17 6·6	69 9·4	16,299	5017	44,793
Barrow	60	54 7·5	−3 12·0	17,249	17 10·6	68 52·7	16,480	5094	44,652
Carlisle	70	54 53·9	−2 55·6	16,998	17 23·5	69 22·8	16,221	5081	45,175
Giggleswick	82	54 4·1	−2 17·6	17,320	16 38·1	68 50·4	16,595	5958	44,746
Newcastle	119	55 0·0	−1 38·9	16,988	16 33·8	69 18·8	16,283	4843	44,989
Port Erin	125								
Ramsey	129								
Redcar	132	54 35·3	−0 59·3	17,192	16 7·4	69 3·8	16,516	4774	44,935
Scarboro	137	54 15·5	−0 23·7	17,474	15 55·4	68 43·1	16,804	4794	44,861
Thirsk	147	54 14·1	−1 21·1	17,241	16 22·7	68 58·5	16,541	4862	44,856
Whitehaven	153	54 32·7	−3 33·8	17,050	17 38·3	69 22·4	16,248	5166	45,297
Mean	. .	55 2·1	−2 45·6				16,157	5025	45,284

District IV. Longitude −10° to −5°.

Station.	No.	Latitude.	Longitude.	Provisional values for epoch January 1, 1915. H.	D.	I.	N.	W.	V.
		° ′	° ′	γ	° ′	° ′	γ	γ	γ
Bunnahabhina	11								
Campbeltown	13	55 25·5	−5 36·8	16,577	19 16·8	69 57·0	15,647	5475	45,422
Port Askaig	42								
Stranraer	50	54 54·0	−5 1·8	16,826	18 30·3	69 44·9	15,956	5340	45,605
Tarbert	52	55 51·7	−5 24·3	16,351	18 54·8	70 13·9	15,468	5300	45,495
Armagh	157	54 21·9	−6 39·7	17,028	19 13·0	69 22·6	16,079	5605	45,254
Ballina	160	54 7·1	−9 8·0	16,744	20 15·3	69 44·9	15,709	5797	45,382
Bangor	162	54 39·5	−5 38·8	16,969	18 37·0	69 29·2	16,081	5417	45,353
Cavan	166	53 59·6	−7 20·6	17,021	19 32·7	69 19·1	16,040	5694	45,068
Coleraine	169	55 8·3	−6 41·4	17,138	19 48·8	69 18·7	16,123	5809	45,382
Cookstown Junc.	170	54 46·3	−6 15·2	16,926	17 20·0	69 31·0	16,157	5043	45,311
Donegal	172	54 39·1	−8 6·4	16,948	19 44·8	69 32·7	15,951	5726	45,438
Enniskillen	175	54 21·4	−7 39·0	16,887	19 52·6	69 37·3	15,881	5742	45,460
Greenore	178	54 1·0	−6 7·7	17,220	19 10·5	69 6·8	16,265	5656	45,126
Londonderry	188	55 1·1	−7 19·4	16,730	19 48·8	69 51·4	15,740	5671	45,610
Sligo	191	54 16·5	−8 28·0	16,829	20 5·8	69 41·0	15,804	5783	45,454
Strabane	192	54 49·2	−7 26·7	16,789	19 50·4	69 47·6	15,792	5698	45,615
Waterfoot	196	55 3·5	−6 3·2	16,755	19 22·4	69 47·5	15,806	5558	45,518
Mean	. .	54 42·9	−6 48·6				15,906	5582	45,406

VI (continued).
Latitude 54° to 56°.

Calculated values.				Observed – calculated.			
N.	W.	V.	D.	N.	W.	V.	D.
γ	γ	γ	° ′	γ	γ	γ	′
15,801	5252	45,564	18 23·2	+ 16	+ 47	+ 366	+ 8·2
15,929	4875	45,446	17 1·0	+ 153	− 56	+ 128	− 20·1
15,802	5111	45,570	17 55·4	+ 136	+ 17	+ 88	− 5·2
16,080	5123	45,275	17 40·3	+ 21	+ 64	+ 102	+ 11·0
15,728	5034	45,651	17 44·9	+ 32	+ 25	− 18	+ 3·0
15,650	5266	45,725	18 35·8	+ 71	− 65	+ 202	− 17·5
15,671	5196	45,704	18 20·6	− 374	+ 62	+ 260	+ 37·6
15,989	4999	45,377	17 21·7	+ 14	+ 48	+ 88	+ 8·7
16,099	4853	45,266	16 46·5	+ 27	+ 6	+ 13	− 0·4
16,375	5005	44,968	16 59·7	− 76	+ 12	− 175	+ 6·9
16,488	5112	44,844	17 13·5	− 8	− 18	− 192	− 2·9
16,196	5041	45,155	17 17·3	+ 25	+ 40	+ 20	+ 6·2
16,600	4990	44,730	16 43·9	− 5	− 32	+ 16	− 5·8
16,279	4861	45,075	16 37·6	+ 4	− 18	− 86	− 3·8
16,514	4789	44,830	16 10·3	+ 2	− 15	+ 105	− 2·9
16,708	4722	44,627	15 46·9	+ 96	+ 72	+ 234	+ 8·5
16,623	4854	44,711	16 16·7	− 82	+ 8	+ 145	+ 6·0
16,279	5143	45,063	17 32·0	− 31	+ 23	+ 234	+ 6·3
16,156	5012	45,199		+ 1	+ 13	+ 85	

Latitude 54° to 56°.

Calculated Values.				Observed – calculated.			
N.	W.	V.	D.	N.	W.	V.	D.
γ	γ	γ	° ′	γ	γ	γ	′
15,715	5386	45,649	18 55·1	− 68	+ 89	− 227	+ 21·7
15,988	5329	45,363	18 26·0	− 32	+ 11	+ 242	+ 4·3
15,555	5339	45,820	18 56·6	− 87	− 39	− 325	− 1·8
16,049	5576	45,288	19 9·5	+ 30	+ 29	− 34	+ 3·5
15,908	5925	45,422	20 25·7	− 199	− 128	− 40	− 10·4
16,027	5424	45,317	18 41·8	+ 54	− 7	+ 36	− 4·8
16,135	5685	45,190	19 24·6	− 95	− 9	− 122	+ 8·1
15,727	5548	45,630	19 25·9	+ 396	+ 261	− 248	+ 22·9
15,921	5507	45,426	19 4·8	+ 236	− 464	− 115	− 104·8
15,789	5761	45,565	20 2·7	+ 162	− 35	− 127	− 17·9
15,955	5712	45,382	19 41·9	− 74	+ 30	+ 78	+ 10·7
16,244	5518	45,083	18 45·7	+ 21	+ 138	+ 43	+ 24·8
15,715	5638	45,639	19 44·2	+ 25	+ 33	− 29	+ 4·6
15,909	5827	45,426	20 7·0	− 105	− 44	+ 28	− 1·2
15,785	5663	45,564	19 44·2	+ 7	+ 35	+ 51	+ 6·2
15,823	5462	45,532	19 2·7	− 17	+ 96	− 14	+ 19·7
15,890	5581	45,456		+ 16	+ 1	− 50	

TABLE

District V. Longitude $-1°$ to $+2°$.

Station.	No.	Latitude.	Longitude.	Provisional values for epoch January 1, 1915.					
				H.	D.	I.	N.	W.	V.
		° ′	° ′	γ	° ′	° ′	γ	γ	γ
Bedford	61	52 8·9	−0 26·6	18,076	15 29·9	67 28·9	17,419	4830	43,600
Cambridge. . . .	67	52 12·9	+0 5·8	18,161	15 7·8	67 23·8	17,532	4740	43,622
Clenchwarton . .	73	52 46·1	+0 20·4	17,988	15 9·5	67 40·8	17,372	4706	43,840
Cromer.	78	52 54·9	+1 19·2	18,004	14 35·0	67 42·7	17,424	4533	43,924
Gainsborough. . .	81	53 23·1	−0 44·7	17,703	15 44·2	68 14·3	17,039	4801	44,347
Grantham	84	52 54·5	−0 40·6	17,840	15 44·8	67 53·6	17,171	4842	43,920
Hull.	92	53 44·1	−0 25·5	17,536	16 1·5	68 26·9	16,855	4841	44,400
Kettering	98	52 23·5	−0 44·5	18,108	15 38·3	67 35·5	17,438	4881	43,915
King's Lynn . . .	100	52 44·5	+0 25·4	18,020	15 6·8	67 39·4	17,397	4698	43,843
Lincoln.	105	53 12·9	−0 31·9	17,743	15 24·6	68 5·2	17,105	4715	44,107
Lowestoft	110	52 27·7	+1 42·5	18,166	14 24·4	67 25·2	17,595	4520	43,684
Mablethorpe . . .	111	53 19·8	+0 14·0	17,709	15 21·2	68 9·5	17,077	4689	44,182
Manton.	114	52 38·0	−0 40·9	18,091	15 34·6	67 39·0	17,427	4858	44,001
March	115	52 32·8	+0 4·4	18,048	15 4·5	67 34·1	17,427	4694	43,719
Melton Mowbray .	116	52 45·1	−0 52·2	18,036	16 29·0	67 49·5	17,295	5117	44,251
Newark.	118	53 4·4	−0 46·8	17,782	15 44·3	67 59·2	17,115	4823	43,983
Northampton. . .	120	52 13·0	−0 53·9	18,079	15 51·1	67 27·8	17,391	4938	43,568
Peterborough. . .	123	52 34·5	−0 17·3	18,063	15 23·5	67 39·4	17,415	4794	43,947
Spalding	140	52 47·2	−0 10·5	18,002	15 5·5	67 43·9	17,381	4687	43,963
Sutton Bridge . .	142	52 45·0	+0 11·6	18,013	15 3·8	67 44·4	17,394	4681	44,008
Thetford	146	52 23·6	+0 43·7	18,108	14 46·5	67 26·7	17,509	4618	43,598
Tilney	148	52 43·2	+0 18·8	18,012	15 16·1	67 41·0	17,376	4743	43,881
Wisbech	155	52 40·3	+0 8·5	18,055	15 9·5	67 40·6	17,427	4721	43,972
Mean	. .	52 44·8	−0 4·4				17,330	4760	43,925

VI (continued).

Latitude 52° to 54°.

Calculated values.				Observed – calculated.			
N.	W.	V.	D.	N.	W.	V.	D.
γ	γ	γ	° ′	γ	γ	γ	′
17,571	4820	43,707	15 20·4	−152	+ 10	−107	+ 9·5
17,597	4743	43,684	15 5·1	− 65	− 3	− 62	+ 2·7
17,393	4685	43,909	15 4·5	− 21	+ 21	− 69	+ 5·0
17,428	4545	43,870	14 37·0	− 4	− 12	+ 54	− 2·0
17,032	4807	44,278	15 45·6	+ 7	− 6	+ 69	− 1·4
17,235	4819	44,063	15 37·3	− 64	+ 23	−143	+ 7·5
16,920	4748	44,400	15 40·5	− 65	+ 93	0	+21·0
17,442	4850	43,833	15 32·3	− 4	+ 31	+ 82	+ 6·0
17,412	4675	43,882	15 1·7	− 15	+ 23	− 39	+ 5·1
17,123	4785	44,183	15 36·8	− 18	− 70	− 76	−12·2
17,653	4511	43,634	14 20·1	− 58	+ 9	+ 50	+ 4·3
17,219	4683	44,085	15 12·9	−142	+ 6	+ 97	+ 8·3
17,348	4831	43,943	15 33·7	+ 79	+ 27	+ 58	+ 0·9
17,458	4732	43,831	15 9·9	− 31	− 38	−112	− 5·4
17,281	4852	44,013	15 41·0	+ 14	+265	+238	+48·0
17,157	4826	44,145	15 42·6	− 42	− 3	−162	+ 1·7
17,498	4879	43,782	15 34·8	−107	+ 59	−214	+16·3
17,411	4780	43,879	15 21·1	+ 4	+ 14	+ 68	+ 2·4
17,335	4755	43,960	15 20·3	+ 46	− 68	+ 3	−14·8
17,386	4706	43,908	15 8·7	+ 8	− 25	+100	− 4·9
17,585	4649	43,700	14 48·5	− 76	− 31	−102	− 2·0
17,410	4691	43,887	15 4·8	− 34	+ 52	− 6	+11·3
17,413	4717	43,879	15 9·4	+ 14	+ 4	+ 93	+ 0·1
17,361	4743	43,933		− 31	+ 17	− 8	

TABLE

District VI. Longitude −5° to −1°.

Station.	No.	Latitude.	Longitude.	Provisional values for epoch January 1, 1915.					
				H.	D.	I.	N.	W.	V.
		° ′	° ′	γ	° ′	° ′	γ	γ	γ
Stonyhurst . . .	S.	53 50·7	−2 28·2	17,353	16 42·1	68 41·5	16,621	4987	44,489
Aberystwith . . .	55	52 23·8	−4 3·5	17,913	16 55·3	67 54·6	17,137	5214	44,137
Birkenhead . . .	62	53 20·5	−3 7·3	17,507	17 2·3	68 30·8	16,739	5130	44,474
Birmingham . . .	63	52 25·5	−1 52·2	17,989	15 48·2	67 44·9	17,309	4899	43,967
Cardigan	69	52 5·3	−4 39·9	17,924	17 34·3	67 51·8	17,088	5411	44,061
Chesterfield . . .	71	53 13·1	−1 27·6	17,742	16 7·4	68 9·6	17,044	4927	44,269
Coalville	76	52 44·4	−1 18·7	17,943	15 33·5	67 51·1	17,286	4813	44,082
Holyhead	90	53 17·8	−4 38·3	17,359	17 51·4	68 44·7	16,561	5323	44,627
Kenilworth . . .	97	52 21·2	−1 36·7	17,984	16 1·2	67 52·0	17,286	4963	44,215
Lampeter	102	52 6·5	−4 5·2	17,947	17 4·5	67 47·6	17,156	5270	43,963
Leeds	103	53 51·7	−1 33·8	17,455	16 17·3	68 35·2	16,754	4896	44,509
Leicester	104	52 36·0	−1 6·0	17,967	15 34·0	67 48·0	17,308	4822	44,027
Llandudno. . . .	106	53 18·5	−3 49·2	17,450	17 47·8	68 37·4	16,615	5333	44,581
Llangollen	107	52 58·7	−3 9·9	17,721	17 7·3	68 12·1	16,936	5217	44,309
Llanidloes	108	52 26·8	−3 32·9	17,875	16 51·4	67 57·5	17,107	5183	44,150
Loughborough . .	109	52 45·8	−1 13·2	17,920	15 24·8	67 50·8	17,275	4763	44,014
Malvern	112	52 5·3	−2 20·4	18,057	16 18·2	67 37·9	17,331	5069	43,878
Manchester . . .	113	53 25·7	−2 21·9	17,549	16 22·4	68 26·8	16,837	4947	44,429
Nottingham . . .	121	52 56·4	−1 13·5	17,884	15 49·4	68 2·6	17,206	4876	44,361
Preston.	126	53 42·3	−2 42·4	17,408	16 57·7	68 38·0	16,651	5078	44,496
Pwllheli	128	52 52·9	−4 24·4	17,813	17 38·4	68 12·9	16,975	5398	44,570
Shrewsbury . . .	138	52 41·8	−2 46·8	17,818	16 50·8	68 0·0	17,053	5164	44,101
Stoke-on-Trent . .	141	52 57·7	−2 13·0	17,756	16 23·8	68 4·9	17,034	5012	44,129
Wheelock	152	53 7·9	−2 19·7	17,685	16 21·5	68 11·4	16,969	4981	44,193
Mean . . .	. .	52 54·0	−2 40·2				17,011	5070	44,251

VI. (continued).

Latitude 52° to 54°.

Calculated values.				Observed – calculated.			
N.	W.	V.	D.	N.	W.	V.	D.
γ	γ	γ	° ′	γ	γ	γ	′
16,673	5024	44,649	16 46·1	− 52	− 37	−160	− 4·0
17,114	5305	44,171	17 13·3	+ 23	− 91	− 34	−18·0
16,817	5136	44,493	16 59·0	− 78	− 6	− 19	+ 3·3
17,317	5004	43,969	16 7·0	− 8	−105	− 2	−18·8
17,182	5402	44,095	17 27·2	− 94	+ 9	− 34	+ 7·1
17,030	4913	44,276	16 5·5	+ 14	+ 14	− 7	+ 1·9
17,242	4914	44,052	15 54·5	+ 42	−101	+ 30	−21·0
16,687	5345	44,622	17 45·6	−126	− 22	+ 5	+ 5·8
17,372	4972	43,921	15 58·3	− 86	− 9	+294	+ 2·9
17,230	5322	44,047	17 9·9	− 74	− 52	− 84	− 5·0
16,755	4900	44,568	16 18·1	− 1	− 4	− 59	− 0·8
17,320	4891	43,970	15 46·2	− 12	− 69	+ 57	−12·2
16,762	5233	44,546	17 20·3	−147	+100	+ 35	+27·5
16,962	5157	44,338	16 54·7	− 26	+ 60	− 29	+12·6
17,144	5233	44,143	16 58·5	− 37	− 50	+ 7	− 7·1
17,241	4900	44,053	15 51·9	+ 34	−137	− 39	−27·1
17,410	5083	43,867	16 16·5	− 79	− 14	+ 11	+ 1·7
16,855	5028	44,454	16 36·6	− 18	− 81	− 25	−14·2
17,168	4893	44,131	15 54·5	+ 38	− 17	+230	− 5·1
16,708	5063	44,611	16 51·5	− 57	+ 15	−115	+ 6·2
16,880	5332	44,414	17 36·5	+ 95	+ 66	+156	+ 1·9
17,116	5117	44,177	16 38·7	− 63	+ 47	− 76	+12·1
17,062	5028	44,238	16 25·2	− 28	− 16	−109	− 1·4
16,981	5036	44,323	16 31·1	− 12	− 55	−130	− 9·6
17,043	5093	44,255		− 32	− 23	− 4	

TABLE

District VII. Longitude −11° to −6°.

Station.	No.	Latitude.	Longitude.	Provisional values for epoch January 1, 1915.					
				H.	D.	I.	N.	W.	V.
		° ′	° ′	γ	° ′	° ′	γ	γ	γ
Athlone	158	53 26·8	− 7 55·9	17,304	19 28·4	69 1·1	16,314	5769	45,122
Bagnalstown . . .	159	52 40·6	− 6 56·0	17,660	18 52·5	68 22·1	16,710	5713	44,532
Ballywilliam . . .	161	52 26·1	− 6 52·9	17,650	18 35·5	68 25·5	16,729	5627	44,639
Bantry	163	51 40·0	− 9 28·9	18,017	19 39·3	67 58·1	16,967	6060	44,523
Carrick-on-Shannon .	164	53 56·6	− 8 4·5	17,130	20 0·2	69 18·4	16,097	5860	45,349
Castlereagh . . .	165	53 45·4	− 8 31·4	17,120	20 12·1	69 19·1	16,067	5912	45,351
Charleville	167	52 21·1	− 8 39·9	17,705	19 36·2	68 19·9	16,679	5940	44,562
Clifden	168	53 30·0	−10 1·3	17,077	20 32·3	69 17·3	15,992	5991	45,165
Cork	171	51 54·5	− 8 30·1	17,923	19 22·1	68 2·5	16,908	5944	44,454
Drogheda	173	53 42·6	− 6 22·3	17,277	18 58·4	69 0·1	16,338	5617	45,012
Dublin	174	53 23·5	− 6 18·7	17,474	18 46·0	68 42·3	16,545	5622	44,830
Galway	176	53 17·2	− 9 1·8	17,320	20 25·1	69 3·1	16,232	6042	45,242
Gort	177	53 4·3	− 8 47·6	17,449	19 50·6	68 50·0	16,413	5923	45,064
Kells	179	53 42·0	− 6 53·0	17,327	19 17·8	69 1·3	16,354	5726	45,190
Kildare	180	53 9·7	− 6 52·2	17,515	19 1·8	68 37·2	16,558	5711	44,739
Kilkenny	181	52 38·9	− 7 16·0	17,671	18 50·6	68 21·2	16,724	5707	44,526
Killarney	182	52 3·6	− 9 33·1	17,908	19 57·5	68 12·1	16,832	6113	44,777
Kilrush	183	52 38·6	− 9 28·6	17,549	20 11·3	68 42·1	16,471	6056	45,015
Leenane	184	53 36·7	− 9 40·2	16,986	20 24·4	69 24·8	15,920	5923	45,222
Limerick	185	52 38·8	− 8 38·9	17,660	19 52·3	68 31·3	16,608	6003	44,882
Lisdoonvarna . . .	186	53 1·8	− 9 16·0	17,486	19 58·7	68 48·5	16,434	5974	45,101
Lismore	187	52 9·1	− 7 54·6	17,823	19 6·3	68 8·5	16,841	5833	44,429
Oughterard . . .	189	53 26·2	− 9 18·4	17,177	20 37·3	69 14·0	16,076	6050	45,298
Parsonstown . . .	190	53 4·4	− 7 56·0	17,422	19 29·9	68 48·7	16,423	5815	44,944
Tipperary	193	52 28·6	− 8 12·0	17,724	19 23·5	68 21·9	16,719	5885	44,686
Tralee	194	52 16·6	− 9 43·5	17,712	20 10·6	68 24·9	16,625	6109	44,770
Valencia	195	51 55·6	−10 17·9	17,911	20 12·0	68 8·9	16,809	6185	44,664
Waterford	197	52 17·1	− 7 10·9	17,809	18 30·5	68 12·6	16,888	5653	44,548
Westport	198	53 48·3	− 9 29·5	16,921	20 12·8	69 38·6	15,879	5846	45,605
Wexford	199	52 21·6	− 6 27·5	17,778	18 16·5	68 14·2	16,881	5575	44,531
Wicklow	200	52 58·7	− 6 3·6	17,557	18 20·7	68 29·6	16,665	5526	44,556
Mean . . .	. .	52 53·1	− 8 14·9				16,506	5862	44,882

VI. (continued).

Latitude 51° to 54°.

Calculated values.				Observed – calculated.			
N.	W.	V.	D.	N.	W.	V.	D.
γ	γ	γ	° ′	γ	γ	γ	′
16,303	5790	45,010	19 33·1	+ 11	− 21	+112	− 4·7
16,718	5687	44,575	18 47·2	− 8	+ 26	− 43	+ 5·3
16,822	5690	44,464	18 41·3	− 93	− 63	+175	− 5·8
16,884	6080	44,382	19 48·3	+ 83	− 20	+141	− 9·0
16,084	5788	45,241	19 47·5	+ 13	+ 72	+108	+12·7
16,117	5856	45,204	19 58·1	− 50	+ 56	+147	+14·0
16,682	5938	44,603	19 35·6	− 3	+ 2	− 41	+ 0·6
16,076	6074	45,238	20 41·9	− 84	− 83	− 73	− 9·6
16,880	5935	44,392	19 22·3	+ 28	+ 9	+ 62	− 0·2
16,347	5565	44,972	18 48·0	− 9	+ 52	+ 40	+10·4
16,484	5571	44,827	18 40·4	+ 61	+ 51	+ 3	+ 5·6
16,261	5948	45,047	20 5·5	− 29	+ 94	+195	+19·6
16,373	5925	44,930	19 53·6	+ 40	− 2	+134	− 3·0
16,301	5636	45,018	19 4·4	+ 53	+ 90	+172	+13·4
16,524	5657	44,781	18 53·9	+ 34	+ 54	− 42	+ 7·9
16,697	5734	44,595	18 57·2	+ 27	− 27	− 69	− 6·6
16,715	6072	44,561	19 57·9	+117	+ 41	+216	− 0·4
16,482	6037	44,810	20 7·0	− 11	+ 19	+205	+ 4·3
16,064	6021	45,252	20 32·8	−144	− 98	− 32	− 8·4
16,562	5923	44,730	19 40·7	+ 46	+ 80	+152	+11·6
16,344	5991	44,958	20 7·8	+ 90	− 17	+143	− 9·1
16,830	5844	44,441	19 8·9	+ 11	− 11	− 12	− 2·6
16,172	5979	45,140	20 17·4	− 96	+ 71	+158	+19·9
16,456	5807	44,847	19 26·2	− 33	+ 8	+ 97	+ 3·7
16,676	5869	44,611	19 23·3	+ 43	+ 16	+ 75	+ 0·2
16,609	6087	44,673	20 7·6	+ 16	+ 22	+ 97	+ 3·0
16,697	6181	44,576	20 18·8	+112	+ 4	+ 88	− 6·8
16,855	5738	44,428	18 48·0	+ 33	− 85	+120	−17·5
16,002	5988	45,320	20 31·0	−123	−142	+285	−18·2
16,895	5636	44,390	18 26·9	− 14	− 61	+141	−10·4
16,679	5554	44,621	18 25·0	− 14	− 28	− 65	− 4·3
16,503	5858	44,795		+ 3	+ 4	+ 87	

TABLE

District VIII. Longitude −1° to +2°.

Station.	No.	Latitude.	Longitude.	Provisional values for epoch January 1, 1915.					
				H.	D.	I.	N.	W.	V.
		° ′	° ′	γ	° ′	° ′	γ	γ	γ
Greenwich. . . .	G.	51 28·6	+0 0·3	18,520	15 2·0	66 52·0	17,886	4804	43,350
Braintree	64	51 53·1	+0 31·8	18,348	14 57·0	67 6·7	17,727	4733	43,461
Chichester	72	50 50·0	−0 47·0	18,800	15 12·1	66 26·9	18,142	4930	43,131
Colchester	77	51 55·2	+0 53·1	18,394	15 2·6	66 56·6	17,764	4774	43,215
Dover	79	51 8·0	+1 19·6	18,740	14 4·7	66 28·0	18,177	4558	43,031
Harwich	87	51 56·8	+1 19·4	18,349	14 26·5	66 55·6	17,769	4576	43,074
Harpenden. . . .	88	51 47·8	−0 21·3	18,335	15 22·7	67 10·1	17,679	4862	43,550
Haslemere	89	51 5·3	−0 45·6	18,672	15 16·7	66 40·0	18,012	4920	43,287
Horsham	91	51 4·3	−0 21·0	18,720	15 9·9	66 32·5	18,068	4897	43,139
Kew	99	51 28·1	−0 18·8	18,483	15 22·1	66 56·1	17,822	4898	43,406
Purfleet	127	51 29·4	+0 16·2	18,503	14 55·0	66 56·0	17,879	4763	43,450
Ranmore	130	51 14·5	−0 23·4	18,694	15 15·7	66 35·2	18,035	4921	43,172
Reading.	131	51 29·0	−0 57·5	18,489	15 18·8	67 2·2	17,833	4883	43,635
St. Leonards . . .	135	50 53·0	+0 32·5	18,812	14 31·6	66 21·0	18,211	4719	42,957
Southend	139	51 33·2	+0 43·8	18,497	14 47·2	66 53·0	17,884	4721	43,331
Tunbridge Wells. .	149	51 6·8	+0 15·8	18,706	14 19·4	66 30·7	18,125	4628	43,045
Windsor	154	51 28·9	−0 35·8	18,476	15 34·8	66 56·3	17,795	4962	43,397
Worthing	156	50 49·4	−0 24·4	18,809	15 6·1	66 24·7	18,159	4900	43,076
Mean . . .	. .	51 22·3	+0 3·2				17,943	4803	43,262

VI. (continued).

Latitude 50° to 52°.

Calculated values.				Observed – calculated.			
N.	W.	V.	D.	N.	W.	V.	D.
γ	γ	γ	° ′	γ	γ	γ	′
17,892	4788	43,370	14 58·8	− 6	+ 16	− 20	+ 3·2
17,775	4699	43,497	14 50·3	− 48	+ 34	− 36	+ 6·7
18,079	4917	43,165	15 12·9	+ 63	+ 13	− 34	− 0·8
17,795	4648	43,478	14 38·3	− 31	+ 126	− 263	+ 24·3
18,163	4622	43,090	14 16·6	+ 14	− 64	− 59	− 11·9
17,827	4587	43,446	14 25·8	− 58	− 11	− 372	+ 0·7
17,725	4824	43,545	15 13·5	− 46	+ 38	+ 5	+ 9·2
17,977	4910	43,275	15 16·6	+ 35	+ 10	+ 12	+ 0·1
18,024	4854	43,227	15 4·4	+ 44	+ 43	− 88	+ 5·5
17,864	4832	43,397	15 8·1	− 42	+ 66	+ 9	+ 14·0
17,912	4751	43,350	14 51·3	− 33	+ 12	+ 100	+ 3·7
17,950	4853	43,305	15 7·7	+ 85	+ 68	− 133	+ 8·0
17,794	4920	43,467	15 27·4	+ 39	− 37	+ 168	− 8·6
18,189	4740	43,057	14 36·4	+ 22	− 21	− 100	− 4·8
17,931	4686	43,332	14 38·7	− 47	+ 35	− 1	+ 8·5
18,067	4769	43,185	14 47·2	+ 58	− 141	− 140	− 27·8
17,831	4870	43,431	15 16·6	− 36	+ 92	− 34	+ 18·2
18,121	4873	43,124	15 3·1	+ 38	+ 27	− 48	+ 3·0
17,940	4786	43,319		+ 3	+ 17	− 57	

TABLE

District IX. Longitude $-6°$ to $-1°$.

Station.	No.	Latitude.	Longitude.	Provisional values for epoch January 1, 1915.					
				H.	D.	I.	N.	W.	V.
		° ′	° ′	γ	° ′	° ′	γ	γ	γ
Southampton	O.S.	50 57·1	−1 22·9	18,696	15 19·2	66 35·5	18,032	4940	43,187
Alresford	58	51 4·7	−1 9·5	18,686	15 17·6	66 40·8	18,024	4929	43,347
Brecon	65	51 56·9	−3 24·2	18,116	16 42·8	67 33·4	17,351	5210	43,859
Bude	66	50 49·6	−4 33·3	18,513	17 1·5	67 0·2	17,702	5420	43,627
Cardiff	68	51 29·8	−3 13·0	18,396	16 27·7	67 10·0	17,642	5213	43,691
Clifton	74	51 28·3	−2 39·4	18,419	16 16·3	67 11·3	17,681	5161	43,792
Clovelly	75	51 0·0	−4 24·2	18,451	16 55·6	67 6·7	17,652	5372	43,704
Falmouth	80	50 9·2	−5 4·7	18,814	17 2·6	66 25·3	17,988	5514	43,108
Gloucester	83	51 52·5	−2 13·3	18,200	16 16·5	67 25·1	17,471	5101	43,762
Ilfracombe	93	51 12·6	−4 8·0	18,394	16 53·8	67 9·8	17,600	5346	43,679
King's Sutton	101	52 1·2	−1 16·2	18,196	15 57·4	67 25·2	17,495	5002	43,756
Milford	117	51 42·8	−4 55·5	18,228	17 11·4	67 28·6	17,414	5387	43,956
Oxford	122	51 45·7	−1 15·0	18,257	15 38·6	67 17·8	17,581	4923	43,638
Plymouth	124	50 21·9	−4 8·5	18,789	16 36·2	66 25·4	18,006	5369	43,054
Ryde	133	50 43·3	−1 10·6	18,802	15 9·7	66 24·4	18,148	4918	43,050
St. Cyres	134	50 46·4	−3 35·3	18,657	16 37·1	66 41·9	17,878	5336	43,318
Salisbury	136	51 5·5	−1 48·3	18,607	15 32·0	66 44·2	17,927	4983	43,281
Swansea	143	51 37·3	−4 0·9	18,328	16 50·6	67 19·4	17,542	5311	43,865
Swindon	144	51 32·9	−1 45·9	18,378	15 23·8	67 9·6	17,718	4879	43,634
Taunton	145	51 0·7	−3 5·1	18,575	16 16·4	66 49·2	17,831	5205	43,381
Wallingford	150	51 35·1	−1 5·9	18,418	15 28·2	67 5·2	17,751	4913	43,573
Weymouth	151	50 36·3	−2 26·8	18,807	15 52·7	66 26·2	18,089	5146	43,123
Mean	. .	51 13·2	−2 51·2				17,751	5163	43,518

VI. (continued).

Latitude 50° to 52°.

Calculated values.				Observed – calculated.			
N.	W.	V.	D.	N.	W.	V.	D.
γ	γ	γ	° ′	γ	γ	γ	′
17,972	5001	43,276	15 12·8	+ 60	− 61	− 89	+ 6·4
17,941	4965	43,310	15 28·1	+ 83	− 36	+ 37	−10·5
17,353	5225	43,911	16 45·4	− 2	− 15	− 52	− 2·6
17,712	5441	43,533	17 4·6	− 10	− 21	+ 94	− 3·1
17,567	5229	43,695	16 34·6	+ 75	− 16	− 4	− 6·9
17,633	5153	43,629	16 17·4	+ 48	+ 8	+163	− 1·1
17,656	5413	43,594	17 2·7	− 4	− 41	+110	− 7·1
17,938	5541	43,289	17 9·9	+ 50	− 27	−181	− 7·3
17,509	5076	43,763	16 10·0	− 38	+ 25	− 1	+ 6·5
17,596	5367	43,659	16 57·7	+ 4	− 21	+ 20	− 3·9
17,543	4939	43,733	15 43·4	− 48	+ 63	+ 23	+14·0
17,311	5453	43,957	17 29·1	+103	− 66	− 1	−17·7
17,650	4948	43,618	15 39·6	− 69	− 25	+ 20	− 1·0
17,953	5405	43,290	16 45·3	+ 53	− 36	−236	− 9·1
18,087	4983	43,156	15 24·2	+ 61	− 65	−106	−14·5
17,829	5311	43,414	16 35·3	+ 49	+ 25	− 96	+ 1·8
17,873	5053	43,379	15 47·2	+ 54	− 70	− 98	−15·2
17,438	5333	43,828	17 0·3	+104	− 22	+ 37	− 9·7
17,688	5028	43,575	15 52·1	+ 30	−149	+ 59	−28·3
17,780	5232	43,468	16 23·8	+ 51	− 27	− 87	− 7·4
17,739	4935	43,526	15 32·8	+ 12	− 22	+ 47	− 4·6
18,010	5162	43,229	15 59·6	+ 79	− 16	−106	− 6·9
17,717	5191	43,538		+ 34	− 28	− 20	

We have now reached a stage at which a comparison between the results of the re-survey and those obtained by RÜCKER and THORPE is desirable. It appeared to me best to take the results of the 1886 survey rather than those of the more extended survey in 1891. Accordingly Table VII. has been drawn up to show station by station and district by district the change of H, D, and I, between epoch January 1, 1886, and January 1, 1915.

Before discussing the differences obtained, several points must be referred to :—

(1) Since the stations differ a little from those used by RÜCKER and THORPE, we ought strictly to introduce corrections allowing for the differences of latitude and longitude. In more peaceful times such a course would probably have been adopted, but in the present circumstances the considerable amount of computation involved could hardly be justified and so must be postponed till a more favourable occasion.

(2) In view of the known differences between different instruments, I was anxious to find out if possible how the survey standards adopted by RÜCKER and THORPE would compare with those adopted for the re-survey (viz., the Greenwich standards for 1915). So far my endeavours have not met with any success. The instruments used by them are either no longer available or have undergone re-organisation. RÜCKER and THORPE did not make any direct observation at Greenwich, and I gather that the values they assign to Greenwich were supplied by the Astronomer Royal from the observatory apparatus.

They made comparison with the Kew observatory apparatus and found some discrepancy. Those in D and I were not very serious and have since been explained and show that in D and I their standards would not differ seriously from those in use at Greenwich at present. In H, however, their survey standard was 29γ higher than the Kew standard at the time. I am not without hope that some light on the matter may arise from careful investigation, but not at the present time.

These points, however, emphasize the urgent necessity of preparing an adequate standard of magnetic force if full advantage is to be taken of the results of the future surveys. I would again urge as on p. 2 that the instruments used by me in the re-survey should on no account suffer the same fate as those used by RÜCKER and THORPE, but should be carefully preserved for comparison with Greenwich when the next survey is made.

Looking at the differences tabulated they are on a general conspectus extremely satisfactory and show a remarkably uniform change all over the British Isles. I mean, of course, in the total change, for we know that the annual rate at any one place varies from time to time. There are, however, a few outstanding differences of considerable interest.

The case that first attracted my notice was that of Dundee, where the increase of H was only 88γ and the decrease of I only $12'$. It will be seen that the differences at Glasgow, Stirling and Strachur are very similar to those at Dundee. This group is quite unique.

Table VII.

District I.

Station.	Survey, January 1, 1915.			Survey, January 1, 1886.			Differences.		
	H.	D.	I.	H.	D.	I.	H.	D.	I.
	γ	° ′	° ′	γ	° ′	° ′	γ	° ′	° ′
Aberdeen	16,007	17 23·4	70 49·3	15,734	20 16·3	71 12·3	+273	−2 52·9	−0 23·0
Ballater	16,035	17 28·8	70 46·5	15,714	20 29·5	71 15·4	+321	−3 0·7	−0 28·9
Banff	15,966	17 53·8	70 54·5	15,684	21 4·5	71 19·0	+282	−3 10·7	−0 24·5
Boat of Garten	16,064	18 50·5	70 51·1	15,786	22 7·7	71 16·3	+278	−3 17·2	−0 25·2
Crianlarich	16,350	18 55·3	70 27·1	15,980	21 50·6	70 52·5	+370	−2 55·3	−0 25·4
Crieff	16,337	18 18·1	70 21·1	16,079	21 33·6	70 53·6	+258	−3 15·5	−0 32·5
Dalwhinnie	16,234	18 46·3	70 39·4	15,909	21 45·5	71 0·1	+325	−2 59·2	−0 20·7
Dundee	16,090	17 34·0	70 40·3	16,002	20 44·5	70 52·2	+ 88	−3 10·5	−0 11·9
Elgin	15,906	18 2·1	71 5·9	15,577	20 57·5	71 32·0	+329	−2 55·4	−0 26·1
Loch Eriboll	15,468	19 15·2	71 43·7	15,198	22 18·1	72 9·4	+270	−3 2·9	−0 25·7
Fort Augustus	15,969	18 47·3	71 6·9	15,641	21 45·6	71 27·7	+328	−2 58·3	−0 38·7
Golspie	15,671	19 1·9	71 25·4	15,382	21 30·2	71 46·7	+289	−2 28·3	−0 21·3
Inverness	15,924	18 37·5	71 7·5	15,642	21 43·3	71 31·1	+282	−3 5·8	−0 23·6
Kirkwall	15,362	18 25·0	71 50·8	15,108	21 29·3	72 12·8	+254	−3 4·3	−0 22·0
Lairg	15,627	18 55·3	71 27·6	15,356	21 50·3	71 50·3	+271	−2 55·0	−0 22·7
Lochgoilhead	16,382	19 14·6	70 15·0	16,021	21 54·2	70 46·1	+361	−2 39·6	−0 31·1
Pitlochrie	16,198	18 8·9	70 29·4	15,899	21 8·3	70 57·4	+299	−2 59·4	−0 28·0
Row	16,366	18 39·1	70 17·0	15,978	21 47·7	70 51·0	+388	−3 8·6	−0 34·0
Stirling	16,073	18 46·8	70 41·6	15,945	21 28·6	70 53·3	+128	−2 41·8	−0 11·7
Stromness	15,399	18 21·2	71 48·5	15,149	21 27·9	72 11·7	+250	−3 6·7	−0 23·2
Thurso	15,486	18 7·6	71 36·2	15,217	21 38·4	72 1·1	+269	−3 30·8	−0 24·9
Wick	15,491	18 25·3	71 42·4	15,144	21 15·3	72 9·8	+347	−2 50·0	−0 27·4
						Mean	+285	−3 0·4	−0 25·1

TABLE VII. (continued).

District II.

Station.	Survey, January 1, 1915.			Survey, January 1, 1886.			Differences.		
	H.	D.	I.	H.	D.	I.	H.	D.	I.
	γ	° ′	° ′	γ	° ′	° ′	γ	° ′	° ′
Arinagower	—	—	—	—	23 40·4	—	—	—	—
Loch Aylort . . .	—	—	—	15,663	23 16·5	71 24·0	—	—	—
Banavie	16,219	19 3·4	70 50·6	15,940	22 6·7	71 11·4	+279	−3 3·3	−0 20·8
Loch Boisdale . . .	—	—	—	15,310	22 53·3	71 39·3	—	—	—
Callernish	—	—	—	15,236	23 40·6	72 7·1	—	—	—
Canna	—	—	—	15,092	23 13·0	72 45·0	—	—	—
Gairloch	15,610	19 31·9	71 18·1	15,353	22 14·4	71 44·3	+257	−2 42·5	−0 26·2
Loch Inver	15,208	19 37·2	71 53·0	14,990	22 7·4	72 0·2	+218	−2 30·2	−0 7·2
Iona	—	—	—	16,185	23 28·6	70 55·8	—	—	—
Kyle Akin	15,796	19 58·1	71 11·6	15,465	23 10·4	71 38·5	+331	−3 12·3	−0 26·9
Loch Maddy . . .	—	—	—	15,365	23 18·0	71 52·1	—	—	—
Oban	16,415	19 13·8	70 17·2	16,103	22 11·9	70 48·8	+312	−2 58·1	−0 31·6
Portree	16,468	18 50·1	70 3·6	15,876	22 45·6	71 8·6	+592	−3 55·5	−1 5·0
Scarnish	—	—	—	15,909	24 27·9	71 19·4	—	—	—
Soa	—	—	—	15,072	23 14·9	71 59·6	—	—	—
Stornoway	—	—	—	15,196	24 16·3	72 10·5	—	—	—
Strachur	16,187	18 36·3	70 27·4	16,095	21 48·9	70 42·9	+ 92	−3 12·6	−0 15·5

RÜCKER and THORPE'S values at Portree (*b*), and Stornoway (*a*), Oban (*b*), 'Phil. Trans.,' A, vol. 181, 1891.

Table VII. (continued).

District III.

Station.	Survey, January 1, 1915.			Survey, January 1, 1886.			Differences.		
	H.	D.	I.	H.	D.	I.	H.	D.	I.
	γ	° ′	° ′	γ	° ′	° ′	γ	° ′	° ′
Ayr	16,681	18 31·4	70 2·4	16,345	21 17·9	70 21·4	+336	−2 46·5	−0 19·0
Berwick	16,789	16 40·9	69 46·6	16,483	19 36·4	70 15·9	+306	−2 55·5	−0 29·3
Carstairs.	16,743	17 50·2	69 51·7	16,448	20 52·2	70 15·7	+295	−3 2·0	−0 24·0
Cumbrae.	—	—	—	15,911	21 37·2	71 2·3	—	—	—
Dumfries	16,916	17 51·3	69 33·3	16,542	20 47·4	70 2·6	+374	−2 56·1	−0 29·3
Edinburgh	16,552	17 47·9	70 3·8	16,183	20 47·2	70 38·5	+369	−2 59·3	−0 34·7
Fairlie	16,559	18 18·3	70 10·4	16,172	—	70 42·8	+387	—	−0 32·4
Glasgow	16,176	18 58·2	70 36·7	16,064	21 11·5	70 44·7	+112	−2 13·3	−0 8·0
Hawick	16,779	17 30·4	69 44·6	16,487	20 16·0	70 7·3	+292	−2 45·6	−0 22·7
Alnwick	16,842	16 46·1	69 35·8	16,511	19 45·0	70 3·6	+331	−2 58·9	−0 27·8
Appleby	17,054	17 6·6	69 9·4	16,690	20 5·8	69 44·9	+364	−2 59·2	−0 35·5
Barrow	17,249	17 10·6	68 52·7	16,875	20 9·3	69 30·6	+374	−2 58·7	−0 37·9
Carlisle	16,998	17 23·5	69 22·8	16,625	20 25·8	69 54·0	+373	−3 2·3	−0 31·2
Giggleswick. . . .	17,320	16 38·1	68 50·4	16,962	19 35·3	69 22·3	+358	−2 57·2	−0 31·9
Newcastle	16,988	16 33·8	69 18·8	16,665	19 30·3	69 49·5	+323	−2 56·5	−0 30·7
Port Erin	—	—	—	16,678	20 55·4	69 48·1	—	—	—
Ramsey	—	—	—	16,617	20 54·9	69 55·0	—	—	—
Redcar	17,192	16 7·4	69 3·8	16,847	19 5·6	69 31·5	+345	−2 58·2	−0 27·7
Scarborough . . .	17,474	15 55·4	68 43·1	17,017	18 48·3	69 15·6	+457	−2 52·9	−0 32·5
Thirsk	17,241	16 22·7	68 58·5	16,912	19 21·7	69 28·3	+329	−2 59·0	−0 29·8
Whitehaven . . .	17,050	17 38·3	69 22·4	16,727	20 41·6	69 47·6	+323	−3 3·3	−0 25·2
						Mean . . .	+336	−2 54·6	−0 28·3

TABLE VII. (continued).

District IV.

Station.	Survey, January 1, 1915.			Survey, January 1, 1886.			Differences.		
	H.	D.	I.	H.	D.	I.	H.	D.	I.
	γ	° ′	° ′	γ	° ′	° ′	γ	° ′	° ′
Bunnahabain . . .	—	—	—	16,243	23 10·3	70 43·0	—	—	—
Campbeltown . . .	16,577	19 16·8	69 57·0	16,244	22 8·1	70 34·2	+ 333	−2 51·3	−0 37·2
Port Askaig. . . .	—	—	—	16,340	23 0·7	70 36·2	—	—	—
Stranraer	16,826	18 30·3	69 44·9	16,435	21 35·0	70 13·5	+ 391	−3 4·7	−0 28·6
Tarbert	16,351	18 54·8	70 13·9	16,053	22 4·3	70 46·8	+ 298	−3 9·5	−0 32·9
Armagh	17,028	19 13·0	69 22·6	16,625	22 16·5	69 57·6	+ 403	−3 3·5	−0 35·0
Ballina	16,744	20 15·3	69 44·9	16,323	23 26·9	70 25·8	+ 421	−3 11·6	−0 40·9
Bangor	16,969	18 37·0	69 29·2	16,598	21 44·4	70 1·3	+ 371	−3 7·4	−0 32·1
Cavan.	17,021	19 32·7	69 19·1	16,629	22 37·8	69 57·3	+ 392	−3 5·1	−0 38·2
Coleraine.	17,138	19 48·8	69 18·7	16,085	22 36·9	70 47·7	+1053	−2 48·1	−0 39·0
Cookstown Junction .	16,926	17 20·0	69 31·0	16,830	21 32·8	69 34·5	+ 96	−4 12·8	−0 3·5
Donegal	16,948	19 44·8	69 32·7	16,449	23 20·1	70 15·3	+ 499	−3 35·3	−0 42·6
Enniskillen	16,887	19 52·6	69 37·3	16,477	23 5·3	70 14·2	+ 410	−3 12·7	−0 36·9
Greenore.	17,220	19 10·5	69 6·8	16,833	22 14·5	69 42·2	+ 387	−3 4·0	−0 35·4
Londonderry . . .	16,730	19 48·8	69 51·4	16,335	22 50·5	70 26·9	+ 395	−3 1·7	−0 35·5
Sligo	16,829	20 5·8	69 41·0	16,430	23 4·6	70 17·8	+ 399	−2 58·8	−0 36·8
Waterfoot	16,755	19 22·4	69 47·5	16,293	22 15·1	70 29·0	+ 462	−2 52·7	−0 41·5
						Mean . . .	+ 421	−3 9·3	−0 34·4

TABLE VII. (continued).

District V.

Station.	Survey, January 1, 1915.			Survey, January 1, 1886.			Differences.		
	H.	D.	I.	H.	D.	I.	H.	D.	I.
	γ	° ′	° ′	γ	° ′	° ′	γ	° ′	° ′
Bedford	18,076	15 29·9	67 28·9	17,705	18 27·4	68 7·3	+371	−2 57·5	−0 38·4
Cambridge	18,161	15 7·8	67 23·8	17,784	18 5·0	68 2·4	+377	−2 57·2	−0 38·6
Clenchwarton	17,998	15 9·5	67 40·8	17,662	18 10·3	68 17·9	+336	−3 0·8	−0 37·1
Cromer	18,004	14 35·0	67 42·7	17,603	17 35·8	68 20·0	+401	−3 0·8	−0 37·3
Gainsborough	17,703	15 44·2	68 14·3	17,321	18 36·4	68 49·3	+382	−2 52·2	−0 35·0
Grantham	17,840	15 44·8	67 53·6	17,527	18 29·0	68 28·0	+313	−2 44·2	−0 34·4
Hull	17,536	16 1·5	68 26·9	17,125	18 57·8	69 3·9	+411	−2 56·3	−0 37·0
Kettering	18,108	15 38·3	67 35·5	17,656	18 36·0	68 10·7	+452	−2 57·7	−0 35·2
King's Lynn	18,020	15 6·8	67 39·4	17,656	17 57·9	68 17·8	+364	−2 51·1	−0 38·4
Lincoln	17,743	15 24·6	68 5·2	17,395	18 18·9	68 43·0	+348	−2 54·3	−0 37·8
Lowestoft	18,166	14 24·4	67 25·2	17,797	17 24·0	68 0·4	+369	−2 59·6	−0 35·2
Mablethorpe	17,709	15 21·2	68 9·5	17,370	18 16·5	68 42·7	+339	−2 55·3	−0 33·2
Manton	18,091	15 34·6	67 39·0	17,661	18 21·7	68 17·1	+430	−2 47·1	−0 38·1
March	18,048	15 4·5	67 34·1	17,719	18 2·8	68 10·3	+329	−2 58·3	−0 36·2
Melton Mowbray	18,036	16 29·0	67 49·5	17,620	19 10·9	68 27·8	+416	−2 41·9	−0 38·3
Newark	17,782	15 44·3	67 59·2	17,464	18 46·2	68 33·4	+318	−3 1·9	−0 34·2
Northampton	18,079	15 51·1	67 27·8	17,667	18 41·7	68 9·4	+412	−2 50·6	−0 41·6
Peterborough	18,063	15 23·5	67 39·4	17,692	18 21·9	68 14·8	+371	−2 58·4	−0 35·4
Spalding	18,002	15 5·5	67 43·9	17,512	17 51·6	68 23·1	+490	−2 46·1	−0 39·2
Sutton Bridge	18,013	15 3·8	67 44·4	17,620	17 54·1	68 21·1	+393	−2 50·3	−0 36·7
Thetford	18,108	14 46·5	67 26·7	17,791	17 41·2	68 1·4	+317	−2 54·7	−0 34·7
Tilney	18,012	15 16·1	67 41·0	17,655	17 58·1	68 20·7	+357	−2 42·0	−0 39·7
Wisbech	18,055	15 9·5	67 40·6	17,653	18 5·6	68 19·0	+402	−2 56·1	−0 38·4
						Mean . . .	+378	−2 53·7	−0 37·0

RÜCKER and THORPE, King's Lynn (*a*), Melton Mowbray (*a*), *loc. cit.*

TABLE VII. (continued).

District VI.

Station.	Survey, January 1, 1915.			Survey, January 1, 1886.			Differences.		
	H.	D.	I.	H.	D.	I.	H.	D.	I.
	γ	° ′	° ′	γ	° ′	° ′	γ	° ′	° ′
Stonyhurst	17,353	16 42·1	68 41·5	17,002	19 42·6	69 11·4	+351	−3 0·5	−0 29·9
Aberystwith	17,913	16 55·3	67 54·6	17,488	19 56·5	68 34·7	+425	−3 1·2	−0 40·1
Birkenhead	17,507	17 2·3	68 30·8	17,176	19 58·3	69 4·3	+331	−2 56·0	−0 33·5
Birmingham	17,989	15 48·2	67 44·9	17,669	18 44·0	68 21·3	+320	−2 55·8	−0 36·4
Cardigan	17,924	17 34·3	67 51·8	17,535	20 25·8	68 31·3	+389	−2 51·5	−0 39·5
Chesterfield	17,742	16 7·4	68 9·6	17,351	19 11·9	68 48·5	+391	−3 4·5	−0 38·9
Coalville	17,943	15 33·5	67 51·1	17,534	18 41·4	68 24·1	+409	−3 7·9	−0 33·0
Holyhead	17,359	17 51·4	68 44·7	16,958	20 51·1	69 23·1	+401	−2 59·7	−9 38·4
Kenilworth	17,984	16 1·2	67 52·0	17,576	19 1·4	68 28·8	+408	−3 0·2	−0 36·8
Lampeter	17,947	17 4·5	67 47·6	17,559	19 55·3	68 25·5	+388	−2 50·8	−0 37·9
Leeds	17,455	16 17·3	68 35·2	17,082	19 8·9	69 10·8	+373	−2 51·6	−0 35·6
Leicester	17,967	15 34·0	67 48·0	17,538	18 23·6	68 24·0	+429	−2 49·6	−0 36·0
Llandudno	17,450	17 47·8	68 37·4	17,084	20 51·5	69 12·0	+366	−3 3·7	−0 34·6
Llangollen	17,721	17 7·3	68 12·1	17,331	20 8·4	68 49·4	+390	−3 1·1	−0 37·3
Llanidloes	17,875	16 51·4	67 57·5	17,501	19 53·8	68 33·8	+374	−3 2·4	−0 36·3
Loughborough	17,920	15 24·8	67 50·8	17,531	18 18·7	68 27·7	+389	−2 53·9	−0 36·9
Malvern	18,057	16 20·7	67 37·9	17,663	19 11·4	68 14·4	+394	−2 50·7	−0 36·5
Manchester	17,549	16 22·4	68 26·8	17,125	19 16·7	69 3·9	+424	−2 54·3	−0 37·1
Nottingham	17,884	15 49·4	68 2·6	17,470	18 44·9	68 37·6	+414	−2 55·5	−0 35·0
Preston	17,408	16 57·7	68 38·0	17,053	19 52·3	69 14·7	+355	−2 54·6	−0 36·7
Pwllheli	17,813	17 38·4	68 12·9	17,407	20 41·9	68 50·9	+406	−3 3·5	−0 38·0
Shrewsbury	17,818	16 50·8	68 0·0	17,342	19 41·2	68 36·4	+476	−2 50·4	−0 36·4
Stoke-on-Trent	17,756	16 23·8	68 4·9	17,401	19 22·7	68 43·6	+355	−2 58·9	−0 38·7
Wheelock	17,685	16 21·5	68 11·4	—	—	68 49·0	—	—	−0 37·6
						Mean . . .	+389	−2 57·3	−0 36·5

Malvern (mean).

Table VII. (continued).

District VII.

Station	Survey, January 1, 1915.			Survey, January 1, 1886.			Differences.		
	H.	D.	I.	H.	D.	I.	H.	D.	I.
	γ	° ′	° ′	γ	° ′	° ′	γ	° ′	° ′
Athlone	17,304	19 28·4	69 1·1	16,852	22 26·7	69 40·0	+452	−2 58·3	−0 38·9
Bagnalstown . . .	17,660	18 52·5	68 22·1	17,208	21 55·0	69 5·1	+452	−3 2·5	−0 43·0
Ballywilliam . . .	17,650	18 35·5	68 25·5	17,222	21 37·3	69 5·6	+428	−3 1·8	−0 40·1
Bantry	18,017	19 39·3	67 58·1	17,529	22 40·3	68 46·0	+488	−3 1·0	−0 47·9
Carrick-on-Shannon .	17,130	20 0·2	69 18·4	16,700	23 3·1	69 53·3	+430	−3 2·9	−0 34·9
Castlereagh	17,120	20 12·1	69 19·1	16,716	23 11·1	69 56·3	+404	−2 59·0	−0 37·2
Charleville	17,705	19 36·2	68 19·9	17,226	22 30·8	69 5·3	+479	−2 54·6	−0 45·4
Clifden	17,077	20 32·3	69 17·3	16,631	24 20·7	70 4·8	+446	−2 48·4	−0 47·5
Cork	17,923	19 22·1	68 2·5	17,506	22 18·1	68 46·4	+417	−2 56·0	−0 43·9
Drogheda	17,277	18 58·4	69 0·1	16,895	21 54·7	69 36·3	+382	−2 56·3	−0 36·2
Dublin	17,474	18 46·0	68 42·3	17,087	21 40·8	69 15·7	+387	−2 54·8	−0 33·4
Galway	17,320	20 25·1	69 3·1	16,867	23 29·8	69 41·6	+453	−3 4·7	−0 38·5
Gort	17,449	19 50·6	68 50·0	17,013	22 50·5	69 31·7	+436	−2 59·9	−0 41·7
Kells	17,327	19 17·8	69 1·3	16,925	22 7·0	69 38·7	+402	−2 49·2	−0 37·4
Kildare	17,515	19 1·8	68 37·2	17,073	22 0·4	69 17·2	+442	−2 58·6	−0 40·0
Kilkenny	17,671	18 50·6	68 21·2	17,258	21 58·7	69 5·0	+413	−3 8·1	−0 43·8
Killarney	17,908	19 57·5	68 12·1	17,405	22 55·8	68 56·5	+503	−2 58·3	−0 44·4
Kilrush	17,549	20 11·3	68 42·1	17,090	23 11·4	69 23·2	+459	−3 0·1	−0 41·1
Leenane	16,986	20 24·4	69 24·8	16,512	23 36·2	70 8·0	+474	−3 11·8	−0 43·2
Limerick	17,660	19 52·3	68 31·3	17,235	23 36·6	69 8·8	+425	−2 44·3	−0 37·5
Lisdoonvarna . . .	17,486	19 58·7	68 48·5	17,042	22 58·5	69 31·8	+444	−2 59·8	−0 43·3
Lismore	17,823	19 6·3	68 8·5	17,427	22 5·5	68 48·6	+396	−2 59·2	−0 40·1
Oughterard	17,177	20 37·3	69 14·0	16,762	23 40·6	69 56·7	+415	−3 3·3	−0 42·7
Parsonstown . . .	17,422	19 29·9	68 48·7	16,989	22 27·0	69 30·3	+433	−2 57·1	−0 41·6
Tipperary	17,724	19 23·5	68 21·9	17,272	22 22·6	69 4·9	+452	−2 59·1	−0 43·0
Tralee	17,712	20 10·6	68 24·9	—	—	69 9·4	—	—	−0 44·5
Valencia	17,911	20 12·0	68 8·9	17,448	23 16·0	68 54·7	+463	−3 4·0	−0 45·8
Waterford	17,809	18 30·5	68 12·6	17,329	21 27·9	68 53·7	+480	−2 57·4	−0 41·1
Westport	16,921	20 12·8	69 38·6	16,509	23 15·1	70 17·9	+412	−3 2·3	−0 39·3
Wexford	17,778	18 16·5	68 14·2	17,324	21 18·1	68 56·2	+454	−3 1·6	−0 42·0
Wicklow	17,557	18 20·7	68 29·6	17,126	21 21·4	69 9·9	+431	−3 0·7	−0 40·3
						Mean . . .	+435	−2 59·2	−0 41·3

Rücker and Thorpe, Galway (*b*), *loc. cit.*

TABLE VII. (continued).

District VIII.

Station.	Survey, January 1, 1915.			Survey, January 1, 1886.			Differences.		
	H.	D.	I.	H.	D.	I.	H.	D.	I.
	γ	° ′	° ′	γ	° ′	° ′	γ	° ′	° ′
Greenwich	18,520	15 2·0	66 52·0	18,141	17 56·3	67 28·6	+379	−2 54·3	−0 36·6
Braintree	18,348	14 57·0	67 6·7	17,942	17 55·4	67 45·4	+406	−2 58·4	−0 38·7
Chichester	18,800	15 12·1	66 26·9	18,395	18 5·5	67 11·6	+405	−2 53·4	−0 44·7
Colchester	18,394	15 2·6	66 56·6	18,012	17 55·2	67 35·3	+382	−2 52·6	−0 38·7
Dover	18,740	14 4·7	66 28·0	18,336	16 57·2	67 8·0	+404	−2 52·5	−0 40·0
Harwich	18,349	14 26·5	66 55·6	18,031	17 18·8	67 38·4	+318	−2 52·3	−0 42·8
Harpenden	18,335	15 22·7	67 10·1	17,916	18 16·5	67 52·4	+419	−2 53·8	−0 42·3
Haslemere	18,672	15 16·7	66 40·0	18,282	18 7·7	67 20·6	+390	−2 51·0	−0 40·6
Horsham	18,720	15 9·9	66 32·5	18,309	18 3·3	67 15·2	+411	−2 53·4	−0 42·7
Kew	18,483	15 22·1	66 56·1	18,093	18 16·3	67 37·4	+390	−2 54·2	−0 41·3
Purfleet	18,503	14 55·0	66 56·0	18,134	17 54·5	67 30·9	+369	−2 59·5	−0 34·9
Ranmore	18,694	15 15·7	66 35·2	18,261	18 8·9	67 20·0	+433	−2 53·2	−0 44·8
Reading	18,489	15 18·8	67 2·2	18,110	18 15·2	67 40·7	+379	−2 56·4	−0 38·5
St. Leonards	18,812	14 31·6	66 21·0	18,437	17 24·8	66 58·9	+375	−2 53·2	−0 37·9
Southend	18,497	14 47·2	66 53·0	18,112	17 44·4	67 30·8	+385	−2 57·2	−0 37·8
Tunbridge Wells	18,706	14 19·4	66 30·7	18,297	17 41·3	67 10·8	+409	−3 21·9	−0 40·1
Windsor	18,476	15 34·8	66 56·3	18,084	18 29·9	67 38·8	+392	−2 55·1	−0 42·5
Worthing	18,809	15 6·1	66 24·7	18,402	17 59·0	67 6·4	+407	−2 52·9	−0 41·7
						Mean	+392	−2 55·9	−0 40·4

RÜCKER and THORPE, Reading (*a*), *loc. cit.*

Table VII. (continued).

District IX.

Station.	Survey, January 1, 1915. H.	D.	I.	Survey, January 1, 1886. H.	D.	I.	Differences. H.	D.	I.
	γ	° ′	° ′	γ	° ′	° ′	γ	° ′	° ′
Southampton	18,696	15 19·2	66 35·5	—	—	—	—	—	—
Alresford	18,686	15 17·6	66 40·8	18,241	18 9·7	67 22·3	+445	−2 52·1	−0 41·5
Brecon	18,116	16 42·8	67 33·4	17,701	19 38·6	68 15·8	+415	−2 55·8	−0 42·4
Bude	18,513	17 1·5	67 0·2	18,080	19 56·5	67 44·2	+433	−2 55·0	−0 44·0
Cardiff	18,396	16 27·7	67 10·0	17,944	19 19·7	67 52·3	+452	−2 52·0	−0 42·3
Clifton	18,419	16 16·3	67 11·3	17,996	19 10·7	67 48·7	+423	−2 54·4	−0 37·4
Clovelly	18,451	16 55·6	67 6·7	18,000	19 53·8	67 49·9	+451	−2 58·2	−0 43·2
Falmouth	18,814	17 2·6	66 25·3	18,323	19 53·4	67 15·0	+491	−2 50·8	−0 49·7
Gloucester	18,200	16 16·5	67 25·1	17,811	19 12·9	68 4·3	+389	−2 56·4	−0 39·2
Ilfracombe	18,394	16 53·8	67 9·8	17,952	19 46·5	67 53·8	+442	−2 52·7	−0 44·0
King's Sutton	18,196	15 57·4	67 25·2	17,778	18 51·8	68 6·4	+418	−2 54·4	−0 41·2
Milford	18,228	17 11·4	67 28·6	17,808	20 8·8	68 9·9	+420	−2 57·4	−0 41·3
Oxford	18,257	15 38·6	67 17·8	17,890	18 33·7	67 57·5	+367	−2 55·1	−0 39·7
Plymouth	18,789	16 36·2	66 25·4	18,309	19 31·6	67 14·7	+480	−2 55·4	−0 49·3
Ryde	18,802	15 9·7	66 24·4	18,391	18 1·6	67 7·8	+411	−2 50·9	−0 43·4
St. Cyres	18,657	16 37·1	66 41·9	18,260	19 28·6	67 26·2	+397	−2 51·5	−0 44·3
Salisbury	18,607	15 32·0	66 44·2	18,242	18 23·9	67 25·6	+365	−2 51·9	−0 41·4
Swansea	18,328	16 50·6	67 19·4	17,931	19 45·6	67 59·7	+397	−2 55·0	−0 40·3
Swindon	18,378	15 23·8	67 9·6	17,930	—	67 51·4	+448	—	−0 41·8
Taunton	18,575	16 16·4	66 49·2	18,154	19 10·7	67 32·7	+421	−2 54·3	−0 43·5
Wallingford	18,418	15 28·2	67 5·2	17,986	18 21·6	67 48·4	+432	−2 53·4	−0 43·2
Weymouth	18,807	15 52·7	66 26·2	18,329	18 46·7	67 11·7	+478	−2 54·0	−0 45·5
						Mean . . .	+427	−2 54·0	−0 42·8

Portree is abnormal in the other direction, for the increase of H is 592γ and the decrease in I 65′. Coleraine has an increase of 1053γ in H and a decrease in I of 39′ (practically normal), while Cookstown Junction in the same district has an increase of only 96γ in H and a decrease of 4′ in I. With these exceptions nothing very remarkable is apparent until we come to analyse the disturbing forces.

We conclude that "as a whole the change of the magnetic elements in 29 years has been remarkably uniform at all points in the British Isles."

The mean annual change of the elements during the 29 years is set out for the different districts in Table VIII. They appear to have a systematic although small dependence on the latitude and longitude.

In all cases the agreement between the deduced formulæ and the observations is good, except in the case of the vertical component for districts III., VII. and VIII. A comparison of these discrepancies with those in Table IV. is interesting and may

TABLE VIII.—Mean Annual Changes from 1886 to 1915.

District.	λ_0.	l_0.	H.	D.	I.	N.	W.	V.	From formulæ. H.	From formulæ. D.	From formulæ. I.	From formulæ. N.	From formulæ. W.	From formulæ. V.	Observed − calculated. H.	Observed − calculated. D.	Observed − calculated. I.	Observed − calculated. N.	Observed − calculated. W.	Observed − calculated. V.
	° ′	° ′	γ	′	′	γ	γ	γ	γ	′	′	γ	γ	γ	γ	′	′	γ	γ	γ
I.	57 21 ·8	−3 44 ·8	+ 9 ·83	−6 ·22	−0 ·87	+18 ·83	−23 ·52	− 7 ·93	10 ·54	6 ·28	0 ·79	19 ·48	23 ·28	8 ·42	−0 ·71	−0 ·06	+0 ·08	−0 ·65	−0 ·24	−0 ·49
II.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
III.	55 2 ·1	−2 45 ·6	+11 ·59	−6 ·02	−0 ·98	+20 ·38	−24 ·17	− 8 ·00	11 ·90	6 ·16	1 ·04	21 ·29	24 ·51	9 ·77	−0 ·31	−0 ·14	−0 ·06	−0 ·91	−0 ·34	−1 ·77
IV.	54 42 ·9	−6 48 ·6	+14 ·52	−6 ·53	−1 ·19	+24 ·52	−24 ·10	−13 ·28	13 ·49	6 ·32	1 ·20	23 ·51	23 ·97	13 ·43	+1 ·03	+0 ·21	−0 ·01	+1 ·01	+0 ·13	−0 ·15
V.	52 44 ·8	−0 4 ·4	+13 ·03	−5 ·99	−1 ·28	+21 ·41	−25 ·90	−11 ·45	12 ·65	5 ·97	1 ·22	20 ·98	26 ·00	10 ·83	+0 ·38	+0 ·02	+0 ·06	+0 ·43	−0 ·10	+0 ·62
VI.	52 54 ·0	−2 40 ·2	+13 ·41	−6 ·11	−1 ·26	+22 ·48	−25 ·59	−13 ·69	13 ·42	6 ·09	1 ·28	22 ·44	25 ·50	13 ·84	−0 ·01	+0 ·02	−0 ·02	+0 ·04	+0 ·09	−0 ·15
VII.	52 53 ·1	−8 14 ·9	+15 ·00	−6 ·18	−1 ·42	+25 ·48	−24 ·24	−16 ·28	15 ·30	6 ·32	1 ·45	25 ·87	24 ·57	18 ·06	−0 ·30	−0 ·14	−0 ·03	−0 ·39	−0 ·33	−1 ·78
VIII.	51 22 ·3	+0 3 ·2	+13 ·52	−6 ·07	−1 ·39	+22 ·14	−27 ·28	−17 ·07	13 ·61	5 ·92	1 ·38	22 ·01	26 ·65	14 ·76	−0 ·09	+0 ·15	+0 ·01	+0 ·13	+0 ·63	+2 ·31
IX.	51 13 ·2	−2 51 ·2	+14 ·72	−6 ·00	−1 ·44	+23 ·69	−25 ·93	−17 ·59	14 ·76	6 ·04	1 ·48	24 ·01	26 ·23	17 ·24	−0 ·04	−0 ·04	−0 ·04	−0 ·32	−0 ·30	+0 ·35
Mean	53 31 ·8	−3 23 ·3	+13 ·20	−6 ·14	−1 ·23	+22 ·37	−25 ·09	−13 ·16												

Linear formulæ deduced by equations of condition :—

$$\begin{aligned} & \qquad \gamma \\ \delta H &= 13 \cdot 20 - 0 \cdot 0121\, \Delta\lambda - 0 \cdot 0056\, \Delta l, \\ -\delta D &= 6' \cdot 14 + 0 \cdot 000554\, \Delta\lambda - 0 \cdot 000703\, \Delta l, \\ -\delta I &= 1' \cdot 23 - 0 \cdot 00194\, \Delta\lambda - 0 \cdot 000512\, \Delta l. \end{aligned}$$

$$\begin{aligned} & \qquad \gamma \\ \delta N &= 22 \cdot 37 - 0 \cdot 0135\, \Delta\lambda - 0 \cdot 0102\, \Delta l, \\ -\delta W &= 25 \cdot 09 - 0 \cdot 0076\, \Delta\lambda + 0 \cdot 0028\, \Delta l, \\ -\delta V &= 13 \cdot 16 - 0 \cdot 0323\, \Delta\lambda - 0 \cdot 0125\, \Delta l, \end{aligned}$$

where $\Delta\lambda$ and Δl are the differences of latitude and longitude from the mean position 53° 31′ ·8 N and 3° 23′ ·3 W, expressed in minutes of arc.

be significant. There is no obvious reason why linear formulæ should apply to the British Isles, but on the other hand there is a well-founded distrust in the present methods of measuring vertical force. In view of the highly important discriminating value of good vertical component values in theoretical work, our results emphasize the urgency of improved methods of observation of this component.

We have now to consider the Disturbing Forces indicated by our analysis of this survey, and to compare them with those found by RÜCKER and THORPE. But before we enter on a detailed comparison it is desirable to emphasize the theoretical principles involved.

Stated in general terms our problem is to abstract the features common to a large number of observations. This problem is common to the investigation of all natural phenomena; but whereas in laboratory observations the conditions can be controlled, so that a definite solution can be obtained, the magnetic observations in a survey are made under uncontrolled conditions and a determinate solution is not possible. Our only test is the closeness with which we can represent the observations by an empirical formula. When the formula ceases to be simple, or to admit of easy interpretation, we must stop. The residuals are the disturbing forces for which causes must be assigned within the region surveyed.

In their survey RÜCKER and THORPE aimed at making the residuals as small as possible, by using overlapping districts, and formulæ proceeding to squares of the geographical co-ordinates; but in the present survey, the districts did not overlap, the formulæ used were linear in the geographical co-ordinates, and moreover conformed to a magnetic potential.

Since the surveys differ in epoch by 29 years and the main parts of the magnetic forces have changed considerably in the interval, this is equivalent to a change of the uncontrolled conditions. Thus a comparison of the disturbing forces is very instructive.

In the Tables IX. and X. the disturbing forces for 1886 were computed from the values given by RÜCKER and THORPE, 'Phil. Trans.,' A, vol. 181, p. 270, and it must be remembered that the new stations are not identical with the old ones.

As regards the horizontal components, the agreement is in most cases remarkably close and supports the view that these disturbing forces are not mere errors of experiment, but are due to real local or regional causes. In a few cases (*e.g.*, Portree) the discrepancies may reasonably be attributed to the change of observing point in a highly disturbed region. There are, however, a number of discrepancies that cannot well be accounted for by change of observing point, and they imply either error of observation or change of the local conditions.

When we compare the vertical components of disturbance the results do not appear so concordant, and this is brought out in Table X., which gives the district disturbing forces. It might have been expected that RÜCKER and THORPE's formulæ would give lower residuals for the districts, but the table shows little if any superior

Table IX.—Disturbing Forces

District I.

Station	1915.			1886.		
	N.	W.	V.	N.	W.	V.
	γ	γ	γ	γ	γ	γ
Aberdeen	− 85	− 43	− 25	− 66	− 48	− 28
Ballater	− 3	− 148	− 129	− 47	− 144	− 41
Banff	+ 97	+ 39	− 196	+ 38	+ 105	− 124
Boat of Garten	+ 58	+ 142	− 2	+ 15	+ 211	+ 56
Crianlarich	+ 55	+ 93	+ 71	+ 5	+ 39	− 219
Crieff	+ 11	+ 31	− 131	+ 31	+ 110	+ 217
Dalwhinnie	+ 139	+ 92	+ 71	+ 103	+ 75	− 247
Dundee	− 207	− 114	+ 28	− 23	0	+ 10
Elgin	+ 96	− 52	+ 61	+ 34	− 79	+ 45
Loch Eriboll	+ 62	− 22	− 53	+ 21	− 31	+ 175
Fort Augustus	+ 23	− 40	+ 369	− 14	− 73	+ 57
Golspie	− 12	+ 62	+ 24	− 3	− 89	− 65
Inverness	+ 78	− 19	+ 173	+ 61	0	+ 156
Kirkwall	+ 71	− 16	− 100	+ 21	− 17	+ 109
Lairg	+ 18	− 42	− 70	+ 14	− 72	− 34
Lochgoilhead	− 46	+ 141	− 278	− 12	+ 20	− 328
Pitlochrie	+ 16	− 28	− 304	+ 15	− 29	− 242
Row	− 47	− 10	− 159	− 117	− 21	− 188
Stirling	− 374	+ 46	+ 90	− 166	+ 8	− 92
Stromness	+ 128	− 67	− 108	+ 72	− 34	+ 146
Thurso	+ 98	− 141	− 265	+ 12	− 16	− 47
Wick	− 25	− 10	+ 139	− 124	− 84	+ 242
Mean	+ 7	− 5	− 36	− 6	− 8	− 20

District II. (Incomplete).

Station.	1915.			1886.		
	N.	W.	V.	N.	W.	V.
	γ	γ	γ	γ	γ	γ
Banavie	+ 147	+ 41	+ 470	+ 167	+ 54	+ 268
Gairloch	− 55	− 78	− 538	+ 18	− 208	− 451
Loch Inver	− 311	− 108	− 321	− 204	− 253	− 853
Kyle Akin	− 98	+ 74	− 86	− 126	+ 61	− 168
Oban	+ 184	+ 80	− 263	+ 200	+ 57	− 128
Portree	+ 762	− 65	− 1200	+ 379	+ 74	− 378
Strachur	− 117	− 116	− 324	+ 88	− 1	− 269

TABLE IX.—Disturbing Forces (continued).

District III. (Incomplete.)

Station.	1915. N.	1915. W.	1915. V.	1886. N.	1886. W.	1886. V.
	γ	γ	γ	γ	γ	γ
Ayr	+ 16	+ 47	+366	+ 57	− 23	−145
Berwick	+153	− 56	+128	+173	− 46	+230
Carstairs	+136	+ 17	+ 88	+168	+ 42	− 79
Dumfries	+ 21	+ 64	+102	+ 16	+ 24	− 87
Edinburgh	+ 32	+ 25	− 18	15	+ 8	+107
Fairlie	+ 71	− 65	+202	—	—	+135
Glasgow	−374	+ 62	+260	− 80	− 86	− 80
Hawick	+ 14	+ 48	+ 88	+ 76	− 1	− 99
Alnwick	+ 27	+ 6	+ 13	+ 26	+ 14	− 50
Appleby	− 76	+ 12	−175	− 67	+ 14	− 56
Barrow	− 8	− 18	−192	+ 3	− 35	− 71
Carlisle	+ 25	+ 40	+ 20	+ 9	+ 40	− 52
Giggleswick	− 5	− 32	+ 16	+ 35	− 35	+ 12
Newcastle	+ 4	− 18	− 86	+ 31	− 16	− 4
Redcar	+ 2	− 15	+105	+ 22	− 6	+ 11
Scarborough	+ 96	+ 72	+234	+ 29	+ 37	+ 63
Thirsk	− 82	+ 8	+145	− 22	+ 20	+173
Whitehaven	− 31	+ 23	+234	+ 15	+ 39	+ 24
Mean	+ 1	+ 13	+ 85	+ 28	− 1	+ 7

District IV.

Station.	1915. N.	1915. W.	1915. V.	1886. N.	1886. W.	1886. V.
	γ	γ	γ	γ	γ	γ
Campbeltown	− 68	+ 89	−227	− 26	+ 25	− 9
Stranraer	− 32	+ 11	+242	− 38	+ 1	− 72
Tarbert	− 87	− 39	−325	− 53	− 12	−150
Armagh	+ 30	+ 29	− 34	− 22	+ 11	−158
Ballina	−199	−128	− 40	−186	− 82	− 74
Bangor	+ 54	− 7	+ 36	+ 68	+ 4	− 93
Cavan	− 95	+ 9	−122	− 68	+ 4	−111
Coleraine	+396	+261	−248	−215	− 70	+106
Cookstown Junction	+236	−464	−115	+400	− 42	−677
Donegal	+162	− 35	−127	+ 25	+ 50	−250
Enniskillen	− 74	+ 30	+ 78	−101	+ 37	− 78
Greenore	+ 21	+138	+ 43	+ 29	+135	− 60
Londonderry	+ 25	+ 33	− 29	+ 24	0	−116
Sligo	−105	− 44	+ 28	− 63	− 87	− 79
Strabane	+ 7	+35	+ 51	− 9	− 44	−163
Waterfoot	− 17	+96	− 14	− 85	− 6	+ 1
Mean	+ 16	+ 1	− 50	− 17	− 5	−123

RÜCKER and THORPE, Stranraer (*a*), *loc. cit. ante.*

TABLE IX.—Disturbing Forces (continued).

District V.

Station.	1915.			1886.		
	N.	W.	V.	N.	W.	V.
	γ	γ	γ	γ	γ	γ
Bedford	−152	+10	−107	−129	+27	+39
Cambridge	−65	−3	−62	−53	+21	+110
Clenchwarton	−21	+21	−69	+30	+71	+207
Cromer	−4	−12	+54	−1	+25	+208
Gainsborough	+7	−6	+69	+34	−25	+132
Grantham	−64	+23	−143	+41	−5	+50
Hull	−65	+93	0	−89	+86	+94
Kettering	−4	+31	+82	−51	+30	−92
King's Lynn	−15	+23	−39	+43	+15	+195
Lincoln	−18	−70	−76	+60	−66	+172
Lowestoft	−58	+9	+50	−27	+55	+192
Mablethorpe	−142	+6	+97	−13	+31	+163
Manton	+79	+27	+58	+67	−22	+79
March	−31	−38	−112	+36	+1	+111
Melton Mowbray	+14	+265	+238	+16	+184	+305
Newark	−42	−3	−162	+37	+42	+6
Northampton	−107	+59	−214	−107	+29	−69
Peterborough	+4	+14	+68	+29	+43	+150
Spalding	+46	−68	+3	−19	−133	−48
Sutton Bridge	+8	−25	+100	+35	−43	+200
Thetford	−76	−31	−102	+17	−2	+94
Tilney	−34	+52	−6	+29	−2	+311
Wisbech	+14	+4	+93	+17	+10	+227
Mean	−31	+17	−8	0	+16	+123

RÜCKER and THORPE, King's Lynn (*a*), and Melton Mowbray (*a*), *loc. cit. ante.*

Table IX.—Disturbing Forces (continued).

District VI.

Station.	1915.			1886.		
	N.	W.	V.	N.	W.	V.
	γ	γ	γ	γ	γ	γ
Stonyhurst	− 52	− 37	− 160	− 1	− 22	− 223
Aberystwith	+ 23	− 91	− 34	+ 9	− 76	− 78
Birkenhead	− 78	− 6	− 19	+ 15	+ 2	+ 26
Birmingham	− 8	− 105	− 2	+ 95	− 80	+ 152
Cardigan	− 94	+ 9	− 34	− 67	− 6	− 52
Chesterfield	+ 14	+ 14	− 7	+ 12	+ 55	+ 145
Coalville	+ 42	− 101	+ 30	+ 26	− 51	− 109
Holyhead	− 126	− 22	+ 5	− 148	− 37	+ 21
Kenilworth	− 86	− 9	+ 294	− 102	+ 13	+ 287
Lampeter	− 74	− 52	− 84	− 44	− 68	− 137
Leeds	− 1	− 4	− 59	+ 28	− 35	+ 59
Leicester	− 12	− 69	+ 57	− 9	− 108	− 27
Llandudno	− 147	+ 100	+ 35	− 110	+ 114	+ 12
Llangollen	− 26	+ 60	− 29	− 20	+ 67	− 9
Llanidloes	− 37	− 50	+ 7	− 15	− 13	− 22
Loughborough	+ 34	− 137	− 39	+ 66	− 140	+ 22
Malvern (*a*)	− 140	− 68	+ 46	− 91	− 77	—
,, (*b*)	− 77	+ 61	− 1	− 73	+ 97	+ 21
,, (*c*)	− 69	+ 45	− 23	− 69	+ 42	—
,, (*d*)	− 33	− 95	+ 20	− 20	− 146	—
Manchester	− 18	− 81	− 25	− 25	− 102	− 50
Nottingham	+ 38	− 17	+ 230	+ 29	− 15	+ 179
Preston	− 57	+ 15	− 115	+ 3	− 2	+ 49
Pwllheli	+ 95	+ 66	+ 156	+ 88	+ 88	+ 114
Shrewsbury	− 63	+ 47	− 76	− 117	− 14	− 319
Stoke-on-Trent	− 28	− 16	− 109	+ 17	+ 3	+ 85
Wheelock	− 12	− 55	− 130	—	—	—
Mean	− 32	− 23	− 4	− 20	− 20	+ 6

TABLE IX.—Disturbing Forces (continued).

District VII.

Station.	1915. N.	1915. W.	1915. V.	1886. N.	1886. W.	1886. V.
	γ	γ	γ	γ	γ	γ
Athlone	+ 11	− 21	+ 112	+ 9	− 58	− 68
Bagnalstown	− 8	+ 26	− 43	− 25	+ 29	− 113
Ballywilliam	− 93	− 63	+ 175	− 93	− 46	+ 45
Bantry	+ 83	− 20	+ 141	+ 24	+ 31	− 12
Carrick-on-Shannon	+ 13	+ 72	+ 108	+ 15	+ 47	− 171
Castlereagh	− 50	+ 56	+ 147	− 11	+ 35	+ 25
Charleville	− 3	+ 2	− 41	− 26	− 17	− 152
Clifden	− 84	− 83	− 73	− 150	+ 105	+ 37
Cork	+ 28	+ 9	+ 62	+ 34	+ 39	+ 3
Drogheda	− 9	+ 52	+ 40	+ 37	+ 24	− 14
Dublin	+ 61	+ 51	+ 3	+ 96	+ 37	− 126
Galway	− 29	+ 94	+ 195	− 27	+ 93	− 51
Gort	+ 40	− 2	+ 134	+ 67	− 6	+ 56
Kells	+ 53	+ 90	+ 172	+ 105	+ 26	+ 106
Kildare	+ 34	+ 54	− 42	+ 43	+ 31	− 118
Kilkenny	+ 27	− 27	− 69	+ 32	+ 28	− 4
Killarney	+ 117	+ 41	+ 216	+ 63	+ 57	− 54
Kilrush	− 11	+ 19	+ 205	− 10	+ 27	− 4
Leenane	− 144	− 98	− 32	− 171	− 95	− 151
Limerick	+ 46	+ 80	+ 152	+ 102	+ 25	− 89
Lisdoonvarna	+ 90	− 17	+ 143	+ 116	− 14	+ 100
Lismore	+ 11	− 11	− 12	+ 25	+ 26	− 135
Oughterard	− 96	+ 71	+ 158	− 59	+ 70	+ 183
Parsonstown	− 33	+ 8	+ 97	− 6	− 5	+ 48
Tipperary	+ 43	+ 16	+ 75	+ 26	+ 28	− 31
Tralee	+ 16	+ 22	+ 97	—	—	—
Valencia	+ 112	+ 4	+ 88	+ 88	+ 79	− 53
Waterford	+ 33	− 85	+ 120	− 3	− 18	− 118
Westport	− 123	− 142	+ 285	− 76	− 156	+ 196
Wexford	− 14	− 61	+ 141	− 49	− 50	+ 15
Wicklow	− 14	− 28	− 65	− 15	− 33	− 117
Mean	+ 3	+ 4	+ 87	+ 5	+ 11	− 26

RÜCKER and THORPE, Galway (*b*), *loc. cit.*

Table IX.—Disturbing Forces (continued).

District VIII.

Station.	1915.			1886.		
	N.	W.	V.	N.	W.	V.
	γ	γ	γ	γ	γ	γ
Greenwich	− 6	+ 16	− 20	+ 7	+ 35	− 5
Braintree	− 48	+ 34	− 36	− 65	+ 63	+ 50
Chichester	+ 63	+ 13	− 34	+ 37	+ 28	+ 130
Colchester	− 31	+ 126	− 263	− 28	+ 130	− 99
Dover	+ 14	− 64	− 59	− 12	− 59	+ 21
Harwich	− 58	− 11	− 372	+ 29	+ 9	+ 79
Harpenden	− 46	+ 38	+ 5	− 59	+ 37	+ 146
Haslemere	+ 35	+ 10	+ 12	+ 38	+ 15	+ 87
Horsham	+ 44	+ 43	− 88	+ 17	+ 54	+ 20
Kew	− 42	+ 66	+ 9	− 44	+ 79	+ 162
Purfleet	− 33	+ 12	+ 100	− 21	+ 56	+ 89
Ranmore	+ 85	+ 68	− 133	+ 36	+ 77	+ 11
Reading	+ 39	− 37	+ 168	+ 49	− 7	+ 235
St. Leonards	+ 22	− 21	− 100	+ 5	− 3	− 61
Southend	− 47	+ 35	− 1	− 48	+ 66	+ 74
Tunbridge Wells	+ 58	− 141	− 140	− 2	+ 22	− 104
Windsor	− 36	+ 92	− 34	− 14	+ 56	+ 136
Worthing	+ 38	+ 27	− 48	0	+ 44	+ 24
Mean	+ 3	+ 17	− 57	− 4	+ 33	+ 55

Rücker and Thorpe, Reading (*a*), *loc. cit.*

Table IX.—Disturbing Forces (continued).

District IX.

Station.	1915.			1886.		
	N.	W.	V.	N.	W.	V.
	γ	γ	γ	γ	γ	γ
Southampton	+ 60	− 61	− 89	—	—	—
Alresford	+ 83	− 36	+ 37	+ 33	− 35	+ 6
Brecon	− 2	− 15	− 52	− 20	− 20	+ 7
Bude	− 10	− 21	+ 94	− 50	− 20	+ 61
Cardiff	+ 75	− 16	− 4	+ 26	− 18	− 53
Clifton	+ 48	+ 8	+ 163	+ 15	+ 23	+ 33
Clovelly	− 4	− 41	+ 110	− 63	+ 1	+ 21
Falmouth	+ 50	− 27	− 181	− 47	+ 4	− 190
Gloucester	− 38	+ 25	− 1	− 27	+ 37	+ 46
Ilfracombe	+ 4	− 21	+ 20	− 34	− 11	− 2
King's Sutton	− 48	+ 63	+ 23	− 63	+ 57	+ 121
Milford	+ 103	− 66	− 1	+ 90	− 38	− 72
Oxford	− 69	− 25	+ 20	− 34	− 17	+ 169
Plymouth	+ 53	− 36	− 236	− 29	+ 6	− 210
Ryde	+ 61	− 65	− 106	+ 33	− 49	− 18
St. Cyres	+ 49	+ 25	− 96	+ 46	+ 55	− 5
Salisbury	+ 54	− 70	− 98	+ 80	− 44	− 43
Swansea	+ 104	− 22	+ 37	+ 105	+ 7	+ 30
Swindon	+ 30	− 149	+ 59	—	—	+ 38
Taunton	+ 51	− 27	− 87	+ 26	0	− 59
Wallingford	+ 12	− 22	+ 47	− 8	− 25	+ 145
Weymouth	+ 79	− 16	− 106	− 13	0	− 144
Mean	+ 34	− 28	− 20	+ 3	− 4	− 2

Table X.—District Disturbing Forces.

District.	1915.			1886.		
	N.	W.	V.	N.	W.	V.
	γ	γ	γ	γ	γ	γ
I.	+ 7	− 5	− 36	− 6	− 8	− 20
II.	—	—	—	—	—	—
III.	+ 1	+ 13	+ 85	+ 28	− 1	+ 7
IV.	+ 16	+ 1	− 50	− 17	− 5	− 123
V.	− 31	+ 17	− 8	0	+ 16	+ 123
VI.	− 32	− 23	− 4	− 20	− 20	+ 6
VII.	+ 3	+ 4	+ 87	+ 5	+ 11	− 26
VIII.	+ 3	+ 17	− 57	− 4	+ 33	+ 55
IX.	+ 34	− 28	− 20	+ 3	− 4	− 2

agreement in the horizontal components, while in the vertical component the residuals are distinctly greater than those obtained in the new survey.

Moreover, the district vertical residuals of the older survey do not follow any very obvious law of dependence on the geographical co-ordinates, whereas in this element in the new survey the district residuals could be much reduced by supposing that there is a line of +vertical disturbance running from the south of Ireland to the north of England, while as we pass to N.W. or S.E. from this line, the downward vertical force diminishes. In this connexion it appears not unlikely that a reduction of RÜCKER and THORPE'S observations by the method used in the re-survey, may be of considerable interest.

The district table shows that both surveys agree in giving nearly the same decrease of W in passing from District V. to VI., and from VIII. to IX., and the result is important in RÜCKER and THORPE'S theory of "Ridge and Valley Lines."

The Disturbing Forces deduced for the new survey are shown on Chart 5. The arrows represent the magnitude and direction of the horizontal forces on a scale of 1 mm. = 20γ. The base of the arrow is the station, and the number adjoining is the vertical disturbance in units γ, the + sign indicating a downward force.

This chart may be compared with that prepared by RÜCKER and THORPE.

In the main qualitative features there is a general agreement between the disturbing forces in the two surveys. Thus, on the principles used by RÜCKER and THORPE, the "ridge" lines along the Caledonian Canal, from Ayr to Edinburgh, from Greenwich to Milford Haven, and from Portsmouth to Nottingham, are indicated by both surveys. Further, the peculiar features near the Wash and in the Reading vicinity are exhibited in both. But, on the other hand, the evidence for the Yorkshire "ridge" line in the new survey does not appear to me very conclusive, nor do I think that a simple "ridge" from Portsmouth to Reading adequately accounts for the data in the re-survey.

Moreover, quantitative analysis has led me to such results that one must suppose that in some cases the disturbing forces are either of a very local origin, or else indicate the existence of magnetic material on a somewhat colossal scale. I therefore introduce here a digression on the quantitative explanation of disturbing forces before resuming the main argument.

If the "disturbing forces" assigned to the stations of a magnetic survey are regarded as independent and of very local origin (say within a range of 100 metres) their physical interpretation is easy, but of very local value. But if the disturbances are correlated even on a parochial scale (say 10 km.) a quantitative explanation leads to conclusions of a somewhat startling character. The quantity of magnetic material required for such explanation is specially great when the observed disturbing force is upwards.

My attention was directed to this matter, in the first instance, when I considered the disturbing forces at Strachur and Lochgoilhead. I shall return to this case later, but without further preface I may say that the following theoretical cases were worked out in detail, in order to illustrate the difficulties that may arise in actual cases. I venture to hope that they may have some constructive value.

The very simplest source of disturbance we can contemplate is an isolated magnetic pole beneath the surface, the equal and opposite pole being sufficiently remote to produce no effect. The effects of an isolated pole are so simple and obvious that discussion would be superfluous. If the observed forces which we have to explain are correlated, isolated poles are, by the data, of little help.

The next simple source is a doublet. Now a doublet need not be confined to a small region, for a uniformly magnetised sphere is equivalent, at all external points, to a doublet placed at its centre. Moreover, the sphere may be naturally magnetised, or magnetised by the earth's induction.

We shall consider in detail three cases: (1) a doublet with its axis vertical; (2) a doublet with its axis horizontal; (3) a doublet with axis inclined at $\tan^{-1} 3$, a case which closely represents a sphere magnetised along the direction of the resultant earth's force in the British Isles.

Case 1. A doublet with its axis vertical.

Let the south pole be upwards, and let the magnetic moment be μ. Take axes through the centre of the doublet, x and y horizontal and z vertical. Then the magnetic potential is

$$\phi = -\mu z/\rho^3$$

where

$$\rho^2 = x^2+y^2+z^2.$$

Hence if ζ is the depth of the doublet beneath the surface we find that the forces at the surface are

$$\text{Vertical component } \mathrm{V} = \frac{\mu}{\zeta^3}\frac{(r^2-2)}{(r^2+1)^{\frac{5}{2}}},$$

$$\text{Radial component } \mathrm{R} = -\frac{3\mu}{\zeta^3}\frac{r}{(r^2+1)^{\frac{5}{2}}},$$

where

$$r^2 = (x^2+y^2)/\zeta^2.$$

The curves in fig. 1 show the forces to scale. The abscissæ are the values of the distances from C, the point on the surface vertically above the doublet at D. The unit of distance is ζ, the depth of the doublet. The ordinates are the values of the forces on a scale of 1 cm. $= \frac{1}{2}\mu/\zeta^3$.

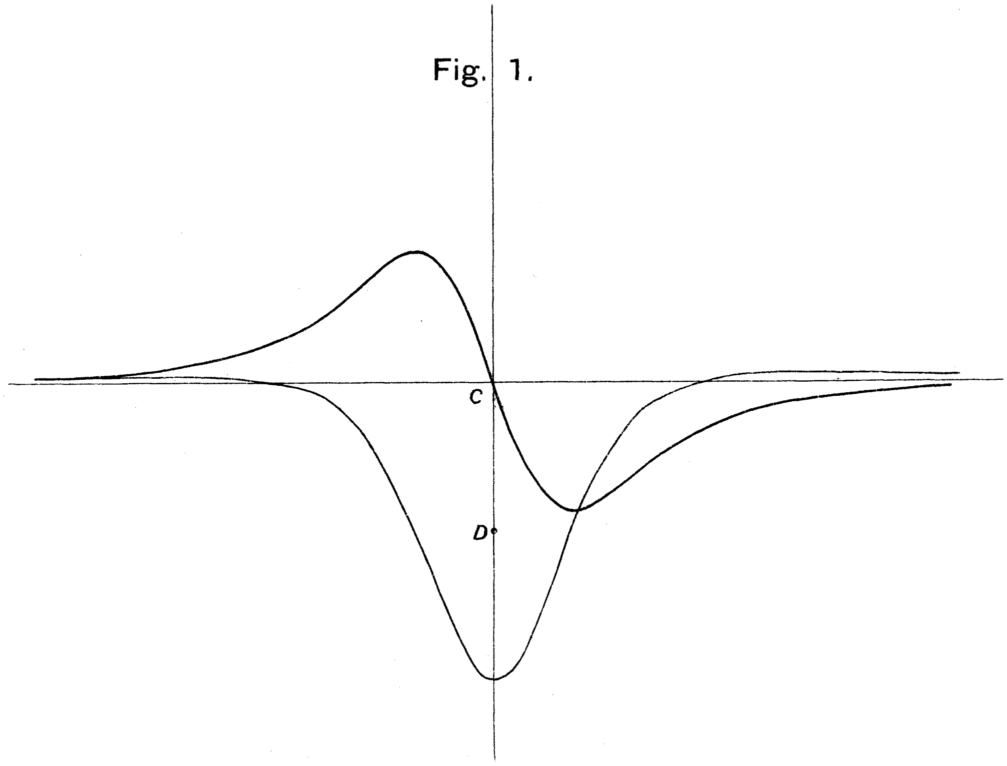
The radial force is everywhere towards C, being zero at C, rising to a maximum when $r = \frac{1}{2}$ and then diminishing as r increases.

The vertical force is down near C, being a maximum at C. It becomes zero at $r = 2^{\frac{1}{2}}$, rises to a positive maximum at $r = 2$ and then diminishes.

Note that the value of V at $r = 2$ is only about $\frac{1}{50}$th of the value at $r = 0$, while the maximum of R is rather less than one half the maximum value of V.

To face page 64.

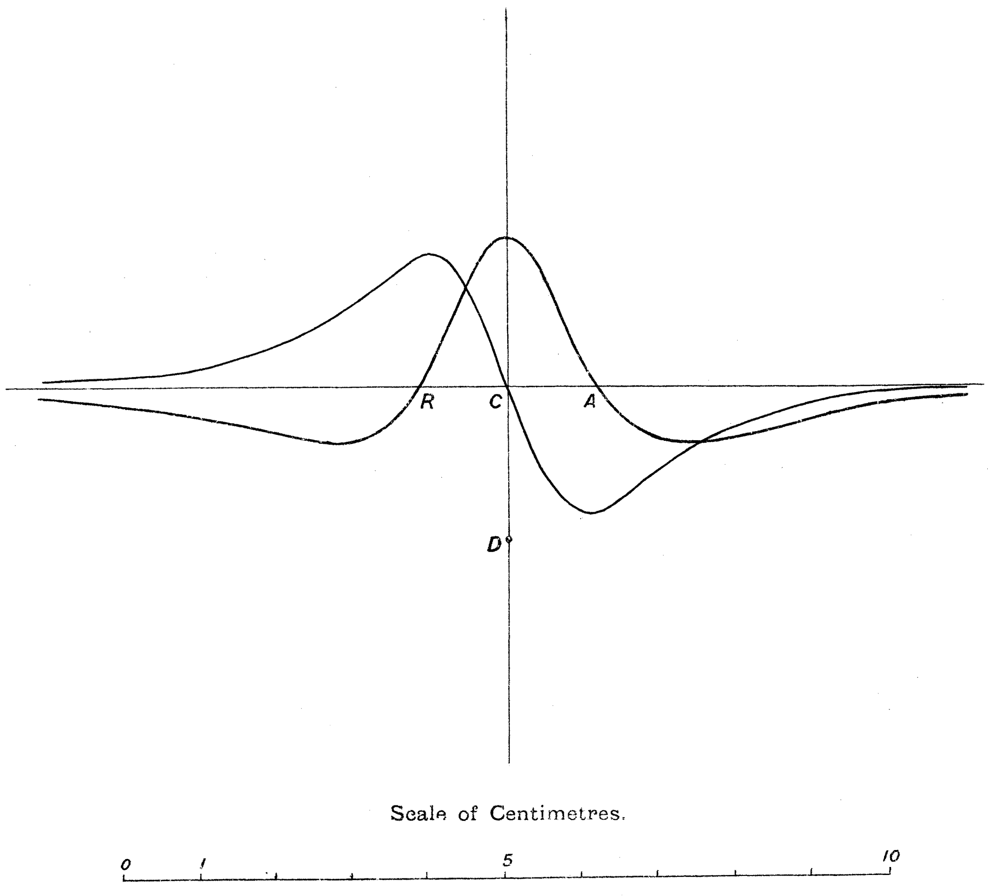
Fig. 1.



Doublet at D, *axis vertical.*
Forces in Meridian Section.

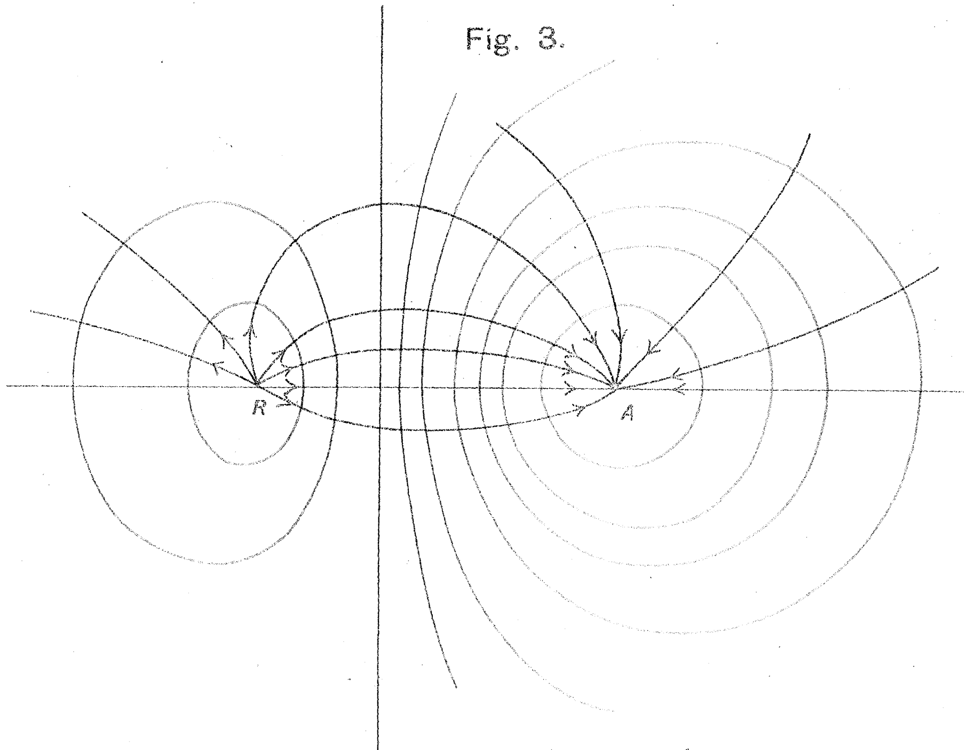
Radial Force (Black)	+	*right*
	—	*left*
Vertical Force (Red)	+	*up*
	—	*down*

Fig. 2.



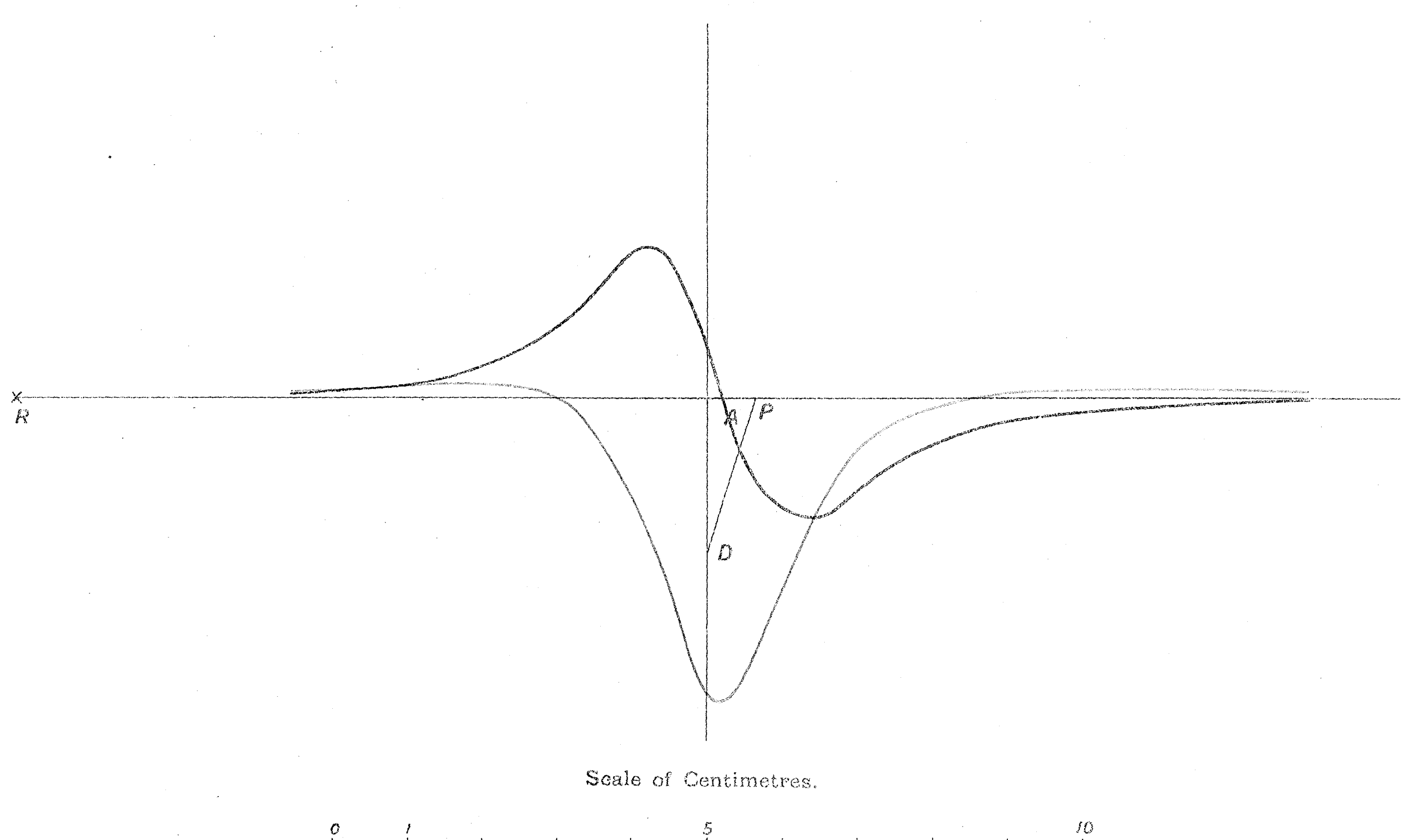
Doublet at D, *axis horizontal.*
Forces in Meridian Section.

Fig. 3.



Doublet with axis inclined at $\tan^{-1} 3$.
Equipotential curves on horizontal plane (Red).
Apparent line of horizontal force (Black).

Fig. 4.



D *represents the position of Doublet.*

P *the point where its axis meets the horizontal plane.*

Forces in Meridian Section.

Case 2. A doublet with axis horizontal with south pole to the right.

Take axes as before with x in the vertical plane containing the axis of the doublet, then

$$\phi = -\mu x/\rho^3.$$

In the vertical plane containing the magnetic axis we find that the forces at the surface are

$$\mathrm{V} = -\frac{\mu}{\zeta^3}\frac{3\xi}{(\xi^2+1)^{\frac{5}{2}}}, \qquad \mathrm{H} = \frac{\mu}{\zeta^3}\frac{(1-3\xi^2)}{(\xi^2+1)^{\frac{5}{2}}},$$

where

$$\xi = x/\zeta.$$

The curves are shown in fig. 2 with the same conventions and on the same scale as in fig. 1. In this case the points A and R will appear to act as attracting and repelling centres respectively.

We observe also that the maximum vertical force is less than half what it is in Case 1, while the maximum horizontal force is not very much increased. Further, in Case 2 the changes of both V and H are not so rapid as in Case 1.

Case 3. A doublet of moment μ with its south pole upwards, the axis being inclined to the horizontal at an angle I.

This case is intermediate between Cases 1 and 2. We have

$$\phi = -\mu \cos \mathrm{I}\,(x+z \tan \mathrm{I})/\rho^3,$$

and for the special case $\tan \mathrm{I} = 3$,

$$\phi = 0{\cdot}316\mu\,(x+3z)/\rho^3.$$

In fig. 3 we show the equipotential curves and the lines of apparent horizontal force on the surface. The unit of distance is again the depth of the doublet beneath the surface and in the figure is taken as 1 cm. There appears a strong attracting centre at A and a weak repelling centre at R. If C is the surface point vertically above the doublet CA $= +0{\cdot}109$ and CR $= -4{\cdot}609$.

In the vertical plane containing the axis of the doublet the forces at the surface are

$$\mathrm{V} = 0{\cdot}316\,\frac{\mu}{\zeta^3}\,\frac{3\,(\xi-2)\,(\xi+1)}{(\xi^2+1)^{\frac{5}{2}}},$$

$$\mathrm{H} = 0{\cdot}316\,\frac{\mu}{\zeta^3}\left\{\frac{-2\,(\xi+4{\cdot}609)\,(\xi-0{\cdot}109)}{(\xi^2+1)^{\frac{5}{2}}}\right\},$$

where $\xi = x/\zeta$.

The values are shown to scale in fig. 4. The conventions are as in figs. 1 and 2, and the unit of distance is ζ, but the ordinate scale is now 1 cm. $= 0{\cdot}474\mu/\zeta^3$, so that it is slightly more open than in Cases 1 and 2.

We note that H changes sign at $\xi = +0{\cdot}109$ and $\xi = -4{\cdot}609$, while V changes sign at $\xi = 2$ and $\xi = -1$.

These cases show that important quantitative tests can and must be applied in seeking to explain observed disturbing forces in this way. The rapid fall in the values of V as we pass to increasing distances raises a difficulty in actual cases, to which we shall return later. The difficulty can be met, at least partially, by considering the magnetic disturbing system to extend horizontally over a considerable area. We accordingly examine:

Case 4. A very oblate spheroid magnetised vertically.

The total magnetic moment is μ, and the disc extends horizontally in a circle of radius a at a depth ζ beneath the surface. The magnetic potential at any point is

$$\phi = -3\mu \frac{z}{a^3}\left(\psi - \frac{\pi}{2} + \cot\psi\right),$$

where ψ is determined from the equation

$$(x^2+y^2)\cos^2\psi + z^2\cot^2\psi = a^2.$$

The forces at the surface in any vertical plane through the centre of the disc are

$$\mathrm{V} = \frac{3\mu}{a^3}\left\{\psi - \frac{\pi}{2} + \sin\psi\cos\psi\frac{(1+r^2\sin^2\psi)}{(1+r^2\sin^4\psi)}\right\},$$

$$\mathrm{R} = -\frac{3\mu}{a^3}\frac{r\sin\psi\cos^3\psi}{(1+r^2\sin^4\psi)},$$

where

$$r^2 = (x^2+y^2)/\zeta^2,$$

and the appropriate positive values of ψ given by

$$r^2\cos^2\psi + \cot^2\psi = a^2/\zeta^2$$

are used.

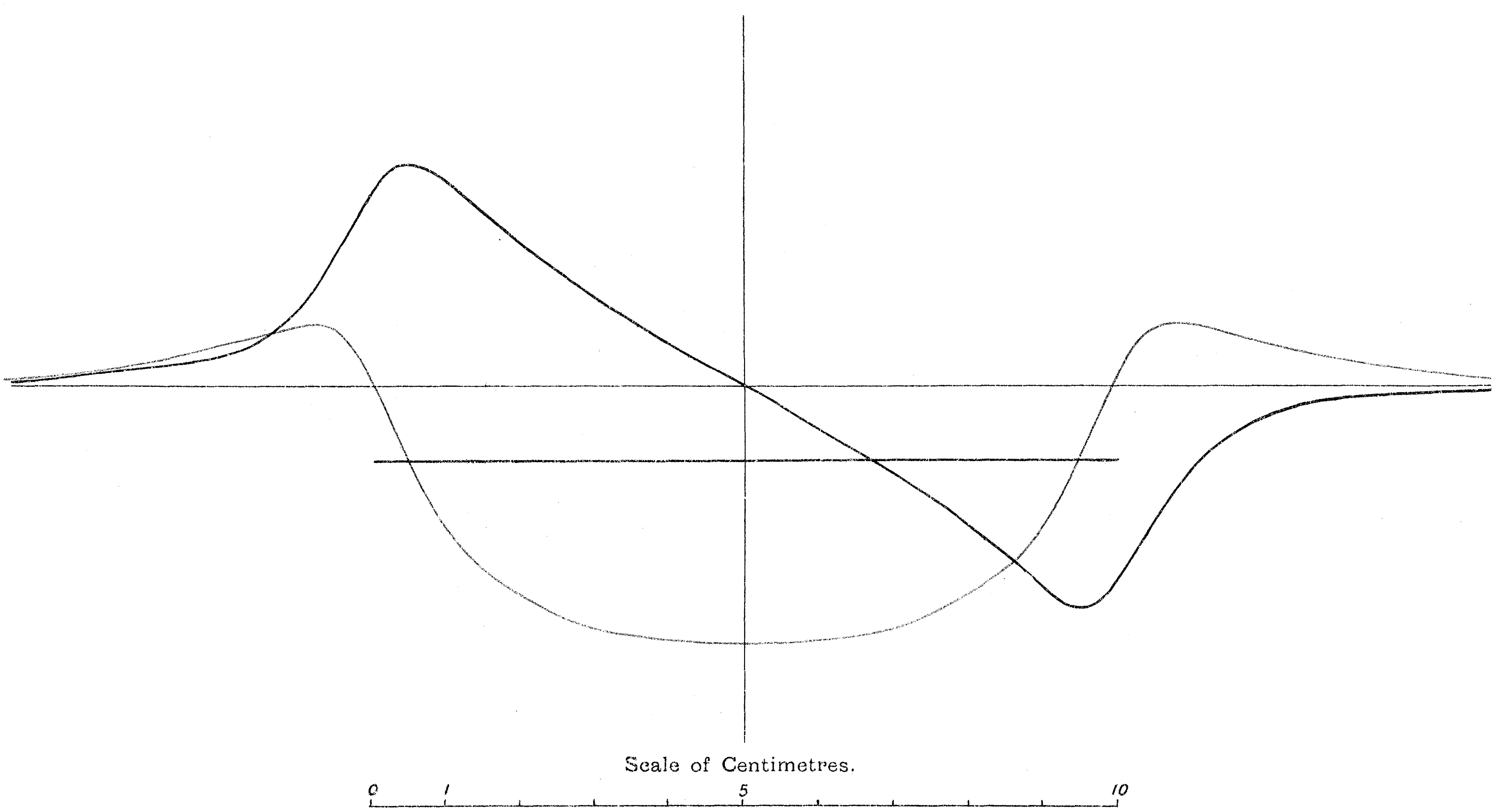
Fig. 5 shows the values of V and R in the same way as before, the unit of distance being ζ the depth of the disc. In the figure ζ is now taken as 1 cm. and a is assumed to be 5 times ζ. The scale of the ordinates is now 1 cm. $= \mu/a^3$.

The curves show the important feature we require, viz., that the changes of V are now less rapid. Thus the + maximum of V at $r = 5{\cdot}9$ is now about one-fourth of the value at $r = 0$, whereas in Case 1 the + maximum of V at $r = 2$ was $\frac{1}{50}$th of the value at $r = 0$.

Let us now examine the special case that suggested these calculations.

At Strachur the disturbing forces are 324γ upwards and 164γ horizontally, while at Lochgoilhead we have 278γ upwards and 148γ horizontally. The horizontal disturbing forces intersect at a point nearly 6 km. from each station. It will simplify

Fig. 5.



Flat spheroid magnetized vertically.

Radial Force (Black) + *to right.* — *to left.*

Vertical Force (Red) + *up* — *down*

the arithmetic without vitiating our inferences if we suppose that at both stations the forces are the same and take the vertical disturbance as 300γ and the horizontal disturbance as 150γ.

It is clear that if we are to correlate these forces with some magnetic source between the stations we cannot do so by south poles alone, which would have to be high up in the air, nor by north poles alone which would give the wrong direction for the horizontal forces. But a doublet with its axis vertical south pole up, situated at a point beneath the point of intersection of the horizontal forces, will meet the case. Thus, using the formulæ of Case 1, we find that to explain an upward force of 300γ and a horizontal attraction of 150γ at a distance of 6 km. we require a magnetic moment of $7 \cdot 1 \times 10^{14}$ c.g.s. at a depth of 0·95 km.

Now even if this doublet is regarded as a sphere magnetised as strongly as a laboratory magnet its moment per unit volume could not exceed 100 units. Thus the volume of the sphere required is $7 \cdot 1 \times 10^{12}$ c.c., and if the density is 7·5 the mass of material involved is $5 \cdot 3 \times 10^{13}$ gr., or nearly 53 million tons. This is a minimum estimate, for if the sphere was magnetised only by the earth's induction a much larger quantity of material would be required.

Such a large quantity raises a serious difficulty in the explanation, and another difficulty must be mentioned. If the explanation is correct the vertical forces experienced just above the doublet would come to $40,000\gamma$, which is not far short of the normal force due to the earth. Only direct test could settle if this is so, but the result seems rather improbable.

To remove this latter difficulty we may apply Case 4 to explain the data.

We find that the depth required is 0·75 km., and the magnetic moment of the disc $5 \cdot 3 \times 10^{14}$ c.g.s. units, so that on the same supposition as before we must have at least about 40 million tons of material as strongly magnetised as a laboratory magnet. The maximum vertical force over the centre of the disc is now only 3600γ.

Thus we have considerably reduced the vertical forces to be expected near the centre, but we have not substantially reduced the amount of material required, although it is spread over a greater area.

Thus if the disturbing forces are correlated we have to conclude that the existence of quantities of magnetic material much larger than would have been suspected at first sight has to be admitted.

The preceding theoretical discussion with its illustrative example taken from the survey shows the serious difficulty that arises in giving a quantitative explanation of the correlation of disturbing forces over a range even as small as 5 km. The difficulty is enormously increased when we attempt correlation over larger distances.

It may be recalled that RÜCKER and THORPE considered that the separate examination of the vertical and horizontal forces provided two independent tests of the existence of ridge and valley lines. Their data gave considerable support to the view that comparatively simple ridge lines could be traced in this way for considerable distances. The results of the re-survey led me to rather different inferences. At all events it appears to me that the combined information supplied by a knowledge of the horizontal and vertical disturbances is required to determine the origin of the disturbances, and that the independence of the horizontal and vertical force tests is somewhat illusory.

It is impossible to enter on a detailed discussion of every part of the survey. But we may select a few illustrative cases in order to bring out the points of resemblance and difference in the data and the inferences.

Consider the region from Portsmouth to Reading. The horizontal forces from the two surveys are in good agreement and suggest a ridge of convergence running along the meridian 1° W. The vertical forces differ considerably in the two surveys.

Starting in the south with Ryde, Chichester and Worthing, the old survey gives -18, $+130$, $+24$, so that a pronounced downward maximum is indicated near Chichester. The new survey gives -106, -34, -48. Thus the maximum at Chichester is not nearly so sharply defined, and its value is 160γ less than RÜCKER and THORPE'S.

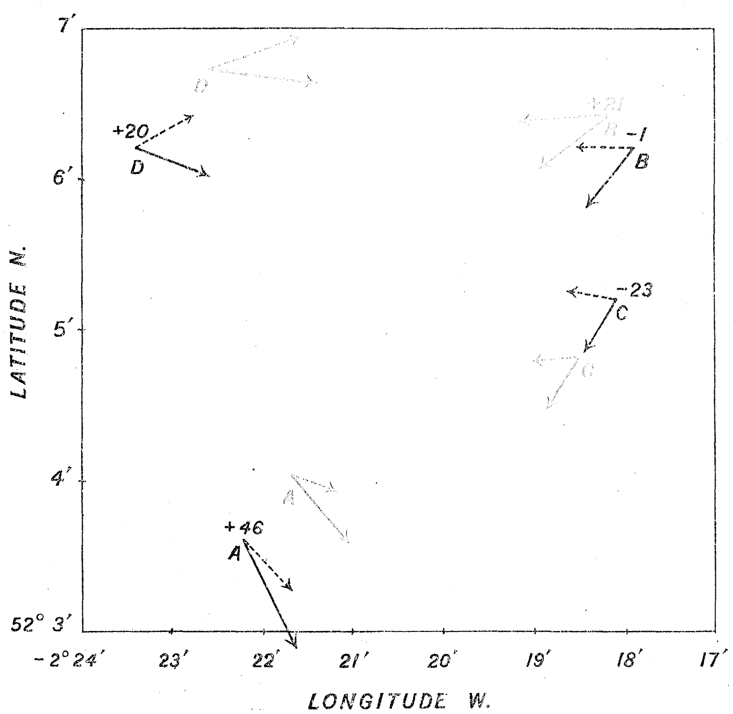
Next take Salisbury, Alresford, Haslemere and Horsham. The old survey gives $+43$, 6, $+87$, $+20$. This gives a fairly pronounced maximum at Haslemere, and a secondary one at Salisbury. The new survey gives -98, $+37$, $+12$, -88, so that the maximum is indicated near Alresford.

Again, take Swindon, Wallingford, Reading and Windsor. The old survey gives $+38$, $+145$, $+235$, $+136$, so that the maximum is near Reading. The new survey gives $+59$, $+47$, $+168$, -34, so that Reading is again indicated as the maximum.

It is to be remarked that the old values are all positive, and in the District Table RÜCKER and THORPE'S values are about 100γ higher than mine. The addition of 100γ to the above values for the new survey would give a better general agreement with the values for the old survey in this particular district, although some discrepancies would remain. Thus the line of maximum values in the old survey, viz., Chichester ($+130$), Haslemere ($+87$), Reading ($+235$), and that of the new survey, Chichester (-34), Alresford ($+37$), Reading ($+168$), indicate a difference which is not to be explained by uniform shift of the datum plane. The new survey thus gives no suggestion of a peak at Chichester, but the maxima continually increase towards Reading. The question what is the correct datum plane from which to reckon disturbance is, as already explained, a very difficult one, and one that does not at present admit of exact solution. But having started with the principle that we are to make the residuals as small as possible, we are not at liberty to alter the datum plane in any particular region unless we have reached an impasse.

No necessity arises in the present case for such a change in the datum plane. The general character of the data in this region appears to admit of explanation by the supposition of an underground disc of material magnetised vertically. The boundary

Fig. 6.



Malvern Hills.
Disturbing Forces.

would have to run a little west of Swindon, round by Salisbury, Southampton and Portsmouth. Then it would turn rather sharply, and passing to the north of Chichester, pass between Haslemere and Horsham and so towards Windsor and Reading. A gradual increase in the intensity as we move from the boundary towards Reading is required.

The inferences in this case differ a little from those of RÜCKER and THORPE, partly on account of the difference in the data, but mainly on account of the guiding principle used. This principle consists essentially in regarding the disturbing sources as doublets distributed over a considerable area, in place of single poles in a concentrated form. It is thus an extension of the method used by RÜCKER and THORPE, the necessity for which was clearly adumbrated in their second memoir.

We shall next consider the vicinity of the Malvern Hills. This case is of special interest because four points very close together were selected by RÜCKER and THORPE.

The data contained in the table are shown graphically in fig. 6. The lines in red refer to RÜCKER and THORPE's survey and those in black to the re-survey. The horizontal disturbing forces are shown in magnitude and direction by full lines on a scale 1 mm. = 10γ, and the numbers are the vertical disturbances. RÜCKER and THORPE observed the inclination at station B only.

The results of the two surveys are in very good agreement and undoubtedly prove the attraction created by the Malvern Ridge. A quantitative explanation would be greatly facilitated by additional observation at the mean point. Another point of importance is suggested. The mean horizontal disturbance for the four stations is from the old survey $N = -63$, $W = -21$, and from the re-survey $N = -79$, $W = -15$. Now if this resulting disturbance is of any value in correlating Malvern with other stations over a wide area, the true effect of the Malvern Hills is better represented by compounding this mean force reversed with the original values. The result is shown by dotted lines. If, however, the original values are due solely to the Malvern Hills, our mean station is not representative and we have no right to use the mean value to connect Malvern with stations at a distance. The matter may be settled by direct observation at a new station to the south of the Hereford Beacon. It seems to me vital in the whole question of the explanation of disturbing forces to prove that the selected station is representative of at least a parochial area, and the Malvern Hills provide a particularly good test case deserving of further experimental investigation.

We now pass to consideration of the Leicestershire region. This case is interesting on account of the presence of iron ore, known to exist in this part of the country.

The value of the vertical disturbance at Loughborough (-39) appears to be somewhat anomalous, but the enquiry slip from Greenwich states that the magnetographs there were very much disturbed during the time of my observations at Loughborough, and that the values supplied could not be relied on for my purpose. We ought, therefore, to attach little weight to the values for Loughborough, although it happens that the horizontal disturbing force presents no anomaly. (So far as I know Loughborough is the only case in which serious magnetic variations were occurring during the observations, and it is matter for congratulation that the survey has been carried out under such favourable conditions in this respect.)

The horizontal forces in this region are in the main in very good agreement in the two surveys, but we ought to recall that RÜCKER and THORPE used two stations at Melton Mowbray and got different results. The magnitude of the horizontal force was the same at both, but very different in direction. The directions intersected quite close to Melton Mowbray. The vertical components also differed, being $+80\gamma$ and $+305\gamma$ at the two stations. This renders doubtful the existence of direct correlation between the forces at Melton Mowbray and those at Loughborough and Coalville to the west. The vertical disturbances in the two surveys differ considerably.

Thus taking Nottingham, Melton (a), and Manton, the old survey gives $+179$, $+305$, $+79$, while the re-survey gives $+230$, $+238$, $+58$.

Again, for Coalville and Leicester the old survey gives -109, -27, while the new survey gives $+30$ and $+57$.

Consider next the line Nottingham, Newark, Lincoln. The old survey gives $+179$, $+6$, $+172$, while the re-survey gives $+230$, -162, -76.

For the line Melton (a), Grantham, Lincoln, the old survey gives $+305$, $+50$, $+172$, and the re-survey gives $+238$, -143, and -76.

The inferences from the two surveys are somewhat different, and I think it will be admitted that the values for the re-survey form a rather simpler system to explain.

There is a known ridge of iron ore running from Lincoln through Grantham to Melton, and if I understand the matter correctly, this ore is naturally magnetised. The magnetic data suggest that Melton itself is the most important part of this ridge. Reasoning by analogy of the data, it would not be surprising if a ridge of similar ore exists along the line Lincoln through Newark to Nottingham, the latter being the most intense point. It would seem natural, further, to join up Nottingham and Melton by a ridge of considerable intensity passing near Loughborough.

The possible economic importance of this inference seems sufficient to justify the selection of a few more stations in order to test its validity.

The examination of other districts in the British Isles and the problems connected with the magnetic data has attracted my attention, but this is not the time or place to give a detailed account, especially as the work is only in its initial stages. But the three cases discussed will serve to indicate the importance of the matter in its practical as well as in its purely scientific aspect.

Conclusion.

I think that I should fail in an obvious duty towards the future progress of the magnetic survey of the British Isles if I did not set out, for the assistance of those who will carry out the work, several matters of importance suggested to me by the experience of the present re-survey.

(1) The enormous advantages that the re-survey has enjoyed from association with the Ordnance Survey Office has impressed me very much. The stations are permanently marked and the co-ordinates and azimuths determined. They can be recovered at any time by, and only by, the O.S.O. No private individual or scientific society could arrange for this with the same degree of rapidity or efficiency.

It is an almost obvious conclusion that the further magnetic survey of the British Isles should be handed over to the Ordnance Survey Department as a definite part of the general survey of the Kingdom. Moreover, the present re-survey, in conjunction with that of RÜCKER and THORPE, provides a very good basis from which to work; so that it appears to me that, instead of leaving over the next re-survey for 10 or 15 years, it would be better to arrange for a continuous revision of the magnetic data, to be carried on by the officers of the Ordnance Survey concurrently with the regular scheme of revision of the general survey as arranged by that Department of the Public Service.

I take this opportunity of drawing attention to the excellence of the magnetic charts in this volume which have been prepared by the Ordnance Survey Office from my original drawings.

(2) While the present arrangement of stations gives results of great value, the stations are not selected on any systematic scheme. I hope that as opportunity occurs some of the older stations may be abandoned and new stations determined, so as to bring the general scheme into some definite geometrical order. While I do not advocate any large increase in the number of stations, there are clear indications of localities where observations at a few additional properly selected points would greatly simplify the elucidation of the phenomena. Further, there are obvious lacunæ where new observational stations should be chosen.

In this connexion it is important to ascertain if a station is really representative of a moderately extensive area. The manner of testing this is properly included under the next main point.

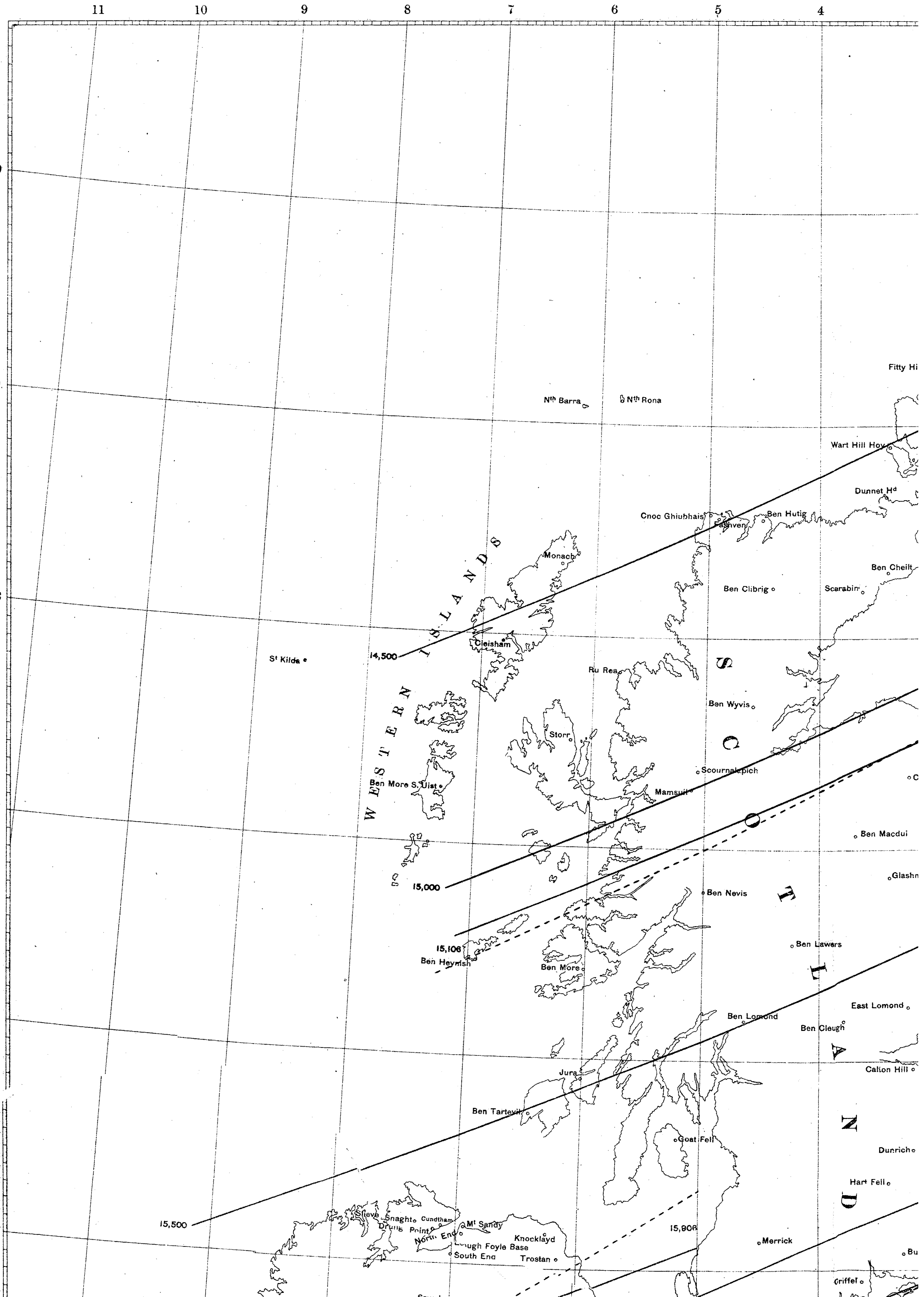
(3) Magnetic surveying by the use of absolute instruments appears to me to be unnecessarily cumbrous and not conducive to the best results. Further, no standard of magnetic force exists at present by which instruments can be compared with an accuracy of 1γ. It thus seems desirable that a standard should be prepared in terms of the electrical standards of the country.

In the 'Roy. Soc. Proc.,' A, vol. 92, p. 313, 1916, I have given the results obtained in Ireland by means of a portable magnetometer which gives by a single direct reading the horizontal force at any station referred to a standard base value. The success attained by this method justifies a serious attempt to improve the instrument, so that two horizontal components at right angles can be measured, and further, to apply the same principle to the construction of a similar apparatus for the vertical component. Even if the instruments required comparison with a standard from time to time, their introduction would much reduce the field work of the survey and give greater accuracy. They would be specially useful in making detailed surveys of special regions and in proving if a station is really representative and not subject to disturbance of very local origin.

1.

CHART OF EQUAL NORTH COMPONENT.

Magnetic Survey of the B
for epoch Ist January
by G.W. Walker, Esq., F.R.



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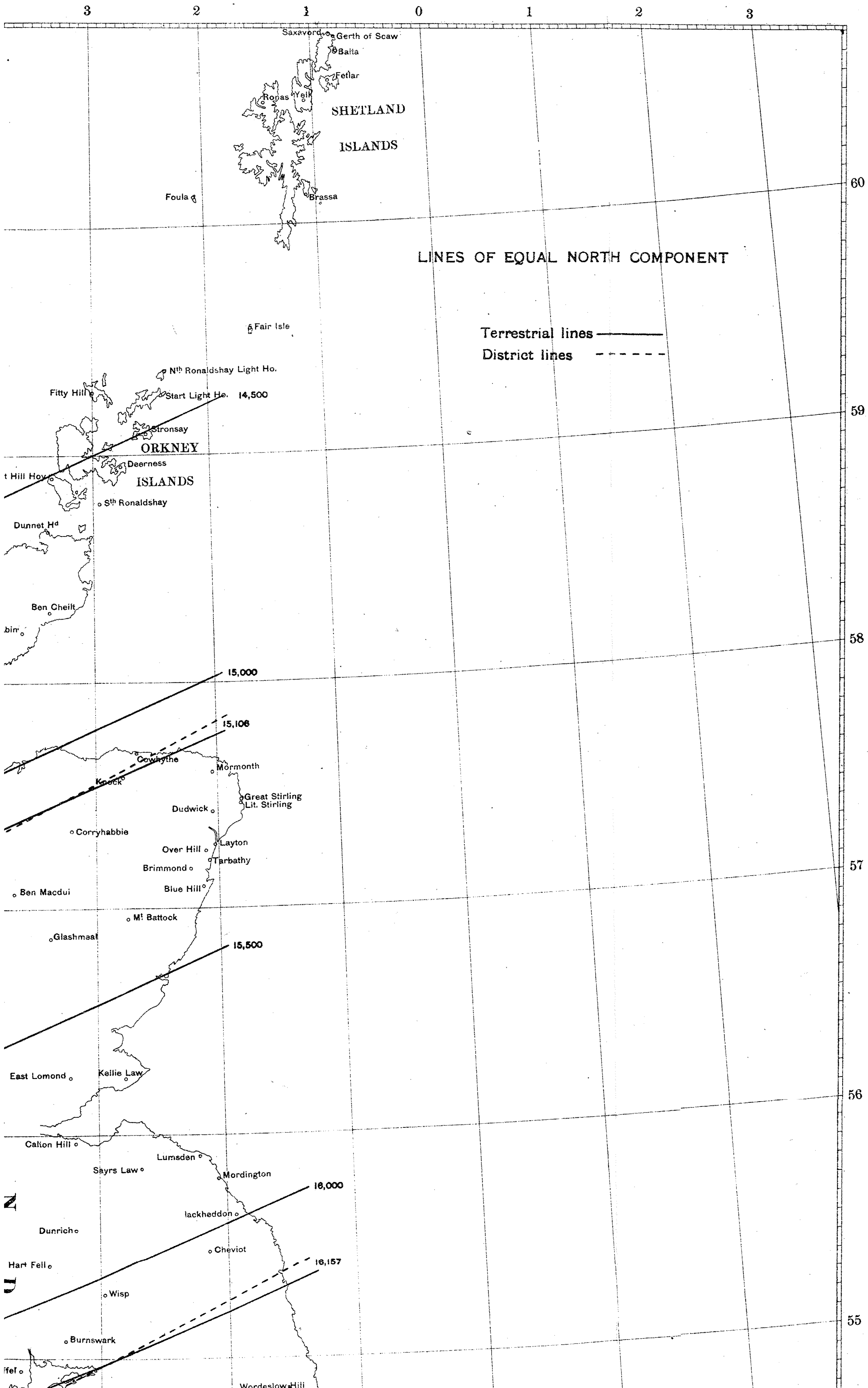

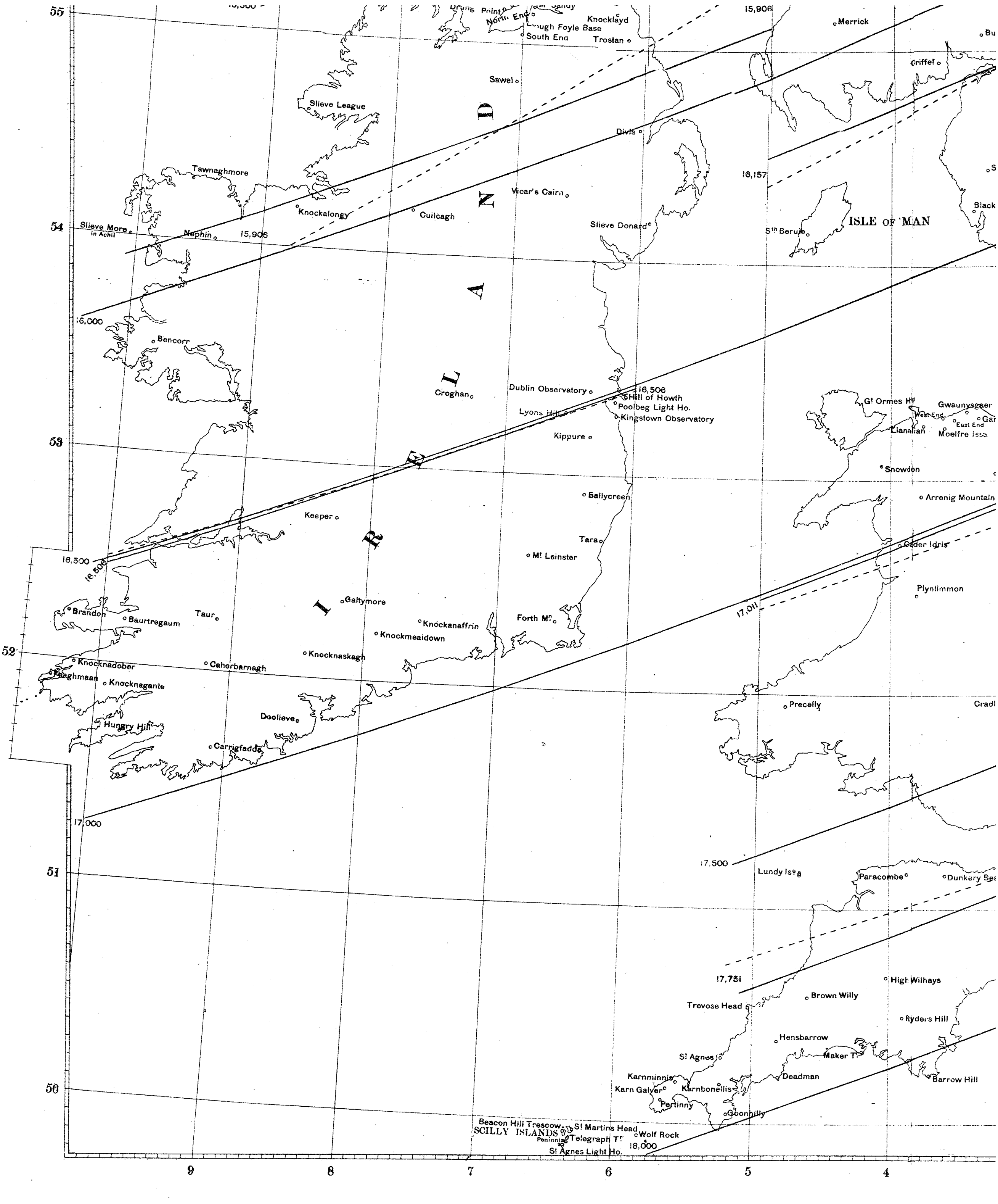

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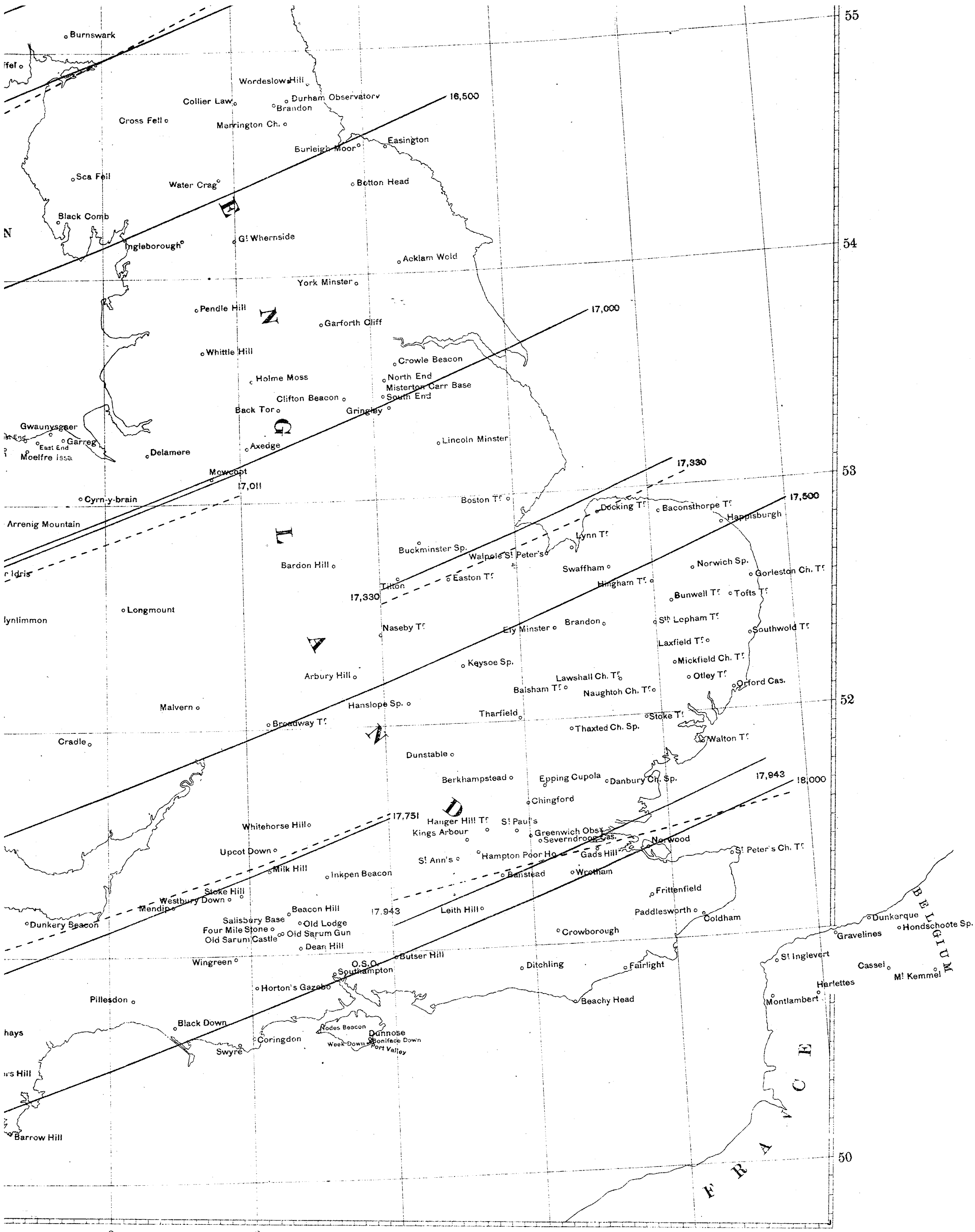

Ordnanee Survey, July 1918.

2.

CHART OF EQUAL WEST COMPONENT.

Magnetic Survey of the Br
for. epoch Ist January
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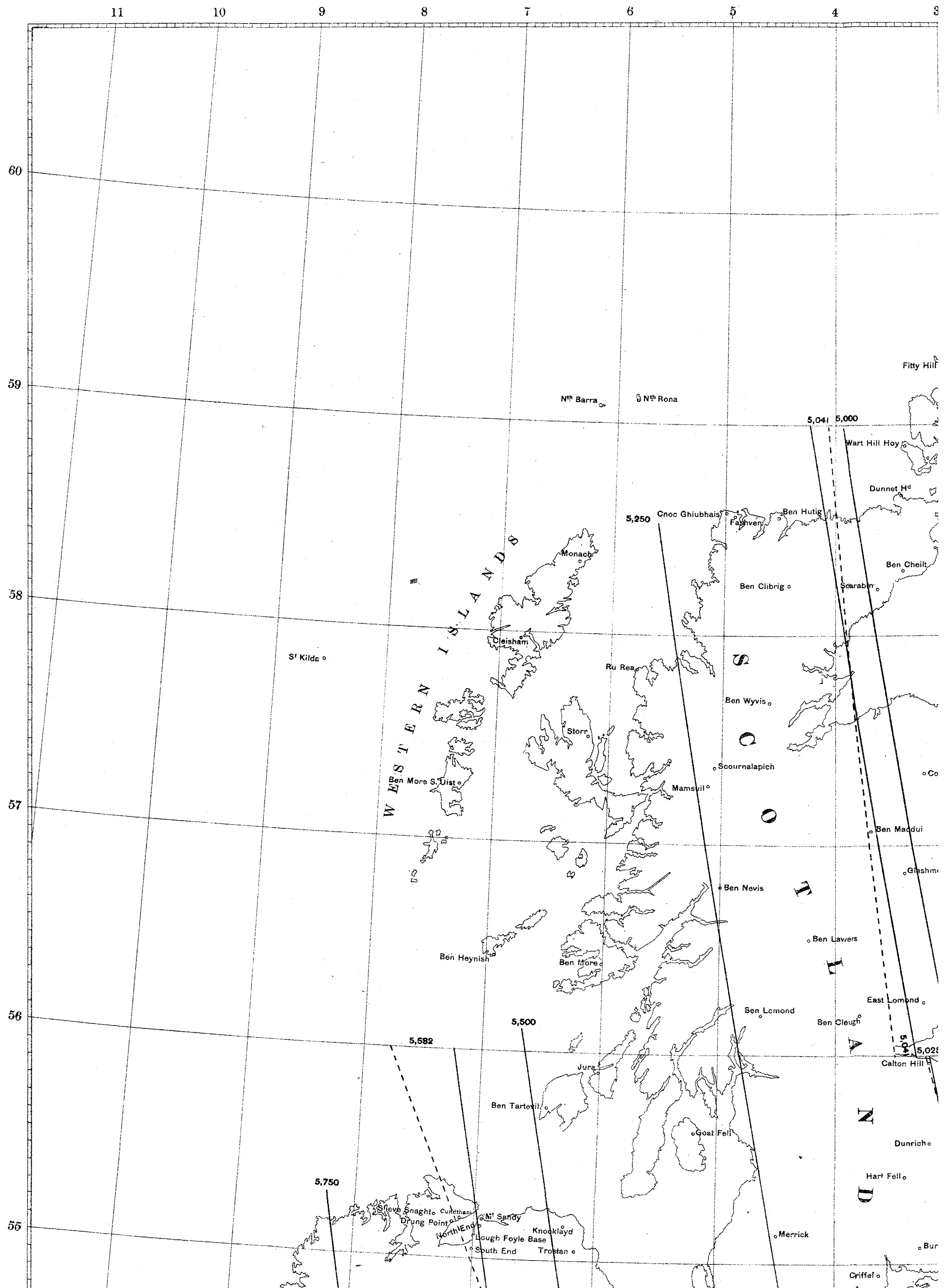

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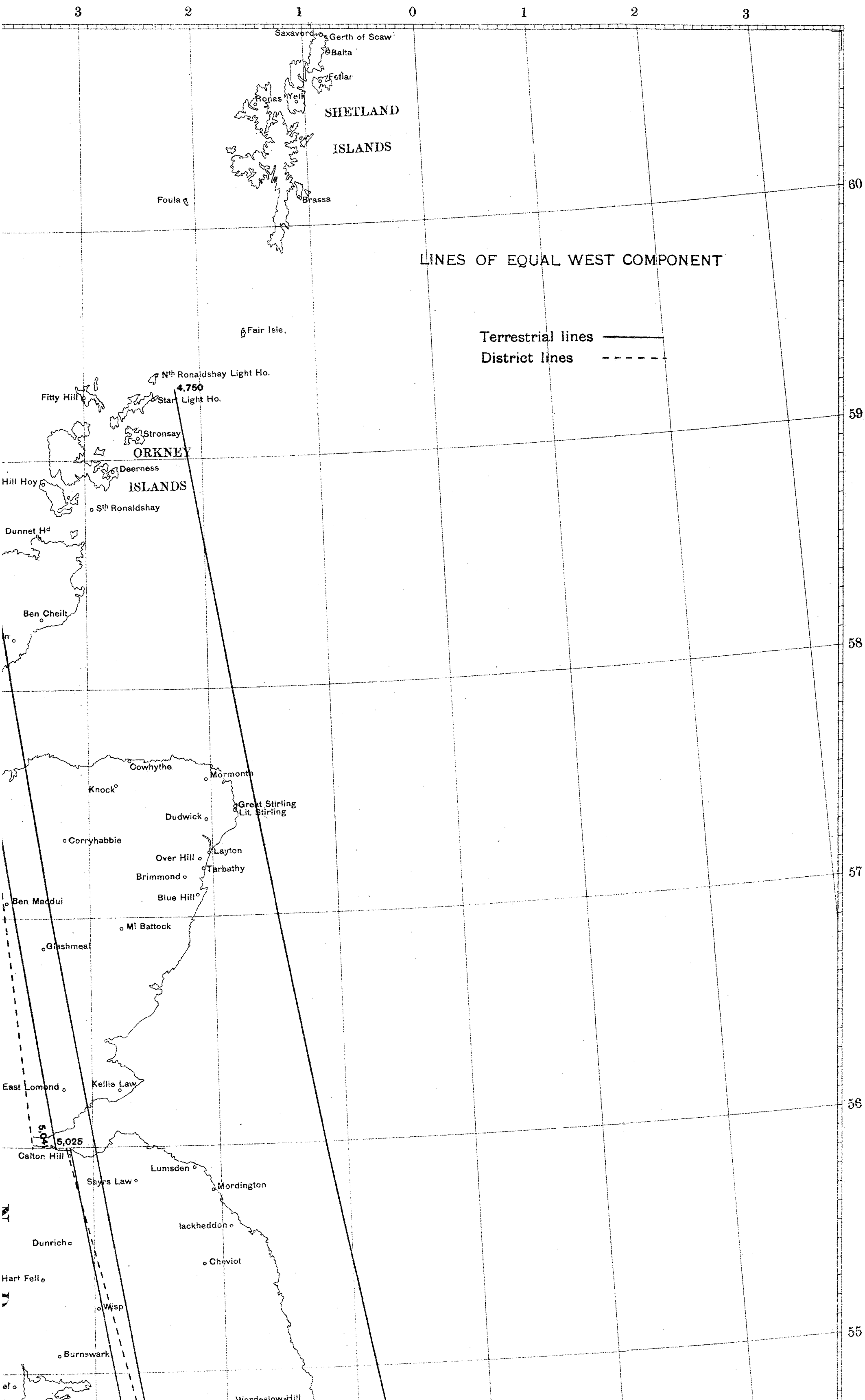

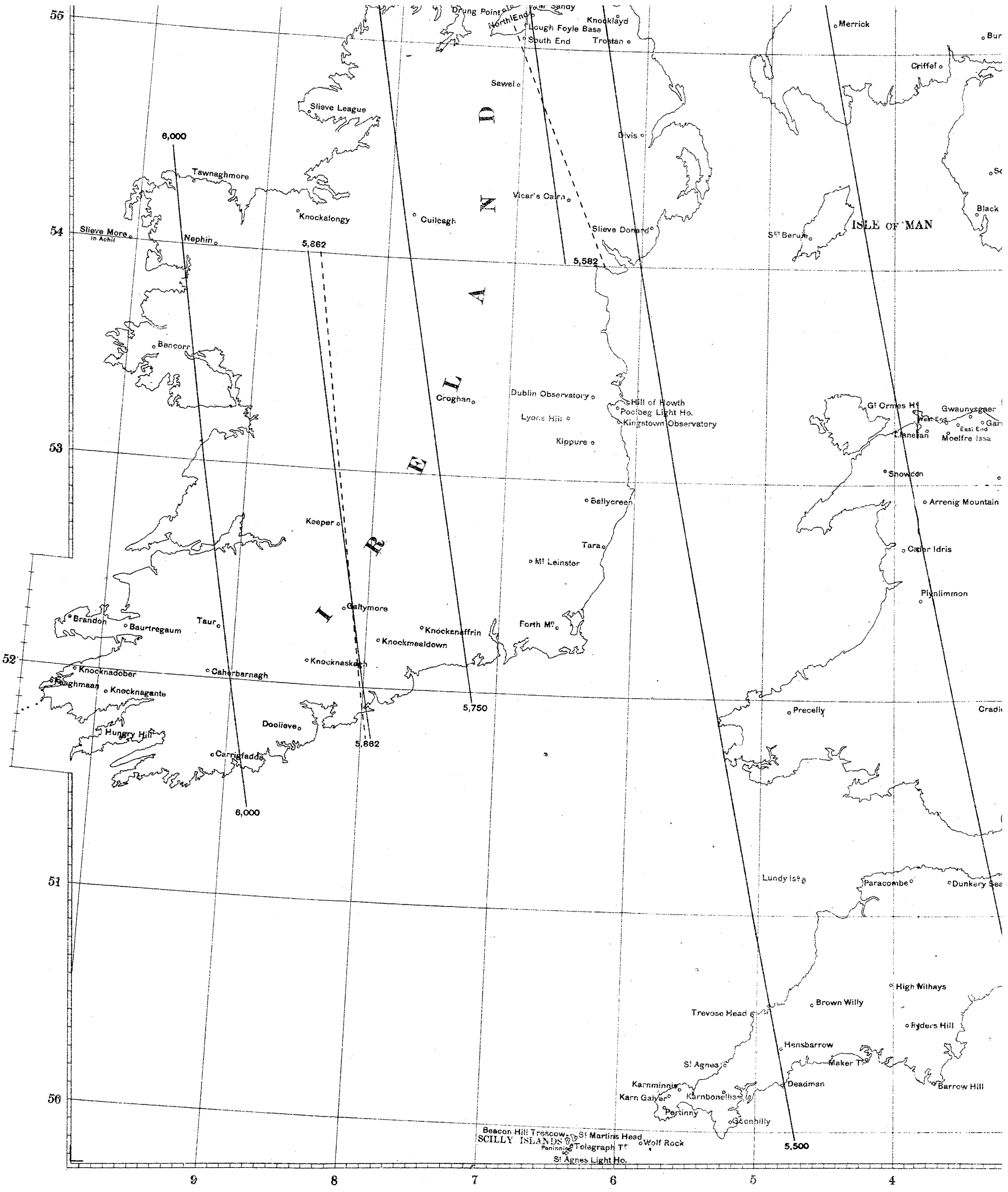
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High Wilhays
Brown Willy
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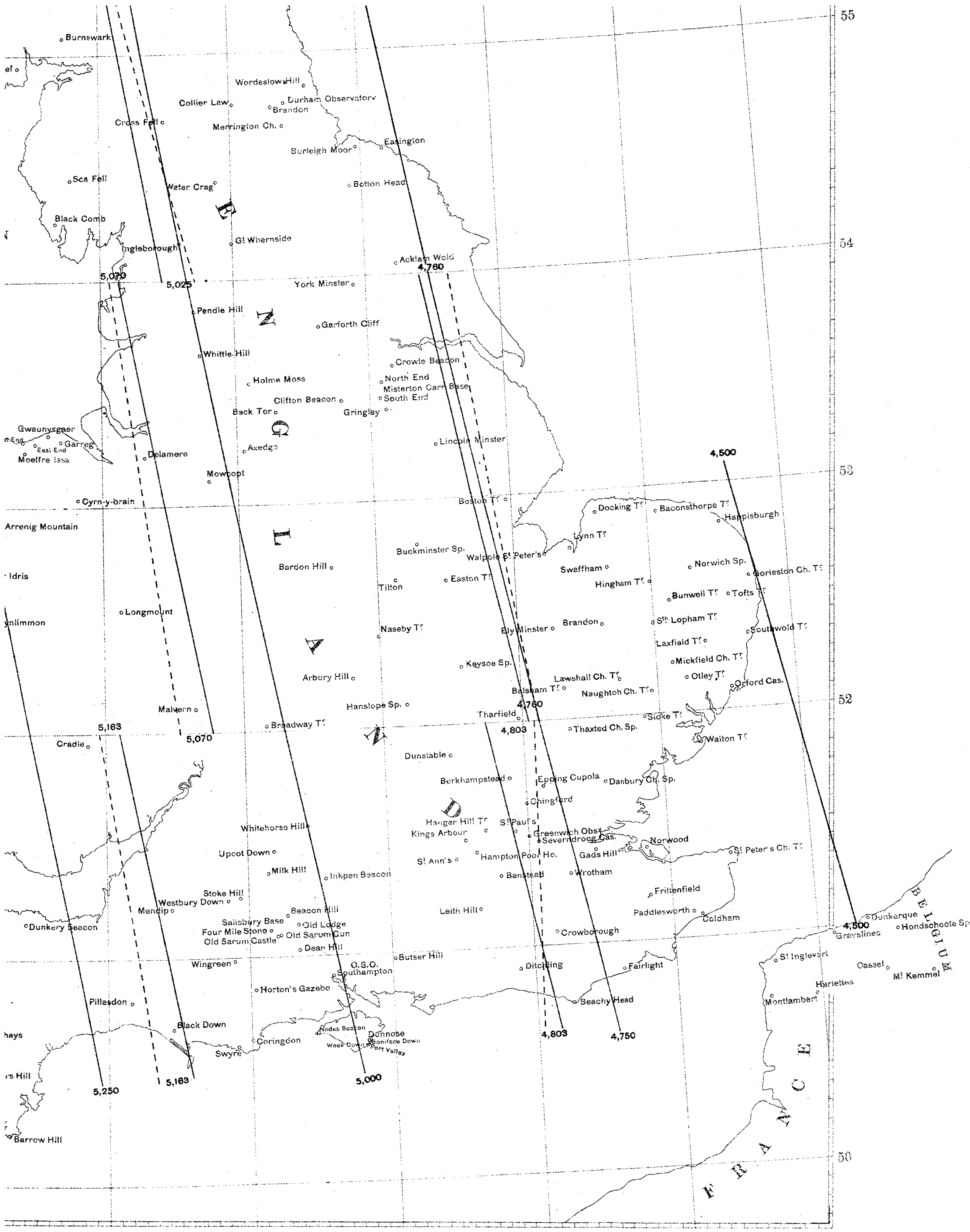

Ordnance Survey, July 1918.

3.

CHART OF EQUAL VERTICAL COMPONENT.

Magnetic Survey of the Br

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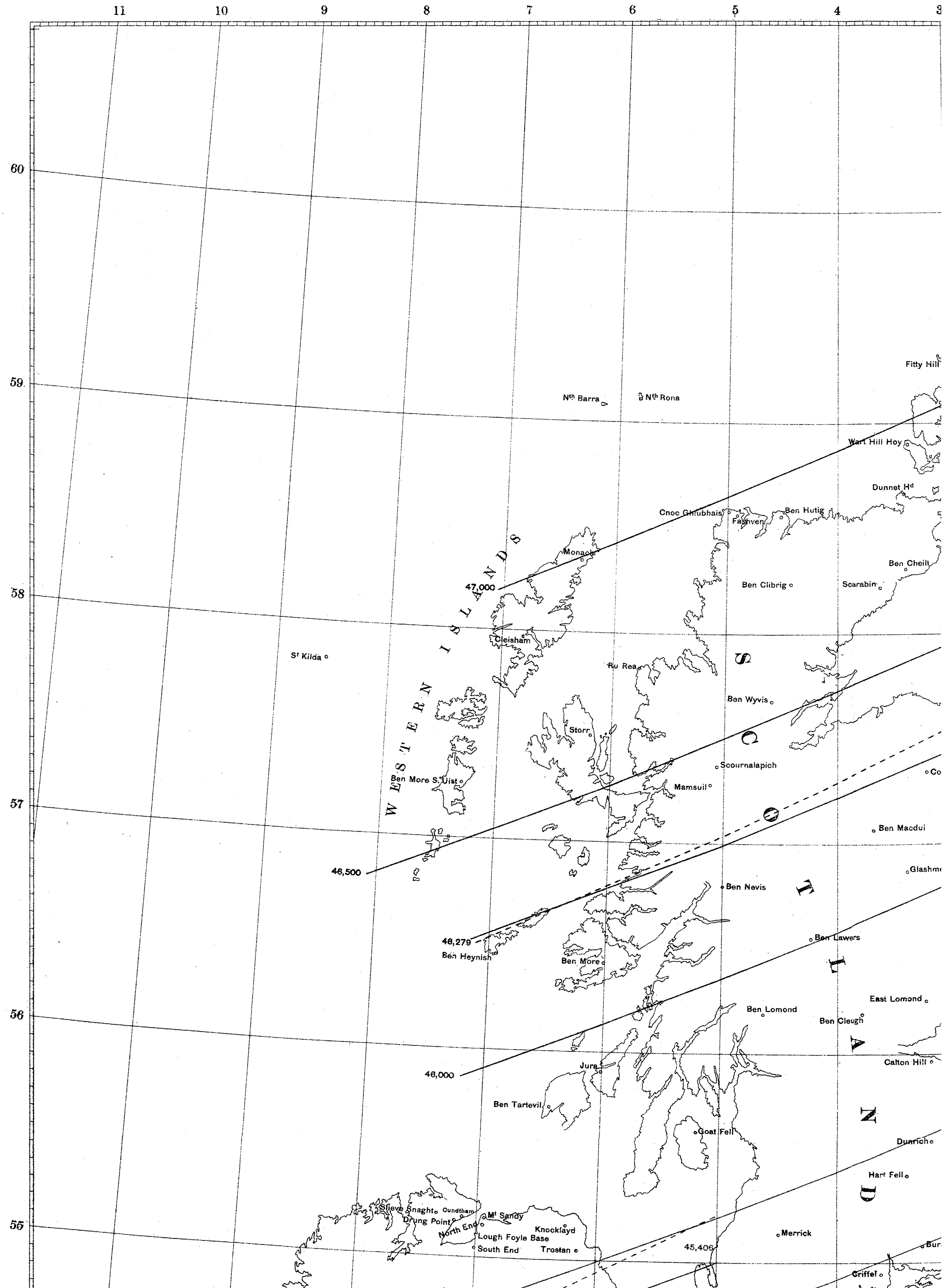

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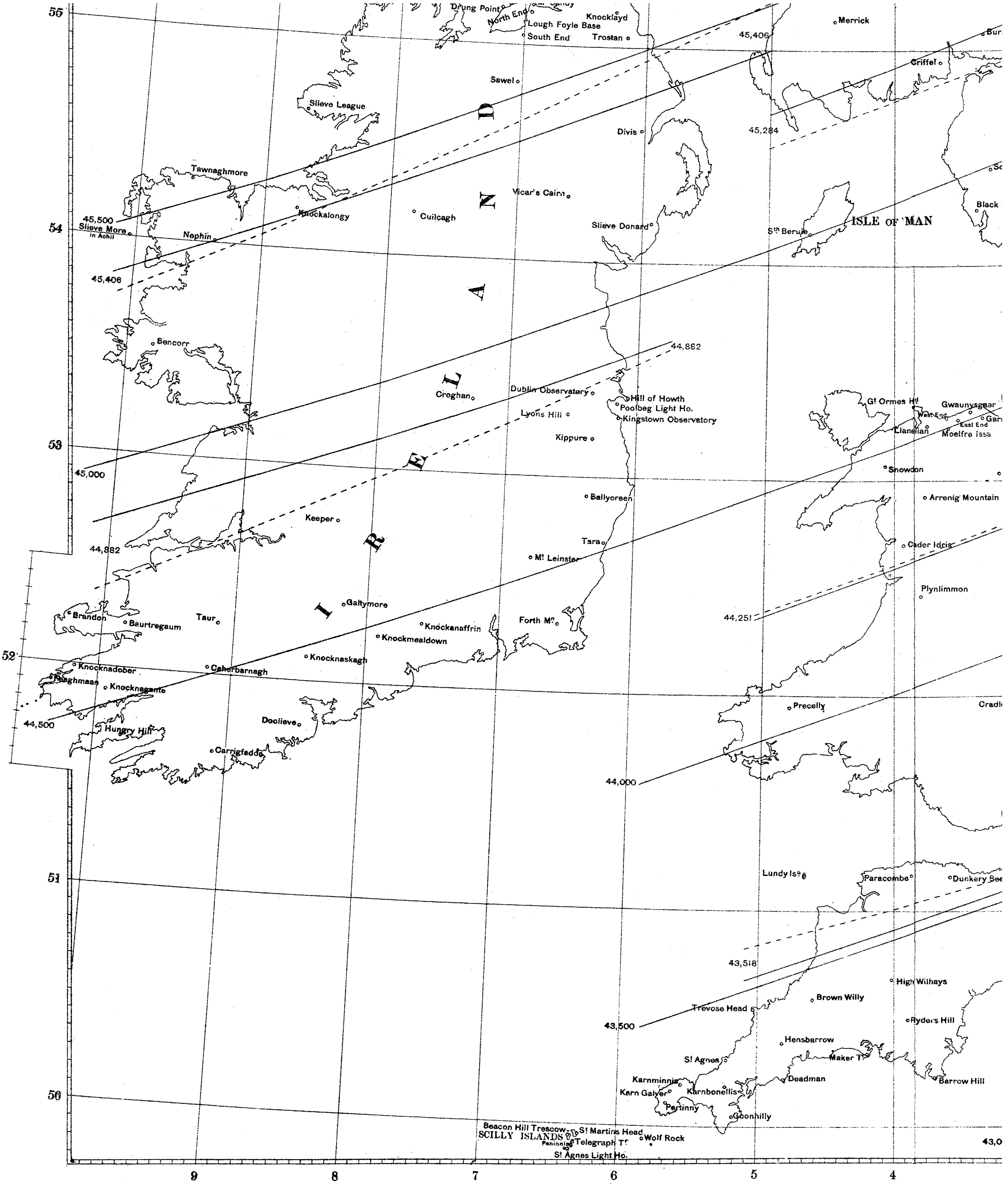

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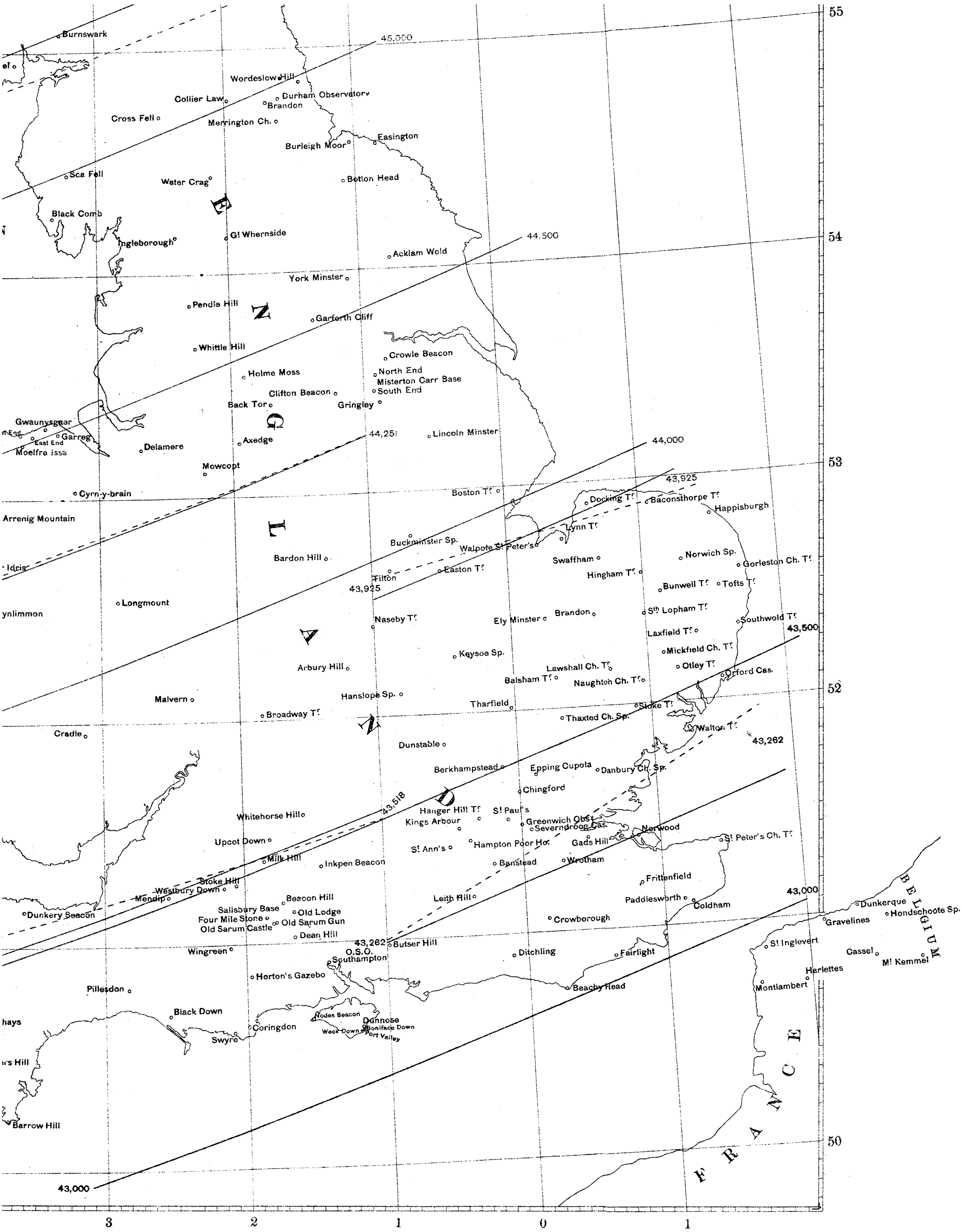

Ordnance Survey, July 1918.

4.

CHART OF EQUAL DECLINATION.

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for epoch 1st January 19
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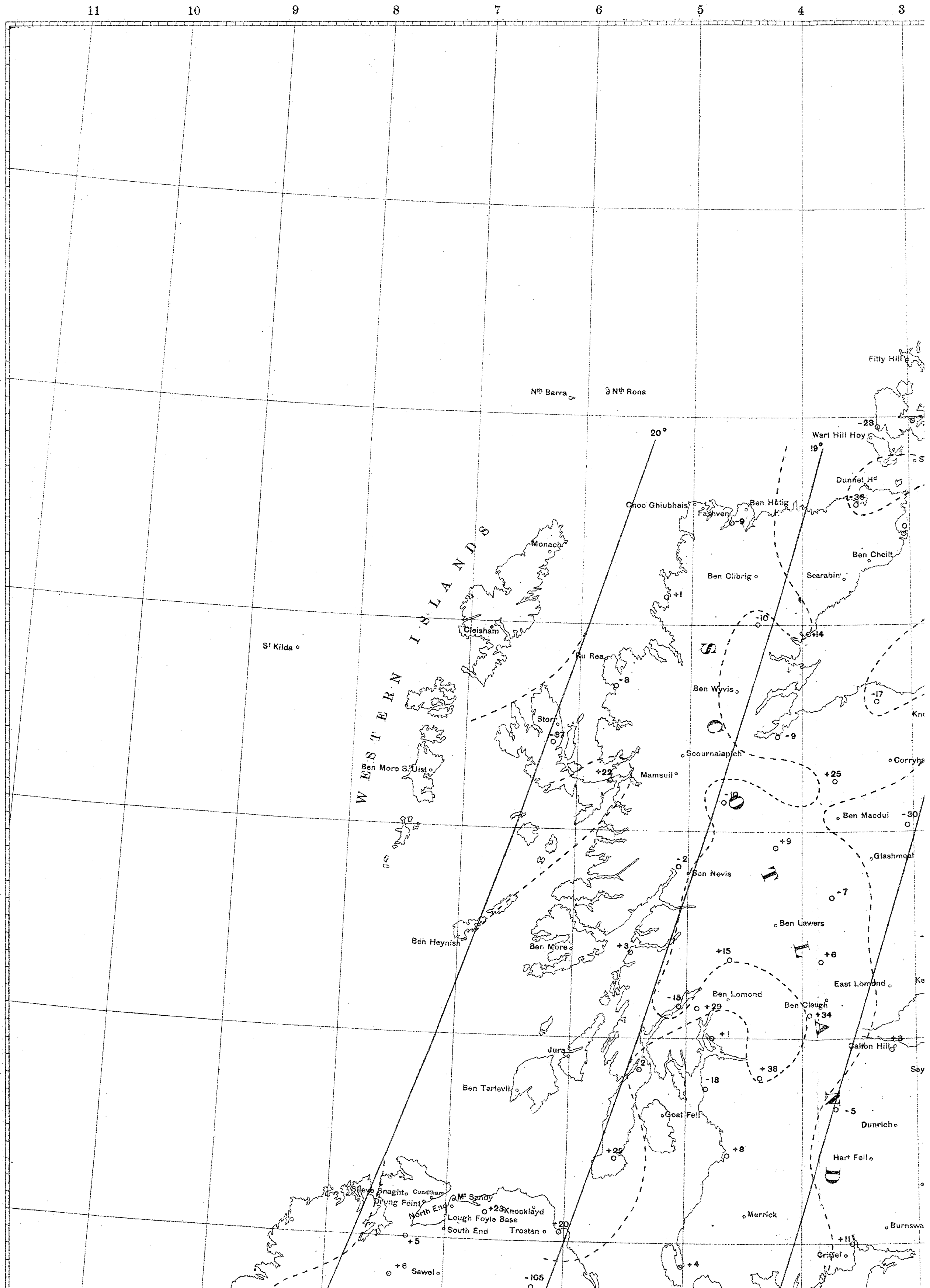

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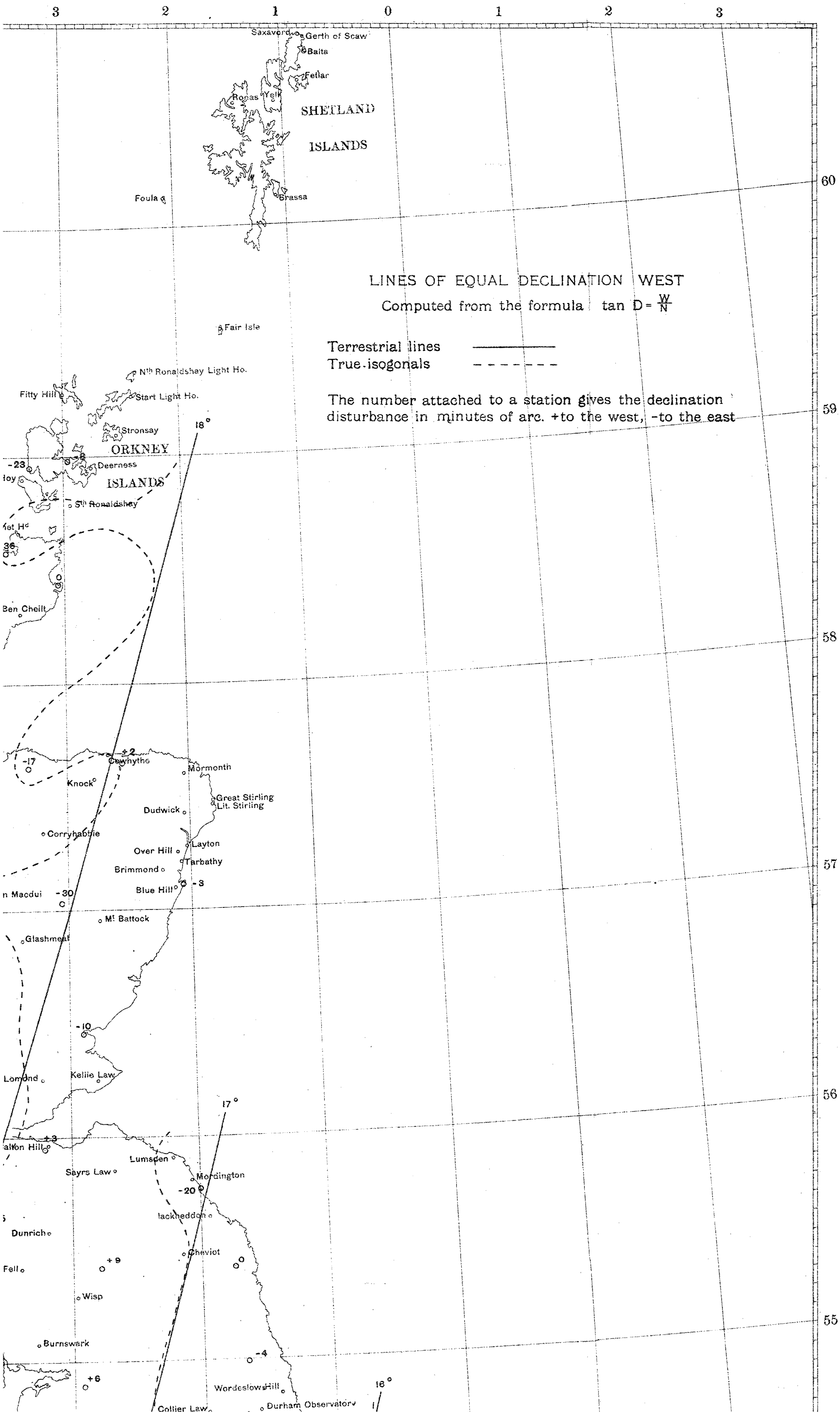

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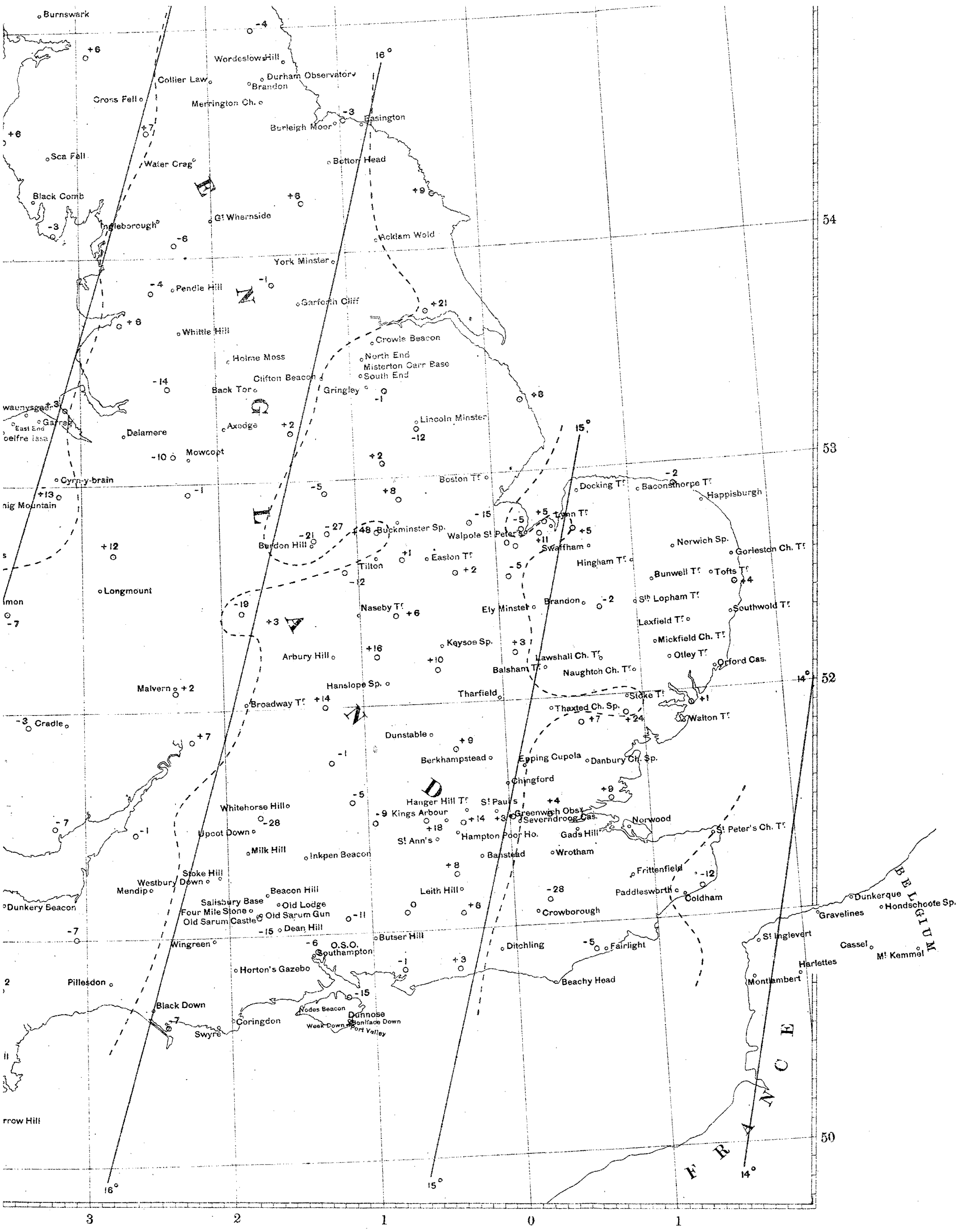

Ordnance Survey, July 1918.

5.

CHART OF DISTURBING FORCES.

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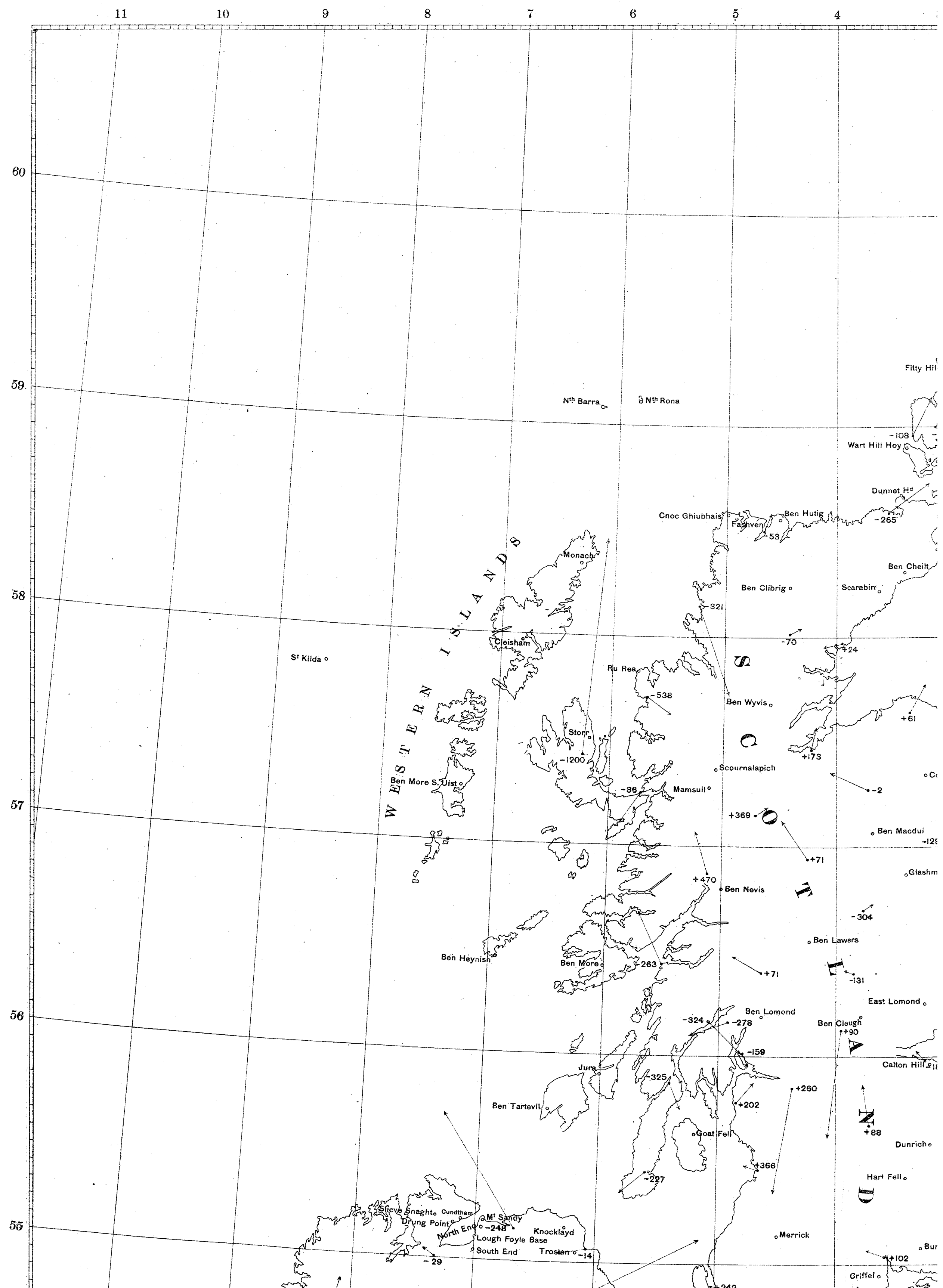
by G.W. Walker, Esq., F.R.S



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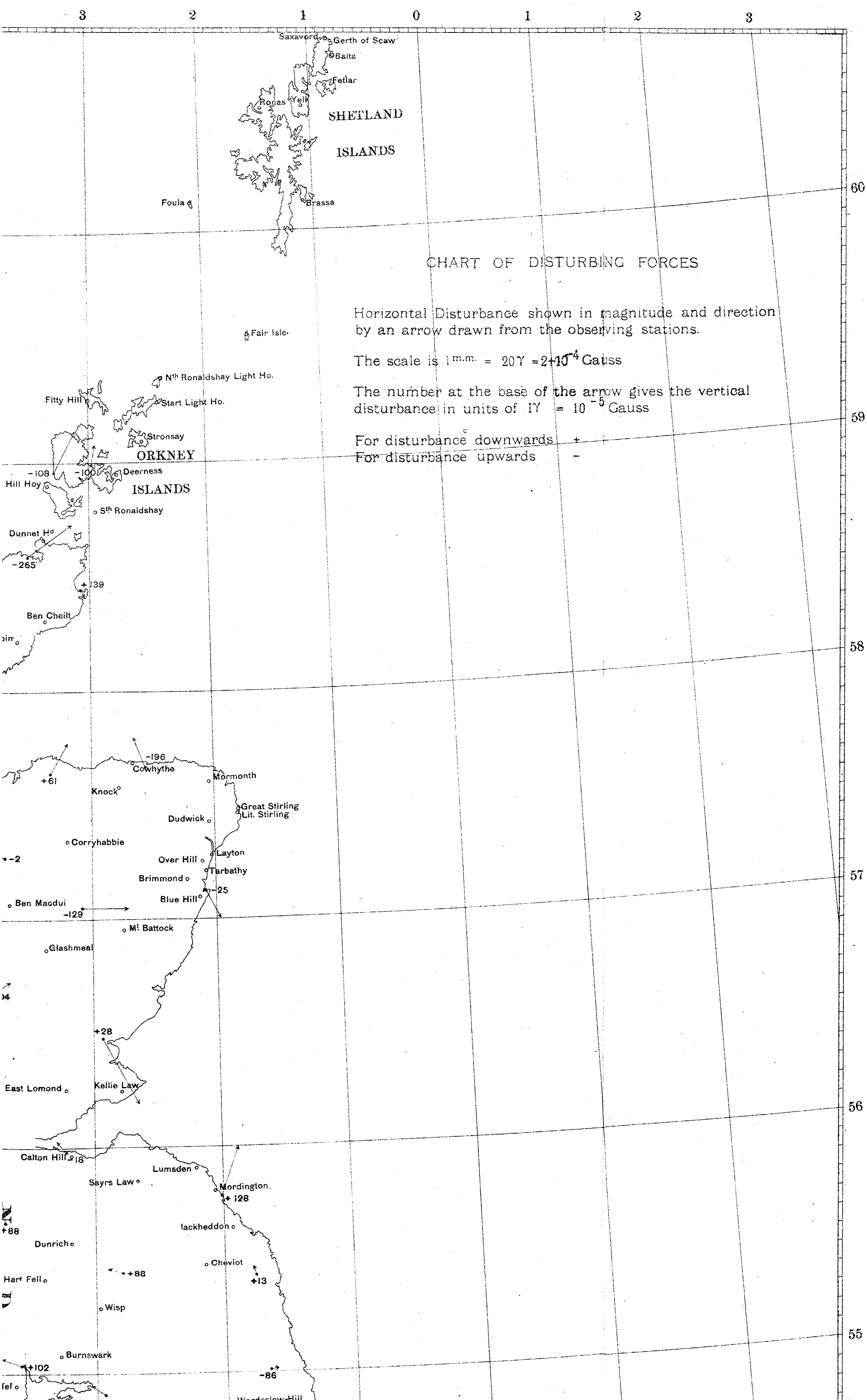

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Lough Foyle Base
South End
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Merrick
+102
Criffel
+242
Sawel
+51
−115
Slieve League
−127
+36
Divis
+234
Tawnaghmore
+28
+78
−34
Vicar's Cairn
Knockalongy
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Black
Slieve More in Achil
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Nephin
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Sth Berule
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+108
+43
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+172
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+97
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Snowdon
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Arrenig Mountain
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Keeper
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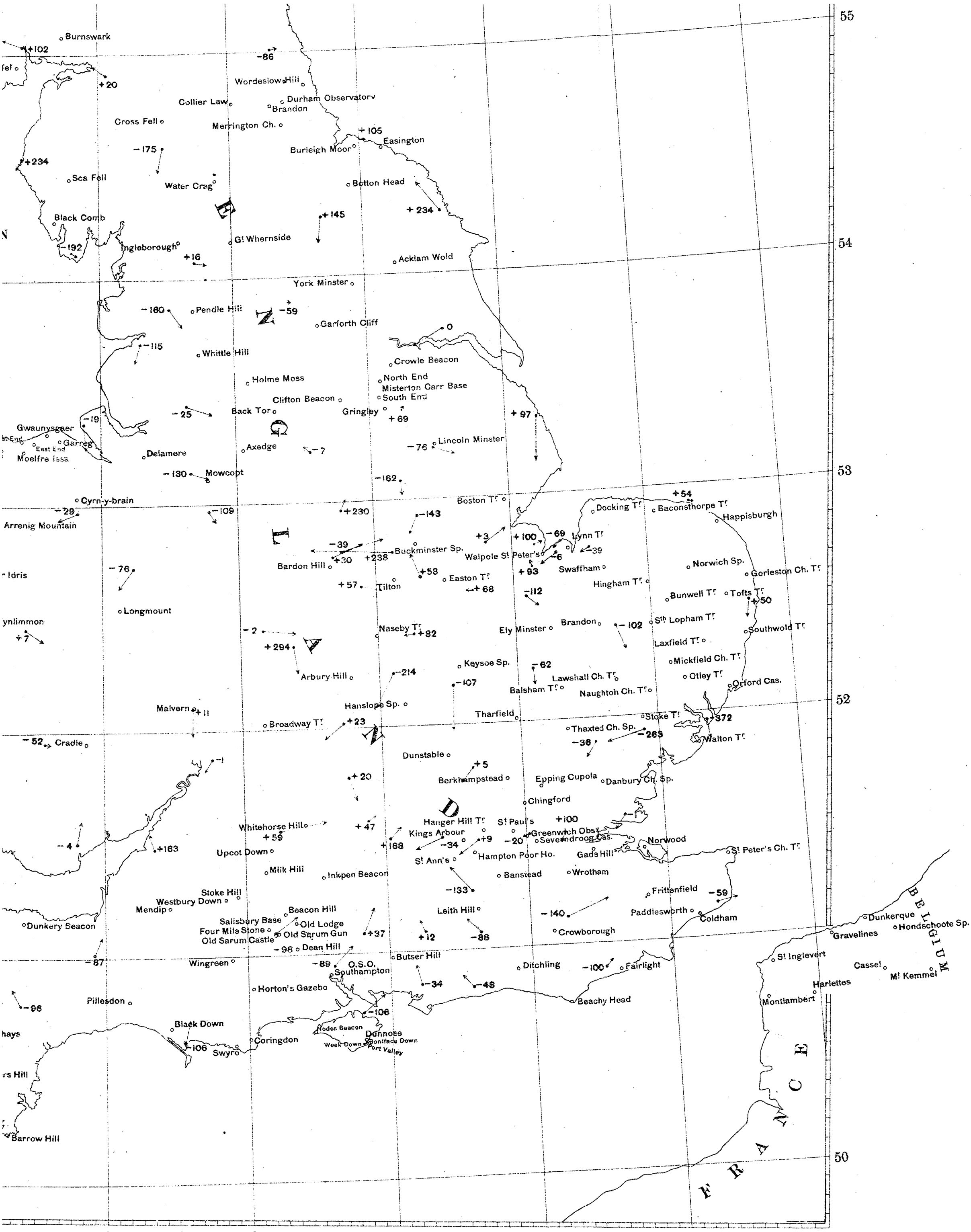

Ordnanee Survey, July 1918.

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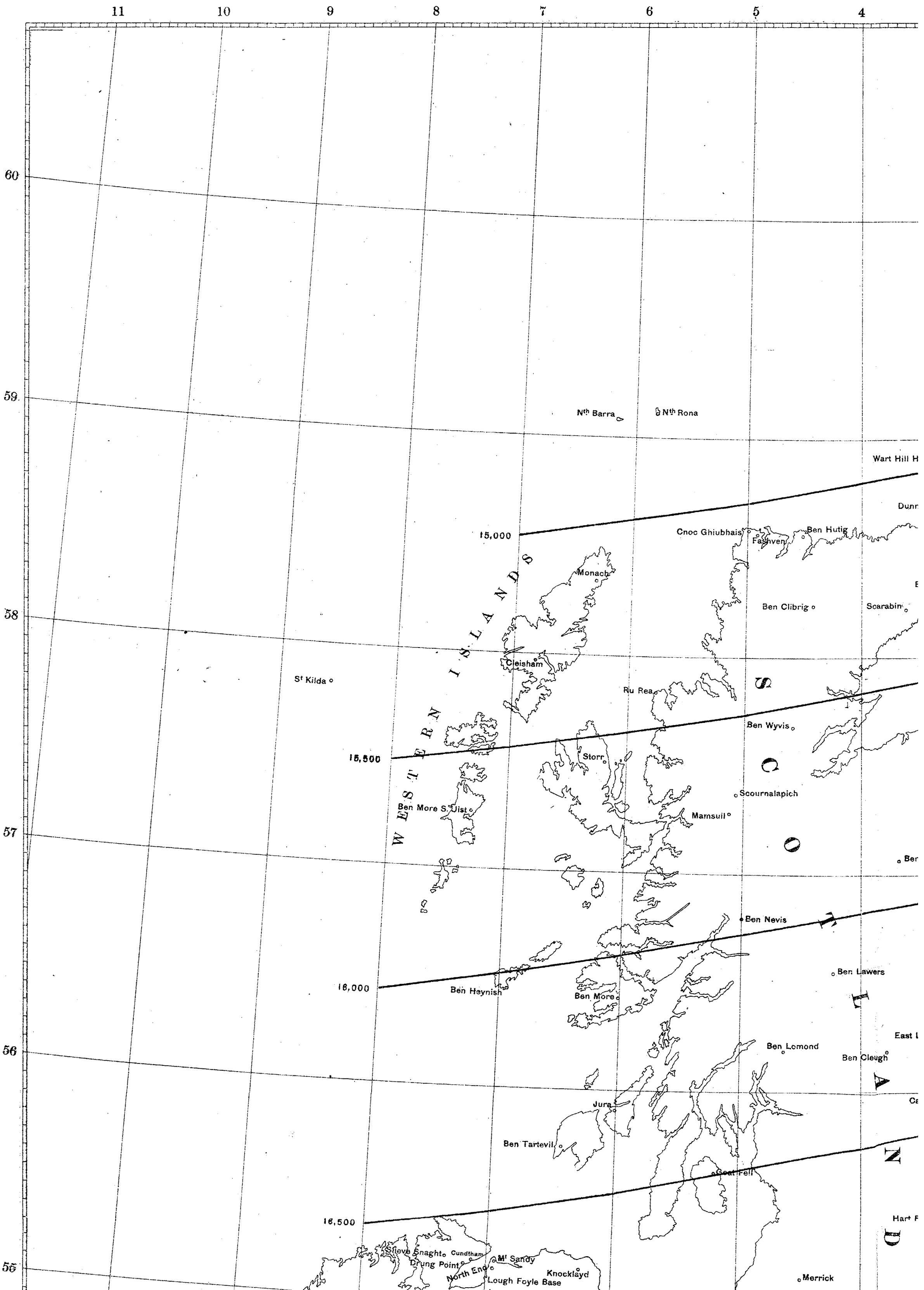

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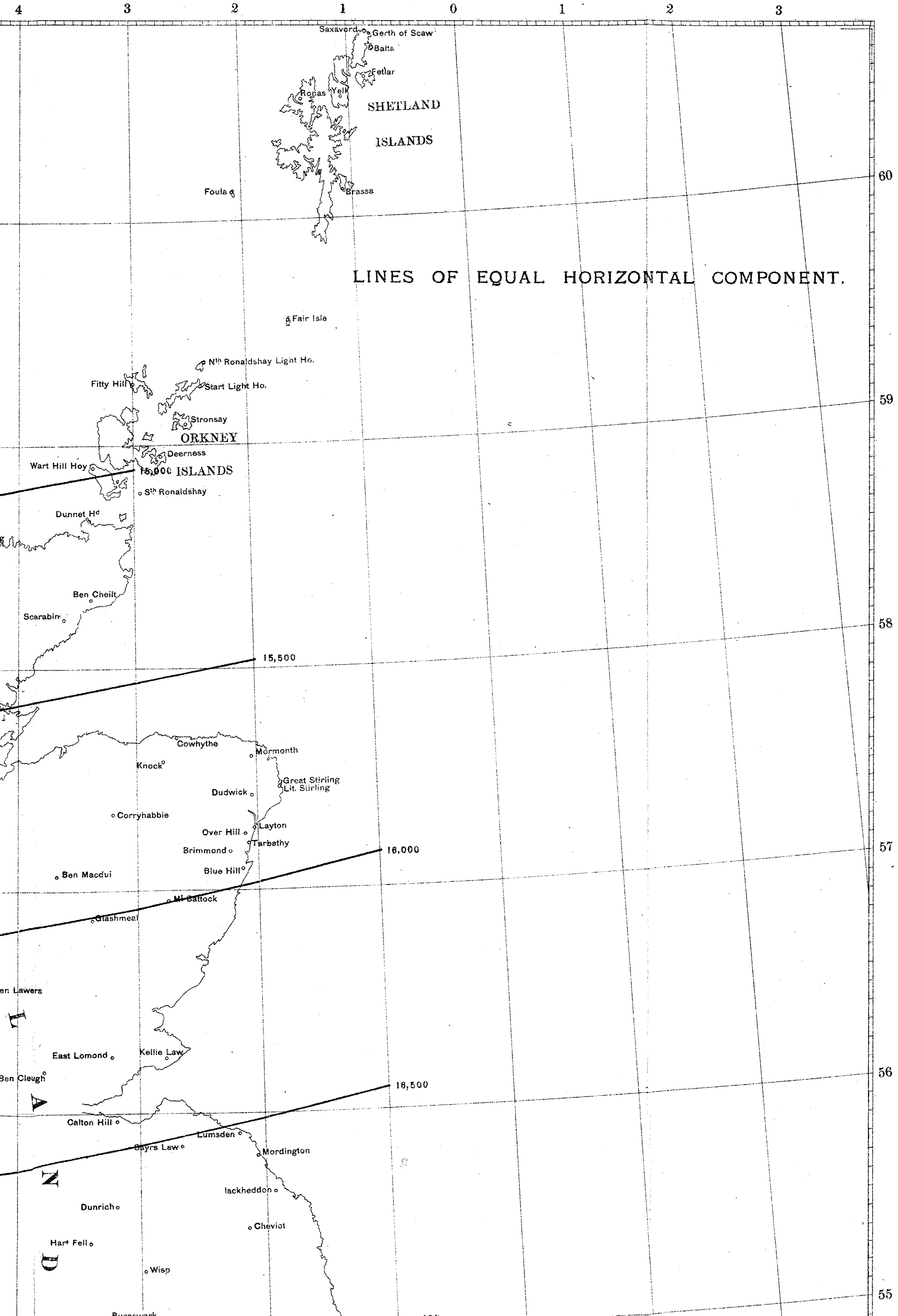

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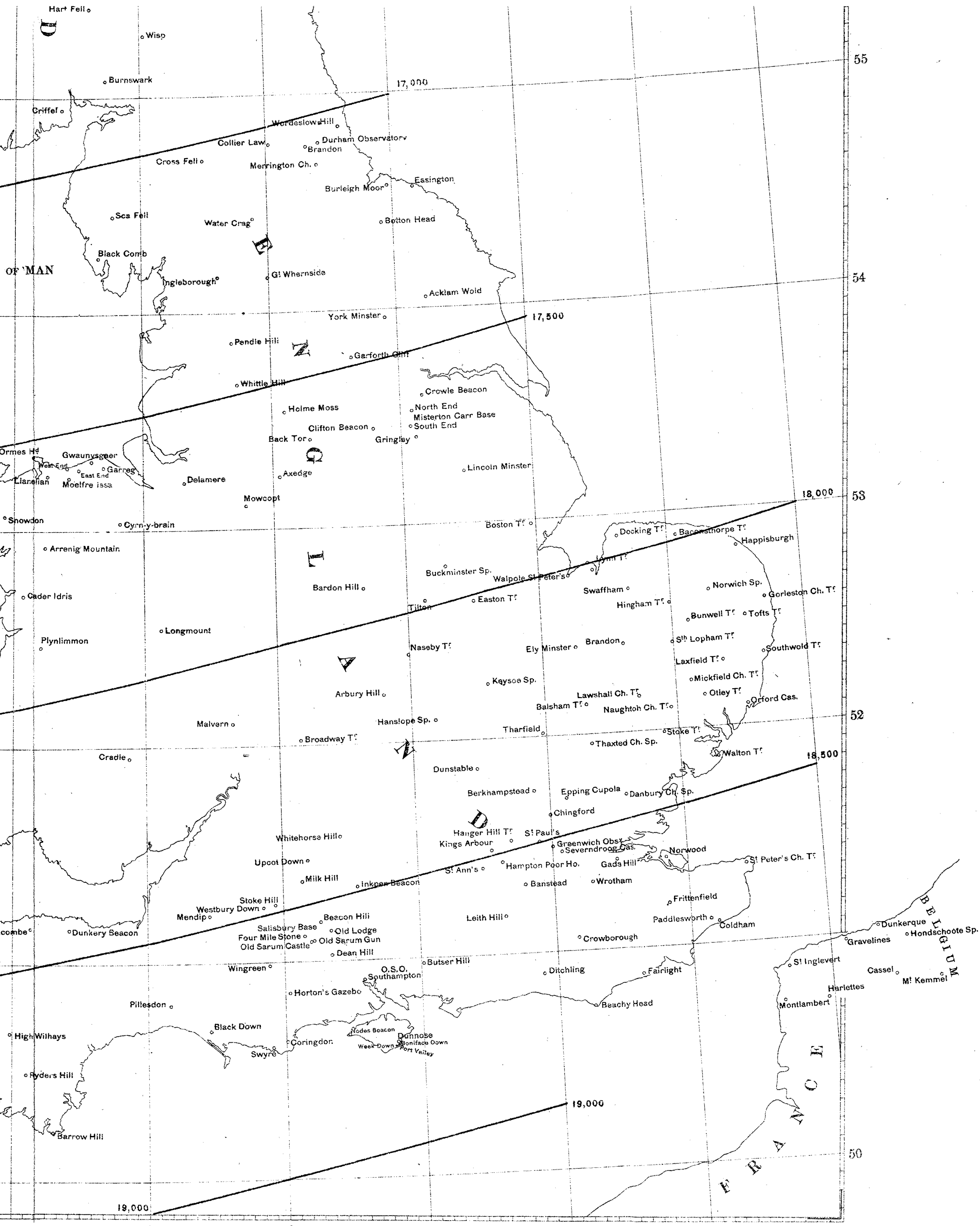

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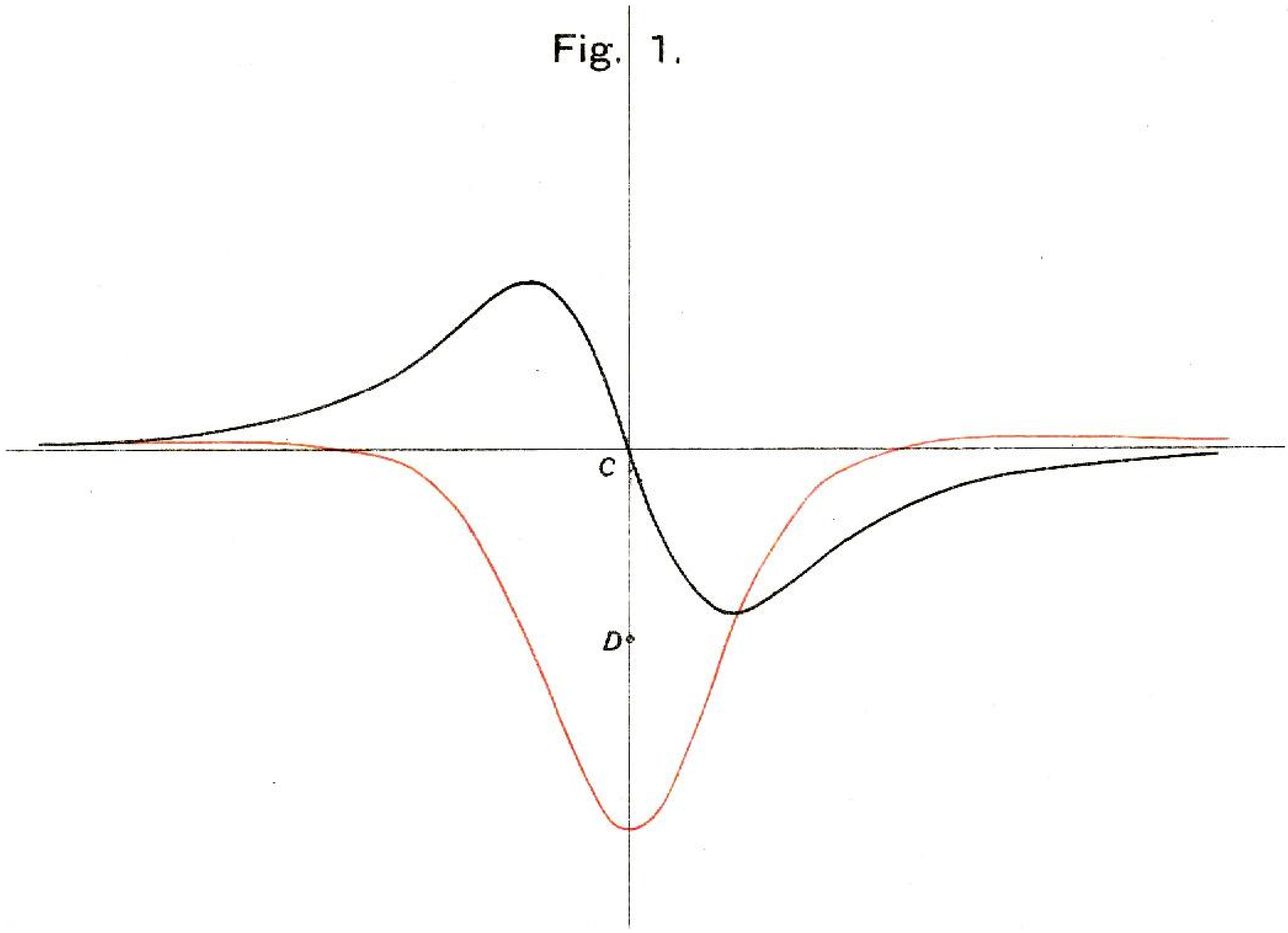
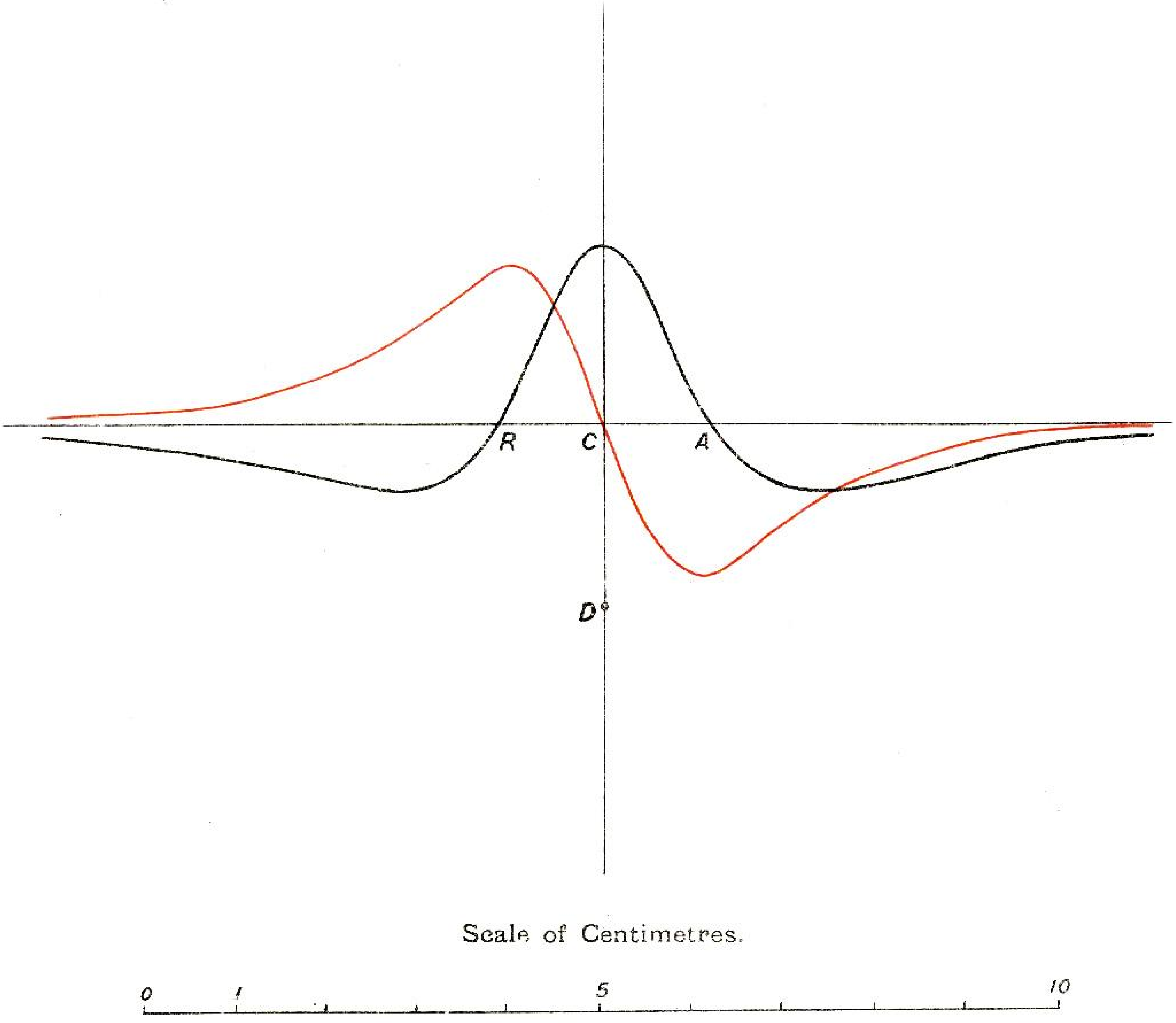
Fig. 1.



Doublet at D, *axis vertical.*
Forces in Meridian Section.

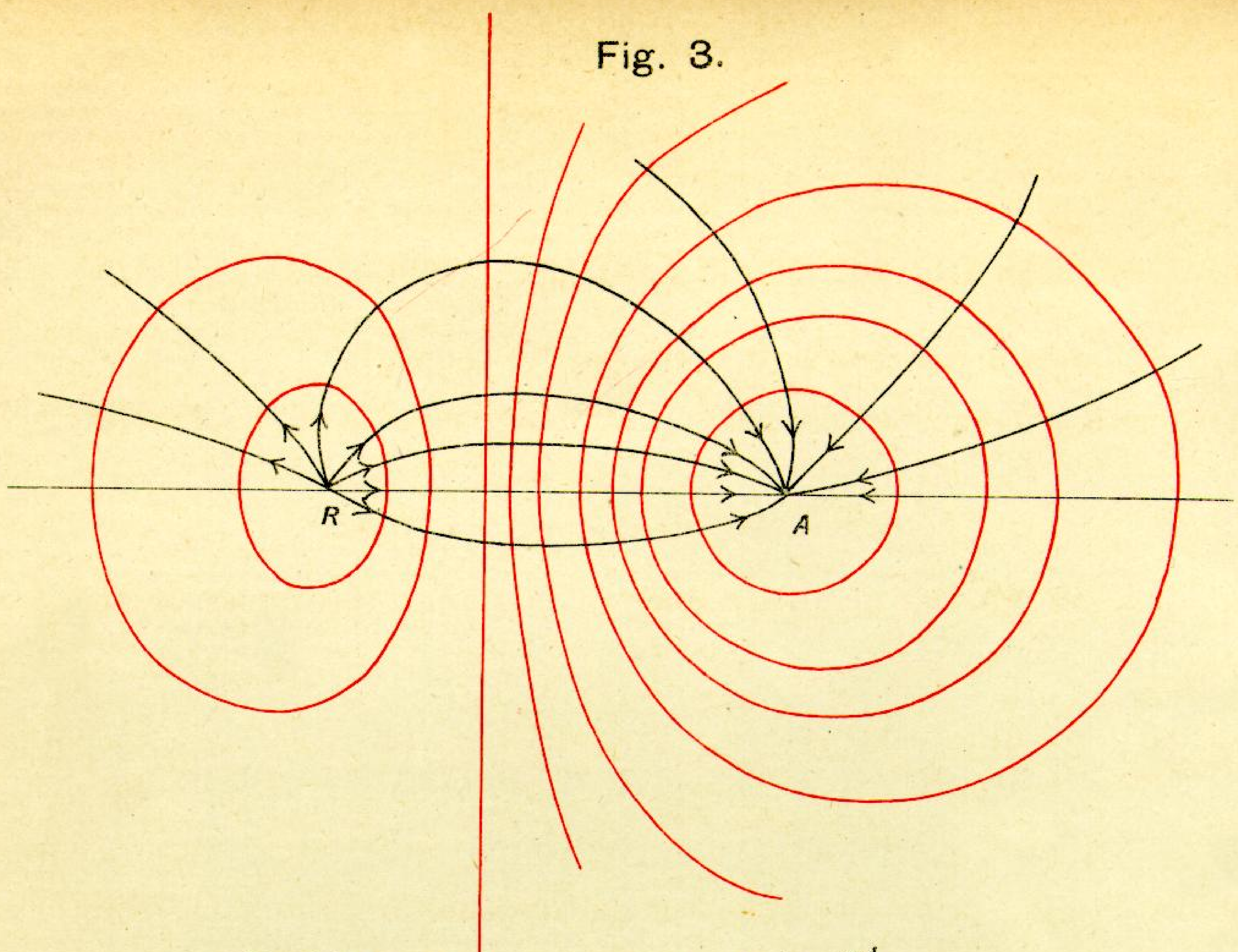
Radial Force (Black)	+	*right*
	—	*left*
Vertical Force (Red)	+	*up*
	—	*down*

Fig. 2.



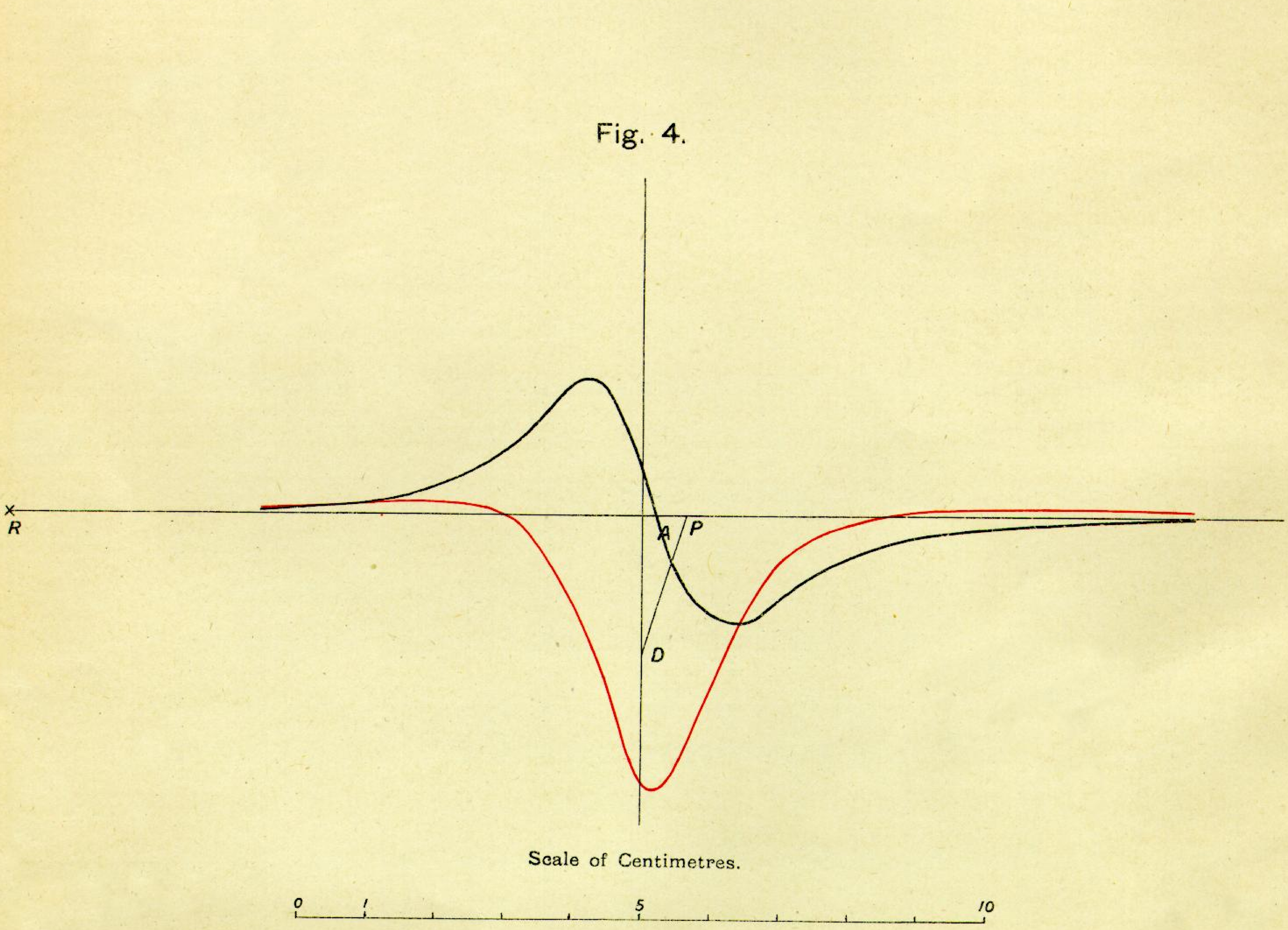
Doublet at D, *axis horizontal.*
Forces in Meridian Section.

Fig. 3.



Doublet with axis inclined at tan $^{-1}$ 3.
Equipotential curves on horizontal plane (Red).
Apparent line of horizontal force (Black).

Fig. 4.

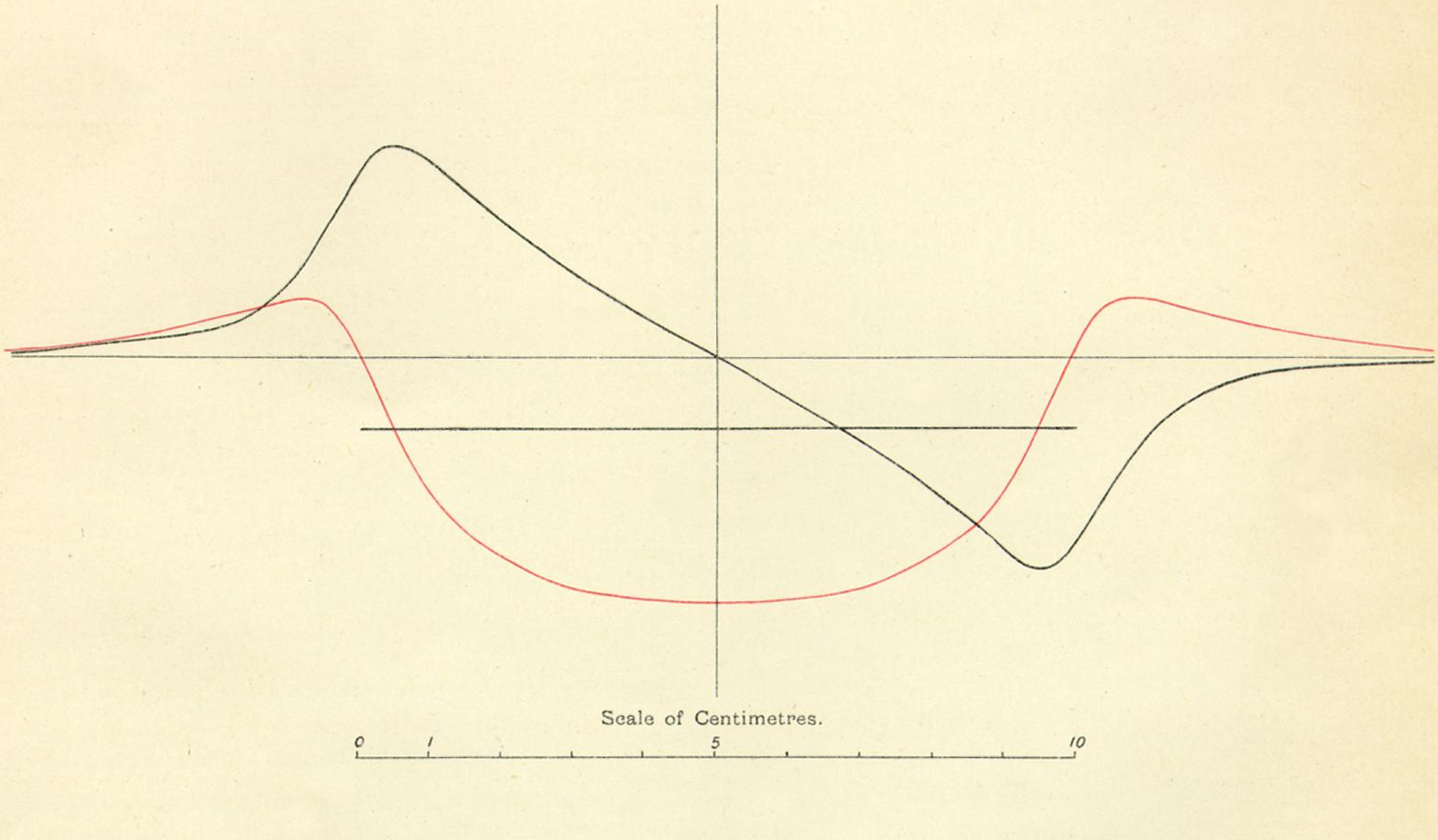


D *represents the position of Doublet.*
P *the point where its axis meets the horizontal plane.*

Forces in Meridian Section.

To face page 66.

Fig. 5.

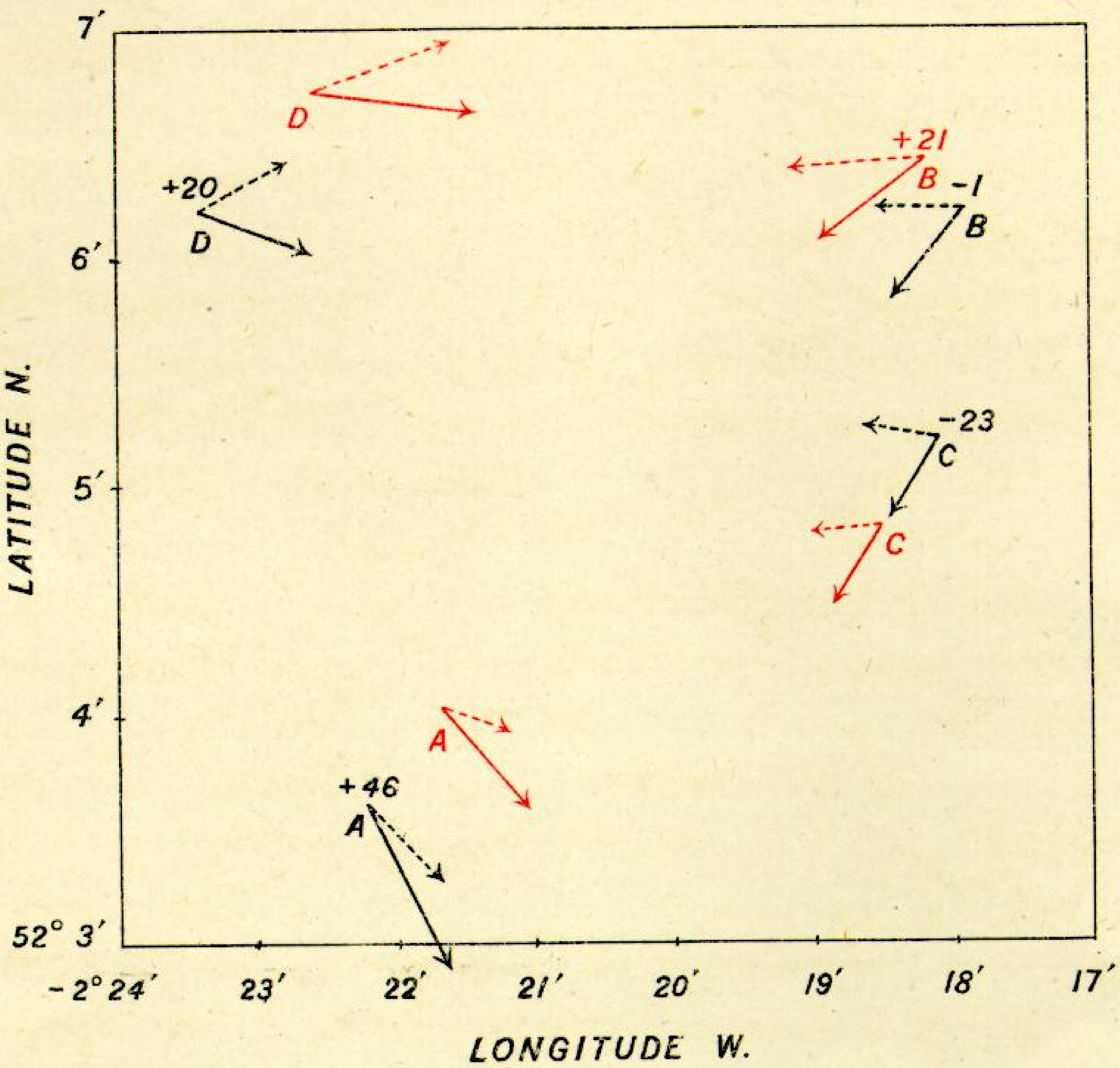


Flat spheroid magnetized vertically.

Radial Force (Black) + *to right.* — *to left.*

Vertical Force (Red) + *up* — *down*

Fig. 6.

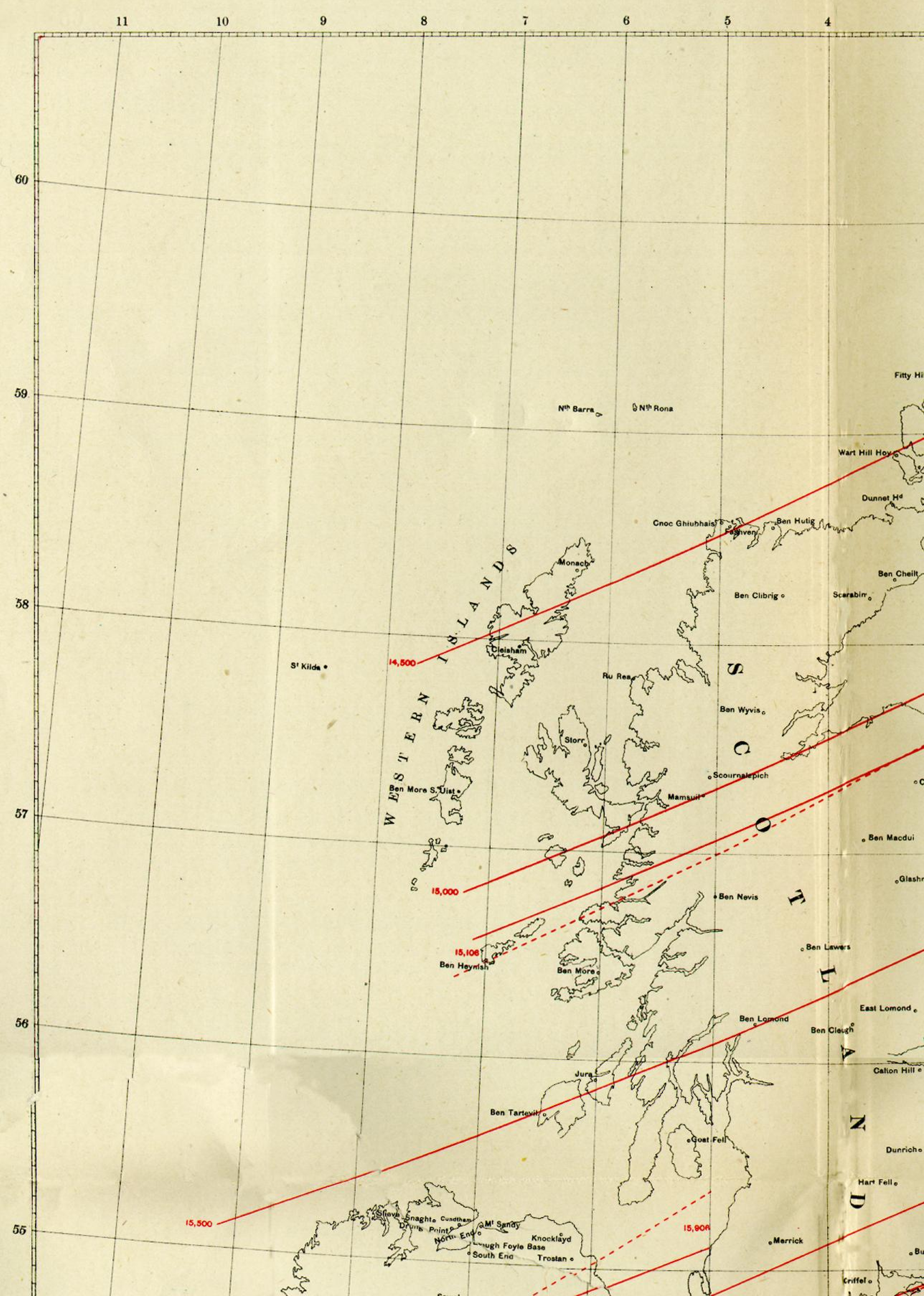


Malvern Hills.

Disturbing Forces.

Magnetic Survey of the British Isles
for epoch 1st January 1915.
by G.W. Walker, Esq., F.R.S.

Magnetic Survey of the B
for epoch 1st January
by G.W. Walker, Esq., F.R.



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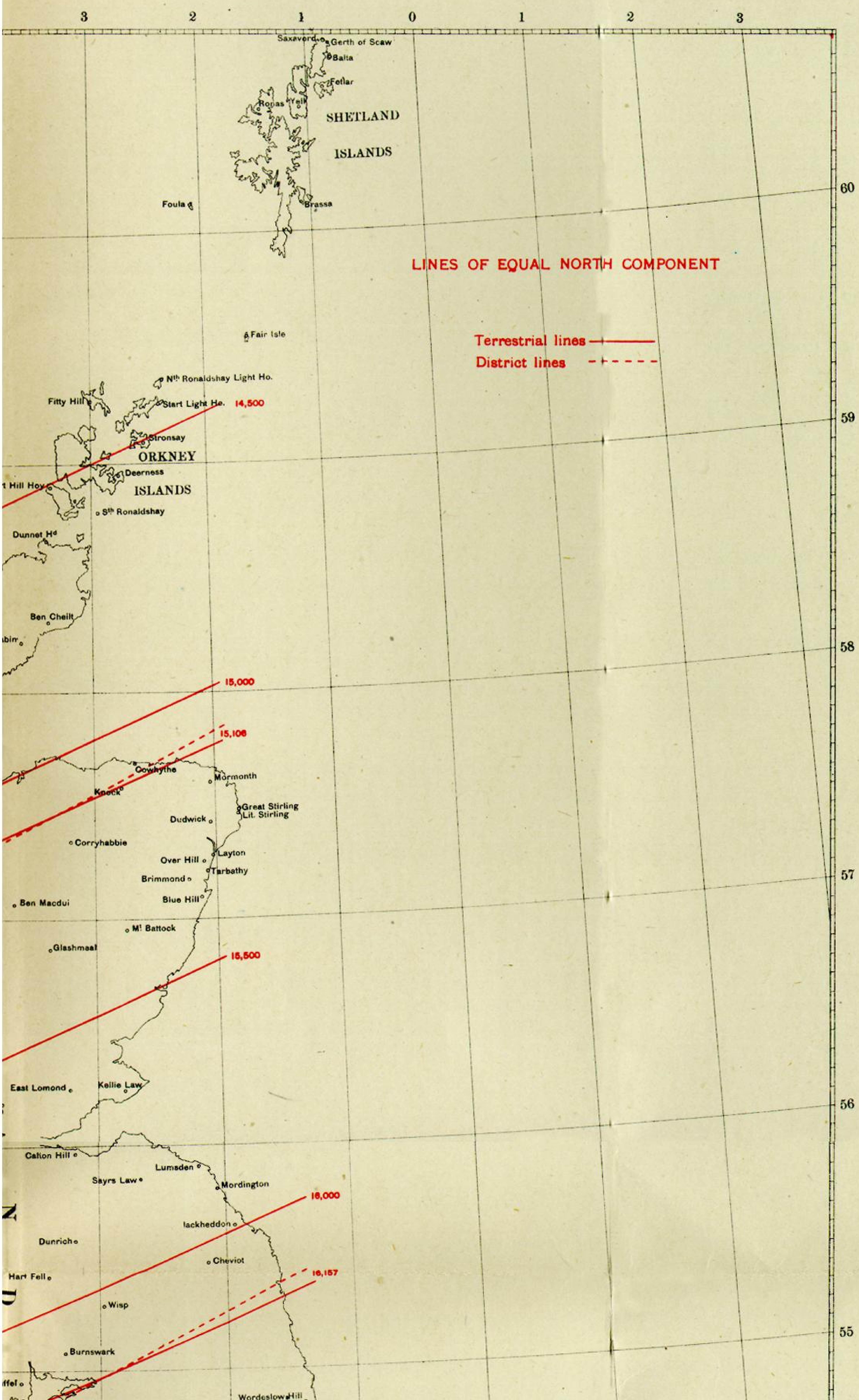

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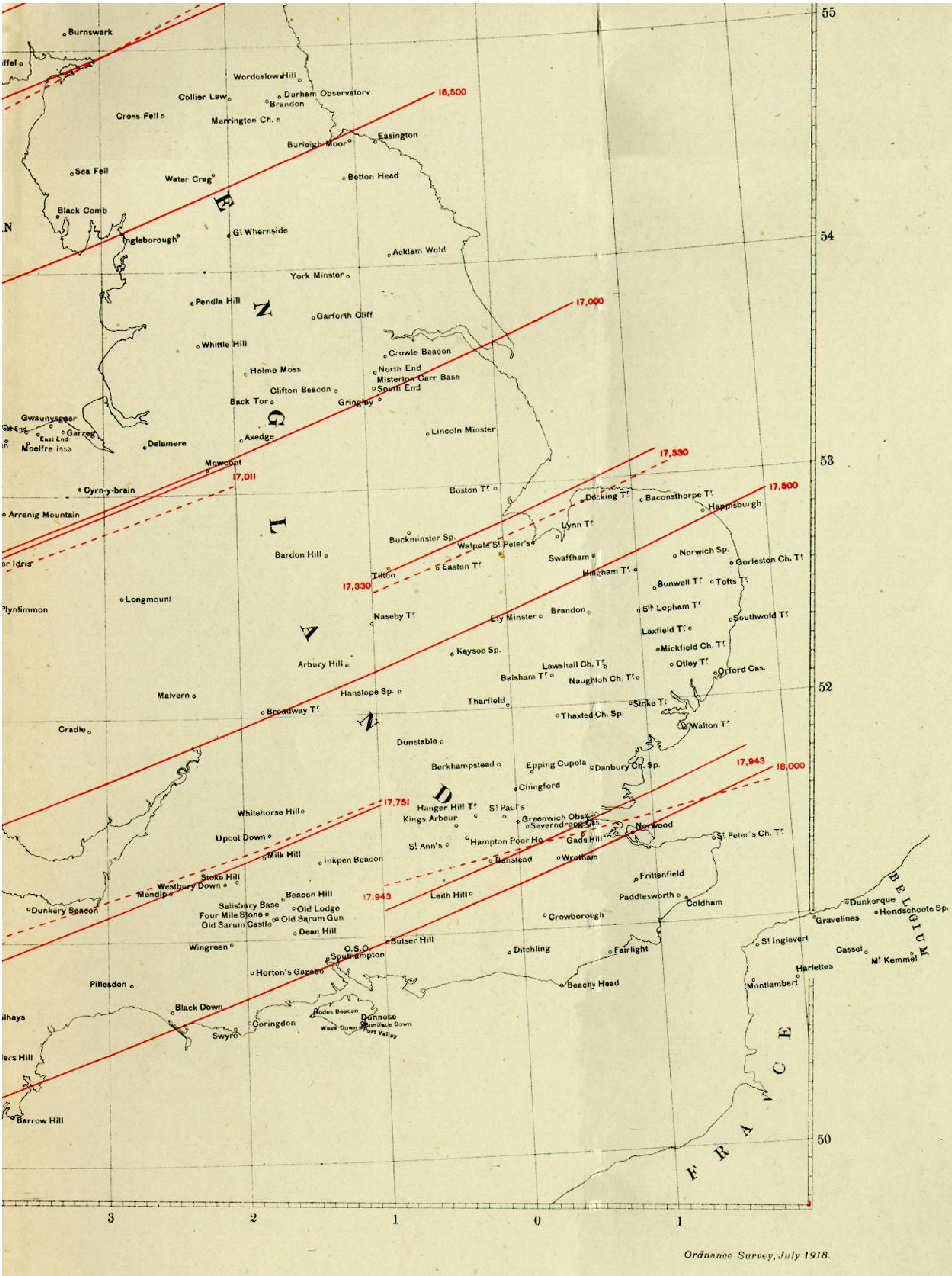

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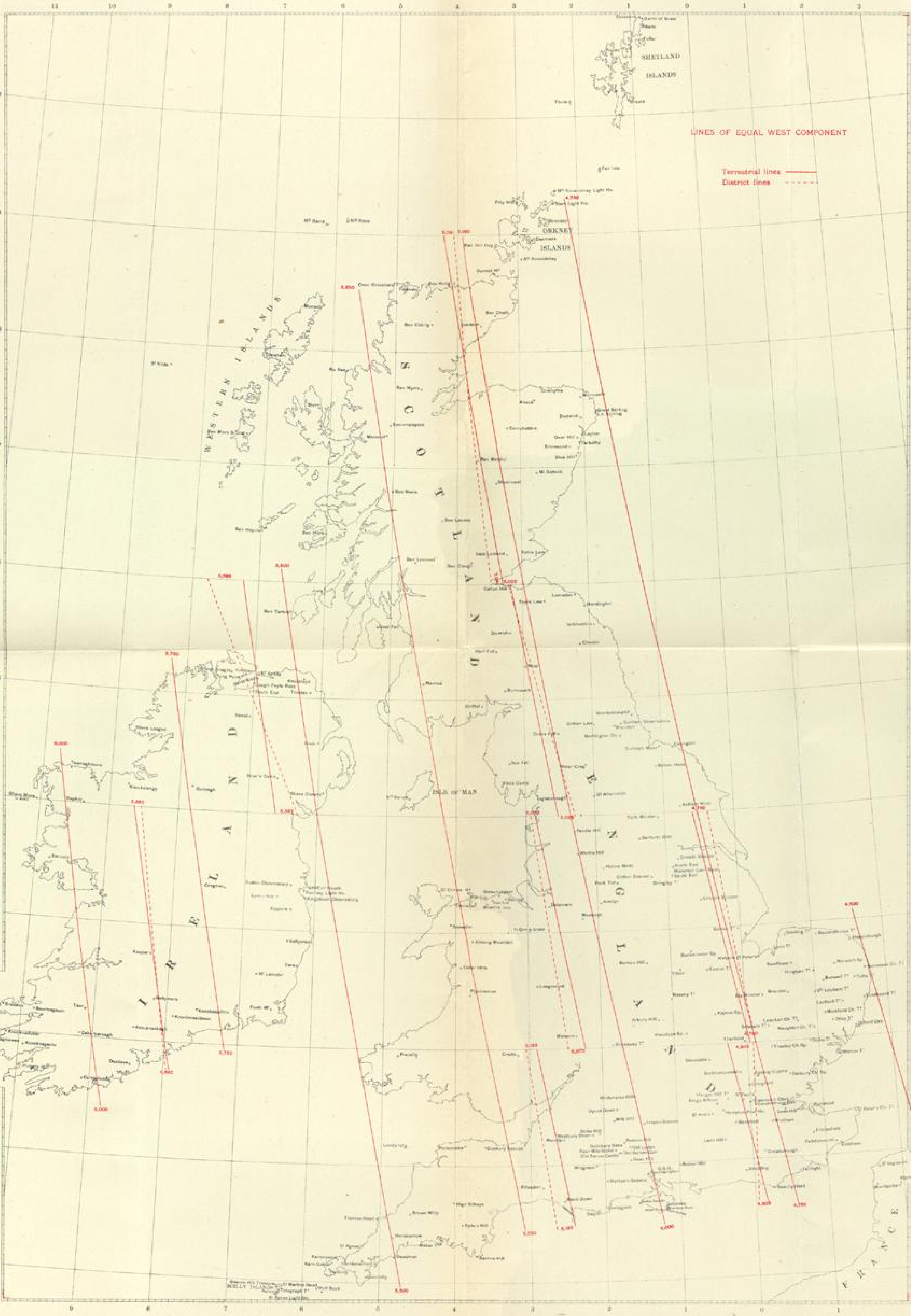

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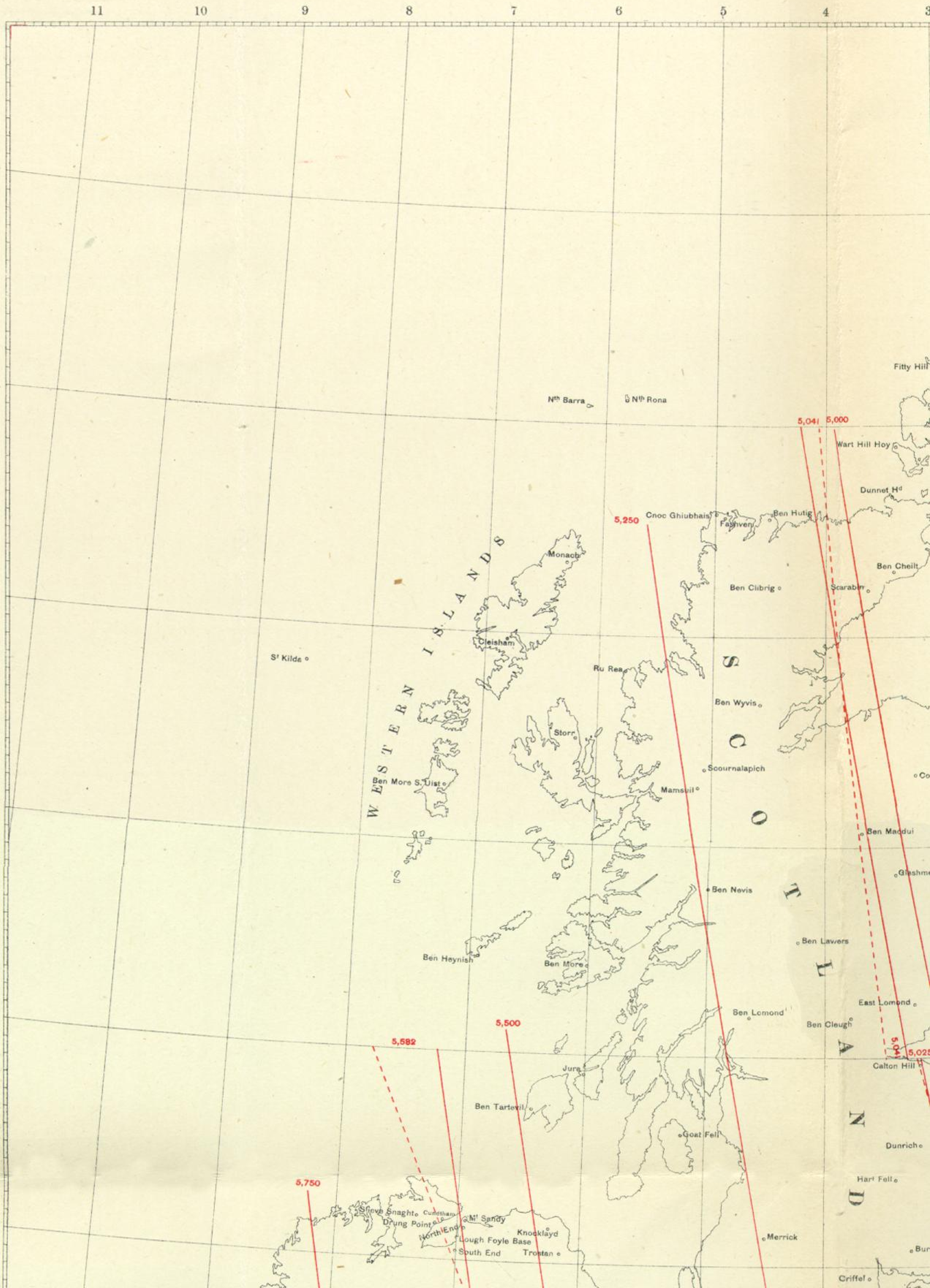
for epoch 1st January

by G.W. Walker, Esq., F.R.S.



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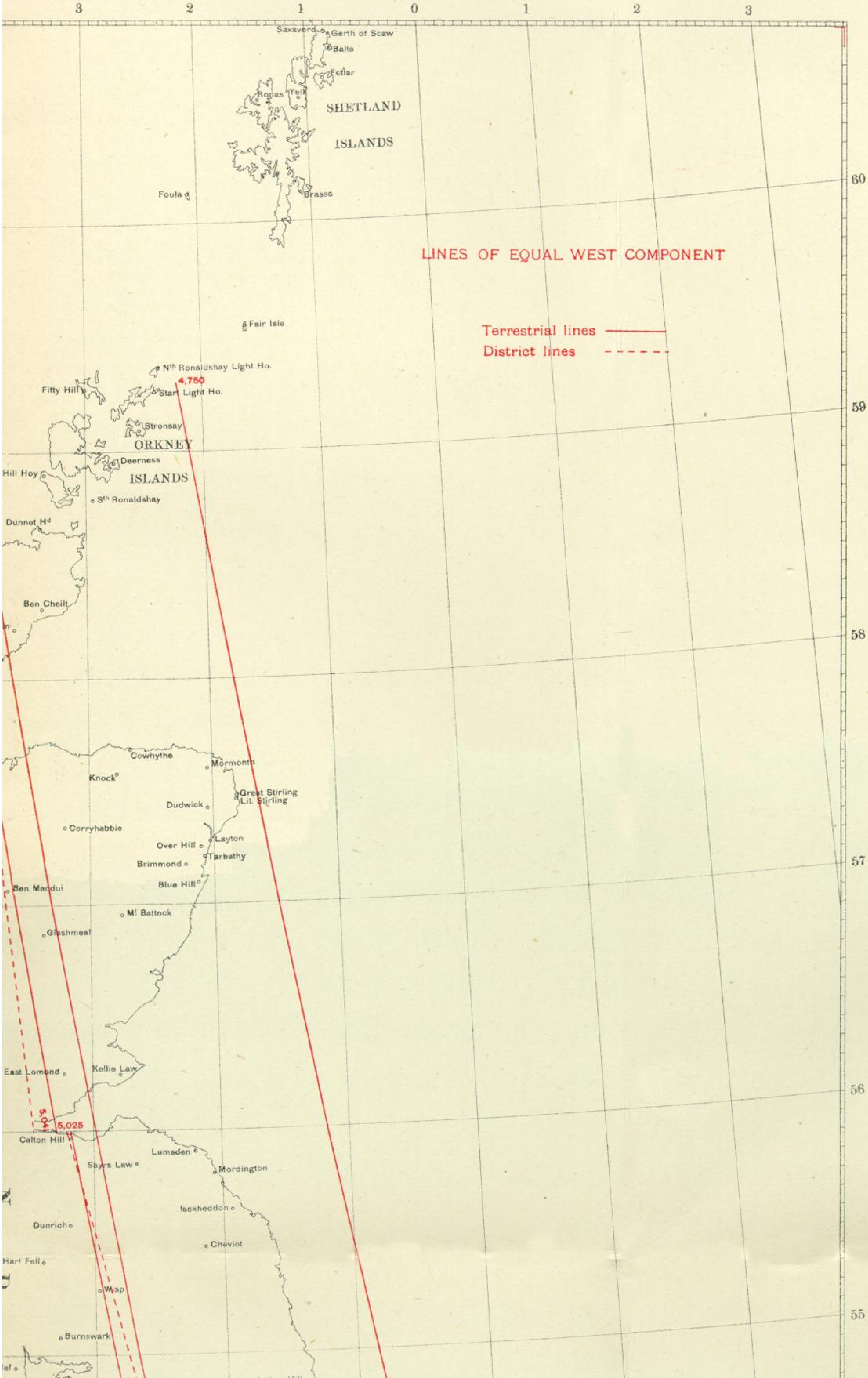

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I R E L A N D
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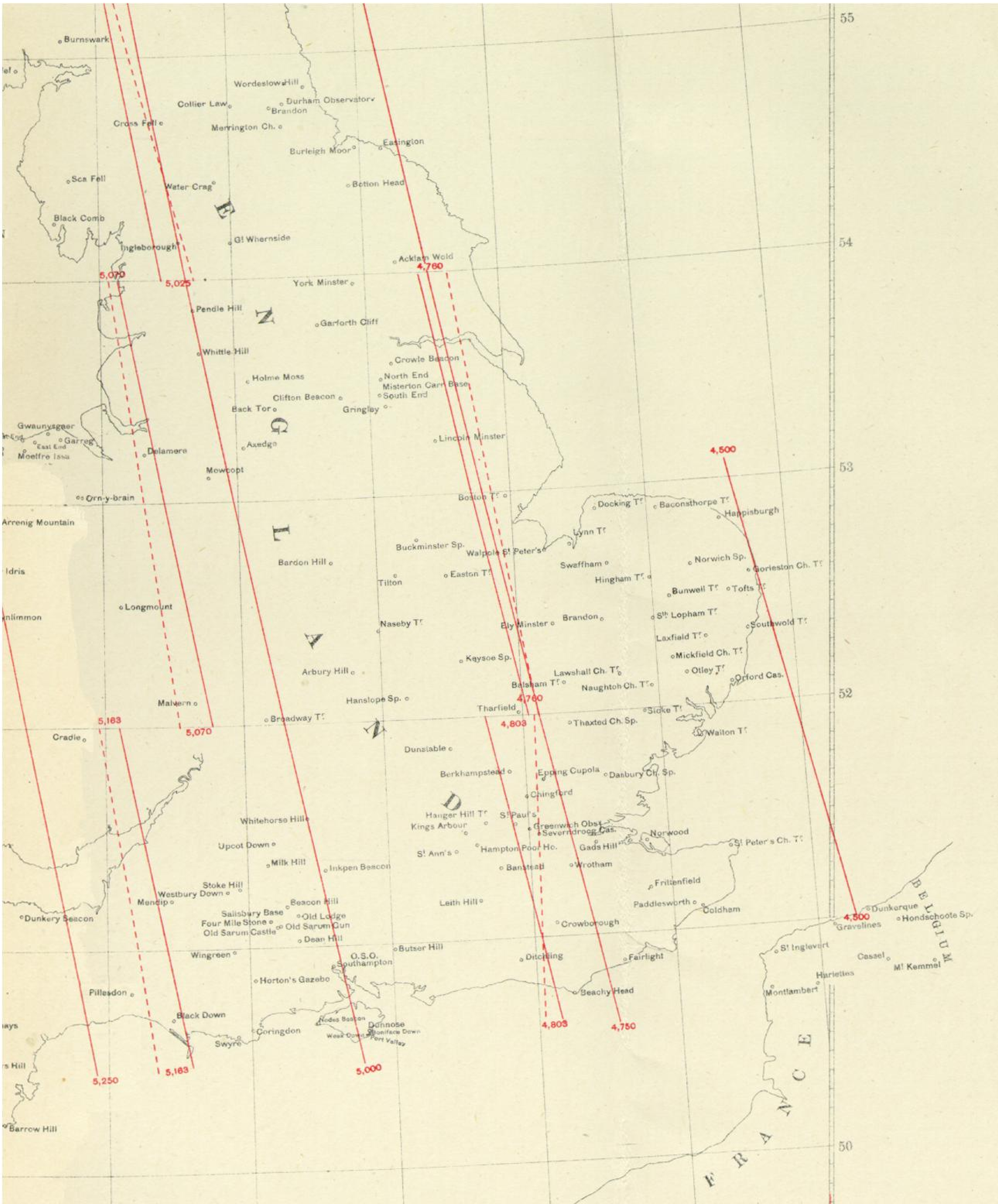
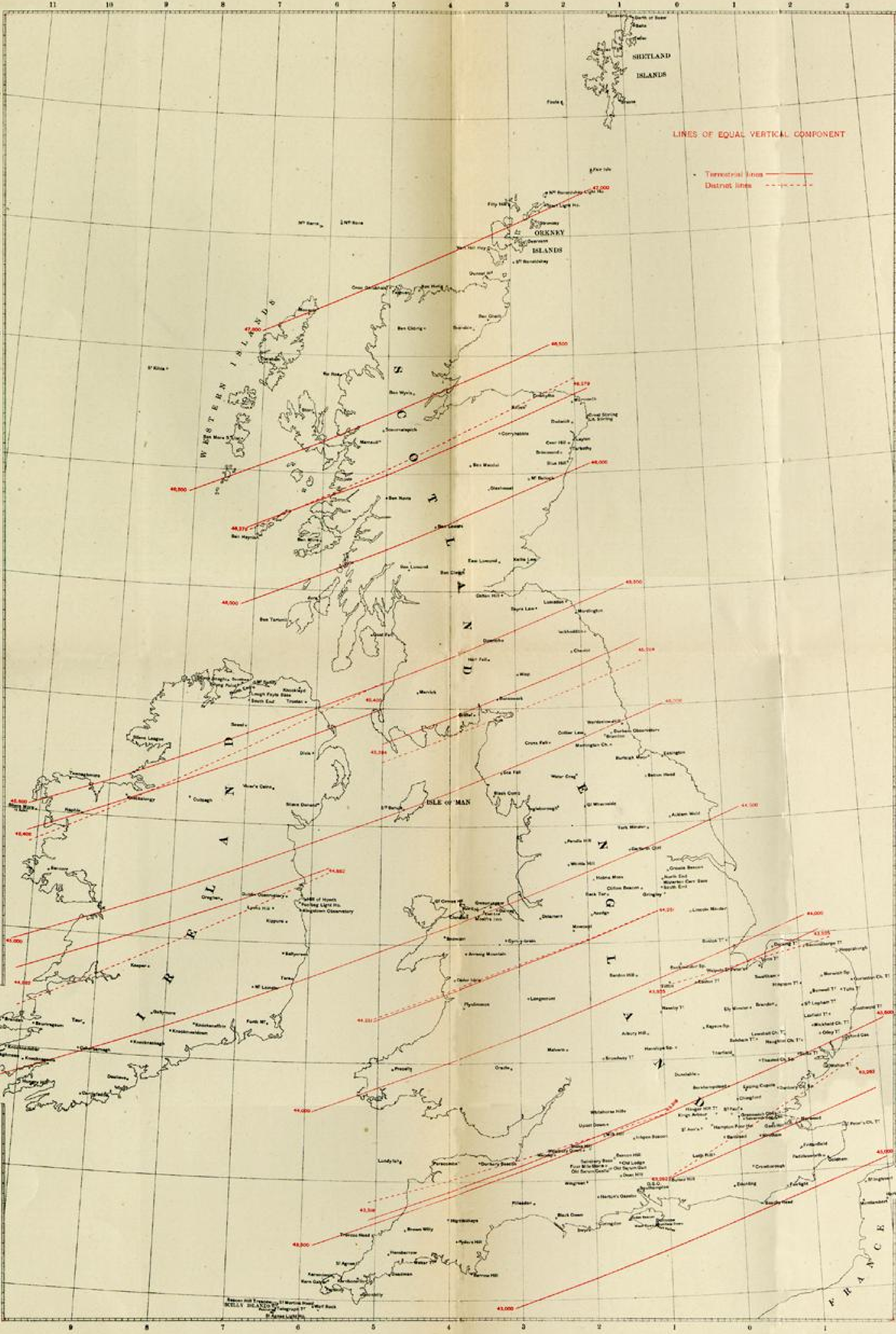
5,750
5,582
5,500
Drung Point
North End
Mt Sandy
Lough Foyle Base
South End
Knocklayd
Trostan
Merrick
Criffel
Sawel
Slieve League
Divis
Tawnaghmore
Knockalongy
Cuilcagh
Vicar's Cairn
Slieve Donard
Slieve More in Achil
Nephin
St Berule
Black
Bencorr
Croghan
Dublin Observatory
Hill of Howth
Poolbeg Light Ho.
Kingstown Observatory
Lyons Hill
Kippure
Gt Ormes Hd
Gwaunysgaer
West End
East End
Moelfre Issa
Snowdon
Ballycreen
Arrenig Mountain
Keeper
Tara
Cader Idris
Mt Leinster
Plynlimmon
Brandon
Baurtregaum
Taur
Galtymore
Knockanaffrin
Knockmeeldown
Forth Mn
Knocknadober
Caherbarnagh
Knocknaskagh
Knocknagante
Precelly
Cradle
Hungry Hill
Doolieve
Carrigfadda
Lundy Isd
Paracombe
Dunkery Beacon
High Willhays
Brown Willy
Trevose Head
Ryders Hill
Hensbarrow
St Agnes
Maker Tr
Karnminnis
Deadman
Barrow Hill
Karn Galver
Karnbonellis
Pertinny
Goonhilly
Beacon Hill Trescow
St Martins Head
Telegraph Tr
Wolf Rock
St Agnes Light Ho.



Ordnance Survey, July 1918.

Magnetic Survey of the British Isles
for epoch 1st January 1915.
by G.W. Walker, Esq., F.R.S.



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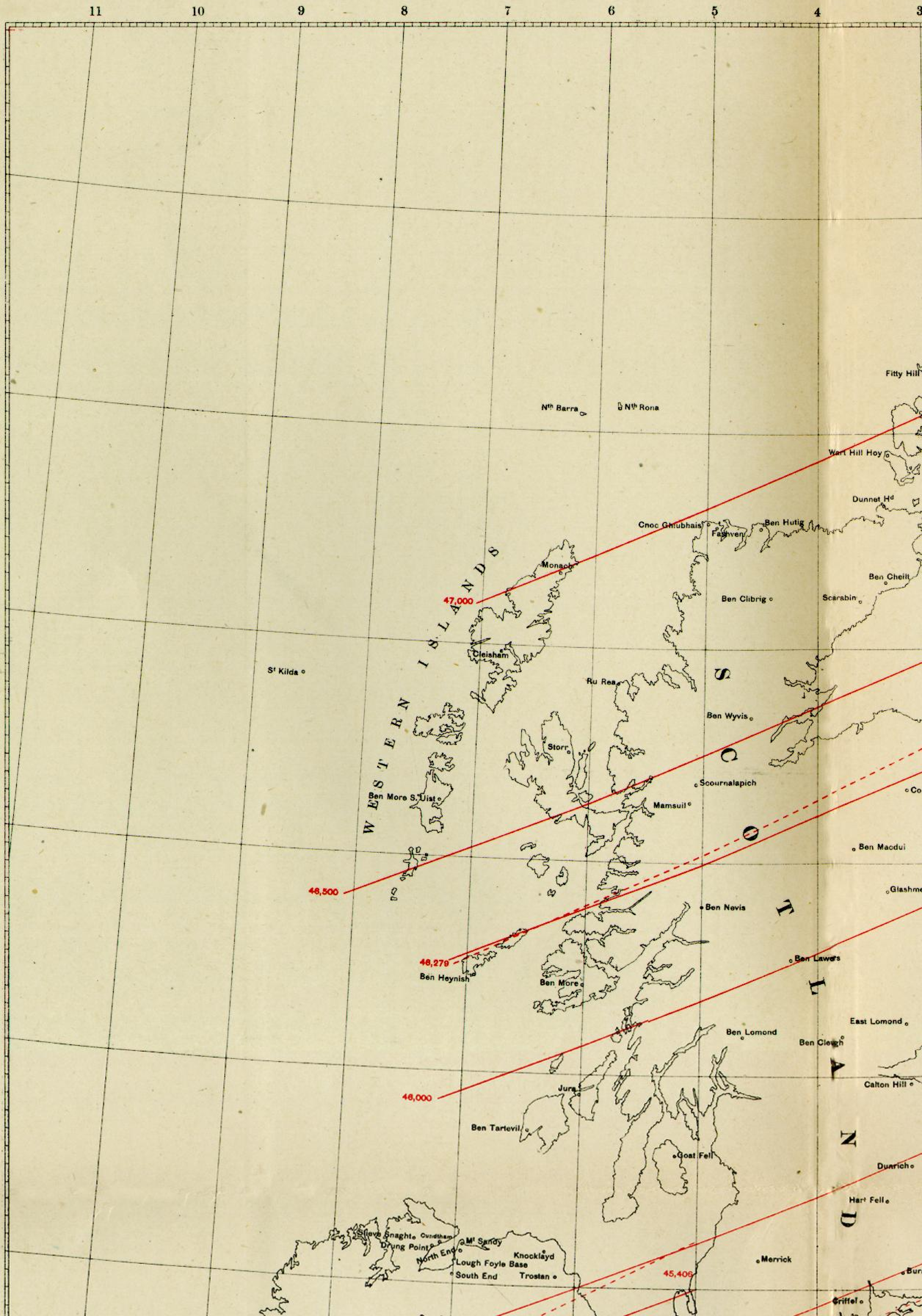

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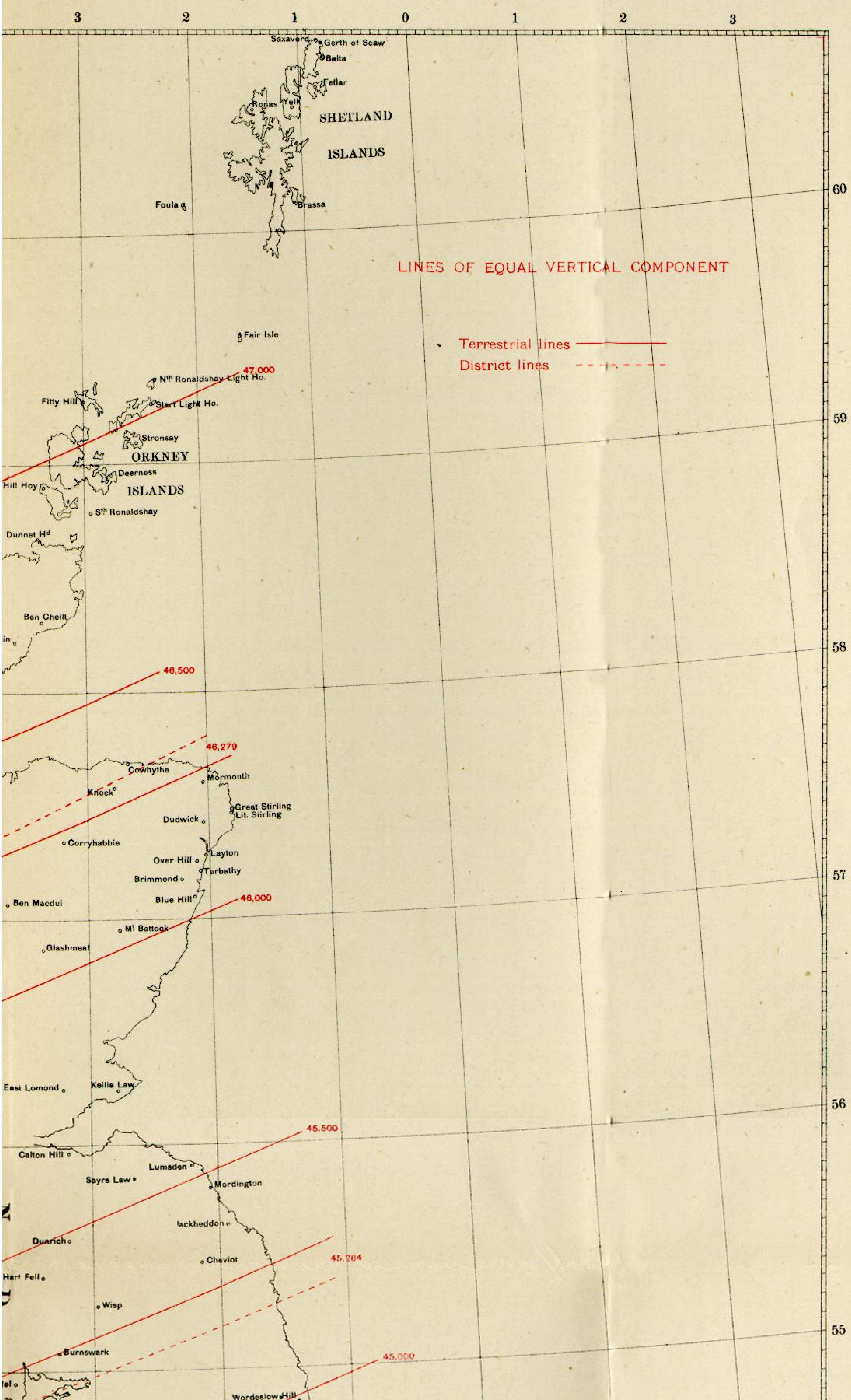

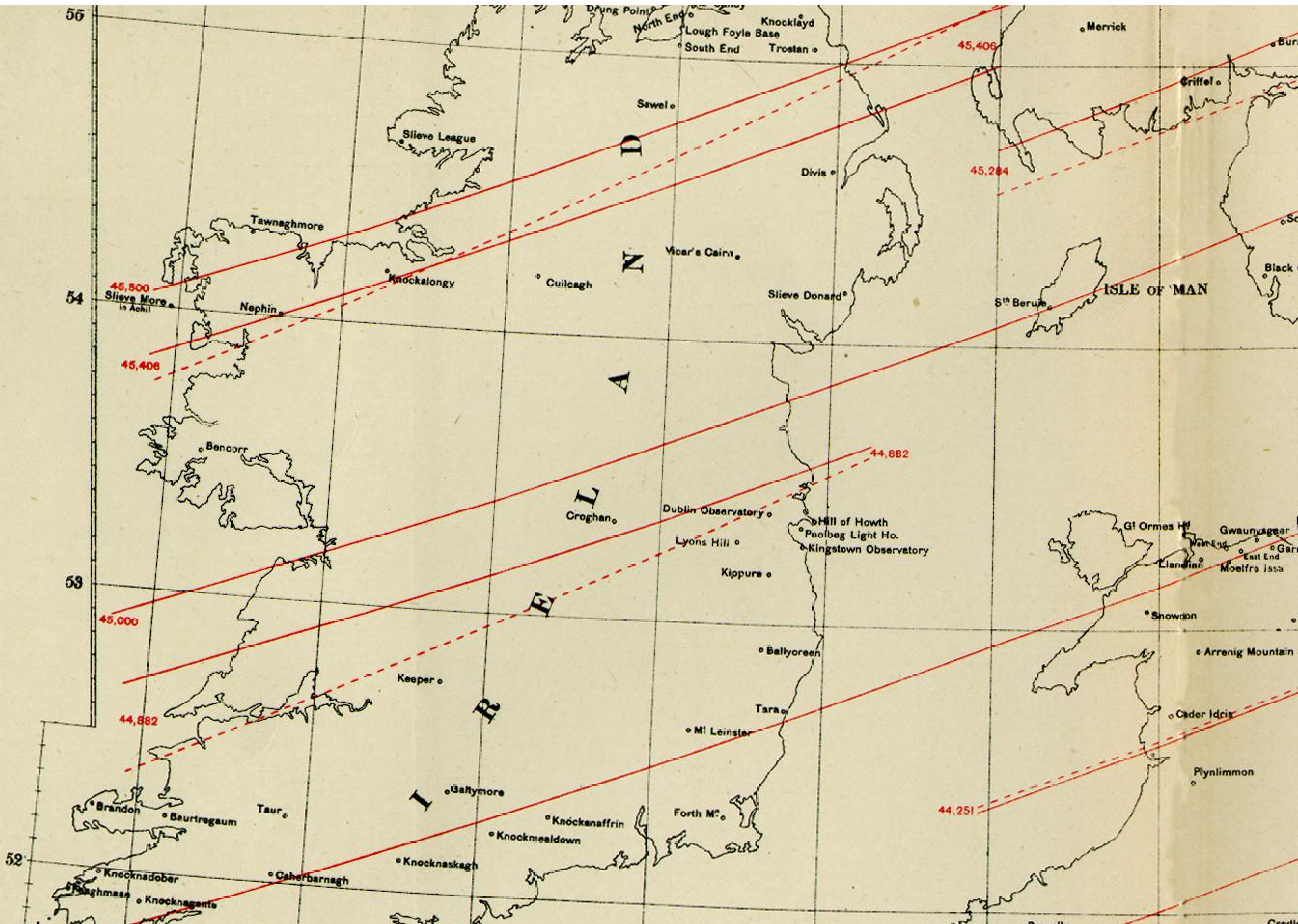

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I R E L A N D
ISLE OF MAN
SCILLY ISLANDS
45,500
45,406
45,000
44,882
44,500
45,406
45,284
44,251
44,000
43,518
43,500
Knocklayd
North End
Lough Foyle Base
South End
Trostan
Merrick
Sawel
Slieve League
Divis
Criffel
Tawnaghmore
Vicar's Cairn
Knockalongy
Cuilcagh
Slieve More in Achil
Nephin
Slieve Donard
Sth Berule
Black
Bencorr
Croghan
Dublin Observatory
Hill of Howth
Poolbeg Light Ho.
Kingstown Observatory
Lyons Hill
Kippure
Gt Ormes Hd
Gwaunysgear
Llandian
Moelfre Issa
Snowdon
Arrenig Mountain
Ballycreen
Keeper
Tara
Mt Leinster
Cader Idris
Plynlimmon
Brandon
Baurtregaum
Taur
Galtymore
Knockanaffrin
Knockmealdown
Forth Mn
Knocknaskagh
Knocknadober
Caherbarnagh
Knocknagante
Precelly
Doolieve
Hungry Hill
Carrigfadda
Lundy Isd
Paracombe
Dunkery Beacon
High Wilhays
Brown Willy
Trevose Head
Hensbarrow
Ryders Hill
St Agnes
Maker Tr
Karnminnis
Karn Galver
Karnbonellis
Deadman
Barrow Hill
Pertinny
Goonhilly
Beacon Hill Trescow
St Martins Head
Telegraph Tr
Wolf Rock
St Agnes Light Ho.
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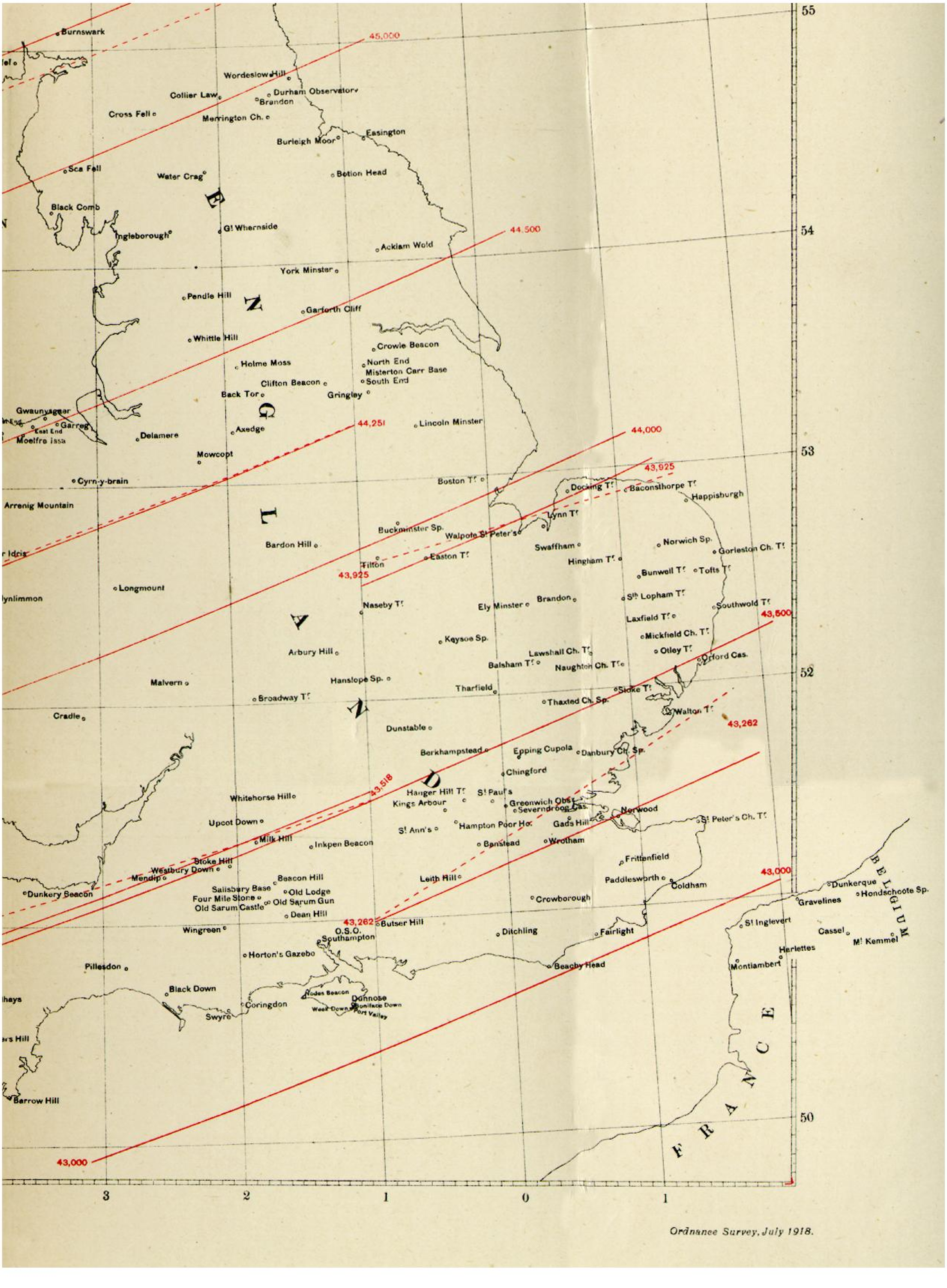

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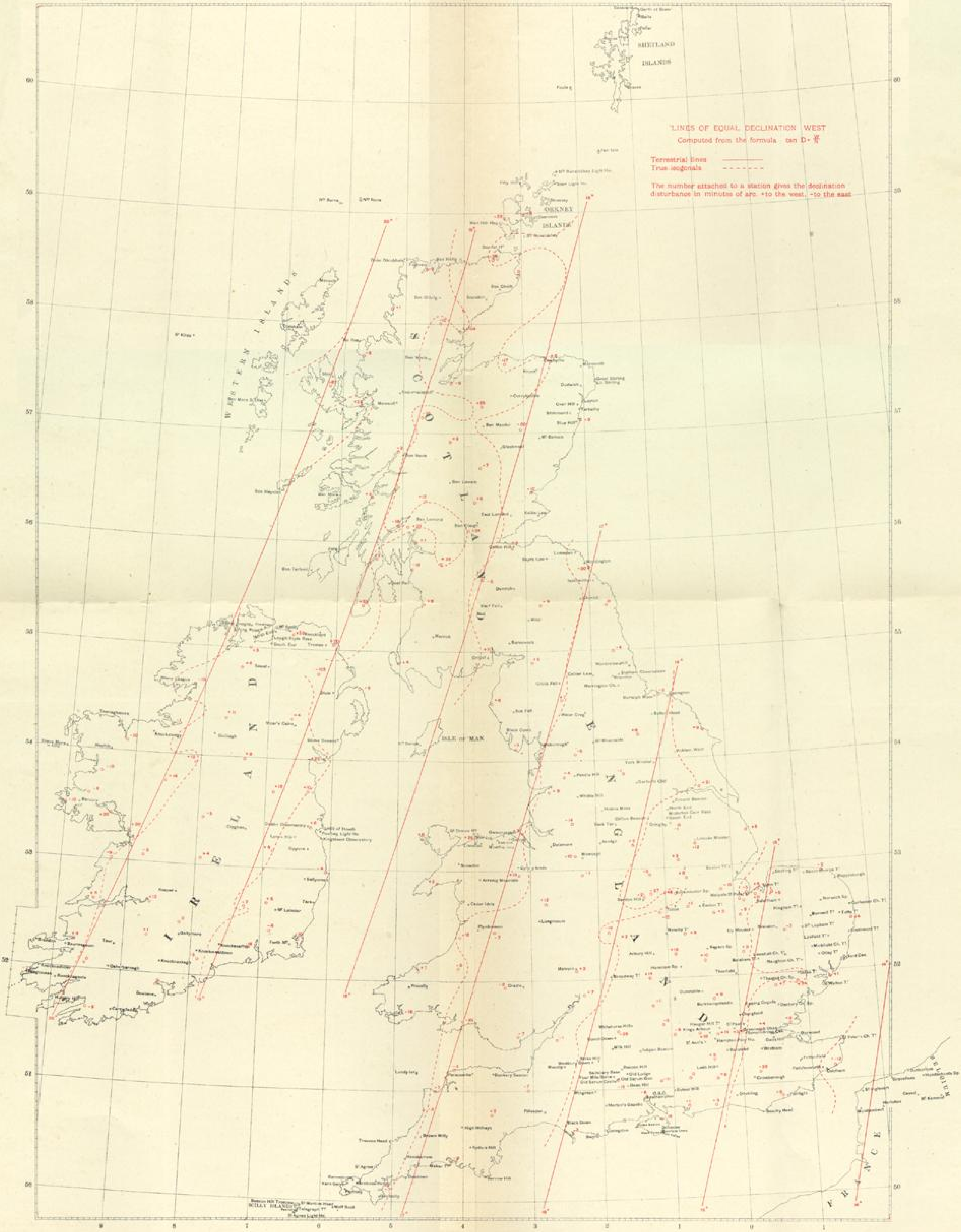

Magnetic Survey of the Briti
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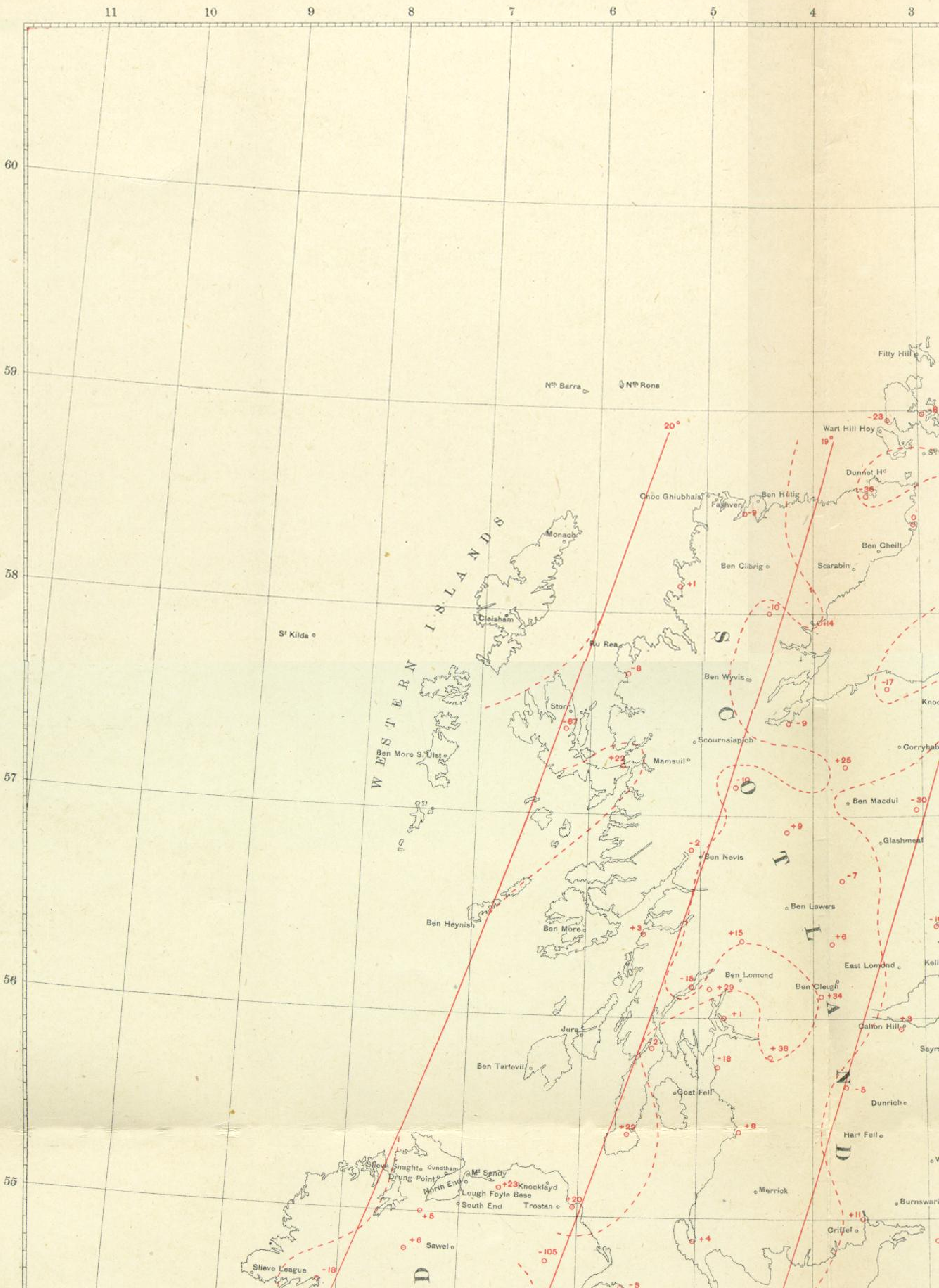
by G.W. Walker, Esq., F.R.S.



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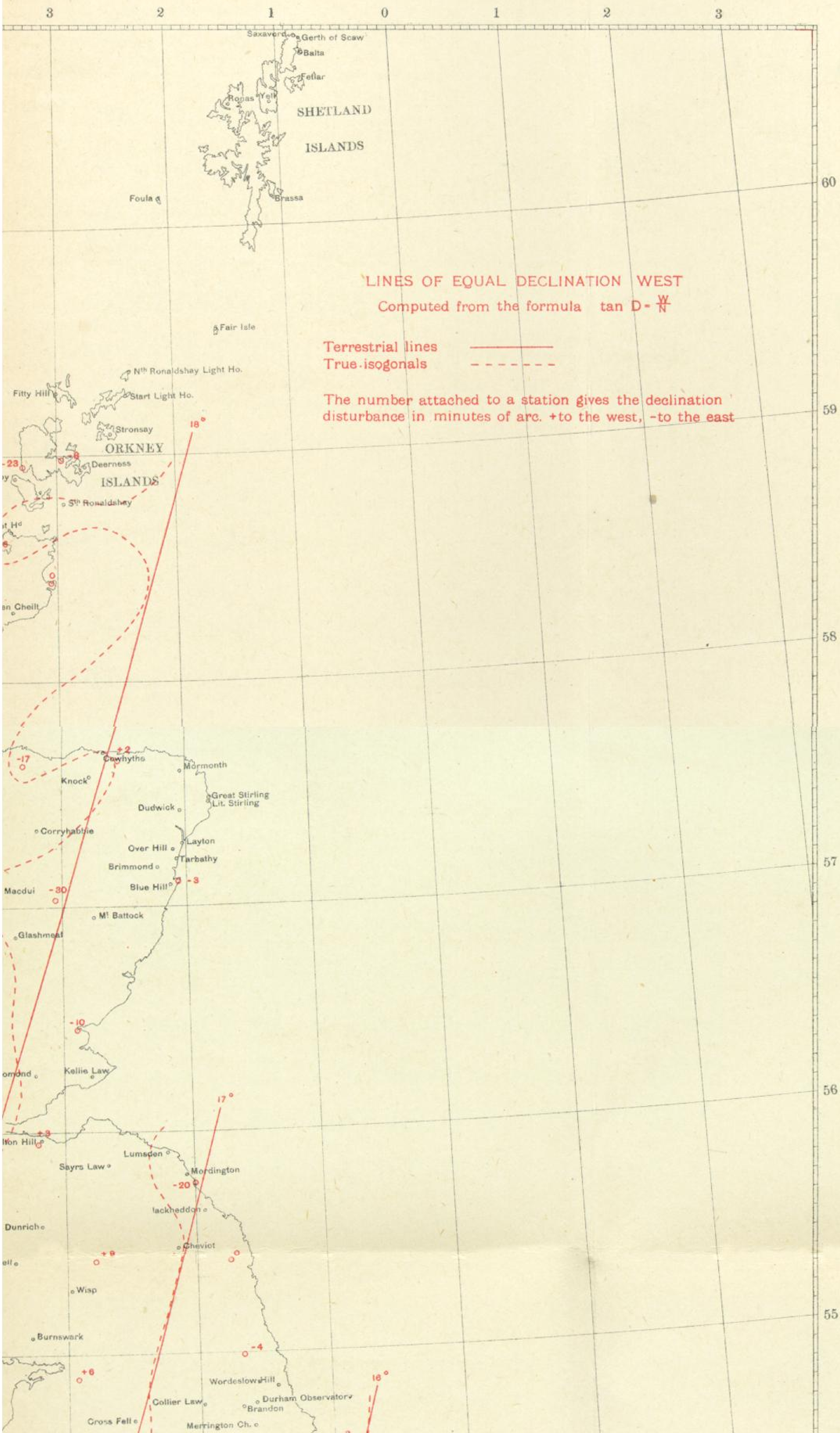

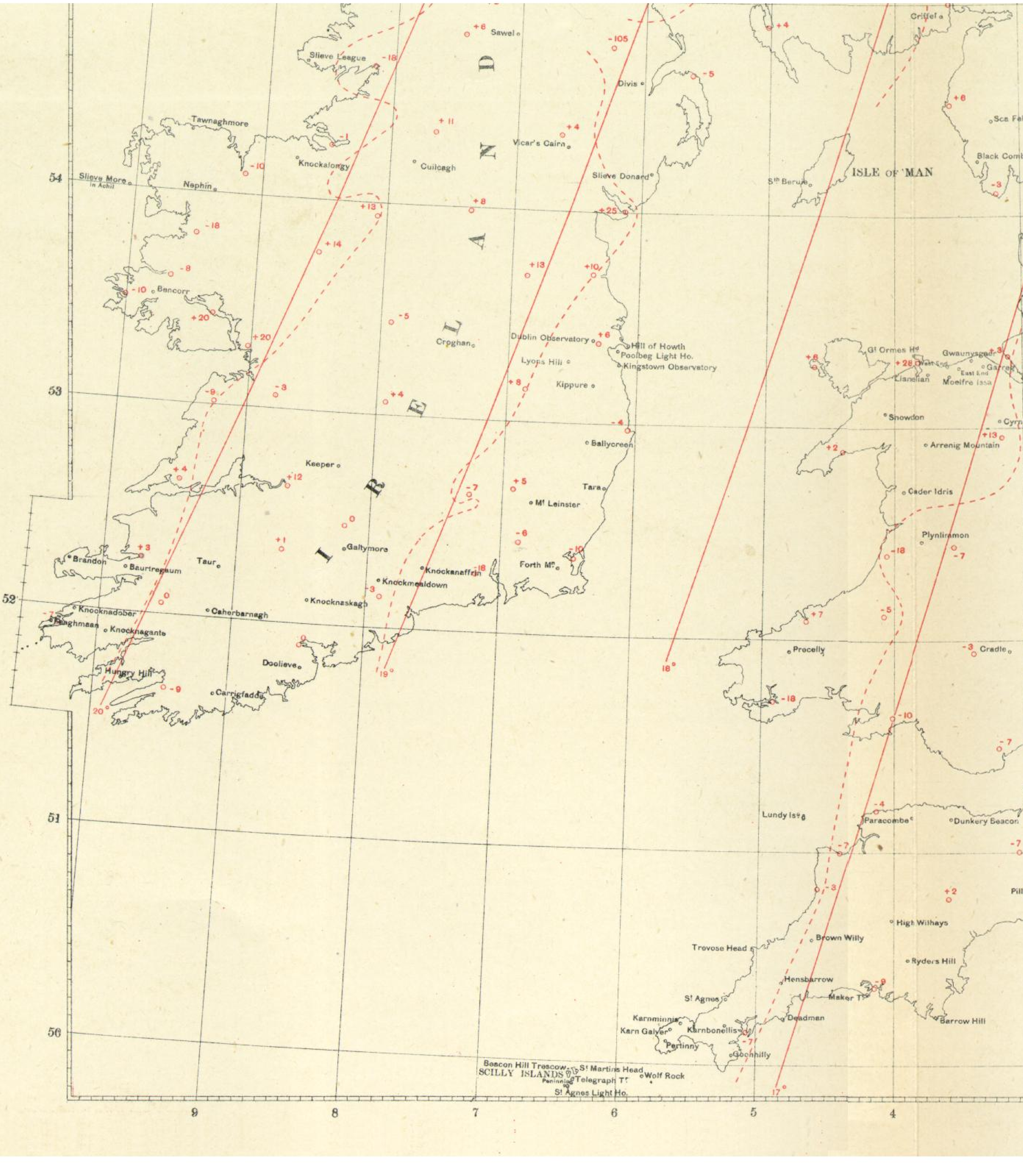

IRELAND
ISLE OF MAN
SCILLY ISLANDS
Sawel
Slieve League
Divis
Tawnaghmore
Vicar's Cairn
Knockalongy
Cuilcagh
Slieve Donard
Sth Berule
Criffel
Sca Fell
Black Comb
Slieve More
in Achil
Nephin
Bencorr
Croghan
Dublin Observatory
Hill of Howth
Poolbeg Light Ho.
Kingstown Observatory
Lyons Hill
Kippure
Gt Ormes Hd
Gwaunysgar
Llanelian
Moelfre issa
Garreg
Snowdon
Ballycreen
Arrenig Mountain
Keeper
Tara
Cader Idris
Mt Leinster
Plynlimmon
Galtymore
Brandon
Baurtregaum
Taur
Knockanaffrin
Forth Mn
Knockmealdown
Knocknaskagh
Knocknadober
Caherbarnagh
Knocknagante
Precelly
Cradle
Hungry Hill
Doolieve
Carrigfadda
Lundy Isd
Paracombe
Dunkery Beacon
High Wilhays
Brown Willy
Trevose Head
Ryders Hill
Hensbarrow
St Agnes
Maker Tr
Deadman
Barrow Hill
Karnminnis
Karn Galver
Karnbonellis
Pertinny
Goonhilly
Beacon Hill Trescow
St Martins Head
Wolf Rock
Telegraph Tr
Peninnis
St Agnes Light Ho.
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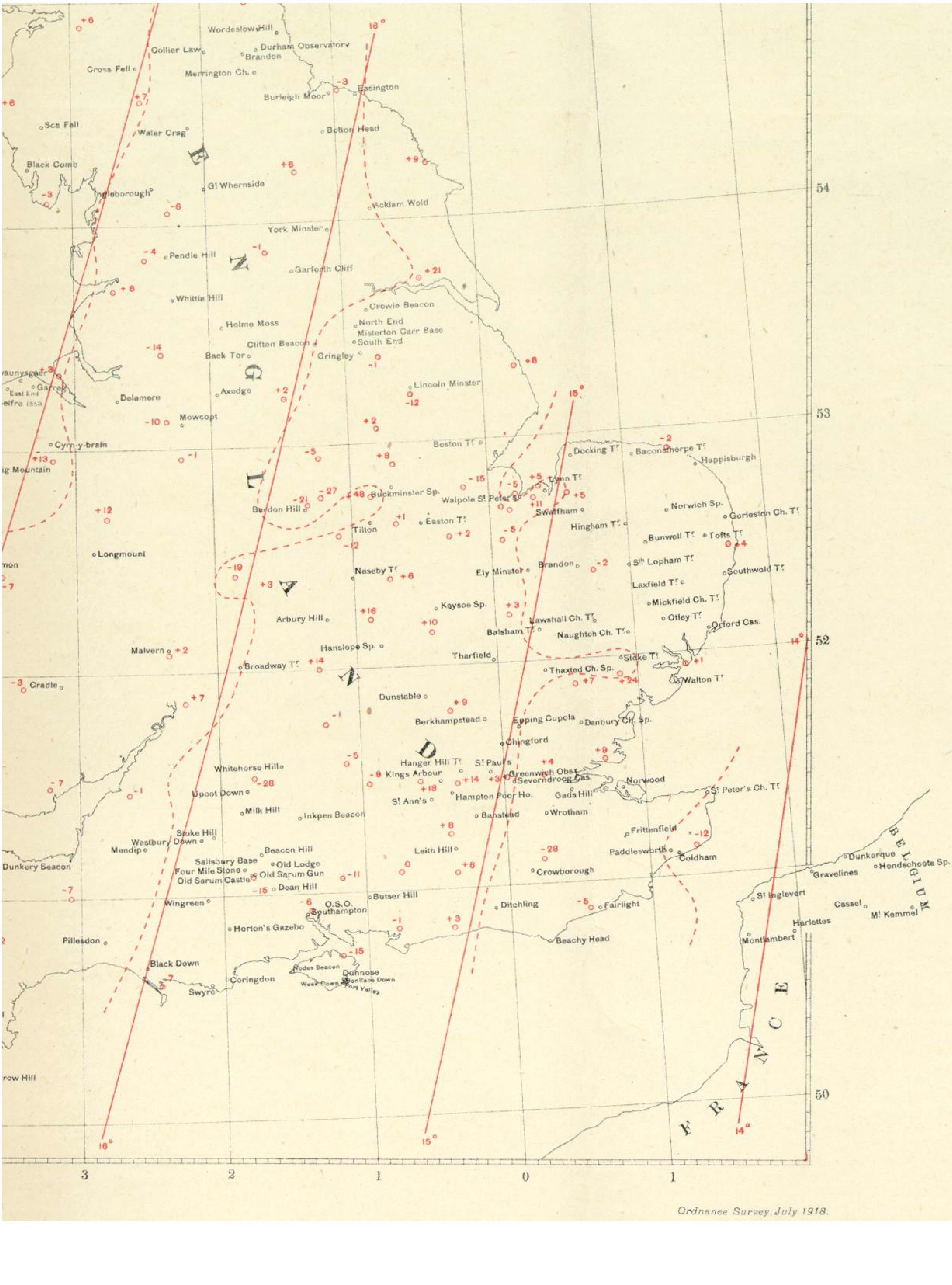

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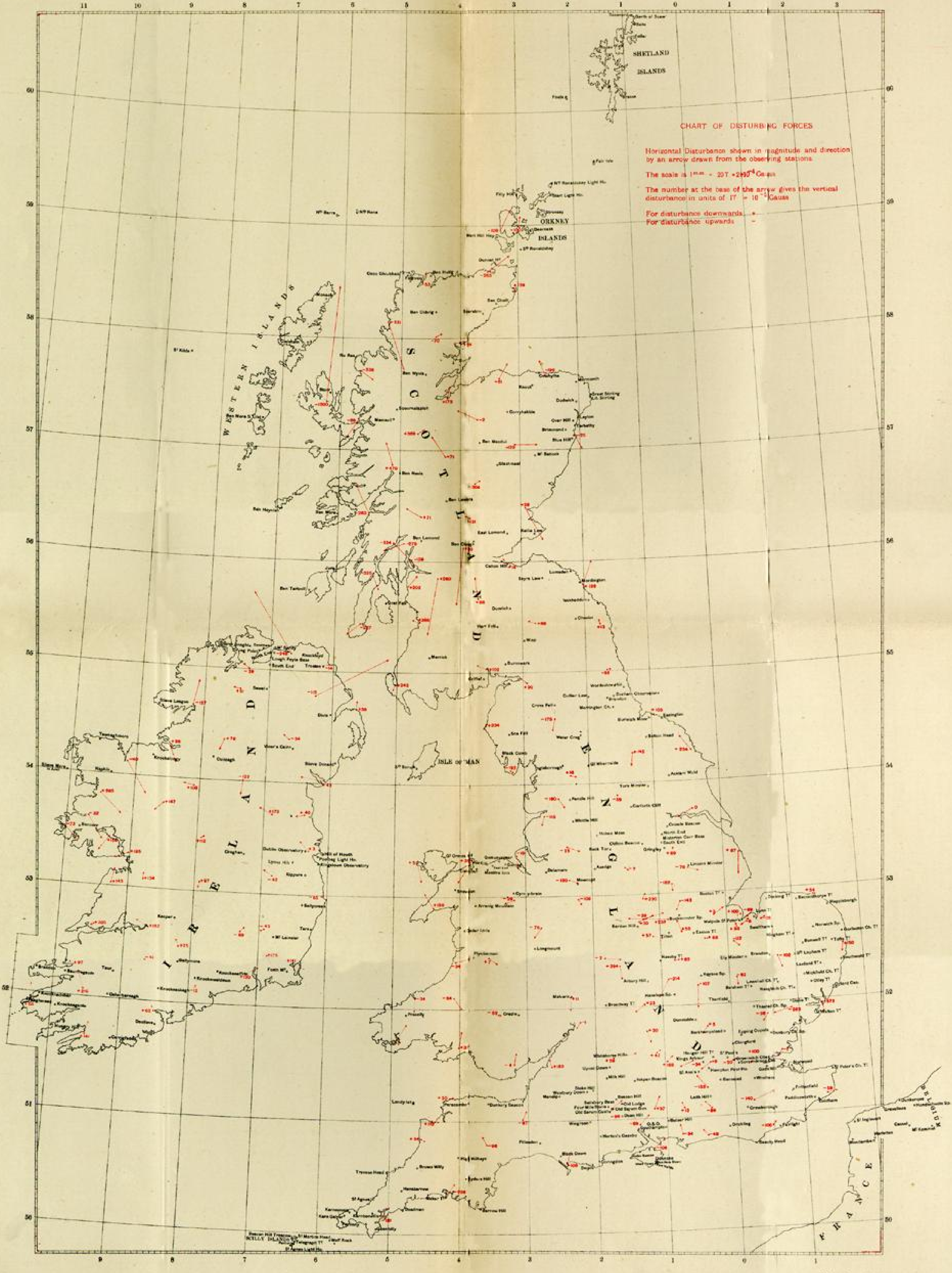

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for epoch Ist January
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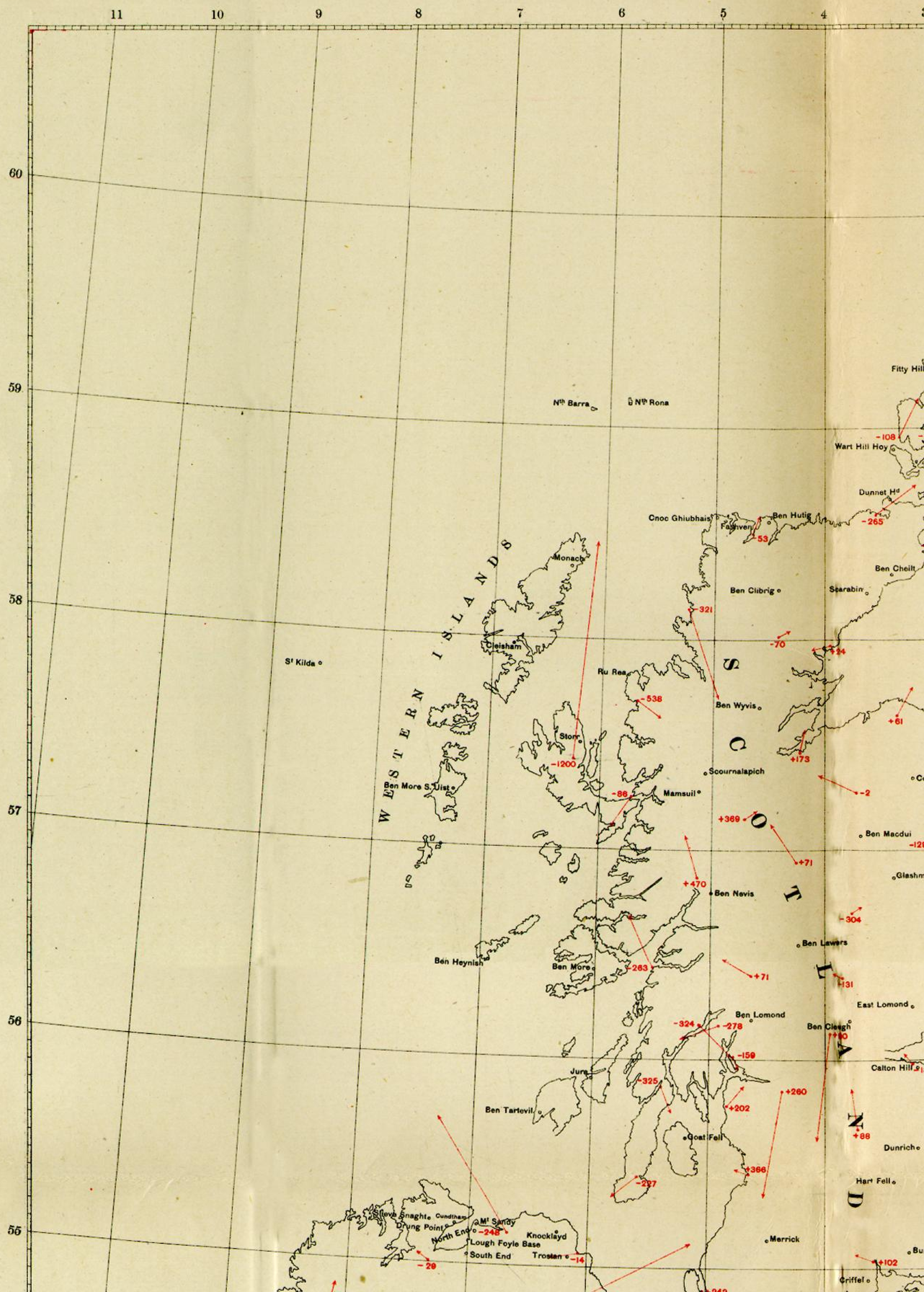

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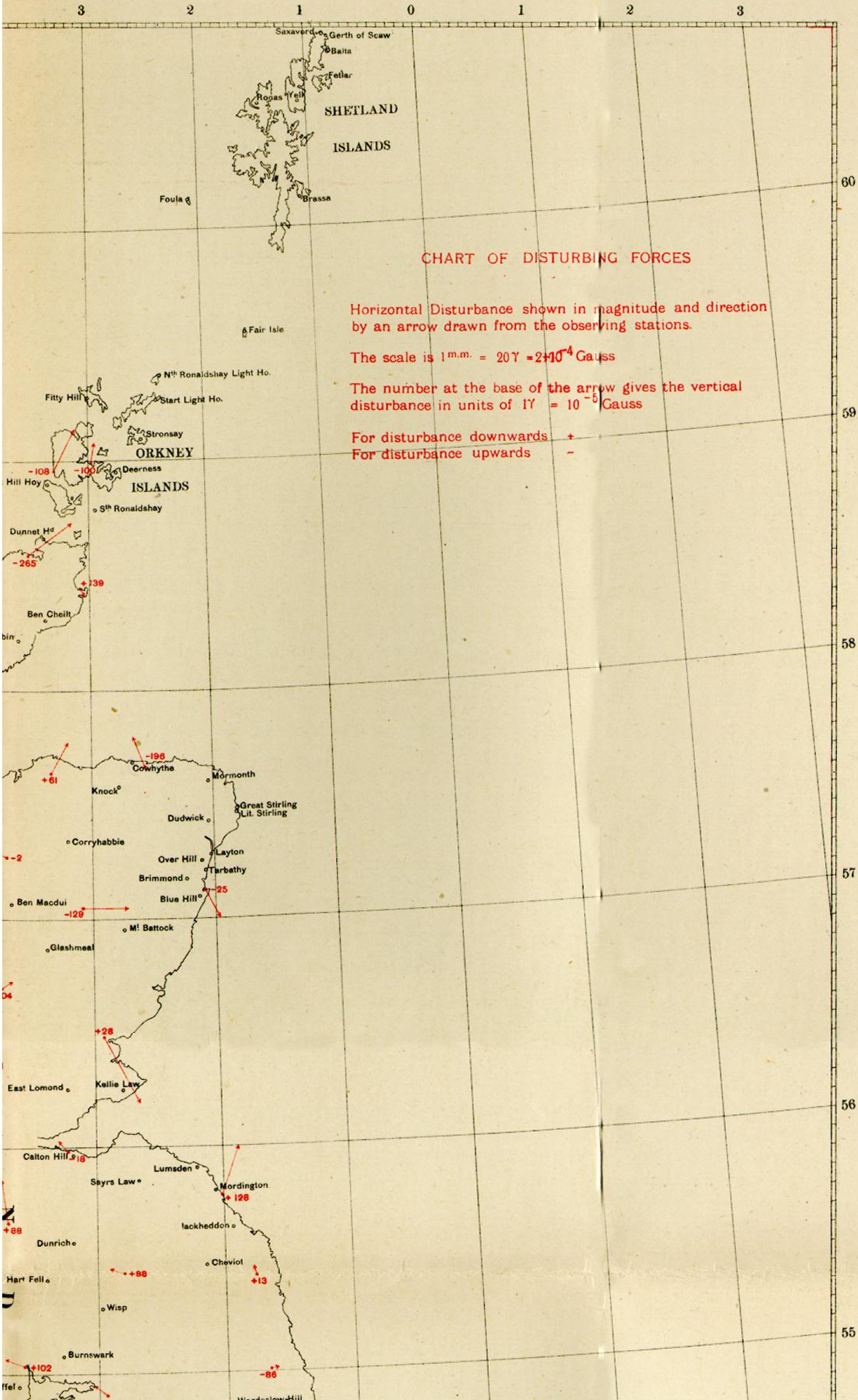

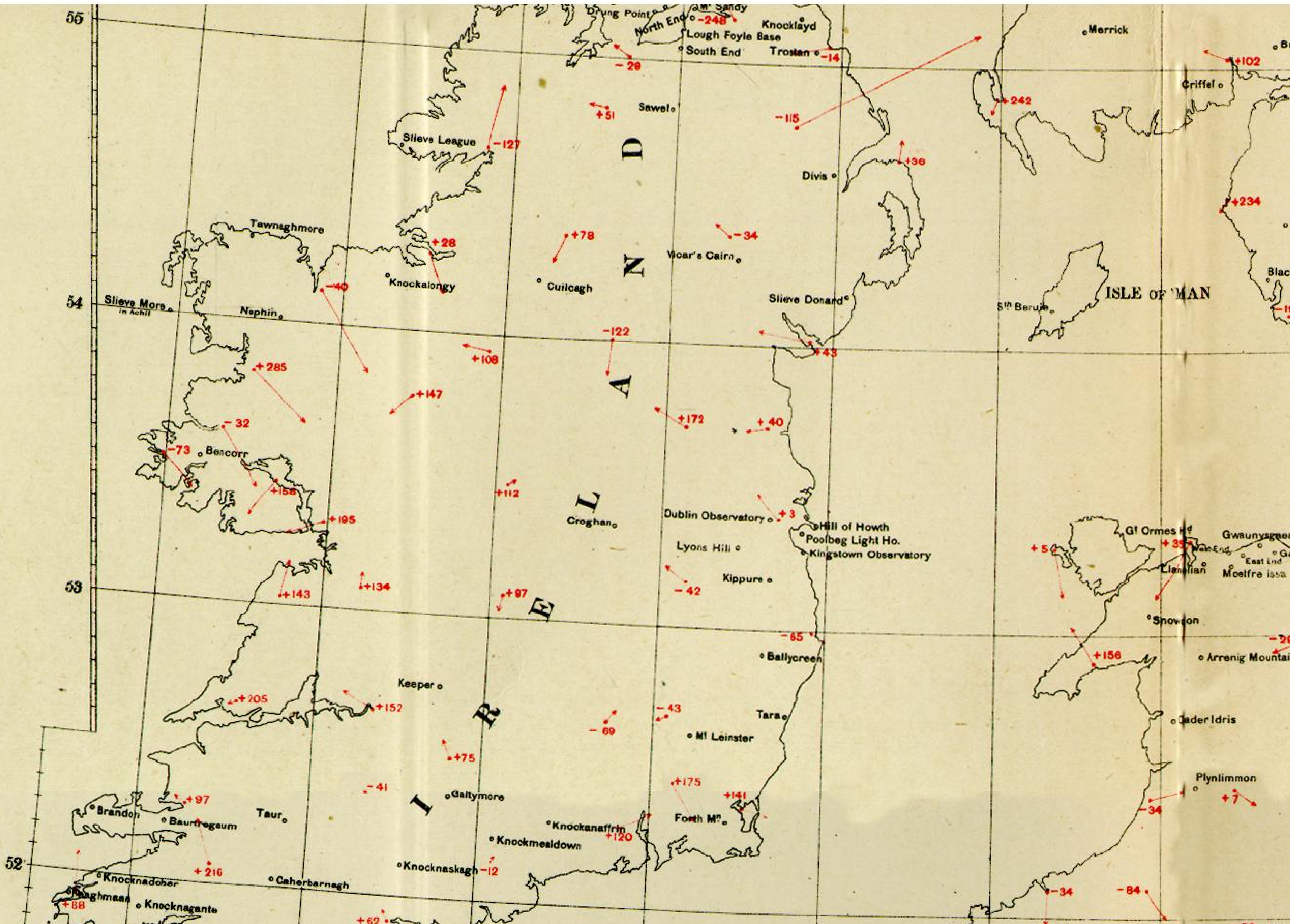
IRELAND
ISLE OF MAN
SCILLY ISLANDS
Drung Point
North End
Mt Sandy
Knocklayd
Lough Foyle Base
South End
Trostan
Merrick
Criffel
Sawel
Slieve League
Divis
Tawnaghmore
Vicar's Cairn
Cuilcagh
Knockalongy
Slieve More in Achil
Nephin
Slieve Donard
St. Berule
Bencorr
Croghan
Dublin Observatory
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Lyons Hill
Kippure
Gt Ormes Hd
Llanelian
Moelfre Issa
Snowdon
Arrenig Mountain
Ballycreen
Keeper
Tara
Mt Leinster
Cader Idris
Plynlimmon
Galtymore
Brandon
Baurtregaum
Taur
Knockanaffrin
Forth Mn
Knockmealdown
Knocknaskagh
Knocknadober
Caherbarnagh
Knocknagante
Precelly
Doolieve
Hungry Hill
Carrigfadda
Lundy Isd
Paracombe
Dunkery Be
High Wilhays
Brown Willy
Trevose Head
Hensbarrow
Maker Tr
Barrow Hill
St Agnes
Karnminnis
Karnbonellis
Deadman
Karn Galver
Goonhilly
Beacon Hill Trescow
St Martins Head
Telegraph Tr
Wolf Rock
St Agnes Light Ho.
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+234
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-34
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-122
+108
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+147
-32
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+158
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+205
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+75
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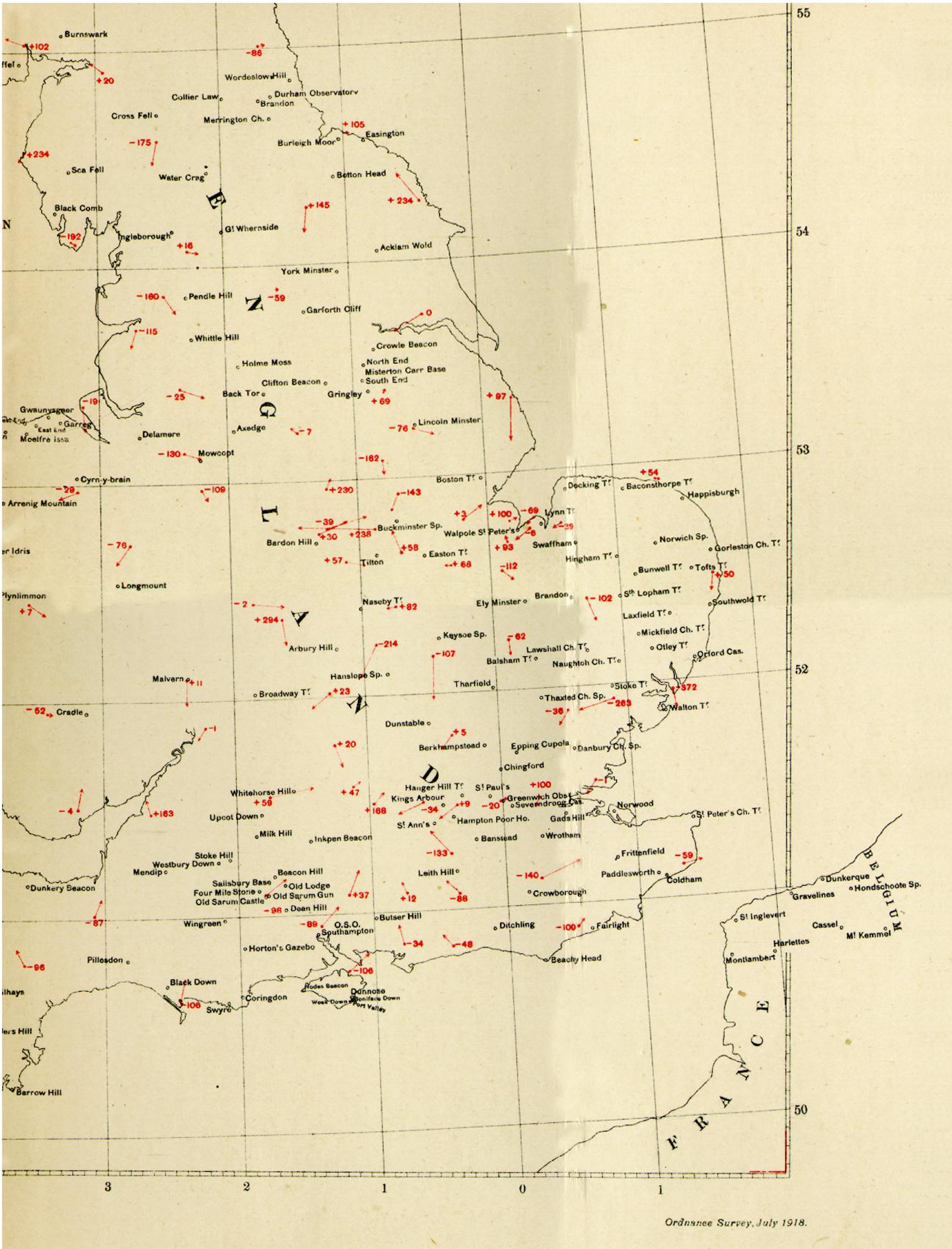

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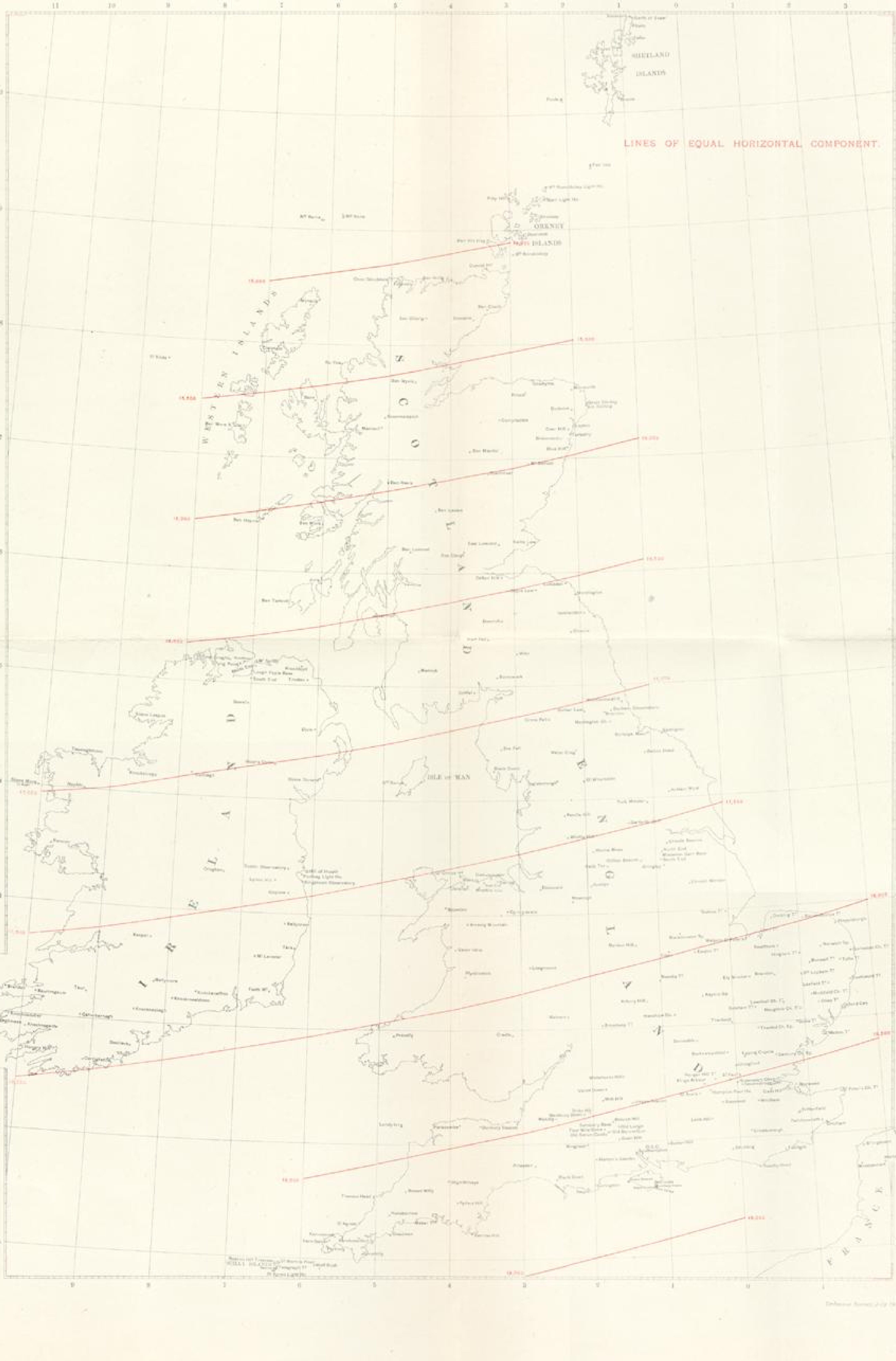

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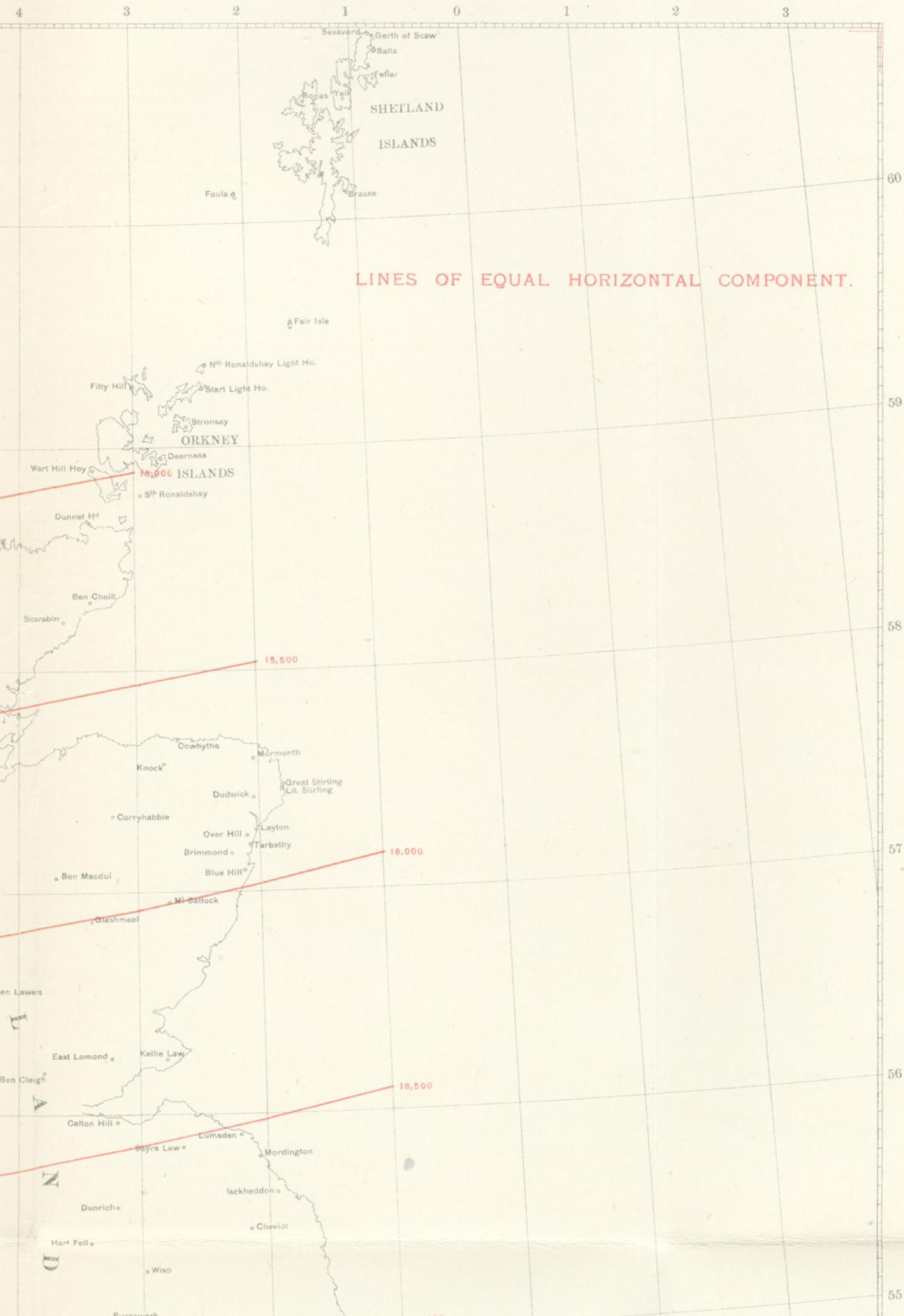

18,500
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Slieve Snaght
Drung Point
Mt Sandy
North End
Knocklayd
Lough Foyle Base
South End
Trostan
Merrick
Criffel
Sawel
Slieve League
Divis
Tawnaghmore
Vicar's Cairn
Knockalongy
Cuilcagh
Slieve More
in Achil
Nephin
54
17,000
Slieve Donard
ISLE OF MAN
Bencorr
Croghan
Dublin Observatory
Hill of Howth
Poolbeg Light Ho.
Kingstown Observatory
Lyons Hill
Kippure
53
Gt Ormes Hd
Llanelian
Snowdon
17,500
Ballycreen
Keeper
Tara
Mt Leinster
I R E L A N D
Galtymore
Brandon
Baurtregaum
Taur
Knockanaffrin
Forth Mt
Knockmealdown
52
Knocknaskagh
Knocknadober
Caherbarnagh
Knocknagante
Precelly
Hungry Hill
Doolieve
Carrigfadda
18,000
51
Lundy Isd
Paracombe
18,500
High Wilhays
Brown Willy
Trevose Head
Hensbarrow
St Agnes
Maker Tr
Karnminnis
Deadman
Karn Galver
Karnbonellis
Pertinny
Goonhilly
Beacon Hill Trescow
St Martins Head
SCILLY ISLANDS
Telegraph Tr
Wolf Rock
St Agnes Light Ho.
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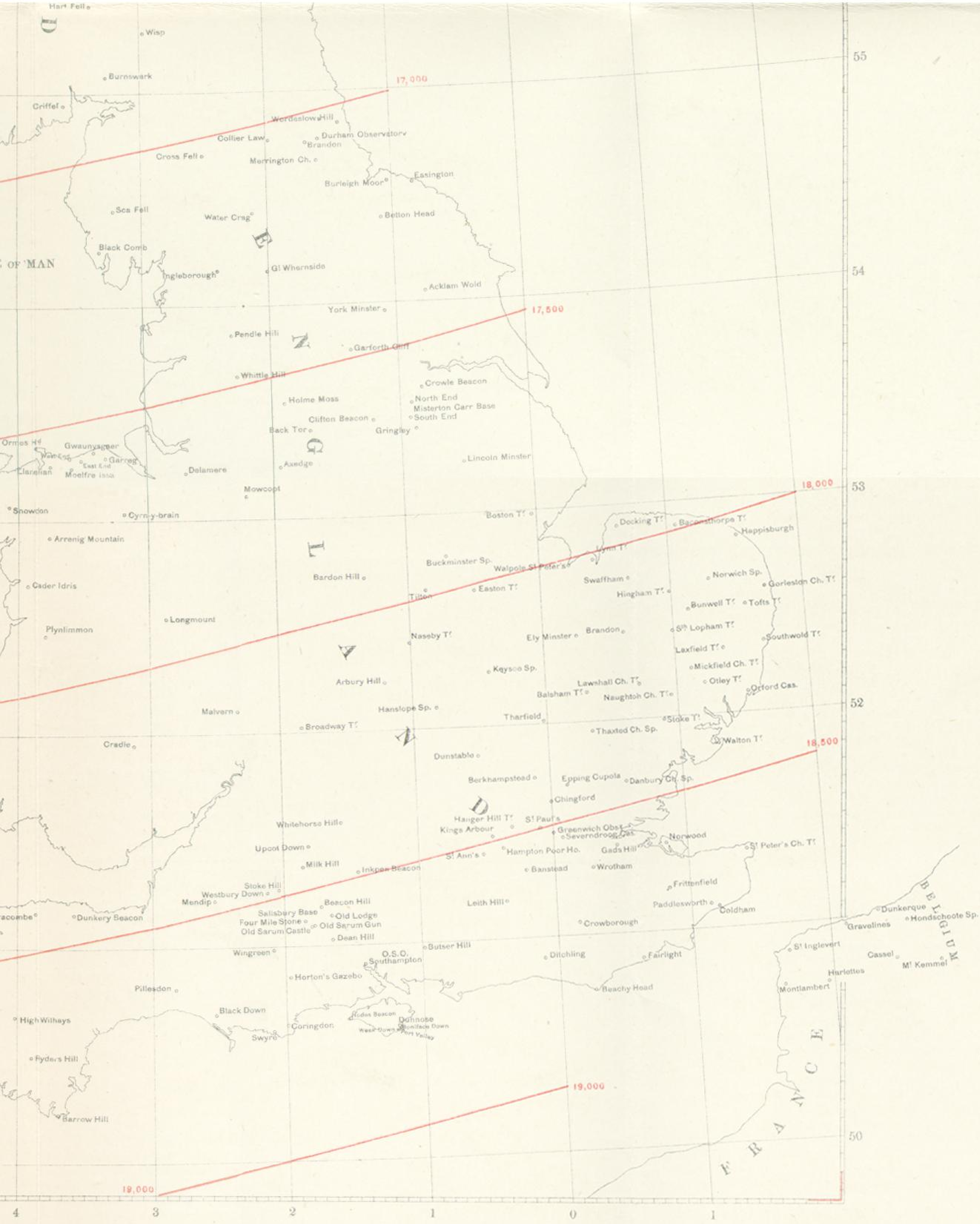

Ordnance Survey, July 1918.