EXTRACTS

FROM

NARRATIVE REPORTS

OF OFFICERS OF THE

Survey of India

FOR THE SEASON

1906-07

PREPARED UNDER THE DIRECTION OF

BT.-COLONEL S. G. BURRARD, R.E., F.R.S.,
OFFG. SURVEYOR GENERAL OF INDIA

CONTENTS

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CONTENTS

I.

THE MAGNETIC SURVEY OF INDIA.

Extracted from the Narrative Report of Captain R. H. Thomas, R.E., in charge of No. 26 Party (Magnetic) for season 1906-07.

INTRODUCTION.

The present report deals with the work of the Magnetic Survey in 1906-07. The report is divided into four main heads as follows :—

I.—FIELD OPERATIONS IN 1906-07.

1. *Work of the field detachments.*—The field season opened on October 19th, 1906, and closed early in May 1907, when the party moved to recess quarters.

Four field detachments were employed during the year under report; two were employed in Burma, one in Assam, Manipur and Lushai, and the fourth in Chota Nagpur, the Agency Tracts of Vizagapatam and the tributary states of Orissa. In addition, observations were carried out at eight stations grouped round Buxar to investigate the abnormal value of declination found in 1903-04.

The out-turn of new stations was 152: the total number of stations to date is 1,110 with 22 repeat stations.

In addition, the magnetic survey is indebted to Captain C. M. Browne, D.S.O., R.E., for observations of the magnetic declination at 25 stations on the Seistan trade route, the results of which are embodied in the table of results (p. 85). These observations were taken with a spare magnetometer supplied by this party.

2. *Work of the Imperial officers.*—Two Imperial officers were available throughout the working season.

The four observatories under the control of the Survey were inspected and comparative observations carried out at each to determine the differences from the survey standard; observations were also made at Alibag Observatory to which magnetic work has been transferred from Colaba.

Vertical force instruments were erected at Barrackpore, Kodaikanal and Toungoo observatories and satisfactory adjustments made of the temperature co-efficients. The dip circles at the four observatories, Dehra Dun, Barrackpore, Kodaikanal and Toungoo, were replaced by Schulze Earth Inductors.

The temperature co-efficient of the Toungoo H. F. magnetograph was also satisfactorily determined, the value found being —7·4γ per +1° F.

In addition, observations were carried out at 22 repeat stations.

3. *Work during recess.*—During the recess season the computation of the previous season's field work and the reduction and tabulation of the base station results for 1906 have been completed.

The field instruments were all compared with the survey standards at the beginning and end of the field season.

Further investigations have been made with regard to the correction of the field observations for diurnal variation. From the results of the four base stations, Colaba, Dehra Dun, Barrackpore and Kodaikanal, simple formulæ connecting change in diurnal variation with change in latitude had already been established for Declination and Horizontal Force by which, using the results of two base stations, the diurnal variation at any third station may be determined: in the present investigations the method was extended to the Vertical Force results, and Toungoo Observatory was included in the discussion to determine whether the formulæ would still hold good within the wider limits of longitude.

The results were quite satisfactory and the formulæ have now been established for the limits of the Magnetic Survey of India.

Preliminary investigations on the variation of disturbance from point to point were commenced: these investigations, which require results from Vertical Force magnetographs, could not be commenced earlier, as the installation was completed only in March last.

4. *Comparison of instruments with the Survey standards.*—At the beginning and end of the field season a series of comparisons was made at Dehra Dun to determine the differences from the standards.

The following table shows the results of the comparisons in 1906.

Comparison of field instruments with the standard in H. F. and Declination.

Magnetometer and Magnet.	Declination.		Horizontal Force.	
	End of field season, 1905-06.	Beginning of field season, 1906-07.	End of field season, 1905-06.	Beginning of field season, 1906-07.
17— 1 (2 A) . .	+ 0′·1	+ 0′·6	− 5γ	− 9γ
17— 3 (3 A) . .	+ 0′·1	+ 0′·3	+ 18γ	+ 5γ
17— 4 (4 A) . .	+ 0′·2	− 0′·4	− 4γ	− 10γ
17— 5 (5 A) . .	+ 0′·1	+ 0′·1	+ 21γ	+ 17γ
17— 6 (6 A) . .	+ 0′·5	+ 0′·7	− 28γ	− 19γ
17— 10 (10) .	+ 0′·1	+ 0′·5	+ 28γ	+ 17γ

Comparison of field Dip Circles with the Survey Standard Dip Circle No. 44.

Instrument.		End of field season, 1905-06.	Beginning of field season, 1906-07.
$44_{1\cdot2}$ —	$135_{2\cdot3}$	$-0'\cdot5$	$-1'\cdot2$
	$136_{2\cdot3}$	$+1'\cdot0$	$+0'\cdot9$
	$138_{2\cdot3}$	$+2'\cdot2$	$+0'\cdot9$
	$139_{4c\,4d}$	$+0'\cdot1$	$+0'\cdot1$
	$140_{1\cdot3}$	$+1'\cdot4$	$-0'\cdot5$
	$170_{1\cdot2}$	$+1'\cdot4$	$+0'\cdot5$

5. *Comparison of Earth Inductors.*—As the earth inductors ordered for Barrackpore, Kodaikanal and Toungoo arrived about the same time, advantage was taken of the opportunity to compare them with one another before installing them in the various observatories. The comparisons were carried out by simultaneous observations, exchanging sites between each set. The results were as follows:—

$$I_{30} - I_{44} = -0'\cdot2$$
$$I_{45} = -0'\cdot2$$
$$I_{46} = -0'\cdot1$$

The four inductors are thus in excellent agreement.

The following table shows the detailed comparison of one pair of inductors: the accordance between the different results shows that these instruments are capable of far greater accuracy than the dip circle, while it is to be borne in mind that even better results might have been obtained with observers accustomed to the use of the inductor.

Comparison of Inductors Nos. 30 and 45.

No. 30 in S H or $\frac{SH}{30}$	No. 45 in N H or $\frac{NH}{45}$	X_1 or $\frac{SH}{30} - \frac{NH}{45}$	No. 45 in S H or $\frac{SH}{45}$	No. 30 in N H or $\frac{NH}{30}$	X_2 or $\frac{SH}{45} - \frac{NH}{30}$
43°: 31'·8	43°: 33'·3	$-1'\cdot5$	43°: 32'·7	43°: 33'·6	$-0'\cdot9$
31·8	33·3	$-1'\cdot5$	32·7	33·7	$-1\cdot0$
31·7	33·3	$-1'\cdot6$	32·6	33·7	$-1\cdot1$
32·1	33·6	$-1'\cdot5$	32·5	33·7	$-1\cdot2$
	Mean X_1=	$-1'\cdot5$		Mean X_2=	$-1'\cdot1$

$$\text{Hence } 30 - 45 = \tfrac{1}{2}(X_1 - X_2) = -0'\cdot2$$
$$SH - NH = \tfrac{1}{2}(X_1 + X_2) = -1'\cdot3$$

6. *Values of the distribution co-efficient P for the field instruments.*—In the report for 1905-06 the question was raised as to the uncertainty of the values of P from 30 and 40 cms ($P_{2\cdot3}$) under the existing arrangement of the deflection distances in the determination of $\frac{m}{H}$, and certain modifications were introduced to ensure a value of $P_{2\cdot3}$ with greater weight than that hitherto obtained.

The following tables show the values of $P_{1\cdot2}$, $P_{2\cdot3}$ thus obtained for the field magnets during the field season; the "near" and "far" values are those when the observations at 22·5 and 40 cms., respectively, are grouped in the centre, and at the beginning and end of the observation, the "near" value thus having greatest weight; formerly only "near" values of $P_{1\cdot2}$ and "far" values of $P_{2\cdot3}$ were determined.

It will be seen that, as was to be expected, there is little, if any, difference between the "near" and "far" values of $P_{1\cdot2}$ while in $P_{2\cdot3}$ the discrepancies are considerable.

TABLE A.

Number of magnet.	P from 22·5 and 30 cms. Near Value.					P from 22·5 and 30 cms. Far Value.					Remarks.
	Mean from all observations.	Adopted mean value.	Total number of observations.	Number of rejected observations.	Number of observations used in finding mean.	Mean from all observations.	Adopted mean value.	Total number of observations.	Number of rejected observations.	Number of observations used in finding mean.	
2 A	7·28	7·32	86	19	67	7·30	7·31	155	22	133	
3 A	6·14	6·13	48	4	44	6·13	6·16	49	7	42	
4 A	7·60	7·60	49	2	47	7·61	7·61	53	0	53	
5 A	7·29	7·30	62	1	61	7·32	7·33	65	1	64	
6 A	7·89	7·90	50	1	49	7·89	7·89	48	0	48	
10	5·78	5·77	39	5	34	5·82	5·81	70	15	55	

TABLE A_1.

Number of magnet.	P from 30 and 40 cms. Near Value.					P from 30 and 40 cms. Far Value.					Remarks.
	Mean from all observations.	Adopted mean value.	Total number of observations.	Number of rejected observations.	Number of observations used in finding mean.	Mean from all observations.	Adopted mean value.	Total number of observations.	Number of rejected observations.	Number of observations used in finding mean.	
2 A	9·39	9·41	155	49	106	9·21	9·22	88	29	59	
3 A	7·31	7·32	52	5	47	7·11	6·97	45	8	37	
4 A	8·53	8·53	55	6	49	8·50	8·45	56	6	50	
5 A	8·13	8·12	68	8	60	8·18	8·18	65	6	59	
6 A	8·06	8·06	52	5	47	7·99	7·98	49	6	43	
10	7·50	7·52	69	16	53	7·45	7·40	39	10	29	

The following table shows the p and q terms obtained under the new and old methods :—

Magnet.	New method.				Old method.			
	$P_{1.2}$	$P_{2.3}$	p	q	$P_{1.2}$	$P_{2.3}$	p	q
2 A	7·32	9·41	12·08	−1547	7·32	9·22	11·66	−1406
3 A	6·13	7·32	8·84	− 881	6·30	6·97	8·05	− 622
4 A	7·60	8·53	9·72	− 688	7·60	8·45	9·54	− 629
5 A	7·30	8·12	9·17	− 607	7·30	8·18	9·31	− 651
6 A	7·90	8·06	8·26	− 118	7·90	7·98	8·08	− 59
10	5·77	7·52	9·79	−1295	5·77	7·40	9·49	−1206

The change in H at Dehra Dun taking the q term into account would be respectively :—

Magnet.	New method. I.	Old method. II.	Difference. I—II.
2 A	+ 57 γ	+ 52 γ	+ 5 γ
3 A	+ 32 "	+ 23 "	+ 9 "
4 A	+ 25 "	+ 23 "	+ 2 "
5 A	+ 22 "	+ 25 "	− 3 "
6 A	+ 4 "	+ 2 "	+ 2 "
10	+ 49 "	+ 45 "	+ 4 "

These differences are certainly less than had been anticipated: there is no doubt, however, that the values of $P_{2.3}$ as now obtained are far more reliable, and in view of the possibility that the q term may have to be taken into account in the final reduction of the observations, the additional observations of deflection necessary to obtain the better values will be continued.

These values in conjunction with the recent determinations of log π^2 K will also be essential should time be available to investigate the causes of the instrumental differences.

As far as $P_{1.2}$ is concerned, the observations at 22·5 cms in the more unfavourable arrangement of the deflection distances are practically as good as those with the observations at 22·5 grouped in the centre of the experiment, and as the value at 22·5 cms is alone used to evaluate $\frac{m}{H}$, two additional values of m_0 and H are obtained by combining this result with the two vibrations at the cost of only a few minutes' extra work.

7. *Programme for 1907-08.*—During the ensuing field season, the last allotted to the fundamental survey, four field detachments will be employed, of which three will work in Burma, while the fourth will complete such work as remains in India proper.

The estimated out-turn is about 120 new stations which will give a grand total of 1,230 stations with 22 repeat stations.

The extension of the survey into the Himalayas and Kashmir, which is most desirable, must be postponed to the detail survey.

The two R. E. officers will be employed in the inspection and comparisons of instruments at observatories, observations at repeat stations and the inspection of field detachments when practicable. If time permits observations will also be made at a number of old field stations. The officer in charge will in addition instal new and improved pattern vertical force magnets at Barrackpore and Kodaikanal.

8. *Results included in this report.*—A table showing the approximate preliminary values (uncorrected) at the field and repeat stations in 1906-07 is appended (see Tables, p. 81-86), together with an index chart showing the position of all stations of observation to date.

The tabulations of the results obtained at Dehra Dun, Kodaikanal, Barrackpore and Toungoo observatories are published for 1906.

II.—THE PRESENT POSITION OF THE QUESTION OF THE PRELIMINARY SURVEY AND ITS BEARING ON THE DETAILED SURVEY.

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8. Approximate corrections for disturbance and how they may be applied for a preliminary reduction.
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1. *Introduction.*—The full scheme of the Indian Magnetic Survey provides for a preliminary survey and a detailed survey, of which the detail survey is to be based on, and a development of the preliminary survey, and entails the thorough investigation of such local peculiarities as are revealed by the preliminary survey. The reduction of the preliminary survey should then precede the commencement of the detail survey and it is desirable therefore to consider what is implied by the reduction and to place on record the obstacles which have prevented this reduction *pari passu* with the progress of the preliminary survey.

In most magnetic surveys it has for various reasons been usual for the detailed survey to be separated from the preliminary survey by an interval of time, the duration of which has varied according to the opportunities and facilities afforded for the development of the survey.

This interval has afforded a convenient opportunity for a more or less leisurely reduction of the preliminary work, reductions which, by reason of the comparative smallness of the areas surveyed, have not involved the consideration of the questions with which we are confronted in India, and hence those responsible for the succeeding work have generally been in a position to determine beforehand with more or less precision their probable spheres of operation.

In India, however, the detailed survey of disturbed localities is to follow the preliminary survey without any such interval and it becomes a matter of importance therefore to review the position in which we stand with regard to the question of the reduction of the field observations, to investigate the labour involved in the precise reduction and to outline the procedure which might be adopted for a preliminary reduction which would be sufficiently accurate for the selection of spheres of operation until such time as the results of the precise reduction were available.

2. *Corrections required.*—The corrections involved in the reduction will now be considered.

In the words of Bauer "The quantities experimentally determined in a magnetic survey are incessantly undergoing changes, some periodic, others non-periodic: a magnetic survey then must be made to refer to some particular moment of time and such means must be taken as will enable all the measurements to be reduced not only to the selected epoch of the survey but also to some other epoch in the near past or future."

Every field observation then requires the following corrections:—

(*a*) Correction for diurnal variation.
(*b*) Correction for instrumental difference from the standards of the survey.
(*c*) Correction for secular change to the selected epoch of the survey.
(*d*) Correction for annual variation, *i.e.*, correction to the mean of the year.
(*e*) Correction for perturbation.

These will now be separately considered.

3. *Correction for diurnal variation.*—In the English survey the field observations were corrected from the Kew curves only, the diurnal variation being assumed sensibly uniform for the whole of the area involved; in India the problem was complicated by the vastness of the area and the fact that the hourly variations at the several observatories differed considerably.

The problem to be considered was to find what relation existed between the magnitudes of the diurnal variations at different observatories, and hence to deduce a convenient and simple formula, empirical or theoretical, by which the diurnal variation at the field stations could be easily calculated. It may be here stated that the investigation of this question was seriously delayed for lack of the necessary data; it was originally intended that the base stations should all be working before the commencement of the survey, but, owing to unforeseen delays, this ideal was not attained: the last observatory at Toungoo was not working until December 1904 or three years after the commencement of the survey, and consequently a year's results from Toungoo were not available before October 1906. Even then only results of Declination and Horizontal Force had been obtained and it was not until March of the present year that V. F. magnetographs had been erected at all the observatories, results from which have only recently become available.

The advice of Sir A. Rücker, F.R.S., had been solicited early in the history of the survey as to the best method to be pursued in this investigation and, in 1905, working on lines suggested by him, Mr. J. Eccles, M.A., using the Declination and H. F. results of Colaba, Dehra Dun, Barrackpore and Kodaikanal, was able to establish a simple relation connecting change in diurnal variation with change in latitude ; the results were submitted to Sir Arther Rücker and pronounced quite satisfactory. The problem could not however be attacked in its entirety till the present year, when the discussion could be extended to the Declination and H. F. results from Toungoo Observatory, to determine whether the formulæ still held good for the wider limits of longitude, and the diurnal variations of Vertical Force at the different observatories examined. The results of these further investigations have proved satisfactory, and the correction of the field observations for diurnal variation may now be proceeded with : the correction for H. F. and Declination observations will be computed by the formulæ given on page 18, the correction to be applied to the Dip observations is dealt with in para. 3, page 18. During these investigations, however, and the preliminary enquiries into the correction for perturbation initiated during the present recess season, certain points have come to light which render it probable that improved methods of computation and measurement will eliminate such piscrepancies as have been observed and thus a certain amount of opening up of old records will probably be necessary. This refers mainly to the Horizontal Force observations; the recomputation is expected to afford better values of the base line than at present obtained, a point of considerable importance in the investigation of the variation of disturbance from point to point.

Method employed in the investigation of diurnal variation.

The method employed in the investigation into the diurnal variation is given below :—The disturbing potential is supposed to travel round the earth and, to a first approximation at all events, the disturbing forces would be the same at the same local time at all places on the same latitude. This supposes the origin of the disturbing force to be outside the earth and at a considerable distance.

The following is the notation used :—

Magnetic elements . . . $H \quad \delta \quad \theta$

I. *Components of magnetic force*—

Horizontal in magnetic meridian $= H$

Horizontal perpendicular to magnetic meridian $= O$

Vertical (taken + upwards) $= V = H \tan \theta$

II. *Geographical components*—

Horizontal in the direction of Geographical North $= N = H \cos \delta$

Horizontal in the direction of Geographical East $= E = H \sin \delta$

Vertical $= V = V$

Disturbances of the magnetic elements produced by diurnal variation (or a magnetic storm).

dH, $d\delta$, $d\theta$ (which is deduced from dV and dH)

The components of disturbing force in the magnetic directions as in I are dH, $Hd\delta$, dV.

III. Components of the disturbing force in the geographical directions as in II are—

$$n = dN = dH \cos \delta - H \sin \delta \, d \delta$$
$$e = dE = dH \sin \delta + H \cos \delta \, d \delta$$
$$v = dV = dV$$

In 1904-05 Mr. J. Eccles, M.A., using the mean monthly values and hourly variations derived from the computations of five quiet days, for such months as were available, computed "n" and "e" for each hour of local time for the various observatories and, using the results from one pair of observatories, computed the "n" and "e" of a third, assuming a constant rate of change with latitude.

The results were quite satisfactory. The example below gives the method of computation.

If A and B be two observatories from which the diurnal variation at C is to be computed, then the difference of "n" and "e" at A and B or B—A must be multiplied by the factor $\frac{\text{latitude A} - \text{latitude C}}{\text{latitude A} - \text{latitude B}}$ and the result added to A (A being the more northerly observatory): or if ${}^{n}_{A\,X}$, ${}^{n}_{B\,X}$, ${}^{n}_{C\,X}$ be the values of n at any hour X and the latitude factor above be denoted by K.

$$ {}^{n}_{C\,X} = {}^{n}_{A\,X} + K\left({}^{n}_{B\,X} - {}^{n}_{A\,X}\right) \text{ and similarly}$$

$$ {}^{e}_{C\,X} = {}^{e}_{A\,X} + K\left({}^{e}_{B\,X} - {}^{e}_{A\,X}\right)$$

The "n" and "e" of C being thus computed, dH and dδ may be calculated from III which gives

$$\left.\begin{aligned} dH &= n\cos\delta + e\sin\delta \\ Hd\delta &= -n\sin\delta + e\cos\delta \end{aligned}\right\} \text{ where } \delta \text{ and } H \text{ have the values at C.}$$

In the example below Colaba is computed from Dehra Dun and Kodaikanal and the multiplier for latitude becomes

Example of method of computation.

$$\frac{\text{latitude Dehra} - \text{latitude Colaba}}{\text{latitude Dehra} - \text{latitude Kodaikanal}} = 0{\cdot}568.$$

DIURNAL VARIATION.

Colaba computed from Dehra and Kodaikanal. November 1903.

HORIZONTAL FORCE.

Unit = 1γ ≡ 1 × 10⁻⁵ C.G.S.

Hour.	n at Dehra.	n at Kodaikanal.	diff. K—D.	diff. × ·568	n computed at Colaba, *i.e.* (ii + v).	dH Colaba computed.	dH observed at Colaba.	O—C. *i.e.*, (viii—vii).
	ii	iii	iv	v	vi	vii	viii	ix
0	—08	—22	—14	—08	—16	—16	—15	+01
1	06	20	14	08	14	14	15	—01
2	07	21	14	08	15	15	15	00
3	05	19	14	08	13	13	11	+02
4	02	16	14	08	10	10	11	—01
5	02	17	15	09	11	11	07	+04
6	+01	14	15	09	08	08	05	03
7	02	04	06	03	01	01	+03	04
8	06	+17	+11	+06	+12	+12	13	01
9	06	42	36	20	26	26	28	02
10	10	59	49	28	38	38	37	—01
11	14	59	45	26	40	40	39	01
12	20	38	18	10	30	30	30	00
13	16	22	06	03	19	19	20	+01
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16	—03	03	00	00	—03	—03	—04	01
17	03	03	00	00	03	03	03	05
18	05	10	05	03	08	08	10	02
19	07	15	08	05	12	12	14	02
20	10	18	08	05	15	15	17	02
21	12	22	10	06	18	18	18	00
22	09	22	13	07	16	16	18	02
23	10	23	13	07	17	17	20	03

DIURNAL VARIATION.

Colaba computed from Dehra and Kodaikanal. November 1903.

DECLINATION.

Unit = 1'.

Hour.	e at Dehra	e at Kodai.	diff. K–D.	diff. × ·568	e computed at Colaba, *i.e.* (ii + v).	dδ computed at Colaba.	dδ observed at Colaba.	O–C., *i.e.* (viii—vii).
i	ii	iii	iv	v	vi	vii	viii	ix
0	+02	00	—02	—01	+01	+0·1	+0·1	0
1	00	00	00	00	00	0·0	0·1	+0·1
2	01	00	01	01	00	0·0	0	0
3	—03	00	00	00	00	0·0	—0·2	—0·2
4	04	-03	00	00	—03	—·03	0·3	0
5	03	06	02	01	05	0·4	0·4	0
6	01	08	05	03	06	0·5	0·6	—·01
7	+09	07	06	03	04	0·4	0·0	+0·4
8	13	03	12	07	+02	+0·2	+0·5	0·3
9	03	+01	12	07	06	0·5	0·5	0
10	—05	01	02	01	02	0·2	0·2	0
11	12	—03	+02	+01	—04	—0·4	—0·6	—0·2
12	10	+01	13	07	05	0·4	0·5	0·1
13	05	03	13	07	03	0·3	0·1	+0·2
14	00	04	09	05	00	0·0	+0·1	0·1
15	+03	05	05	03	+03	+0·3	0·4	0·1
16	02	05	02	01	04	0·4	0·3	—0·1
17	00	03	01	01	03	0·3	0	0·3
18	03	01	01	01	01	0·1	0	0·1
19	03	01	—02	—01	02	0·2	0	0·2
20	02	01	02	01	02	0·2	+0·1	0·1
21	03	01	01	01	01	0·1	0·1	0
22	05	00	03	02	01	0·1	0·1	0
23	05	00	05	03	02	0·2	0·2	0

Tables showing differences between observed and computed values of dH and dδ

The following tables give the differences between the observed and computed values of dH and dδ at various observatories, the latitudes of which are—

	°	′	″
Dehra Dun	30	19	19
Barrackpore	22	46	29
Colaba	18	53	45
Alibag (which has replaced Colaba)	18	38	55
Kodaikanal	10	13	50
Toungoo	18	55	45

The tables for May 1907 are added as they show the results in dH and dS obtained by including Toungoo observatory in the discussion.

Differences between the observed values at Colaba and those computed from Dehra and Kodaikanal.

HORIZONTAL FORCE. Unit = 1γ = 1 × 10^{-5} C.G.S.

Hour.	August 1902.	September 1902.	October 1902.	November 1902.	December 1902.	August 1903.	September 1903.	October 1903.	November 1903.	December 1903.	REMARKS.
0	00	+05	+03	+04	+03	+02	+04	+01	+01	00	
1	00	05	01	02	02	04	05	02	—01	+03	
2	00	04	01	03	03	02	04	04	00	02	
3	—01	05	02	02	03	02	05	03	+02	02	
4	00	04	00	03	02	02	04	05	—01	02	
5	00	05	00	02	03	02	03	03	+04	03	
6	00	04	01	05	03	01	03	03	03	03	
7	+01	05	07	05	04	01	—04	03	04	04	
8	00	—03	08	03	00	00	10	—03	01	06	
9	00	06	04	—03	—01	—04	17	06	02	—02	
10	—01	10	—04	05	01	05	20	10	—01	01	
11	01	15	06	07	02	05	18	10	01	02	
12	04	14	06	10	06	05	10	11	00	03	
13	02	12	08	08	10	03	+02	05	+01	06	
14	00	07	07	05	07	02	09	02	03	07	
15	+02	+01	05	+01	05	02	11	+02	—01	04	
16	04	04	00	00	01	+01	08	04	01	+01	
17	03	06	+02	01	+01	03	04	05	05	00	
18	00	05	00	01	01	01	01	02	02	01	
19	01	03	—02	00	—01	00	01	04	02	01	
20	01	03	00	00	01	01	02	02	02	02	
21	01	04	00	02	+01	02	01	03	00	02	
22	02	04	+01	01	00	01	02	02	02	01	
23	02	04	01	00	00	03	02	04	03	02	

Differences between the observed values at Colaba and those computed from Dehra and Kodaikanal.

DECLINATION. Unit = 1′

Hour.	August 1902.	September 1902.	October 1902.	November 1902.	December 1902.	August 1903.	September 1903.	October 1903.	November 1903.	December 1903.	REMARKS.
0	+·2	+·2	+·1	+·2	+·1	0	+·1	0	0	0	
1	·1	·1	·1	·2	·1	0	·1	0	0	0	
2	0	·1	·1	·1	0	0	0	—·1	0	0	
3	0	·1	0	·1	·2	0	—·2	·1	—·3	—·2	
4	—·1	·1	0	0	0	0	·1	·2	·1	·1	
5	·1	·1	0	0	·1	+·2	+·1	·1	0	·1	
6	+·4	·4	0	—·1	0	·5	·5	·1	·1	0	
7	·3	·4	+·4	0	0	·4	·2	+·3	+·3	·1	
8	·5	·1	·3	·1	·1	·1	—·1	·2	·3	+·1	
9	—·1	—·5	—·1	·4	·1	—·5	·4	—·4	0	·2	
10	·6	·4	·4	·5	·1	·6	·5	·2	0	0	
11	·3	·5	·4	·5	—·1	·3	·6	·5	—·2	·1	
12	·1	·4	·3	·2	0	·1	·3	0	·1	—·1	
13	·2	·2	·1	·1	0	·1	+·2	+·4	+·2	0	
14	+·2	+·2	0	0	0	0	·7	·5	·1	·1	
15	·4	·3	+·1	0	·1	+·1	·6	·2	·1	·2	
16	·4	·2	—·1	0	+·1	0	·3	0	—·1	0	
17	0	0	·2	·1	0	0	0	—·1	·3	0	
18	—·3	·1	0	0	0	—·3	—·1	0	·1	·1	
19	·1	0	·1	0	·1	0	0	·2	·2	·1	
20	0	0	+·1	0	·1	·2	0	·2	·1	·2	
21	0	·1	0	+·1	0	·1	·2	·1	0	0	
22	+·1	·1	—·1	·1	—·1	·1	·2	0	0	0	
23	·2	0	·1	·2	0	0	·1	+·1	0	+·1	

Horizontal Force. Unit = $1\gamma = 1 \times 10^{-5}$ C.G.S.

Hour.	August 1903.	September 1903.	October 1903.	November 1903.	December 1903.	August 1903.	September 1903.	October 1903.	November 1903.	December 1903.	Remarks.
	Differences between the observed values at Barrackpore and those computed from Dehra and Kodaikanal.					*Differences between the observed values at Barrackpore and those computed from Dehra and Colaba.*					
0	−02	+03	+01	00	00	−03	+01	+01	00	00	
1	00	03	04	−02	+03	02	−01	03	−01	+01	
2	+04	04	04	00	−01	+02	+01	01	00	−02	
3	04	01	02	01	00	02	−02	00	02	01	
4	03	02	05	02	00	01	00	02	01	01	
5	05	02	04	+02	+02	03	00	02	01	00	
6	07	04	05	02	02	07	+02	03	00	00	
7	02	−03	01	−01	00	01	−01	−01	04	03	
8	−03	13	−06	03	02	−03	06	05	04	02	
9	10	18	08	07	−03	07	07	05	08	02	
10	16	20	10	04	01	13	07	04	04	01	
11	15	16	08	02	01	12	03	02	02	00	
12	09	04	02	+05	02	05	+03	+05	+05	00	
13	01	+03	00	03	02	00	02	04	02	+02	
14	+02	08	+06	05	03	03	02	07	03	01	
15	04	10	03	04	00	05	03	02	04	03	
16	06	07	01	01	+01	06	02	−01	02	01	
17	06	00	00	−03	−02	04	−03	03	00	−02	
18	04	00	03	+02	00	03	01	+02	03	01	
19	06	+02	02	−01	+02	06	+02	00	01	+01	
20	03	03	02	00	00	02	01	02	03	−02	
21	02	00	04	+01	01	00	00	02	01	00	
22	05	00	01	−01	03	04	−02	−01	00	+02	
23	04	03	04	+04	06	02	+01	+02	06	05	

DECLINATION. Unit = 1′

Hour.	August 1903.	September 1903.	October 1903.	November 1903.	December 1903.	August 1903.	Setpember 1903.	October 1903.	November 1903.	December 1903.	Remarks.
	Differences between the observed values at Barrackpore and those computed from Dehra and Kodaikanal.					*Differences between the observed values at Barrackpore and those computed from Dehra and Colaba.*					
0	—·1	—·2	—·1	—·1	—·1	—·2	—·2	0	—·1	—·2	
1	0	·1	·1	+·1	·1	+0	·1	—·1	+·1	0	
2	+·1	·3	0	—·2	·1	·1	·2	+·1	·1	0	
3	0	·1	+·1	·2	·2	0	0	·2	0	·1	
4	·1	·2	—·2	0	·1	0	·1	—·1	·1	0	
5	—·1	·1	·1	·1	·2	—·2	·1	0	·2	·2	
6	+·2	+·3	·1	·1	·1	·1	+0	·1	·1	0	
7	·8	·7	+1·3	+·1	·2	+·6	·5	·6	·1	·2	
8	·5	·6	·5	·4	+·1	·4	·7	+·4	+·2	+·1	
9	—·2	·1	·3	·2	·3	·1	·4	·6	·3	·2	
10	·7	—·4	0	·3	·5	—·4	0	·1	·3	·5	
11	·6	·8	—·4	—·4	0	·3	—·5	—·4	—·2	·3	
12	·5	·5	·5	·2	0	·2	·2	·5	·1	·1	
13	·2	·1	·5	+·1	—·1	+3	·2	·6	0	—·1	
14	·5	+·1	·1	·3	0	·5	·3	·4	+·3	+·1	
15	·4	·2	0	·3	0	·3	·1	·1	·1	·1	
16	·3	·4	+·2	·1	0	·3	0	+·3	·2	0	
17	·3	·3	·1	—·1	+·1	·3	+·3	·2	0	·1	
18	—·3	—·1	—·2	+·1	—·1	—·1	0	—·2	·1	0	
19	·2	0	+·2	—·1	+·1	·1	0	+·2	0	·1	
20	·5	0	·1	·2	—·1	·2	·1	·1	·1	·1	
21	·1	0	0	·2	+·1	·1	0	·1	·1	·1	
22	·1	+·1	—·1	·2	0	·1	—·1	·1	·2	—·1	
23	·2	0	0	·2	·1	·2	·1	·1	·2	·1	

DIURNAL VARIATION.

Differences between observed and computed values of dH and dδ.

May 1907.

	Hour.	Toungoo from Dehra and Kodaikanal.	Toungoo from Barrackpore and Kodaikanal.	Toungoo from Dehra and Barrackpore.	Dehra from Barrackpore and Toungoo.	Barrackpore from Dehra and Alibag.	Barrackpore from Dehra and Toungoo.	REMARKS.
HORIZONTAL FORCE. Unit = 1γ ≡ 1 × 10⁻⁵ C.G.S.	0	—01	0	—01	—03	+05	+01	The inequalities of Dehra Dun, Barrackpore, Kodaikanal and Toungoo are computed from "all days," those of Alibag from 5 "quiet" days only.
	1	02	+02	+02	+04	03	—01	
	2	04	03	01	02	03	01	
	3	03	02	02	03	01	01	
	4	03	01	0	0	02	0	
	5	04	03	+01	+02	02	—01	
	6	+01	0	—01	—01	03	+01	
	7	02	+01	0	0	06	0	
	8	—01	—02	—03	—06	04	+02	
	9	08	04	0	+01	0	0	
	10	11	07	—02	—04	+01	+01	
	11	08	04	0	0	02	0	
	12	09	05	+01	+02	0	—01	
	13	02	01	—01	—02	+01	+01	
	14	+01	+01	0	+01	—02	0	
	15	0	—01	—01	—03	02	+01	
	16	0	01	02	04	04	01	
	17	—02	02	02	04	05	01	
	18	02	01	01	02	04	01	
	19	0	+01	+02	+03	04	—01	
	20	—01	—01	0	02	03	0	
	21	0	+01	+02	03	02	—01	
	22	+02	01	01	02	03	01	
	23	+02	02	03	05	02	02	

DIURNAL VARIATION.

Differences between observed and computed values of dH and dδ.

May 1907.

	Hour.	Toungoo from Dehra and Kodaikanal.	Toungoo from Barrackpore and Kodaikanal.	Toungoo from Dehra and Barrackpore.	Dehra from Barrackpore and Toungoo.	Barrackpore from Dehra and Alibag.	Barrackpore from Dehra and Toungoo.	REMARKS.
DECLINATION. Unit = 1′	0	+0·1	−0·1	−0·2	−0·3	0	+0·1	
	1	0	0·1	0	0·1	−0·1	0	
	2	0	0	0	0·2	0	0	
	3	0	−0·1	0	0·1	−0·1	0	
	4	0	0	−0·2	0	0	+0·2	
	5	0	−0·1	0·1	−0·3	+0·1	0·1	
	6	−0·4	+0·1	0·2	0·3	0·6	0·1	
	7	0·3	0	0·4	0·9	0·4	0·3	
	8	0·2	+0·1	0·3	0·8	0·2	0·2	
	9	0·2	0·5	+0·7	+1·6	−0·3	−0·4	
	10	−0·1	0·7	1·2	2·4	0·6	0·7	
	11	+0·2	0·6	0·9	2·0	0·4	0·4	
	12	0	0·4	0·5	1·1	0·2	0·1	
	13	0·2	0·2	0·3	0·8	+0·1	0·1	
	14	0·3	−0·1	−0·1	0	0·1	0	
	15	0·2	0·1	0·1	−0·2	0	0	
	16	−0·1	0·2	+0·1	0·6	+0·2	+0·3	
	17	0	0·3	−0·2	+0·7	0	0·3	
	18	+0·1	0·4	0·4	0·7	−0·1	0·1	
	19	0	0·2	0·2	−0·6	0·1	0·2	
	20	0	0	0	0·1	0·4	0	
	21	+0·2	−0·2	−0·1	0·5	0·2	+0·1	
	22	0·2	0·3	0·1	0·4	0·2	0·1	
	23	0·4	0·2	0	0·3	0·1	0·2	

Formulae for correction of diurnal variation in H. F. and declination.

The following formulae for the correction of field observations for diurnal variation in H. F. and declination deduced from the foregoing agreement between the observed and computed values of "n" and "e" are due to Mr. J. Eccles, M.A., of the Survey of India.

Let A and B be two base stations and P any other station.

Let ${}_AH_x$, ${}_A\delta_x$ = the readings of H. F. and declination at A at the hour x.

${}_AH_M$, ${}_A\delta_M$ = the mean values of H. F., declination at A.

${}_An_x$, e_x = the values of n and e at the hour x.

Then—

$$\left.\begin{array}{l} {}_An_x = ({}_AH_x - {}_AH_M)\cos.{}_A\delta_M - {}_AH_M \sin {}_A\delta_M ({}_A\delta_x - {}_A\delta_M)\sin.1'' \\ \text{and similarly—} \\ {}_Bn_x = ({}_BH_x - {}_BH_M)\cos.{}_B\delta_M - {}_BH_M \sin.{}_B\delta_M ({}_B\delta_x - {}_B\delta_M)\sin.1'' \end{array}\right\} \quad . \quad \text{I.}$$

Let K be the multiplier for the latitude of P *viz.* :—

$$K = \frac{\phi_A - \phi_P}{\phi_A - \phi_B}.$$

Then—

$$\left.\begin{array}{l} {}_Pn_x = {}_An_x - K({}_An_x - {}_Bn_x). \\ \quad = (1-K)\,{}_An_x + K\,{}_Bn_x. \\ \text{Similarly—} \\ {}_Pe_x = (1-K)\,{}_Ae_x + K\,{}_Be_x \end{array}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{II}$$

Now ${}_PH_x - {}_PH_M = {}_Pn_x \cos.{}_P\delta_M + {}_Pe_x \sin.{}_P\delta_M$.

and $${}_P\delta_x - {}_P\delta_M = \frac{-{}_Pn_x \sin.{}_P\delta_M + {}_Pe_x \cos.{}_P\delta_M}{{}_PH_M \sin 1''}.$$

and substituting from I and II and for n and e and arranging terms we get

$$\begin{aligned} {}_PH_x - {}_PH_M = (1-K)\,[&({}_AH_x - {}_AH_M)\cos.({}_A\delta_M - {}_P\delta_M) \\ &- {}_AH_M({}_A\delta_x - {}_A\delta_M)\sin.({}_A\delta_M - {}_P\delta_M)\sin.1'']. \\ + K\,[&({}_BH_x - {}_BH_M)\sin.({}_B\delta_M - {}_P\delta_M) \\ &+ {}_BH_M({}_B\delta_x - {}_B\delta_M)\cos.({}_B\delta_M - {}_P\delta_M)\sin.1''] \end{aligned}$$

and

$$\begin{aligned} {}_PH_M \sin.1''({}_P\delta_x - {}_P\delta_M). = (1-K)\,[&({}_AH_x - {}_AH_M)\sin.({}_A\delta_M - {}_P\delta_M) \\ &+ {}_AH_M({}_A\delta_x - {}_A\delta_M)\cos.({}_A\delta_M - {}_P\delta_M)\sin.1''.] \\ + K\,[&({}_BH_x - {}_BH_M)\sin.({}_B\delta_M - {}_P\delta_M) \\ &+ {}_BH_M({}_B\delta_x - {}_B\delta_M)\cos.({}_B\delta_M - {}_P\delta_M)\sin.1''.] \end{aligned}$$

If ${}_PH_O$, ${}_P\delta_O$ be the readings at the hour to which we wish to reduce (*i.e.*, noon, midnight, etc., or mean of the day) then substituting o for x and subtracting we get ${}_PH_X - {}_PH_O$ = Right hand side with o substituted for M in the terms ${}_AH_X - {}_AH_M$, ${}_A\delta_X - {}_A\delta_M$ etc., etc., etc.

Now if $h_a\ h_b\ h_p$ / $\delta_a\ \delta_b\ \delta_p$ be the differences of the readings at A, B and P at the hour x and o (*i.e.*, the hour of observation at P and the hour to which we wish to reduce) δ_a, δ_b and δ_p being in minutes.

$\beta_a\ \beta_b$ the differences of the declination at P from those at A and B.

$H_a\ H_b\ H_p$ the horizontal force at A, B and P then

$$\begin{aligned} h_p &= (1-K)[h_a \cos.\beta_a - H_a\ \delta_a\ \sin.\beta_a\ \sin.1'']. \\ &\quad + K\,[h_b\ \cos.\beta_b - H_b\ \delta_b\ \sin.\beta_b\ \sin 1'']. \end{aligned}$$

$$\begin{aligned} \sin 1''\ H_p\ \delta_p &= (1-K)[h_a \sin.\beta_a + H_a\ \delta_a \cos.\beta_a \sin.1'']. \\ &\quad + K\,[h_b \sin.\beta_b + H_b\ \delta_b \cos.\beta_b\ \sin.1'']. \end{aligned}$$

Now at none of the base stations does the declination exceed 3°, so it will be fair to assume β not greater than 3°.

cos. $3^\circ = \cdot 9986$ and $\cdot 00300 \times \cdot 9986 = \cdot 002996 = \cdot 00300$ to nearest γ.

$\therefore$ if we want the result to the nearest γ we may take, in the first equation, cos. $\beta = 1$ so long as h does not exceed 300γ.

As h will rarely exceed $100\,\gamma$ we may then always take cos. $\beta = 1$.

Again sin $3^\circ = \cdot 052$ and circular measure of $1' = \cdot 00029$.

Product $= \cdot 000015$: H lies between $\cdot 32$ and $\cdot 40$.

$\therefore$ $H_M \sin\beta \sin 1''$ lies between $\cdot 0000048$ and $\cdot 0000060$, so that if we want the result correct to 1γ, for all values of $\delta_a\, \delta_b$ less than $2'$, the second term in the first equation may be neglected.

Subject to these limitations the first equation thus becomes

$$h_p = (1 - K) h_a + K h_b .$$

Again—

$$\frac{\sin 3^\circ \operatorname{cosec} 1''}{\cdot 32} = 33518 \text{ and } \frac{\sin 3^\circ \operatorname{cosec} 1''}{\cdot 40} = 26816$$

$\therefore$ for a 1γ value of h the first terms of the second equation can never be greater than $0{\cdot}3''$, and $0{\cdot}3'' = \cdot 005$ minute, therefore if we wish to be correct to $\frac{1}{4}$ minute we may neglect the first terms of the second equation for all values of $h_a\, h_b$ less than 100γ, *i.e.*, in almost every case.

Also—

$$\frac{H_a}{H_p},\ \frac{H_b}{H_p} \text{ lie between } \frac{\cdot 33}{\cdot 40} \text{ and } \frac{\cdot 38}{\cdot 32}.$$

i.e., between $\cdot 83$ and $1{\cdot}19$

$$\therefore \frac{H_a}{H_p} \cos\beta \text{ lies between } \cdot 83 \times \cdot 9986 \text{ and } 1{\cdot}19 \times 1{\cdot}0.$$

———— $\cdot 83$ and $1{\cdot}19$.

———— $1 - \cdot 17$ and $1 + \cdot 19$.

So that if we wish to be correct to $\frac{1}{4}$ minute we may take $\frac{H_a}{H_p}$, $\frac{H_b}{H_p}$ cos. $\beta = 1$ for all values of $\delta_a\ \delta_b$ less than $2'$.

Subject to the above limitations the second equation becomes

$$\delta_p = (1 - K)\, \delta_a + K \delta_b$$

It will be seen that these two equations for h_p and δ_p are identical in form with the equations for ${}_t n_x$ and ${}_t e_x$ on p. 9.

Correction of dip observations for diurnal variation.

The question of the correction for diurnal variation to be applied to the dip observations requires special consideration, since the results from one vertical force magnetograph only (*viz.* at Colaba) are available for the first five years of the preliminary survey.

The diurnal inequality of dip is obtained by combining the hourly mean values of the horizontal and vertical force components, and it is only recently that data for the vertical force variations have become available for observatories other than Colaba.

The table below gives the diurnal inequality of the vertical force at the five Indian observatories in May 1907 : for Alibag (Bombay) the results from four selected quiet days only have been supplied, for the remaining four observatories the inequalities have been computed :—

(*a*) from all days,

(*b*) from the same four selected quiet days as used at Alibag (except at Kodaikanal where the trace was lost on one day for which another has been substituted).

DIURNAL INEQUALITY OF V. F.

May 1907.

Unit = 1γ ≡ 1 × 10^{-5} C. G. S.

	Dehra Dun.		Barrackpore.		Toungoo.		Kodaikanal.		Alibag.
Hour.	From all days.	From 4 selected quiet days.	From all days.	From 4 selected quiet days.	From all days.	From 4 selected quiet days.	From all days.	From 4 selected quiet days.	From 4 selected quiet days.
0	+ 04	+ 05	+ 06	+ 05	+ 04	+ 05	+ 07	+ 08	+ 04
1	04	06	06	05	04	04	07	08	04
2	04	06	06	06	04	04	07	08	04
3	04	05	06	06	04	04	07	09	03
4	04	05	06	06	04	04	07	07	03
5	05	07	07	06	06	06	08	08	05
6	09	11	07	07	09	06	11	12	11
7	06	07	04	04	07	07	09	09	08
8	01	− 01	− 03	− 01	− 01	01	01	− 01	− 04
9	− 08	11	10	06	09	− 06	− 07	09	16
10	16	15	11	08	12	10	15	18	18
11	17	14	10	10	11	11	20	22	16
12	13	12	08	10	11	14	18	19	12
13	10	08	07	07	06	10	16	16	09
14	05	03	05	06	02	03	12	11	03
15	0	+ 03	03	03	+ 03	+ 02	06	03	+ 03
16	+ 02	03	02	03	04	03	+ 01	+ 01	08
17	02	01	01	01	03	03	02	03	05
18	02	01	0	01	01	01	02	02	02
19	02	02	+ 01	+ 01	0	01	02	02	0
20	03	03	04	03	01	01	04	02	02
21	04	03	04	03	02	02	05	04	04
22	04	04	04	04	03	02	06	06	05
23	05	04	04	05	04	03	07	07	05

From an inspection of the Dehra and Kodaikanal values, there appears to be some slight evidence of a latitude change, but the differences between the various hourly variations are too small to warrant any definite conclusion, as they are of the same order as errors of observation.

The errors obtained after applying a latitude factor to the observed differences are in general as large as those which would be introduced by using the inequalities derived from a single observatory ; and the differences of the observed inequalities are so small that we are led to the important conclusion that the hourly variations of the vertical force at Colaba or Alibag may be used without sensible error throughout the period when results from those observatories were alone available.

For the correction of the dip results, however, we require the hourly variations in dip derived from the hourly mean values of horizontal force and vertical force and the conclusion arrived at above has been further tested by computing the hourly mean values and inequalities of dip at the other observatories :—

(1) from the hourly mean values of horizontal force and vertice force observed at each observatory.

(2) From the observed hourly mean values of horizontal force and the hourly mean values of vertical force obtained by combining the mean observed value of vertical force at each observatory with the inequalities obtained at Alibag.

In the tables below the hourly mean values and diurnal inequalities so derived are numbered (1) and (2) to correspond with the above.

Hourly Mean Values of Dip.

May 1907.

Hour.	Dehra-Dun.			Barrackpur.			Toungoo.			Kodaikanal.		
	(1)	(2)	(1)—(2)	(1)	(2)	(1)—(2)	(1)	(2)	(1)—(2)	(1)	(2)	(1)—(2)
0	43° 37·3	37·2	+ 0·1	30° 30·3	30·2	+ 0·1	23° 2·5	2·4	+ 0·1	3° 26·9	26·5	+ 0·4
1	37·4	37·3	0·1	30·4	30·3	0·1	2·5	2·5	0	26·9	26·5	0·4
2	37·3	37·2	0·1	30·4	30·3	0·1	2·6	2·6	0	26·9	26·5	0·4
3	37·3	37·2	0·1	30·4	30·2	0·2	2·6	2·5	0·1	27·0	26·4	0·6
4	37·3	37·2	0·1	30·4	30·2	0·2	2·5	2·4	0·1	26·8	26·4	0·4
5	37·3	37·2	0·1	30·4	30·3	0·1	2·6	2·6	0	26·9	26·3	0·3
6	37·5	37·5	0	30·4	30·7	− 0·3	2·8	2·9	− 0·1	27·2	27·1	0·1
7	37·4	37·4	0	30·1	30·4	0·3	2·6	2·6	0	26·9	26·8	0·1
8	37·1	36·9	0·2	29·4	29·2	+ 0·2	1·7	1·3	+ 0·4	25·8	25·5	0·3
9	36·3	36·1	0·2	28·8	28·1	0·7	0·8	0·1	0·7	24·9	24·4	0·5
10	35·6	35·4	0·2	28·2	27·5	0·7	0·1	59·5	0·6	24·1	24·1	0
11	34·8	34·7	0·1	27·9	27·5	0·4	22° 59·9	59·5	0·4	23·6	24·2	−0·6
12	34·8	34·7	0·1	27·7	27·6	0·1	59·6	59·8	− 0·2	24·0	24·6	0·6
13	35·1	35·0	0·1	28·1	27·9	0·2	23° 0·2	0·3	0·1	24·4	25·0	0·6
14	35·6	35·6	0	28·5	28·7	− 0·2	1·0	1·0	0	25·0	25·7	0·7
15	36·3	36·3	0	29·0	29·4	0·4	1·6	1·7	0·1	25·8	26·3	0·5
16	36·3	37·1	− 0·8	29·5	30·2	0·7	2·2	2·5	0·3	26·2	26·8	0·6
17	37·0	37·2	0·2	29·8	30·2	0·4	2·5	2·6	0·1	26·4	26·6	0·2
18	37·1	37·1	0	29·9	30·1	0·2	2·3	2·4	0·1	26·3	26·3	0
19	37·1	37·0	+ 0·1	30·1	30·0	+ 0·1	2·3	2·2	+ 0·1	26·3	26·1	+ 0·2
20	37·1	37·0	0·1	30·1	30·0	0·1	2·3	2·3	0	26·3	26·3	0
21	37·0	37·1	− 0·1	30·1	30·2	− 0·1	2·3	2·4	− 0·1	26·5	26·5	0
22	37·0	37·1	0·1	30·2	30·2	0	2·3	2·5	0·2	26·7	28·6	0·1
23	37·1	37·2	0·1	30·3	30·3	0	2·4	2·6	0·2	26·8	26·7	0·1
Mean	43° 36′·6	36′·6	...	30° 29·6	29·6	...	23° 1·8	1·8	...	3° 26·0	26·0	...

Diurnal Inequality in Dip.

Unit = 1 minute.

Hour.	Dehra-Dun.		Barrackpur.		Toungoo.		Kodaikanal.		Alibag.
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	
0	+ 0·7	+ 0·6	+ 0·7	+ 0·6	+ 0·7	+ 0·6	+ 0·9	+ 0·5	+ 0·9
1	0·8	0·7	0·8	0·7	0·7	0·7	0·9	0·5	0·8
2	0·7	0·6	0·8	0·7	0·8	0·8	0·9	0·5	0·8
3	0·7	0·6	0·8	0·6	0·8	0·7	1·0	0·4	0·7
4	0·7	0·6	0·8	0·6	0·7	0·6	0·8	0·4	0·6
5	0·7	0·6	0·8	0·7	0·8	0·8	0·9	0·6	0·8
6	0·9	0·9	0·8	1·1	1·0	1·1	1·2	1·1	1·2
7	0·8	0·8	0·5	0·8	0·8	0·8	0·9	0·8	0·8
8	0·5	0·3	− 0·2	− 0·4	− 0·1	− 0·5	− 0·2	− 0·5	− 0·4
9	− 0·3	− 0·5	0·8	1·5	1·0	1·7	1·1	1·6	1·9
10	1·0	1·2	1·4	2·1	1·7	2·3	1·9	1·9	2·4
11	1·8	1·9	1·7	2·1	1·9	2·3	2·4	1·8	2·5
12	1·8	1·9	1·9	2·0	2·2	2·0	2·0	1·4	2·0
13	1·5	1·6	1·5	1·7	1·6	1·5	1·6	1·0	1·6
14	1·0	1·0	1·1	0·9	0·8	0·8	1·0	0·3	0·9
15	0·3	0·3	0·6	0·2	0·2	0·1	0·2	+ 0·3	0
16	0·3	+ 0·5	0·1	+ 0·6	+ 0·4	+ 0·7	+ 0·2	0·8	+ 0·5
17	+ 0·4	0·6	+ 0·2	0·6	0·7	0·8	0·4	0·6	0·5
18	0·5	0·5	0·3	0·5	0·5	0·6	0·3	0·3	0·4
19	0·5	0·4	0·5	0·4	0·5	0·4	0·3	0·1	0·3
20	0·5	0·4	0·5	0·4	0·5	0·5	0·3	0·3	0·4
21	0·4	0·5	0·5	0·6	0·5	0·6	0·5	0·5	0·6
22	0·4	0·5	0·6	0·6	0·5	0·7	0·7	0·6	0·6
23	0·5	0·6	0·7	0·7	0·6	0·8	0·8	0·7	0·7

It will be seen that the agreement between the hourly mean values of dip whether computed from the hourly variations of vertical force obtained at each observatory or from the Alibag hourly variations, is remarkably good and it therefore follows that the diurnal inequalities for previous years can be obtained with quite sufficient accuracy.

Previous to the installation of Vertical Force magnetographs, observations of dip had been taken bi-weekly at about the same hour at all the observatories and the mean observed value of dip combined with the mean monthly value of H. F. from the magnetographs will give a sufficiently accurate value for the mean monthly value of Vertical Force, to which can be applied the diurnal inequality derived from Colaba or Alibag for the computation of the hourly mean values of dip.

An inspection of the diurnal inequalities of dip given in the second table shows some evidence of a change with latitude, but the differences between even Dehra Dun and Kodaikanal are so small that for the purpose of correcting the field dip observations they may be neglected, especially when it is remembered that the probable error of a dip observation with a dip circle is at least, ± 1'.

From the same consideration, the diurnal variation corrections, for at any rate a preliminary reduction, may be obtained with sufficient accuracy from Colaba observatory alone, while for the final reduction the inequalities may be computed as shown above. Each observatory would then be regarded as dominating the area nearest to it, the mean from two observatories being applied to border stations.

4. *Correction for instrumental differences from the Survey Standards.*—Comparative observations have been taken twice yearly with all the field instruments against the standard, while the observatory instruments have been compared through one or other of the field instruments.

Some investigation remains to be done where the indications of any one instrument have changed largely with reference to the standard during the period embraced by any one field season, and the question yet remains for final settlement as to whether the "q" term is to be taken into account or not.

Apart from these questions, the correction can be made sufficiently well for the purposes of the reduction of the preliminary survey.

5. *Correction for secular change.*—Owing to the paucity of existing data, the secular change can practically only be found from observations made during the survey, for which purpose the results of five observatories and twenty-two repeat stations will be available. Observations will also be repeated at various field stations, suitably situated between observatories and repeat stations. It is intended to take observations at 30 such stations during the next field season. The results from the repeat and field stations however first require to be reduced by corrections for diurnal variation, instrumental difference and perturbation.

Of these the first two corrections can be applied, but corrections for perturbation other than approximate must await the result of the investigations now in hand.

6. *Correction for annual variation.*—From an inspection of the mean monthly values at the various observatories, it is at once evident that the secular change is not uniform from month to month. The values of Horizontal Force at Dehra Dun may be taken as an instance of this. From December 1905 to December 1906 a fall of 33 γ occurred, while up to April 1906 there was a rise of 8 γ. It is obvious, therefore, that before we can correct for secular change, some correction for annual variation must be applied. The importance of this point is emphasized at periods of considerable magnetic disturbance. The great storm of October 30th and 31st, 1903 depressed the value of Horizontal Force for 3 or 4 months and a large correction will have to be applied to observations taken between November 1903 and April 1904. The discussion of this correction must await a more rigid examination of the base line values.

7. *Correction for disturbance.*—The importance of the correction for disturbance cannot be overestimated when it is considered that on each and every day the traces are more or less disturbed.

The normal hourly variations of the various elements are obtained with sufficient accuracy from the indications of quiet days, but even the quiet days themselves are disturbed in their means just as the abnormal traces are. For instance, the daily means in H. F. of the five selected quiet days in May 1907 are at Dehra Dun ·33336, ·33332, ·33322, ·33319 and ·33325, C. G. S., a range of 17 γ.

Thus field observations which happen to have been made on days classified as calm or selected as "quiet" for the purpose of computing the diurnal variation, require correcting for disturbance as well as those on days of obvious disturbance: in other words, every observation requires correction, the amount of which will vary according to the degree of disturbance registered on the base station curves.

Generally speaking, in formulating any theory for the correcting of disturbance the only assumption which appears to be warranted is that magnetic disturbances occur at the same absolute time over large areas; further the disturbed traces show a similarity in phase.

In the English Survey the whole of the field work was corrected from the Kew curves on the assumption that the amplitudes of disturbance measured at Kew could be applied without sensible error over the whole area: in the far greater area of the Indian Survey, however, this assumption is not warranted, and an inquiry into the variation of the magnitude of disturbance from point to point is essential. As far as the time of occurrence is concerned, numerous measurements of similar apices of disturbance have established the fact that over the area of the Indian Survey at least, disturbances occur at the same moments of absolute time, while several measurements, where data have been available, have shown that at times they may be simultaneous in such widely separated countries as England and India.

Sir A. Rücker has suggested that the components of the disturbing force may not be found to differ very much at the base stations and that some simple law might then be found to express the variations from point to point; should this not be so, he has outlined the method that might be employed in the further investigation: this method implies a knowledge of the variation of the vertical component, but V. F. magnetographs have only been working for the last three months at four of the five observatories, and it has thus been impossible to begin the investigation earlier. The purpose of this investigation is to determine whether the same disturbing force is in play at all stations, in which case the actual disturbances at various stations will differ according to the differences in magnitude and direction of the normal forces should this be established, precise formulæ can then be found for the correction of the field stations, with the additional advantage that the corrections can be computed from the results of one base station only, a point the importance of which cannot be overestimated, when it is considered that for almost the entire period of the Preliminary Survey results in vertical force are available from one observatory only, while during the whole of the first season's work Colaba observatory alone was working.

It may not be out of place to briefly outline the method suggested for testing the equality of the disturbing forces :—

With the usual reduction to geographical components (North, East and Zenith)

$$n = dH\cos\delta - H\sin\delta\, d\delta.$$

$$e = dH\sin\delta + H\cos\delta\, d\delta.$$

$$v = dV.$$

then find the components along the following axes, *viz.*, polar axis of earth, and two axes in the plane of the equator in and perpendicular to the meridian of the place. These components are as follows :—

(i) Parallel to polar axis of earth

$$dP = n\cos l + v\sin l, \qquad l = \text{latitude}$$

(ii) In the intersection of the meridian plane of the place and the equatorial plane

$$dM = -n\sin l + v\cos l$$

(iii) In the equatorial plane perpendicular to the meridian plane

$dE = e$

(iv) Similar components of disturbing force with reference to a meridian differing by λ (taken positive to the East) are

$dP' = dP$

$dM' = dM \cos \lambda + dE \sin \lambda.$

$dE' = -dM \sin \lambda + dE \cos \lambda.$

If the agreement between these components for various base stations is good, the equality of the disturbing forces will be established.

Such inquiries as have already been begun can only be regarded as preliminary: magnetic storms of a sufficient magnitude to prove or disprove the theory have been of rare occurrence, since the V. F. magnetographs have been working, nor has time allowed of the computation of the data required for a complete investigation of the material, scant as it is, which is available.

These preliminary investigations, however, have been sufficient to show that, at any rate with our present base line values, the divergencies in magnitude and sign of the components of disturbance (at any rate as regards the Easterly and Vertical components) at various stations are such that with our available reference values no simple law can be found to connect them, and the inquiry has therefore been extended to test the theory outlined above.

The results already obtained afford sufficient internal evidence of agreement to justify the expenditure of considerable time and labour on further investigation, even if the great theoretical importance of the question did not demand it: they have also indicated that the directions in which further inquiries might be pursued with advantage, are the improvement of the base line values by a more rigid scrutiny of the data from which they are derived, and the answer to the question of " What should be regarded as the normal value to which days of disturbance should be referred?"

With regard to the former, any alteration in the base line values will change the hourly mean values, while the hourly variations will remain unaltered: the question then has no bearing on the correction for diurnal variation, but becomes of great importance in the consideration of disturbances when the hourly variations superimposed on the mean value held to be applicable to the day under consideration are considered the normal values of the field.

As regards the second of these questions, Bigelow (see Terrestrial Magnetism, Vol. 1, p. 53) is of opinion "that the attempt to use quiet or steady days as reference for disturbances of an abnormal type is misconceived, that the available reference values are to be obtained by interpolation from monthly means and that only barren results can be expected from computations referred to quiet days."

It appears from this that Bigelow would obtain a mean monthly value from the measurements of all days (except possibly those of abnormal disturbance) and would consider this value to be correct for the middle day of the month. To obtain the correct normal value for any other day he would apparently interpolate between the mean values of two consecutive months assuming that the normal value varies uniformly. If the first contention is correct, then it is obvious that the true normal value for the first day of a month could be obtained by measuring up 15 days before or after. This normal value will not as a rule (especially in the case of Horizontal Force) agree with the value obtained by interpolation from the mid-monthly values and therefore either the normal value does not vary uniformly or measurements of all days do not give a true monthly value.

The truth appears to be that the variation from month to month mainly depends on the aggregate of disturbance registered during each month, the value (of Horizontal Force at any rate) being almost invariably reduced by a magnetic storm and tending to rise during a period of calm. It is, however, fortunate that in the only month which has been examined in detail, the daily variations on the monthly mean in Horizontal Force show a marked similarity for the four observatories and if this is borne out in further examination, it will be immaterial whether we regard the mean value of the day or of the month as the true normal value, since these values will be comparable over the area of the survey. The variations of the monthly values will be allowed for in the annual variation correction.

Daily variation on the monthly mean.

It appears from the above that the normal value of the month cannot be obtained from quiet days only and that all days will have to be measured. The labour in this is not as formidable as would at first appear. The area of the curve on each day can be rapidly measured with a planimeter and the mean ordinate obtained by simple division. Further from the measurements of all days in May 1907 it appears that mean value for the four observatories is slightly less, by a practically constant quantity, than that obtained from the 5 selected quiet days. Should further examination show that this difference between "all day" and "quiet day" means is constant in any month for the four observatories it will only be necessary to measure all days for one observatory, the values of the others being obtained by subtracting this constant quantity from the "quiet day" means. It is, however, essential that the same quiet days be selected for all observatories.. The "quiet day" mean value will be obtained by planimetric measurement, but the hourly values must be measured as heretofore.

Results of quiet days compared with all days.

The variations in declination in the only month for which they have been worked up, *viz.*, May 1907, are in the main small, but the larger variations are accordant in sign and differ little in magnitude; it is in the vertical force results that the discrepancies of magnitude and sign are large. It is to be remembered, however, that the base lines of the Watson magnetographs are by no means remarkable for stability, while in instruments recently erected, such as the vertical force magnetographs, large fluctuations are of by no means uncommon occurrence; in the vertical force instruments, in particular, the temperature correction is at all times a matter of some uncertainty, a factor which acquires considerable importance in the month under consideration when in two observatories the mean temperature differed considerably from the temperature of reduction. It is not unlikely, therefore, that a careful examination of the base lines will considerably modify the results already computed, and if in the sequel the declination and vertical force variations are found to bear some relation to one another as those in horizontal force certainly do, the problem of deciding the reference value to be applied to days of disturbance will be greatly simplified.

Approximate corrections for perturbation and how they may be applied in a preliminary reduction.

8. In the above note an endeavour has been made to show the present position of the investigation into the correction for disturbance; it is obvious that considerable time must elapse before the theory can be considered established or disproved, and it remains to enquire in what way, in the present state of our knowledge, an approximate correction for disturbance may be made, should it be decided that what might be termed a preliminary reduction of the fundamental survey should meanwhile be proceeded with. As regards the correction in horizontal force, the investigations so far show that, taking the mean of the month

Horizontal force.

as the reference value and applying the hourly variations found from quiet days, in most cases the resulting components of disturbing force are in very fair agreement; where they differ, in the majority of instances the differences vary with the differences of latitude. The curves of two observatories will require to be measured, preferably those nearer to the station under consideration; if the agreement between the values is fair the mean value may be applied: if there is any appreciable difference, the trace of a third observatory if available should be measured and the results tested by the latitude variation factor with different pairs of results; if neither of the above bring the results into accordance, then either the results of one or the mean of two base stations should be applied according to the position of the field station with reference to them. It is perhaps fortunate in this connection that the secular changes in horizontal force (see report for 1905-06) are large for most parts of India, and therefore any error involved in applying an approximate correction will have, comparatively speaking, little effect on the final reduced values, except in the observations which have been taken near the selected epoch.

Declination.

As regards the correction for disturbance in declination, no rules can be laid down at present. The magnitudes of declination disturbances so far as they have been examined are however as a rule small, rarely exceeding, on days of ordinary disturbance, a maximum of 3 minutes, and it is therefore worth considering whether any attempt should be made to correct at all for disturbance. In view, however, of the fact (found from the base station results) that the secular change is very small, the errors introduced in the uncorrected results will be of the same order as the secular change; and since, owing to lack of data, we are practically dependent on the survey observations for the values of secular change in the districts intervening between the base stations, it will probably tend to a more satisfactory state of things if some approximate correction for disturbance is made.

In applying an approximate correction it will perhaps be best to regard each base station as dominating the regions which lie nearest to it and to apply a correction as found from the indications of the base station; at stations near the boundary lines the mean of the two nearest base stations might be taken.

The progressive survey of new localities has been so regulated as to allow of the establishment of observatories before the area dominated by each has been commenced.

As regards the dip observations, no correction for dip disturbance can be applied at present. Results in vertical force are available from one observatory only and it would be most unsafe to apply the indications from one observatory to the whole area. The secular change in dip is, however, considerable and therefore the effect of errors in the uncorrected results will, except in observations near the selected epoch, be more or less inconsiderable.

This preliminary reduction will not be entirely superseded by the more rigorous reduction; the corrections for instrumental correction and hourly variation will be the same for both reductions; while any modification of the secular change correction will be easily applied; the measurements of the traces for the approximate correction for disturbance will be required and be available for the final reduction.

Labour entailed in the reduction.

9. The question of the corrections which can be applied at present has been dealt with above; it remains to consider the labour involved in their application.

The number of field stations will be about 1230, and adding the repeat stations of the various years we have a total of about 1500 stations at each of which observations of declination, horizontal force and dip will have been made.

Diurnal variation.

The magnitude of the diurnal variation at any given instant depends upon the local time: thus for the correction for diurnal variation the deviations from the mean must be calculated from two observatories (from the published results) for the mean Local Mean Time of the field observation and applied in the formulæ (see page) with the latitude factor applicable to the station. Normally there will be one observation each of dip and declination at each station ; in horizontal force, however, the correction must be applied to the values of horizontal force computed from each vibration and deflection observation separately (using the mean m_0 applicable to the period).

Disturbance.

For disturbances the curves require to be measured at the moments of absolute time corresponding to the time of the field observation; for the purposes of the survey all times of observation have been recorded in Local Mean Time and Madras Mean Time.

The curves then of two or three observatories must be measured at the corresponding moments of Madras Time to obtain the deviations from the mean, from which must be subtracted the normal value of the particular element at that instant to obtain the temporary disturbance at the time of the field observation. For the present purpose the mean hourly values as given by the computations of quiet days will be considered the reference values.

For horizontal force the curves will require to be measured at the Madras Mean Time corresponding to each vibration and deflection experiment, and since each determination of horizontal force has at various times been in the forms VDV, VDVDV, VDDV, there will be required 3, 5 or 4 measurements of the curves of each observatory for the correction at any one station.

Secular change.

The discussion of the proper values to assign to the secular change must await the reduction of the observations at repeat stations and reobserved field stations; from a consideration of the results, values for the districts intervening between the repeat stations and observatories will be assigned.

For horizontal force, however, the question of secular change is of considerable complexity, since the preliminary investigation made last year showed that the average annual change may vary from—40 γ to + 40 γ, while in some parts of India the annual change is scarcely appreciable.

How the detailed survey may be begun pending the results of the reduction.

10. From the above considerations the time required for even a preliminary reduction is so considerable, that it can scarcely be anticipated that the reduction will be in a sufficiently forward state as to adequately indicate before the field season of 1908-09 the localities in which the detail survey can be most profitably commenced. It remains to be considered therefore in what way the field observations of the preliminary survey can be best utilized in preparing a tentative programme for one or at most two working seasons, by which time the results of either a preliminary or more rigorous reduction should be available according to the progress of the investigation into the correction for disturbance.

The magnetic element in India, the observed results of which are likely to undergo least change in the reduction, is the declination ; the secular change is small and of the same sign over the area of the survey ; the diurnal range for the winter months (in which the field observations are all taken) has even in the north of India a range of less than four minutes, so that the diurnal variation correction varies between ± 2′; while on days of disturbance other than abnormal the correction for disturbance will rarely exceed 3′.

The declination results will then be fairly inter-comparable during the period of the survey without correction, and an inspection of the plotted curves should give at least an approximate indication of regional disturbance.

Where abnormal values apply to a considerable district, there will be a *primâ facie* case for more detailed examination; the values of horizontal force and dip can then be examined (for any particular district these will generally have been taken about the same period), and the points where the values are greatly in excess or defect of the average for the district will determine the focus or foci of the detailed survey. In this connection, however, it is not to be lost sight of that the Geological Survey have asked for a detailed magnetic survey of the northern edge of the Deccan trap, and this might then be taken as the locale of the initial operations of the detailed survey, when the subsequent programmes could be based on the reduction of the preliminary survey, the results of which would probably in the interim have become available.

Concluding remarks.

11. In the above note an attempt has been made to show the present position with regard to the question of the reduction of the preliminary survey, and sufficient evidence has, it is hoped, been adduced to show that, while it is without doubt unfortunate that certain questions are still under investigation, the postponement of their consideration has been due to unforeseen and unavoidable circumstances.

The primary cause of the postponement has been the delay in the erection of the later observatories, and this has been partly due to changes in the sites of observatories owing to developments in electric traction subsequent to the original selection (and in one case after the building had been erected), and partly to difficulties in the supply and test of self-registering instruments of a new pattern; while further, the non-provision of continuously recording instruments for the vertical component was an omission whose effect is only now being keenly felt.

The delay occasioned, however, will not be serious in its effect if, as is hoped, satisfactory results will shortly be obtained in the present investigations.

III.—THE MAGNETIC OBSERVATORIES IN 1906-07.

A.—Dehra Dún Observatory.

1. *General remarks on the working.*—The magnetographs continued to give good results throughout the year under report, a slight re-adjustment only being found necessary in the H. F. magnetograph; the vertical force magnetograph, however, required opening up twice during the rains for cleaning, owing presumably to a deposit of moisture on the agate plane due to the humidity of

the air. A glass cover has now been placed over the magnet box, and this with more frequent changing of the sulphuric acid in the drying box will, it is hoped, prevent a recurrence of the trouble.

The vertical force magnet from the instrument destined for Kodaikanal was mounted in November 1906; the new magnet gave much better results than the old, but matters were not entirely satisfactory until March 1907, when from the experience gained in the erection of the other instruments the arrester was so adjusted as to bring the knife-edge of the magnet further from the edge of the agate plane on which it rests. No means of adjustment is provided by the makers, the plate carrying the adjuster arms being firmly screwed to the bed plate of the magnet box, and it was found necessary to slot the holes through which the holding-down screws pass. The point is worthy of notice, as this adjustment was found necessary in all the instruments; some more refined method should be provided by which each arrester arm may be separately adjusted to ensure the knife-edge being parallel to the edges of the agate plane.

Various experiments were made to determine the best position of the temperature compensation device; ultimately a position was accepted in which the mean of several accordant experiments gave a temperature co-efficient of—

$$-\ 5{\cdot}2\gamma \text{ per } +1^{\circ}\text{ F.}$$

Earth Inductor No. 30 by Schulze was installed in November 1906 to replace dip circle No. 44. Comparisons between them were made through the vertical force magnetograph curves with the resulting difference—

Inductor 30—dip circle 44 = + 0′·8

2. *Mean values of magnetic elements at Dehra Dún in 1906.*—The mean values of the magnetic elements at Dehra Dún for 1906 are as follows:—

Declination	2°: 39′·2 E.
H. F.	·33365 C. G.S.
Dip	43°: 29′·8 N.
V. F.	·31625 C. G.S.

3. *Declination constants and mean monthly base lines.*—The following table gives the mean magnetic collimation of magnet No. 17 (the Survey Standard) for each month in 1906; also the mean monthly values of the base line of the declination magnetograph showing the numbers of observations used in deriving the accepted value:—

Months, 1906.	Monthly mean magnetic collimation.	Mean value of base line.	Total number of values of base line.	Number of values rejected.	Number of values from which the base line is derived.	Probable error of the mean value of the base line.	Probable error of single value.	REMARKS.
	″ ′	° ′						
January	—8 : 32	1 : 41·27	20	1	19	±0·02	±0·10	
February	: 28	41·36	24	2	22	·03	·15	
March	: 27	40·78	25	4	21	·02	·10	
April	: 28	40·96	16	1	15	·04	·14	
May	: 24	41·00	9	1	8	·04	·12	
June	: 21	41·09	13	4	9	·05	·15	
July	: 26	41·05	12	1	11	·04	·15	
August	: 28	41·05	13	0	13	·02	·05	
September . . .	: 34	41·27	10	1	9	·05	·16	
October	: 32	41·35	18	4	14	·04	·15	
November . . .	: 33	41·40	8	0	8	·04	·11	
December . . .	: 34	41·33	6	0	6	·05	·12	

4. ***H. F. constants and mean monthly base lines.***—The table below shows the mean monthly values of the H. F. constants of the Survey Standard and the mean monthly base lines of the H. F. magnetograph.

Months, 1906.	Mean value of M for the month. C. G. S.	Monthly mean value of P from 22·5 & 30 cms.	Monthly mean value of P from 30 & 40 cms.	Mean value of base line. C. G. S.	Total number of values of base line.	Number of values rejected.	Number of values from which the base line is derived.	Probable error of the mean value of the base line.	Probable error of a single value.	REMARKS.
January	915·50	7·66	7·81	·33161	14	1	13	±1·1	±4·0	
February	·40	·58	·35	·33155	17	2	15	1·3	4·9	
March	·43	·47	8·32	·33159	19	2	17	1·0	4·2	
April	·34	·37	7·79	·33160	17	1	16	1·0	3·9	
May	·13	·48	·97	·33151	17	0	17	0·7	3·0	
June	·27	·38	·99	·33147	24	1	23	1·2	5·8	
July	·04	·39	·95	·33138	20	1	19	1·1	4·7	
August	·13	·51	8·08	·33141	15	0	15	0·7	2·8	
September	·26	·44	·07	·33139	12	0	12	1·2	4·0	
October	914·61	·53	7·81	·33134	32	4	28	0·7	3·8	
November	·77	·42	·91	·33130	28	2	26	0·8	4·0	
December	·80	·34	8·37	·33128	20	0	20	0·7	3·5	

5. ***Mean scale value and temperature of the H. F. magnetograph.***—The mean scale value for 1906 was 4·06γ for a change in ordinate of 0″·04, the limiting values being 4·03 and 4·09.

The mean temperature for the year was 26·4°C. with maxima of 27·6°C. in October and November and a minimum of 24·6°C. in May.

The base lines are referred to a temperature of 25°C., the temperature co-efficient being—12·6γ per + 1°C.

6. ***Monthly mean values of, and secular change in magnetic elements for 1905 to 1906.***—The following table gives the mean monthly values of H. F. Declination and Dip for 1905 and 1906 with secular changes deduced therefrom :—

Months.	HORIZONTAL FORCE ·33000 +			DECLINATION E 2° +			DIP N 43° +		
	Values of H. F., 1905.	Values of H. F., 1906.	Secular change, 1905-06.	Values of D, 1905.	Values of D, 1906.	Secular change, 1905-06.	Values of I, 1905.	Values of I, 1906.	Secular change, 1905-06.
	C. G. S.	C. G. S.	γ	′	′	′	′	′	′
January	381	376	—5	40·3	39·6	—0·7	20·1	28·2	+8·1
February	376	371	5	40·6	39·5	1·1	20·4	29·2	8·8
March	384	376	8	40·3	39·3	1·0	21·6	28·1	6·5
April	392	382	10	39·8	39·4	0·4	21·1	27·8	6·7
May	399	365	34	39·9	39·3	0·6	22·5	29·0	6·5
June	392	374	18	39·8	39·2	0·6	22·8	28·0	5·2
July	388	362	26	39·3	38·8	0·5	23·2	29·9	6·7
August	386	363	23	39·6	39·1	0·5	25·7	30·3	4·6
September	373	362	11	39·5	39·1	0·4	26·9	31·4	4·5
October	377	352	25	39·8	39·0	0·8	27·0	30·6	3·6
November	373	355	18	39·8	38·8	1·0	29·8	32·7	2·9
December	375	342	33	39·8	38·8	1·0	28·7	32·9	4·2
	383	365	—18	39·9	39·2	—0·7	24·2	29·8	+5·7

B.—*Kodaikanal Observatory.*

1. General remarks on working.
   Erection of V. F. magnetograph.
2. Mean value of magnetic elements for 1906.
3. Declination constants and monthly mean base lines.
4. H. F. ditto. ditto.
5. Mean scale value and temperature range.
6. Mean monthly values of magnetic elements and secular change 1905-06.
   For hourly mean values and diurnal inequality see P. IV, p. .

1. *General remarks on working.*—The observatory has remained in charge of Surveyor Ramaswami Iyengar throughout the year. Thanks are due to the Director, Solar Physics Observatory, for his cordial assistance in all matters pertaining to the magnetic work.

The H. F. and declination magnetographs continued to give good results during the year: the declination magnetograph however required readjustment in July last, owing to the beam of light being gradually displaced.

The vertical force magnetograph was erected in February 1907. The V.F. magnet which had previously been removed from the Dehra Dún instrument was temporarily installed, pending the arrival of a new pattern magnet which will be mounted in its stead during the ensuing field season. Using heavier counterweights than those provided, a satisfactory position of the compensation device was found after many trials, and the temperature co-efficient was finally determined as

$$+ 3{\cdot}4\ \lambda \text{ per } + 1^\circ \text{ F.}$$

The instrument however has given far from satisfactory results; the balance has required readjustment on several occasions in different directions, though the scale value has remained fairly constant. It seems probable that the knife edge of the present magnet is defective: the new magnet will however be mounted as soon as possible after its receipt.

Earth Inductor No. 45 was installed in February 1907 to replace Dip Circle 46.

The difference between them was determined through the V. F. magnetograph curves and was found to be

Inductor 45 — Dip Circle 46 = + 0′·7

2. *Mean values of magnetic elements for 1906.*—The mean values of the magnetic elements at Kodaikanal for 1906 are as follows:—

Declination	0° : 36′·3 W
H. F.	·37425 C. G. S.
Dip	3° : 21′·1 N.
V. F.	·02192 C. G. S.

3. *Declination constants and mean monthly base lines.*—The table below gives the mean monthly magnetic collimation of magnet No. 16 and the mean monthly base line values of the declination magnetograph.

Months, 1906.	Monthly mean magnetic collimation.	Mean values of base line.	Total number of values of base line.	Number of values from which the base line is derived.	Number of values rejected.	Probable error of the mean values of base line.	Probable error of a single value.	Remarks.
	′ ″	° ′						
January	—2 : 17	1 : 39·69	24	23	1	± 0·03	± 0·14	
February	: 18	39·77	23	19	4	·02	·10	
March	: 19	39·74	23	22	1	·02	·12	
April	: 17	39·99	19	17	2	·03	·13	

Months, 1906.	Monthly mean magnetic collimation.	Mean values of base line.	Total number of values of base line.	Number of values from which the base line is derived.	Number of values rejected.	Probable error of the mean values of base line.	Probable error of a single value.	REMARKS.
	′ ″	° ′						
May	—2 : 15	1 : 40·17	14	13	1	·03	·11	
June	: 10	40·10	15	14	1	·04	·17	
July	: 13	39·98	16	12	4	·05	·18	
August	: 16	39·88	17	15	2	·03	·13	
September . .	: 14	39·87	14	13	1	·03	·12	
October . . .	: 21	39·81	10	9	1	·04	·11	
November . .	: 19	39·99	16	15	1	·04	·15	
December . .	: 16	39·83	13	12	1	·03	·10	

4. *H. F. constants and mean monthly base lines.*—The table below gives the mean monthly values of m_0, $P_{1\cdot2}$ and $P_{2.3}$ of magnet No. 16, and the mean monthly base line values of the H. F. magnetograph.

Months, 1906.	Mean value of M° for the month. C. G. S.	Monthly mean values of P from 22·5 & 30 cms.	Monthly mean values of P from 30 & 40 cms.	Mean value of base line. C.G.S.	Total number of values of base line.	Number of values rejected.	Number of values from which the base line is derived.	Probable error of the mean value of base line.	Probable error of a single value.	REMARKS.
January . .	925·16	6·96	8·39	·36937	22	2	20	± 1·1	± ·05	
February . .	·11	7·11	·98	·37000	22	1	21	1·1	5·0	
March . .	·07	·00	·71	·36997	23	2	21	1·3	5·9	
April . .	·22	·12	·63	·36998	23	1	22	0·6	2·6	
May . .	·00	·02	·46	·36989	34	1	33	0·9	5·1	
June . .	924·99	·09	·61	·36987	29	1	28	0·9	4·6	
July . .	925·08	6·94	·48	·36986	22	1	21	1·0	4·5	
August . .	·03	7·17	·71	·36984	27	3	24	1·0	4·8	
September .	·16	·12	·34	·36983	43	11	32	1·0	5·9	
October . .	·07	·03	·22	·36976	41	6	35	1·0	6·0	
November .	924·99	·01	·69	·36983	44	8	36	0·9	5·5	
December .	925·16	·08	·28	·36986	50	8	42	0·5	3·4	

5. *Mean scale value and temperature range.*—The mean scale value for the year 1906 was 6·14γ for 0″·04 with a variation of ± ·01γ.

The mean temperature was 19·0°C which was also the mean monthly temperature throughout except in June and July when the mean was 19·1°C.

6. *Monthly mean values of magnetic elements and secular change 1905-06.* The table below gives the mean monthly values of the magnetic elements for 1905 and 1906 with the secular change thus deduced.

Months.	Horizontal Force. 0·37000 +			Declination. 0° +			Dip 3° +		
	Values of H. F. 1905.	Values of H. F. 1906.	Secular change 1905-06.	Values of D. 1905.	Values of D. 1906.	Secular change 1905-06.	Values of I 1905.	Values of I 1906.	Secular change 1905-06.
	C. G. S.	C. G. S.	γ	′	′	′	′	′	′
January	396	424	+ 28	30·0	34·2	+ 4·2	12·5	17·2	+ 4·7
February	388	426	38	30·1	34·5	4·4	13·7	19·4	5·7
March	400	429	29	30·5	34·8	4·3	15·5	17·8	2·3
April	407	436	29	30·8	35·4	4·6	15·3	19·4	4·1
May	411	420	9	31·2	35·9	4·7	16·3	21·1	4·8
June	402	419	17	31·9	36·3	4·4	17·2	20·8	3·6
July	406	420	14	32·3	36·7	4·4	18·0	21·8	3·8
August	405	422	17	32·6	36·7	4·1	18·2	21·7	3·5
September	397	428	31	32·9	37·1	4·2	18·2	21·7	3·5
October	412	421	9	33·1	37·4	4·3	18·2	22·3	4·1
November	411	432	21	33·8	38·0	4·2	18·5	24·5	6·0
December	404	427	23	33·9	38·2	4·3	18·5	25·8	7·3
Means	403	425	+ 22	31·9	36·3	+ 4·3	16·7	21·1	+ 4·5

C.—*Barrackpore Observatory.*

1. General remarks on working.
   Erection of the V. F. magnetograph.
2. Mean values of magnetic elements for 1906.
3. Declination constants and monthly mean base lines.
4. H. F. constants and monthly mean base lines.
5. Scale value and temperature range.
6. Monthly mean values of magnetic elements and secular change 1905-06.
   For hourly mean values and diurnal inequality see Part IV, p. 56 to 59.

1. *General remarks on working.*—The observatory was under the charge of K. N. Mukerji throughout the year under report.

The magnetographs continued to give good results, only a slight re-adjustment of the H. F. instrument being found necessary.

The vertical force magnetograph was finally erected in December 1906: after several re-adjustments the temperature co-efficient in the final position of the compensation device was found to be

$$+3{\cdot}9\gamma \text{ per } +1^\circ \text{ F.}$$

The V. F. magnet which has the old pattern compensation arrangement of zinc rods and counterweights, will be replaced in the ensuing field season by a new magnet in which the compensation is provided for by a double strip of zinc and brass pivoted about the centre of the magnet system.

The V. F. magnetograph has given good results throughout.

Earth Inductor No. 46 was installed in January 1907 to replace the observatory dip circle No. 45. The difference in their indications was determined through the magnetograph curves and was found to be

$$\text{Inductor 46} - \text{Dip Circle} = -1'{\cdot}6$$

Observations of the Galvanometer belonging to the Earth Inductor equipment were found to be difficult on account of the vibration of the wooden flooring of the absolute house; a concrete pillar flush with the floor surface has since been built to take the Galvanometer stand.

2. *Mean values of magnetic elements for 1906.*—The mean values of the magnetic elements at Barrackpore observatory for 1906 are

Declination	1°: 14′·1 E
H. F.	·37259 C. G. S.
Dip	30°: 26′·4 N.
V. F.	·21894 C. G. S.

3. *Declination constants and monthly base lines.*—The table below gives the mean monthly values of the magnetic collimation of magnet No. 20 and the mean monthly base line values of the declination magnetograph.

Months 1906.	Monthly mean magnetic collimation.	Mean value of base line.	Total number of values of base line.	Number of values rejected.	Number of values from which the base line is derived.	Probable error of the mean value of base line.	Probable error of a single value.	REMARKS.
	′ ″	° ′						
January . .	−6 : 58	0 : 15·59	14	0	14	± 0·02	± 0·08	
February . .	: 53	15·72	13	0	13	·03	·08	
March . . .	: 53	15·87	13	2	11	·04	·14	
April . . .	: 53	15·93	13	0	13	·03	·09	
May . . .	: 58	15·94	5	0	5	·06	·12	
June . . .	: 53	16·12	9	2	7	·03	·14	
July . . .	: 55	16·40	11	1	10	·04	·12	
August . .	: 48	16·38	9	1	8	·02	·07	
September . .	: 51	16·62	5	0	5	·06	·13	
October . .	: 48	17·36	14	3	11	·04	·13	
November . .	: 68	17·47	7	1	6	·04	·10	
December . .	: 67	20·74	10	3	7	·04	·10	

4. *H. F. constants and mean monthly base lines.*—The following table gives the mean monthly values of M_0, $P_{1\cdot2}$ and $P_{2\cdot3}$ for magnet No. 20 and the mean monthly base line values of the H. F. magnetograph.

Months 1906.	Mean value of M_0 for the month. C. G. S.	Monthly mean value of P. from 22·5 and 30 cms.	Monthly mean value of P. from 30 and 40 cms.	Mean value of base line. C. G. S.	Total number of values of base line.	Number of values rejected.	Number of values from which the base line is derived.	Probable error of the mean value of base line.	Probable error of a single value.	REMARKS.
January . .	952·33	6·79	7·73 {	·36822	6	1	5	±2·7	±6·0	Up to 6th January.
				·36812	17	1	16	1·2	5·0	From 10th January.
February . .	·20	·85	·60	·36813	18	0	18	0·7	3·0	
March . .	·32	·85	·42	·36841	17	0	17	1·0	4·3	
April . .	·19	·82	·66	·36848	16	0	16	1·2	4·7	
May . .	·11	·66	·62	·36849	4	0	4	2·2	4·4	
June . .	951·94	·83	·52	·36836	15	0	15	1·2	4·5	
July . . .	952·13	·80	·42	·36841	20	0	20	0·9	4·2	
August . .	·56	·91	·73	·36841	12	0	12	1·3	4·5	
September .	·46	·80	·58	·36835	17	0	17	1·0	4·2	
October . .	·29	·93	·73	·36845	36	7	29	1·0	5·4	

Months 1906.	Mean value of M_0 for the month.	Monthly mean value of P. from 22·5 and 30 cms.	Monthly mean value of P. from 30 and 40 cms.	Mean value of base line. C. G. S.	Total number of values of base line.	Number of values rejected.	Number of values from which the base line is derived.	Probable error of the mean value of base line.	Probable error of a single value.	REMARKS.
November .	948·79	6·80	7·99	·36845	19	0	19	1·0	4·5	
December .	·85	·84	·60	·36810	...	...	...	...	...	On 4th instant. By Interpolation.
				·36808	...	...	...	...	...	On 5th instant. By Interpolation.
				·37019	6	0	6	1·3	3·2	On 14th instant.
				·37028	14	0	14	1·6	5·8	On 25th instant.
				·37032	8	0	8	1·8	5·2	On 29th instant.

5. *Scale values and temperatures.*—The mean scale value for the H. F. magnetograph was 4·94γ for 0″·04 up to November 1906: the magnetograph was re-adjusted in December when there was a slight fall in the scale value to 4·82γ.

The mean temperature during the year was 30·9° C with a maximum of 31·9° C in July and a minimum of 29·6° C in December.

6. *Monthly mean values and secular change 1905-06.*—The mean monthly values of Declination, Horizontal force and Dip are given below for 1905 and 1906, with the secular changes deduced therefrom.

Months.	HORIZONTAL FORCE. 0·37000.+			DECLINATION. 0°+			DIP. 30°+		
	Values of H. F. 1905.	Values of H. F. 1906.	Secular change 1905-06.	Values of D. 1905.	Values of D. 1906.	Secular change 1905-06.	Values of I. 1905.	Values of I. 1906.	Secular change 1905-06.
	γ	γ	γ	′	′	′	′	′	′
January . . .	229	246	+17	20·1	15·5	−4·6	21·7	25·5	+3·8
February . . .	226	246	20	19·8	15·5	4·3	20·7	24·6	3·9
March . . .	243	257	14	19·4	15·3	4·1	20·4	26·4	6·0
April . . .	245	266	21	19·0	14·9	4·1	21·3	26·1	4·8
May . . .	248	265	17	18·4	14·3	4·1	21·2	24·7	3·5
June . . .	246	255	9	18·0	14·3	3·7	22·1	25·6	3·5
July . . .	250	260	10	17·7	14·3	3·4	22·5	26·3	3·8
August . . .	251	261	10	17·3	13·9	3·4	21·6	27·2	5·6
September . .	237	260	23	17·1	13·8	3·3	24·1	26·9	2·8
October . . .	241	266	25	16·8	13·0	3·8	24·0	28·1	4·1
November . .	243	265	22	16·4	12·7	3·7	25·6	27·3	1·7
December . .	244	261	17	16·1	12·2	3·9	24·7	28·4	3·7
Means .	242	259	+17	18·0	14·1	−3·9	22·5	26·3	+3·9

D.—Toungoo Observatory.

1. *General remarks on working.*—The observatory remained in charge of Surveyor K. K. Dutta throughout the year.

The magnetographs required no re-adjustment.

The temperature co-efficient of the H. F. magnetograph was satisfactorily determined in January 1907. Three magnetometers were employed, of which two were used to register changes in H. F. and the third, change in Declination. In previous experiments the changes in Horizontal Force were determined by deflection observations at 22·5cms. before and after the commencement of the heating of the magnetograph room, the changes in the interim being determined from the differences of the scale reading in one of the deflection positions at 22·5cms: the observations were subsequently reduced to a standard scale division with corrections for changes in temperature and declination. It was found, however, that by merely observing the changes in scale divisions throughout the experiment there were often serious discrepancies in the results from the two H. F. magnetometers: in the present determination of the temperature co-efficient, this procedure was altered and the H. F. was determined hourly by deflection observations, the changes in the hourly intervals only being found by scale readings. In this method the magnetometers gave most accordant results and the final resulting temperature co-efficient was

$$-7{\cdot}4\gamma \text{ per } +1^\circ \text{ F.}$$

The V. F. magnetograph was erected in February 1907. Sufficient attention had not been paid to the packing of the instrument in England, with the result that most of the glass portions of the instrument were broken, while several screws had been sheared off. Fortunately spare parts were available and the installation was only temporarily delayed while these were being fitted.

After the usual trials for focus, the best position for the temperature compensation device was determined and, after several trials, the final adjustment gave a temperature co-efficient of

$$-2{\cdot}1\gamma \text{ per } +1^\circ \text{ F.}$$

The V. F. magnetograph has given very good results since its erection.

Inductor No. 44 was installed at the same time in place of Dip Circle No. 137.. The difference between them has since been determined through the V. F. curves and is

$$\text{Inductor } 44 - \text{Dip Circle } 137_{1\cdot 8} = +1'{\cdot}0$$

As at Barrackpore the vibration of the wooden floor made observations of the Galvanometer a matter of some difficulty: this has been overcome in the same manner by the erection of a concrete pillar for the Galvanometer stand.

The roofing of the observer's quarters has proved unsatisfactory. The former roofing of the Pyingado shingles was of the nature of an experiment, and has proved a failure. Provision has been made for re-roofing with tiles.

2. *Mean values of magnetic elements for 1906.*—The mean values of the magnetic elements for 1906 are as follows:—

Declination	0°: 43′·6 E
H. F.	·38715 C. G. S.
Dip	22° 59′·2 N.
V. F.	·16423 C. G. S.

3. *Declination constants and mean monthly base lines.*—The following table gives the mean monthly values of the magnetic collimation of magnet No. 19 and the mean monthly base line values of the declination magnetograph in 1906.

Months 1906.	Monthly mean magnetic collimation.	Mean value of base line.	Total number of values of base line.	Number of values rejected.	Number of values from which the base line is derived.	Probable error of the mean value of base line.	Probable error of a single value.	REMARKS.
	′ ″	° ′				′	′	
January . .	−16 36	−0 10·25	6	1	5	±0·07	±0·15	
February . .	37	9·97	7	0	7	·07	·18	
March . . .	35	9·78	9	0	9	·05	·14	
April . . .	31	10·04	10	2	8	·05	·13	
May . . .	32	9·51	8	1	7	·05	·13	
June . . .	40	9·88	9	0	9	·03	·08	
July . . .	40	9·98	7	1	6	·06	·15	
August . .	36	10·09	10	2	8	·03	·07	
September . .	40	10·03	8	1	7	·04	·10	
October . .	36	9·88	9	0	9	·05	·15	
November . .	36	9·88	9	0	9	·05	·15	
December . .	34	9·85	8	0	8	·03	·09	

4. *Horizontal force constants and mean monthly base lines.*—The table below shows the monthly mean values of m_0, $P_{1\cdot2}$ and $P_{2\cdot3}$ of magnet No. 19 and the mean monthly base lines of the horizontal force magnetograph.

It will be seen that there has been a small and progressive fall in m_0, and a considerable fluctuation in the value of P while the base line value also shows a considerable fall during the year. The fall in the base line value is probably to be attributed to the settling down of the system, as the values have been much steadier during 1907: a similar effect was experienced in Barrackpore during the earlier months of the working of the horizontal force magnetograph.

Months 1906.	Mean value of m° for the month. C. G. S.	Monthly mean value of P from 22·5 and 30 cms.	Monthly mean value of P from 30 and 40 cms.	Mean value of base line. C. G. S.	Total number of values of base line.	Number of values rejected.	Number of values from which the base line is derived.	Probable error of the mean value of base line.	Probable error of a single value.	REMARKS.
January . .	887·89	7·10	7·83	·38281	24	4	20	±1·4	±6·2	
February . .	·82	·03	·76	·38263	30	2	28	0·9	4·6	Up to 10th March.
March . .	·53	·15	9·52	·38[illegible]50	20	1	19	1·2	5·2	Up to 11th April.
April . .	·22	·21	·08	·38227	8	0	8	1·7	4·8	From 15th April.
May .	·03	·26	8·62	·38227	21	2	19	1·1	5·0	
June . .	886·63	·48	·46	·38220	24	3	21	1·3	6·0	Up to 11th July.
July . .	·76	·44	·39	·38214	6	1	5	0·8	1·7	From 12th July.
August . .	·51	·42	·70	·38[illegible]06	21	1	20	1·4	6·1	
September .	·40	·40	·80	·38207	36	3	33	0·9	5·2	
October . .	·29	·37	·60 {	·38208	10	0	10	1·3	4·2	Up to 6th October.
				·38173	22	0	22	1·1	5·1	From 10th October.
November .	·15	·34	·81 {	·38168	14	0	14	0·9	3·5	Up to 10th November.
				·38157	20	0	20	0·9	4·2	From 15th November.
December .	·14	·27	·70	·38150	28	0	28	1·1	5·8	

5. *Scale value and temperature range.*—The mean scale value for the year was 5·58γ for 0″·04 with a range of 5·53 to 5·60.

The mean temperature for the same period was 89°·0 F with a range of 88·9 to 89·1 which is most satisfactory.

6. *Monthly mean values of magnetic elements and secular change 1905 to 1906.*—The following table gives the mean monthly values of the magnetic elements for 1905 and 1906 with the secular changes thus deduced.

The values of Dip for the first three months of 1905 are omitted as they were obtained by a different dip circle whose results are untrustworthy.

Months.	Horizontal force. ·38000 +			Declination. E 0°+			Dip. N 22°+		
	Values of H. F. 1905.	Values of H. F. 1906.	Secular change 1905-06.	Values of D 1905.	Values of D 1906.	Secular change 1905-06.	Values of I 1905.	Values of I 1906.	Secular change 1905-06.
	γ	γ	γ	′	′	′	′	′	′
January . . .	657	702	+45	51·9	45·2	—6·7	...	58·8	...
February . .	656	703	47	50·6	45·4	5·2	...	59·9	...
March . . .	661	710	49	50·1	45·1	5·0	...	58·8	...
April . . .	666	715	49	49·4	44·4	5·0	60·2	59·0	—1·2
May . . .	682	710	28	49·1	44·4	4·7	58·6	59·2	+0·6
June . . .	677	724	47	48·8	43·8	5·0	58·2	59·2	+1·0
July . . .	689	730	41	48·0	43·5	4·5	58·7	58·9	+0·2
August . . .	690	722	32	47·8	43·1	4·7	59·4	59·5	+0·1
September . .	669	720	51	47·2	42·7	4·5	59·3	59·2	—0·1
October . . .	681	715	34	46·9	42·2	4·7	57·4	59·4	+2·0
November . .	682	721	39	46·4	41·8	4·6	58·7	59·2	+0·5
December . .	684	709	25	46·0	41·6	4·4	58·9	59·1	+0·2
	675	715	+41	48·5	43·6	—4·9	58·8	59·2	+0·4

IV. Tables of—Results.

INDEX TO TABLES.

* For each observatory the following tables are given :—

1. Absolute observations of dip.
2. Hourly means of horizontal force (corrected for temperature) from 5 selected quiet days per month.
3. Diurnal inequality of horizontal force deduced from 2.
4. Hourly means of declination from 5 selected quiet days per month.
5. Diurnal inequality of declination deduced from 4.

† These values are given to the nearest minute in dip and declination and 10γ in horizontal force. They are uncorrected for diurnal variation, perturbation, instrumental difference and secular change.

A.—The Magnetic Elements at the Observatories in 1906.

Observatory.	Latitude.	Longitude.	Horizontal Force.	Declination.	Dip.	Vertical Force.
	° ′ ″	° ′ ″		° ′	° ′	
Dehra Dun . .	30 19 19 N	78 3 19 E	·33356 C. G. S.	2 39·2 E	43 29·8 N	·31625 C. G. S.
Barrackpore . .	22 46 39 „	88 21 39 „	·37259 „	1 14·1 „	30 26·4 „	·21894 „
Kodaikanal . .	10 13 50 „	77 27 46 „	·37425 „	0 36·3 W	3 21·1 „	·02192 „
Toungoo . .	18 55 45 „	96 27 3 „	·38715 „	0 43·6 E	22 59·2 „	·16423 „

D = Dehra Dun . { Lat. 30° 19′ 19″ Long. 78 3 19

K = Kodaikanal . { Lat. 10 13 50 Long. 77 27 36

B.—Dates of Magnetic Disturbances, 1906.

B = Barrackpore . { Lat. 22° 46′ 29″ Long. 88 21 39

T = Toungoo . . { Lat. 18 55 45 Long. 96 27 3

Date. 1906	January. D	January. K	January. B	January. T	February. D	February. K	February. B	February. T	March. D	March. K	March. B	March. T
1	(C)	(C)	(C)	(C)	C	C	C	C	S	S	S	S
2	C	C	C	C	C	C	C	C	C	C	C	C
3	C	C	C	C	C	C	C	C	(C)	(C)	(C)	(C)
4	C	C	C	C	S	S	S	S	M	M	M	S
5	C	C	C	C	(C)	(C)	(C)	(C)	S	S	S	S
6	C	C	C	C	S	S	S	S	S	S	C	C
7	C	C	C	C	S	C	S	C	M	M	M	M
8	C	C	C	C	S	C	C	C	M	M	M	M
9	S	C	C	C	S	S	S	S	M	M	S	S
10	(C)	C	C	C	S	S	S	S	S	S	S	S
11	—	(C)	(C)	(C)	C	C	C	C	C	C	C	C
12	S	S	C	C	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)
13	S	S	S	S	(C)	(C)	(C)	(C)	M	S	S	M
14	S	C	C	C	S	S	S	S	S	S	S	S
15	S	C	C	C	S	S	S	S	S	S	S	S
16	(C)	(C)	(C)	(C)	S	S	S	S	(C)	(C)	(C)	(C)
17	C	C	C	C	C	C	C	C	S	S	S	S
18	C	C	C	C	(C)	(C)	(C)	(C)	S	S	S	S
19	S	S	S	S	M	M	M	M	C	C	C	C
20	(C)	(C)	(C)	(C)	S	S	S	S	C	C	C	C
21	C	C	C	C	S	S	S	S	C	C	C	C
22	S	C	C	C	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)
23	C	C	C	C	S	S	S	C	C	C	C	C
24	C	C	C	C	M	S	S	S	S	S	C	C
25	C	C	C	C	G	M	M	M	M	M	M	M
26	C	C	C	C	M	M	—	S	S	S	S	C
27	S	S	C	C	S	C	C	C	(C)	(C)	(C)	(C)
28	C	C	C	C	C	C	C	C	C	C	C	C
29	C	C	C	C	...	...	...	...	S	S	C	S
30	(C)	(C)	(C)	(C)	...	...	...	...	C	C	C	C
31	S	S	S	S	...	...	...	...	C	C	C	C
C	21	26	28	28	11	14	13	15	14	14	17	17
S	9	5	3	3	13	11	12	11	11	12	10	10
M	...	...	1	...	3	3	2	2	6	5	4	4
G	...	...	...	...	1	...	...	...	...	...	...	...
VG	...	...	...	...	...	...	...	...	...	...	...	...
Trace loss	1	...	...	...	...	...	1	...	...	...	...	...

Date. 1906	April. D	April. K	April. B	April. T	May. D	May. K	May. B	May. T	June. D	June. K	June. B	June. T
1	C	C	C	C	C	C	C	C	S	S	S	S
2	C	C	C	C	(C)	(C)	(C)	(C)	M	M	—	M
3	S	S	S	S	C	C	C	C	M	S	M	S
4	S	S	S	S	C	C	C	C	S	S	—	S
5	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	—	C	—	C
6	C	C	C	C	S	C	S	S	—	(C)	—	(C)
7	(C)	(C)	(C)	(C)	S	C	S	S	(C)	(C)	—	(C)
8	S	S	S	S	S	S	—	S	S	S	—	S
9	S	S	S	S	S	S	—	S	C	C	(C)	C
10	S	S	S	S	C	—	C	C	(C)	C	(C)	C
11	S	S	S	S	S	—	S	S	S	S	S	S
12	C	C	C	C	—	—	C	C	(C)	(C)	—	(C)
13	S	S	S	S	C	—	(C)	C	S	S	—	S
14	C	C	C	C	M	—	M	M	C	C	—	C
15	C	C	C	C	M	M	—	M	S	C	S	C
16	C	C	C	C	S	S	—	S	S	S	S	S
17	(C)	(C)	(C)	(C)	(C)	(C)	—	(C)	S	C	S	S
18	(C)	(C)	(C)	(C)	C	C	—	C	C	C	C	C
19	S	S	S	S	C	C	—	C	C	C	(C)	C
20	C	C	C	C	S	S	—	S	C	C	C	C
21	C	C	—	C	S	S	—	S	C	C	C	C
22	S	S	—	C	C	C	—	C	(C)	(C)	(C)	(C)
23	S	S	S	S	(C)	(C)	—	(C)	C	C	—	C
24	S	S	—	S	C	C	—	C	C	C	C	C
25	S	S	C	S	S	S	—	S	S	C	S	C
26	(C)	(C)	(C)	(C)	C	C	—	C	C	S	S	S
27	C	C	C	C	S	S	(C)	S	C	C	C	C
28	S	S	S	S	S	S	—	S	C	C	C	C
29	M	M	M	M	S	C	—	S	(C)	(C)	(C)	(C)
30	S	S	S	S	C	C	—	C	C	C	—	C
31	...	...	...	...	(C)	(C)	(C)	(C)	...	...	...	...
C	15	16	15	16	16	17	10	17	17	21	11	20
S	14	13	11	13	12	8	3	12	9	8	7	9
M	1	1	1	1	2	1	1	2	2	1	1	1
G	...	...	...	...	...	...	...	...	...	...	...	...
VG	...	...	...	...	...	...	...	...	...	...	...	...
Trace loss	...	...	3	...	1	5	17	...	2	...	11	...

Date. 1906	July. D	July. K	July. B	July. T	August. D	August. K	August. B	August. T	September. D	September. K	September. B	September. T
1	S	S	S	S	(C)	(C)	(C)	(C)	S	S	—	S
2	C	C	C	C	C	C	C	C	S	S	—	S
3	C	S	C	C	C	C	C	C	S	C	—	S
4	C	C	C	C	C	C	C	C	S	S	S	S
5	C	C	C	C	C	C	C	C	S	S	S	S
6	C	S	C	C	C	C	C	C	S	—	S	S
7	(C)	(C)	(C)	(C)	S	S	S	S	C	—	C	C
8	(C)	(C)	(C)	(C)	M	M	M	M	(C)	—	(C)	(C)
9	C	C	C	C	S	S	S	S	C	C	C	C
10	S	S	S	S	S	S	C	C	(C)	(C)	(C)	(C)
11	M	M	—	M	S	C	C	S	(C)	(C)	(C)	(C)
12	M	S	S	S	S	S	S	S	C	(C)	C	C
13	S	S	S	S	S	S	S	S	—	—	—	—
14	C	S	C	C	C	C	C	C	C	C	C	C
15	C	C	C	C	C	C	C	C	S	S	S	C
16	C	C	C	C	(C)	(C)	(C)	(C)	C	S	C	C
17	C	C	C	C	C	S	(C)	C	C	C	C	C
18	C	C	(C)	(C)	(C)	(C)	—	(C)	C	C	C	C
19	(C)	(C)	C	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)
20	(C)	(C)	(C)	—	S	S	C	C	S	C	S	C
21	S	S	S	S	G	C	C	C	S	S	S	S
22	(C)	(C)	—	(C)	C	C	—	(C)	S	S	S	S
23	S	S	—	S	(C)	(C)	(C)	(C)	M	M	M	M
24	C	C	—	C	C	C	—	C	S	S	S	C
25	S	S	S	S	S	S	—	S	S	S	S	C
26	S	S	S	S	S	S	...	S	S	S	S	S
27	S	S	S	S	S	S	S	S	C	C	C	C
28	S	S	(C)	C	S	S	S	S	(C)	(C)	(C)	(C)
29	S	S	S	S	S	S	S	S	C	C	C	C
30	M	M	M	M	S	S	S	S	S	C	S	C
31	S	S	S	S	S	S	S	S	...	...	...	...
C	17	14	16	17	16	16	16	18	15	15	15	20
S	11	15	10	11	14	14	9	12	14	11	11	9
M	3	2	1	2	1	1	1	1	1	1	1	1
G	...	...	...	...	...	...	...	...	...	...	...	...
VG	...	...	...	...	...	...	...	...	...	...	...	...
Trace loss	...	4	...	1	...	...	5	...	...	2	3	...

Date. 1906	October. D	October. K	October. B	October. T	November. D	November. K	November. B	November. T	December. D	December. K	December. B	December. T
1	S	S	S	S	C	(C)	(C)	(C)	C	C	C	C
2	S	S	S	C	(C)	C	C	C	C	C	C	C
3	S	C	S	C	C	C	C	C	C	C	C	C
4	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)
5	S	C	C	C	C	C	C	C	(C)	(C)	(C)	(C)
6	(C)	(C)	(C)	(C)	C	C	C	C	C	C	C	C
7	C	C	C	C	C	C	C	C	C	C	C	C
8	C	(C)	(C)	C	C	C	C	C	M	M	M	M
9	C	C	C	C	C	C	C	C	S	S	—	S
10	C	C	C	C	S	S	S	S	S	S	—	S
11	C	C	C	C	S	S	S	S	C	C	C	C
12	S	S	S	S	S	C	S	C	C	C	C	C
13	S	S	S	S	C	C	C	C	(C)	(C)	—	(C)
14	S	S	S	—	C	C	C	C	C	C	(C)	C
15	S	C	S	—	(C)	(C)	(C)	(C)	S	S	S	S
16	S	S	S	S	C	C	C	C	M	S	S	S
17	C	C	C	C	S	C	C	C	M	M	M	M
18	C	C	C	C	S	S	S	S	S	S	S	S
19	S	S	S	S	S	S	S	S	C	C	C	C
20	C	C	C	C	C	C	C	C	C	C	C	C
21	S	S	S	S	S	S	S	S	C	C	C	C
22	S	S	S	S	M	S	S	S	G	G	G	G
23	S	S	S	S	C	C	C	C	S	S	S	S
24	S	C	S	S	C	C	C	C	S	S	S	S
25	S	C	S	S	S	C	C	C	(C)	(C)	(C)	(C)
26	C	C	C	C	S	C	C	C	S	C	C	S
27	S	S	S	S	(C)	(C)	(C)	(C)	S	S	S	S
28	(C)	(C)	(C)	(C)	C	C	C	C	S	S	S	S
29	(C)	C	C	C	C	C	C	C	C	C	(C)	C
30	S	S	C	C	(C)	(C)	(C)	(C)	C	C	—	C
31	C	(C)	(C)	(C)	...	...	...	...	(C)	(C)	—	(C)
C	14	19	16	18	20	24	23	24	18	19	16	18
S	17	12	15	11	9	6	7	6	9	9	7	10
M	...	...	...	...	1	...	...	...	3	2	2	2
G	...	...	...	...	...	...	...	...	1	1	1	1
VG	...	...	...	...	...	...	...	...	...	...	...	...
Trace loss	...	...	...	2	...	...	...	...	...	...	...	...

C.—*Tables of results at Dehra Dún Observatory for 1906.*

List of Tables.

Absolute observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44, Needles Nos. 1 and 2.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly mean for each Needle.	Monthly mean.	Needles 1-2.	Remarks.
1906.										
Month.		h.	m.		°	′				
January	4	13	37	1	43	28·9	Needle			
"	4	13	37	2	43	27·7	No. 1			
"	11	13	43	1	43	28·5	43° 28·8′			
"	11	13	43	2	43	28·4				
"	15	13	35	1	43	29·7		43° 28·2′	+ 1·2	
"	15	13	35	2	43	28·4				
"	25	13	23	1	43	29·0				
"	25	13	23	2	43	26·5	Needle			
"	29	13	55	1	43	27·9	No. 2			
"	29	13	55	2	43	26·9	43° 27·6′			
February	3	13	45	1	43	30·2	Needle			
"	3	13	45	2	43	28·6	No. 1			
"	5	12	42	1	43	30·2	43° 29·6′			
"	5	12	42	2	43	28·7				
"	5	14	30	1	43	29·6				
"	5	14	30	2	43	28·8				
"	6	12	20	1	43	29·4				
"	6	12	20	2	43	28·2				
"	7	12	22	1	43	27·2				
"	7	12	22	2	43	27·9		43° 29·2′	+ 0·9	
"	9	13	35	1	43	29·1				
"	9	13	35	2	43	28·4				
"	12	13	50	1	43	29·3				
"	12	13	50	2	43	28·3				
"	19	12	57	1	43	29·7				
"	19	12	57	2	43	28·7				
"	23	13	37	1	43	29·9				

Absolute observations of Dip at Dehra Dûn Observatory taken with Barrow's Dip Circle No. 44, Needles Nos. 1 and 2.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly mean for each Needle.	Monthly mean.	Needles 1-2.	REMARKS.
1906.										
Month.		h.	m.		°	′				
February	23	13	37	2	43	27·4	Needle			
"	26	13	48	1	43	31·6	No. 2			
"	26	13	48	2	43	31·6	43° 28·7′			
March	2	13	27	1	43	30·2	Needle			
"	2	13	27	2	43	28·4	No. 1			
"	5	13	12	1	43	30·8	43° 28·4′			
"	5	13	12	2	43	28·0				
"	12	12	29	1	43	26·6				
"	12	12	29	2	43	27·8		43° 28·1	+ 0·7	
"	16	13	38	1	43	29·4				
"	16	13	38	2	43	28·0				
"	19	13	36	1	43	27·2				
"	19	13	36	2	43	27·2	Needle			
"	31	13	31	1	43	25·9	No. 2			
"	31	13	31	2	43	26·8	43° 27·7′			
April	2	13	27	1	43	27·8	Needle			
"	2	13	27	2	43	27·8	No. 1			
"	5	13	51	1	43	28·1	43° 27·9′			
"	5	13	51	2	43	27·1				
"	9	13	46	1	43	28·7		43° 27·8	+ 0·2	
"	9	13	46	2	43	28·7				
"	12	13	44	1	43	27·8				
"	12	13	44	2	43	27·5	Needle			
"	30	13	41	1	43	26·9	No. 2			
"	30	13	41	2	43	27·5	43° 27·7′			
May	4	18	21	1	43	29·5	Needle			
"	4	18	21	2	43	30·7	No. 1			
"	8	14	5	1	43	29·0	43° 28·8′			
"	8	14	5	2	43	29·0				
"	11	12	47	1	43	27·9				
"	11	12	47	2	43	28·9				
"	12	13	7	1	43	30·6				
"	12	13	7	2	43	27·1				
"	13	11	7	1	43	29·6				
"	13	11	7	2	43	32·3				
"	17	13	27	1	43	28·7				

Absolute observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44, Needles Nos. 1 and 2.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly mean for each Needle.	Monthly mean.	Needles 1-2.	REMARKS.
1906. Month.		h.	m.		°	′				
May	17	13	27	2	43	31·2		43° 29·0′	— 0·3	
,,	21	13	52	1	43	30·6				
,,	21	13	52	2	43	31·1				
,,	24	13	28	1	43	28·3				
,,	24	13	28	2	43	26·5				
,,	25	12	29	1	43	28·7				
,,	25	12	29	2	43	28·0				
,,	28	12	36	1	43	27·3				
,,	28	12	36	2	43	28·4	Needle			
,,	28	13	11	1	43	26·9	No. 2			
,,	28	13	11	2	43	26·8	43° 29·1′			
June	1	13	58	1	43	28·6				
,,	1	13	58	2	43	27·0	Needle			
,,	7	14	14	1	43	29·0	No. 1			
,,	7	14	14	2	43	29·2	43° 28·6′			
,,	11	12	39	1	43	30·5				
,,	11	12	39	2	43	28·9		43° 28·0′	— 1·3	
,,	14	12	35	1	43	28·5				
,,	14	12	35	2	43	26·0				
,,	21	12	32	1	43	27·6				
,,	21	12	32	2	43	25·6	Needle			
,,	25	12	40	1	43	27·6	No. 2			
,,	25	12	40	2	43	27·2	43° 27·3′			
July	2	13	49	1	43	29·2	Needle			
,,	2	13	49	2	43	29·5	No. 1			
,,	6	13	53	1	43	31·0	43° 30·0′			
,,	6	13	53	2	43	31·6				
,,	17	13	57	1	43	30·0				
,,	17	13	57	2	43	30·1				
,,	19	13	48	1	43	29·8		43° 29·9′	+ 0·2	
,,	19	13	48	2	43	29·2				
,,	24	13	44	1	43	29·9				
,,	24	13	44	2	43	29·9				
,,	26	13	39	1	43	29·2				
,,	26	13	39	2	43	28·6	Needle			
,,	30	13	33	1	43	30·8	No. 2			
,,	30	13	33	2	43	29·5	43° 29·8′			

Absolute observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44, Needles Nos. 1 and 2.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly mean for each Needle.	Monthly mean.	Needle 1-2.	REMARKS.
1906. Month.		h.	m.		°	′				
August	2	12	57	1	43	31·2	Needle			
,,	2	12	57	2	43	29·0	No. 1			
,,	3	13	16	1	43	29·8	43° 30·7′			
,,	6	13	33	1	43	30·1				
,,	6	13	33	2	43	29·2				
,,	9	12	45	1	43	31·3				
,,	9	12	45	2	43	29·4		43° 30·3′	+ 0·8	
,,	16	13	45	1	43	31·4				
,,	16	13	45	2	43	31·0				
,,	21	13	45	1	43	30·7				
,,	21	13	45	2	43	30·5	Needle			
,,	30	13	35	1	43	30·1	No. 2			
,,	30	13	35	2	43	30·3	43° 29·9′			
September	26	14	50	1	43	32·8	Needle			
,,	26	14	50	2	43	31·0	No. 1			
,,	26	15	28	1	43	33·8	43° 32·0′			
,,	26	15	28	2	43	32·1				
,,	30	11	14	1	43	31·3		43° 31·4′	+ 1·2	
,,	30	11	14	2	43	30·2	Needle			
,,	30	11	55	1	43	30·2	No. 2			
,,	30	11	55	2	43	30·0	43° 30·8′			
October	2	13	39	1	43	30·6	Needle			
,,	2	13	39	2	43	31·0	No. 1			
,,	8	13	44	1	43	28·6	43° 31·3′			
,,	8	13	44	2	43	28·7				
,,	8	14	33	1	43	30·7				
,,	8	14	33	2	43	28·1				
,,	11	14	0	1	43	31·9				
,,	11	14	0	2	43	30·9		43° 30·6′	+ 1·4	
,,	16	13	21	1	43	31·1				
,,	16	13	21	2	43	29·2				
,,	24	12	19	1	43	31·0				
,,	24	12	19	2	43	30·9				
,,	29	13	1	1	43	32·5				
,,	29	13	1	2	43	29·1	Needle			
,,	30	12	42	1	43	33·8	No. 2			
,,	30	12	42	2	43	31·3	43° 29·9′			

Absolute observations of Dip at Dehra Dun Observatory taken with Barrow's Dip Circle No. 44, Needles Nos. 1 and 2.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly mean for each Needle.	Monthly mean.	Needles 1-2	Remarks.
1906.										
Month.		h.	m.		°	'				
November	2	12	56	1	43	32·5	Needle No. 1 43° 32·8'	43° 32·7'	+ 0·3	
,,	2	12	56	2	43	30·8				
,,	8	13	51	1	43	34·3				
,,	8	13	51	2	43	34·5				
,,	13	14	37	1	43	34·7				
,,	13	14	37	2	43	32·5				
,,	13	15	3	1	43	35·2				
,,	13	15	3	2	43	36·6				
,,	15	13	17	1	43	32·1				
,,	15	13	17	2	43	32·5				
,,	20	11	28	1	43	31·2				
,,	20	11	28	2	43	30·5				
,,	26	12	17	1	43	31·0				
,,	26	12	17	2	43	31·2	Needle No. 2 43° 32·5'			
,,	28	11	32	1	43	31·4				
,,	28	11	32	2	43	31·5				
December	7	13	37	1	43	34·3	Needle No. 1 43° 34·2'	43° 32·9'	+ 2·7	
,,	7	13	37	2	43	31·0				
,,	10	14	48	1	43	33·8				
,,	10	14	48	2	43	31·8				
,,	13	12	41	1	43	32·5				
,,	13	12	41	2	43	29·0				
,,	13	13	49	2	43	31·7				
,,	17	12	58	1	43	36·2				
,,	17	12	58	2	43	33·5	Needle No. 2 43° 31·5'			
,,	20	12	21	1	43	34·3				
,,	20	12	42	2	43	32·2				

Hourly Means of Horizontal Force in C. G. S. Units (corrected for temperature) at Dehra Dún from the selected quiet days in 1906.

·3000 C. G. S. +

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Means.
Winter.																									
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January . .	375	375	375	377	374	376	377	378	379	379	371	371	373	374	375	378	379	377	377	377	375	375	378	379	376
February . .	369	364	366	365	367	368	371	375	378	380	379	379	378	379	373	370	368	368	367	367	367	366	363	370	371
March . . .	370	370	368	368	368	371	373	378	381	384	390	392	392	392	389	384	375	370	371	369	367	366	367	372	376
October . .	349	351	350	351	351	351	350	346	341	340	348	358	368	371	365	359	355	351	349	350	350	351	350	351	352
November . .	353	352	352	352	353	353	354	356	356	356	359	364	368	364	358	354	354	351	352	350	350	350	349	353	355
December . .	336	336	339	339	339	340	342	345	349	350	348	345	344	344	343	342	343	342	342	343	342	342	342	341	342
Means . . .	359	358	358	359	359	360	361	363	364	365	366	368	371	371	367	365	362	360	360	359	359	358	359	361	362
Summer.																									
April . . .	373	375	376	378	376	376	376	373	371	377	387	397	405	407	401	395	387	380	378	376	376	377	377	377	382
May . . .	362	362	362	361	360	360	301	359	357	356	361	371	383	388	383	376	370	363	361	361	362	362	362	363	365
June . . .	369	365	364	366	368	369	371	369	368	373	378	384	389	391	391	387	381	375	371	369	369	370	370	370	374
July . . .	357	357	357	357	357	357	359	357	356	360	366	372	378	377	375	370	366	359	356	357	358	361	361	359	362
August . . .	361	361	360	360	361	360	360	356	352	354	360	369	376	375	373	373	370	365	361	361	359	361	362	363	363
September . .	357	357	357	357	358	359	359	354	346	343	349	360	370	378	381	379	373	367	363	363	362	362	363	363	362
Means . . .	363	363	363	363	363	364	364	361	358	361	367	376	384	386	384	380	375	368	365	365	364	366	365	366	363

Diurnal Inequality of the Horizontal Force at Dehra Dún deduced from the preceding Table.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23
Winter.																								
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	−1	−1	−1	+1	−2	0	+1	+2	+3	+3	−5	−5	−3	−2	−1	+2	+3	+1	+1	+1	−1	+1	+2	+3
February	−2	−7	−5	−6	−4	−3	0	+4	+7	+9	+8	+8	+7	+8	+2	−1	−3	−3	−4	−4	−4	−5	−3	−1
March	−6	−6	−8	−8	−8	−5	−3	+2	+5	+8	+14	+16	+16	+16	+13	+8	−1	−6	−5	−7	−9	−10	−9	−4
October	−3	−1	−2	−1	−1	−1	−2	−6	−11	−12	−4	+6	+16	+19	+13	+7	+3	−1	−3	−2	−2	−1	−2	−1
November	−2	−3	−3	−3	−2	−2	−1	+1	+1	+1	+4	+9	+13	+9	+3	−1	−1	−4	−3	−5	−5	−5	−6	−2
December	−6	−6	−3	−3	−3	−2	0	+3	+7	+8	+6	+3	+2	+2	+1	0	+1	0	0	+1	0	0	0	−1
Means	−3	−4	−4	−3	−3	−2	−1	+1	+2	+3	+4	+6	+9	+9	+5	+3	+0	−2	−2	−3	−3	−4	−3	−1
Summer.																								
April	−9	−7	−6	−4	−6	−6	−6	−9	−11	−5	+5	+15	+23	+25	+19	+13	+5	−2	−4	−6	−6	−5	−5	−5
May	−3	−3	−3	−4	−5	−5	−4	−6	−8	−9	−4	+6	+18	+23	+18	+11	+5	−2	−4	−4	−3	−3	−3	−2
June	−5	−9	−10	−8	−6	−5	−3	−5	−6	−1	+4	+10	+15	+17	+17	+13	+7	+1	−3	−5	−5	−4	−4	−4
July	−5	−5	−5	−5	−5	−5	−3	−5	−6	−2	+4	+10	+16	+15	+13	+8	+4	−3	−6	−5	−4	−1	−1	−3
August	−2	−2	−3	−3	−2	−3	−3	−7	−11	−9	−3	+6	+13	+12	+10	+10	+7	+2	−2	−2	−4	−2	−1	0
September	−5	−5	−5	−5	−4	−3	−3	−8	−16	−19	−13	−2	+8	+16	+19	+17	+11	+5	+1	+1	0	0	+1	+1
Means	−5	−5	−5	−5	−5	−5	−4	−7	−10	−8	−1	+8	+16	+18	+16	+12	+7	+0	−3	−4	−4	−3	−2	−2

N. B.—When the sign is + the Force is more and when — less than the mean value for the month.

Hourly Means of the Declination as determined at Dehra Dûn from the selected quiet days in 1906.

Declination 2°+

Winter.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Means.
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	39.5	39.4	39.5	39.3	39.3	39.2	39.2	39.5	40.5	41.2	41.3	40.0	39.0	38.8	38.7	39.0	39.4	39.5	39.4	39.5	39.6	39.5	39.5	39.5	39.6
February	39.4	39.5	39.3	39.3	39.0	38.9	38.9	39.1	40.6	41.6	41.6	40.4	39.2	38.4	.3	38.7	39.2	39.4	39.3	39.3	39.3	39.3	39.5	39.5	39.5
March	39.4	39.5	39.6	39.5	39.5	39.3	39.1	39.9	41.5	42.3	41.9	40.2	38.4	36.9	36.7	37.6	38.5	39.0	39.0	38.7	38.9	39.1	39.1	39.3	39.3
October	39.3	39.2	39.3	39.3	39.2	39.2	39.4	40.1	40.7	40.5	39.4	37.9	36.6	36.4	37.4	38.5	39.2	39.2	39.0	38.9	39.0	39.1	39.2	39.3	39.0
November	39.0	39.0	39.0	38.9	38.9	38.7	38.7	39.0	39.6	39.9	39.5	38.3	37.5	37.8	38.4	38.7	38.8	38.8	38.8	38.8	38.8	38.9	39.1	39.1	38.8
December	39.2	39.1	38.9	38.8	38.7	38.5	38.4	38.3	38.5	39.3	39.3	38.4	38.1	38.1	38.4	38.8	39.0	39.0	39.0	39.1	39.0	39.0	39.2	39.1	38.8
Means	39.3	39.3	39.3	39.2	39.1	39.0	39.0	39.3	40.2	40.8	40.5	39.2	38.1	37.7	38.0	38.6	39.0	39.2	39.1	39.1	39.1	39.2	39.3	39.3	39.2

Summer.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Means.
April	39.6	39.6	39.6	39.4	39.4	39.6	40.4	42.0	43.2	43.0	41.1	38.4	36.9	36.3	36.8	38.1	39.0	39.3	39.3	38.9	38.9	39.0	39.0	39.2	39.4
May	39.5	39.6	39.5	39.6	39.7	40.0	41.3	42.3	42.9	42.2	40.3	38.0	36.3	36.1	36.6	37.0	37.8	38.7	39.2	39.1	39.1	39.2	39.3	39.4	39.3
June	39.6	39.7	39.7	39.8	39.7	40.0	41.1	41.9	42.2	41.5	40.2	38.3	37.1	36.5	36.6	37.0	37.6	38.7	39.1	39.0	38.8	39.0	39.1	39.3	39.2
July	39.0	39.2	39.3	39.3	39.4	39.8	41.3	42.7	42.6	41.4	39.2	37.0	35.6	35.0	35.3	36.1	37.3	38.4	39.1	39.1	38.8	38.8	38.8	38.9	38.8
August	39.0	39.1	39.1	39.1	39.3	39.6	41.5	.6	42.2	40.8	38.9	37.3	36.7	36.6	36.9	37.8	38.5	39.4	39.6	39.1	38.8	38.8	38.7	38.8	39.1
September	39.3	39.4	39.5	39.5	39.5	39.6	40.3	41.4	42.2	41.5	39.7	37.5	36.0	35.7	36.4	37.9	39.0	39.5	39.2	38.9	38.9	39.0	39.1	39.2	39.1
Means	39.3	39.4	39.5	39.5	39.5	39.8	41.0	42.2	42.6	41.7	39.9	37.8	36.4	36.0	36.4	37.3	38.2	39.0	39.3	39.0	38.9	39.0	39.0	39.1	39.2

Diurnal Inequality of the Declination at Dehra Dún as deduced from the preceding Table.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23
Winter.																								
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	−0·1	−0·2	−0·1	−0·3	−0·3	−0·4	−0·4	−0·1	+0·9	+1·6	+1·7	+0·4	−0·6	−0·8	−0·9	−0·6	−0·2	−0·1	−0·2	−0·1	−0·0	−0·1	−0·1	−0·1
February	−0·1	0·0	−0·2	−0·2	−0·5	−0·6	−0·6	−0·4	+1·1	+2·1	+2·1	+0·9	−0·3	−1·1	−1·2	−0·8	−0·3	−0·1	−0·2	−0·2	−0·2	−0·2	0·0	0·0
March	+0·1	+0·2	+0·3	+0·2	+0·2	0·0	−0·2	+0·6	+2·2	+3·0	+2·6	+0·9	−0·9	−2·4	−2·6	−1·7	−0·8	−0·3	−0·3	−0·6	−0·4	−0·2	−0·2	0·0
October	+0·3	+0·2	+0·3	+0·3	+0·2	+0·2	+0·4	+1·1	+1·7	+1·5	+0·4	−1·1	−2·4	−2·6	−1·6	−0·5	+0·2	+0·2	0·0	−0·1	0·0	+0·1	+0·2	+0·3
November	+0·2	+0·2	+0·2	+0·1	+0·1	−0·1	−0·1	+0·2	+0·8	+1·1	+0·7	−0·5	−1·3	−1·0	−0·4	−0·1	0·0	0·0	0·0	0·0	0·0	+0·1	+0·3	+0·3
December	+0·4	+0·3	+0·1	0·0	−0·1	−0·3	−0·4	−0·5	−0·3	+0·5	+0·5	−0·4	−0·7	−0·7	−0·4	−0·0	+0·2	+0·2	+0·2	+0·3	+0·2	+0·2	+0·4	+0·3
Means	+0·1	+0·1	+0·1	0	−0·1	−0·2	−0·2	+0·1	+1·0	+1·6	+1·3	0	−1·1	−1·5	−1·2	−0·6	−0·2	0	−0·1	−0·1	−0·1	0	+0·1	+0·1
Summer.																								
April	+0·1	+0·2	+0·2	0·0	0·0	+0·2	+1·0	+2·6	+3·8	+3·6	+1·7	−1·0	−2·5	−3·1	−2·6	−1·3	−0·4	−0·1	−0·1	−0·5	−0·5	−0·4	−0·4	−0·2
May	+0·2	+0·3	+0·2	+0·3	+0·4	+0·7	+2·0	+3·0	+3·6	+2·9	+1·0	−1·3	−3·0	−3·2	−2·7	−2·3	−1·5	−0·6	−0·1	−0·2	−0·2	−0·1	+0·0	+0·1
June	+0·4	+0·5	+0·5	+0·6	+0·5	+0·8	+1·9	+2·7	+3·0	+2·3	+1·0	−0·9	−2·1	−2·7	−2·6	−2·2	−1·6	−0·5	−0·1	−0·2	−0·4	−0·2	−0·1	+0·1
July	+0·2	+0·4	+0·5	+0·5	+0·6	+1·0	+2·5	+3·9	+3·8	+2·6	+0·4	−1·8	−3·2	−3·8	−3·5	−2·7	−1·5	−0·4	+0·3	+0·3	0·0	0·0	0·0	+0·1
August	−0·1	0·0	0·0	0·0	+0·2	+0·5	+2·4	+3·5	+3·1	+1·7	−0·2	−1·8	−2·4	−2·5	−2·2	−1·3	−0·5	+0·3	+0·5	0·0	−0·3	−0·3	−0·4	−0·3
September	+0·2	+0·3	+0·4	+0·4	+0·4	+0·5	+1·2	+2·3	+3·1	+2·4	+0·6	−1·6	−3·1	−3·4	−2·7	−1·2	−0·1	+0·4	+0·1	−0·2	−0·2	−0·1	0·0	+0·1
Means	+0·1	+0·2	+0·3	+0·3	+0·3	+0·6	+1·8	+3·0	+3·4	+2·5	+0·7	+1·4	−2·8	−3·2	−2·8	−1·9	−1·0	−0·2	+0·1	−0·2	−0·3	−0·2	−0·2	−0·1

N. B.—When the sign is + the Magnet points to the East and when − to the West of the mean position for the month.

D.—Tables of results at Barrackpore Observatory for 1906.

LIST OF TABLES.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Barrackpore Observatory taken with Barrow's Dip, Circle No. 45, Needles Nos. 1 and 2 by Dover.

1		2		3	4		5	6		7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly mean for each Needle.	Monthly Mean.		Needles 1—2.	REMARKS.
1906.		h.	m.		°	′	° ′	°	′	′	
January	1	13	25	1	30	28·0	No. 1. Mean				
,,	1	13	25	2	30	24·4	30 26·7				
,,	8	9	57	1	30	27·4		30	25·5	+2·4	
,,	8	9	57	2	30	24·5	No. 2. Mean				
,,	11	14	46	1	30	26·8	30 24·3				
,,	11	14	46	2	30	23·7					
,,	12	14	56	1	30	25·1					
,,	12	14	56	2	30	23·4					
,,	13	11	56	1	30	24·8					
,,	13	11	56	2	30	21·1					
,,	15	15	52	1	30	27·0					
,,	15	15	52	2	30	25·0					
,,	16	12	56	1	30	25·3					
,,	16	12	56	2	30	23·2					
,,	18	13	29	1	30	25·6					
,,	18	13	29	2	30	24·2					
,,	18	14	37	1	30	27·3					
,,	18	14	37	2	30	25·9					
,,	22	13	45	1	30	26·9					
,,	22	13	45	2	30	24·4					
,,	25	12	39	1	30	28·8					
,,	25	12	39	2	30	26·7					
,,	29	13	23	1	30	27·5					
,,	29	13	23	2	30	24·7					
February	1	13	50	1	30	28·5					
,,	1	13	50	2	30	24·3	No. 1. Mean				
,,	5	13	32	1	30	24·4	30 25·6				
,,	5	13	32	2	30	22·2	No. 2. Mean	30	24·6	+2·1	
,,	8	12	28	1	30	25·4	30 23·5				

Observations of Dip at Barrackpore Observatory taken with Barrow's Dip, Circle No. 45, Needles Nos. 1 and 2 by Dover—contd.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly mean for each Needle.	Monthly Mean.	Needles 1—2.	Remarks.
1906.		h.	m.		°	'	° '	° '	'	
February	8	12	28	2	30	22·6				
„	12	13	47	1	30	24·6				
„	12	13	47	2	30	23·6				
„	15	12	48	1	30	24·8				
„	15	12	48	2	30	23·4				
„	19	14	42	1	30	26·3				
„	19	14	42	2	30	25·1				
„	22	14	45	1	30	25·5				
„	22	14	45	2	30	23·0				
March	5	15	10	1	30	28·9				
„	5	15	10	2	30	26·3	No. 1. Mean			
„	8	13	50	1	30	25·1	30 27·7			
„	8	13	50	2	30	22·2		30 26·4	+2·7	
„	12	9	17	1	30	29·0	No. 2. Mean			
„	12	9	17	2	30	25·4	30 25·0			
„	19	12	27	1	30	28·5				
„	19	12	27	2	30	26·2				
„	26	14	32	1	30	27·1				
„	26	14	32	2	30	24·7				
April	2	16	25	1	30	28·3				
„	2	16	25	2	30	25·2				
„	5	15	20	1	30	26·7	No. 1. Mean			
„	5	15	20	2	30	24·5				
„	9	16	40	1	30	29·0	30 27·1			
„	9	16	40	2	30	27·7				
„	12	17	9	1	30	29·0				
„	12	17	9	2	30	26·8		30 26·1	+2·1	
„	16	11	44	1	30	25·0				
„	16	11	16	2	30	22·8	No. 2. Mean			
„	19	11	30	1	30	24·6				
„	19	11	30	2	30	22·9	30 25·0			
„	23	11	11	1	30	28·2				
„	23	11	11	2	30	25·4				
„	26	12	20	1	30	26·7				
„	26	12	20	2	30	24·5				
„	30	11	9	1	30	26·1				
„	30	11	9	2	30	25·3				

Observations of Dip at Barrackpore Observatory taken with Barrow's Dip, Circle No. 45, Needles Nos. 1 and 2 by Dover—contd.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly Mean for each Needle.	Monthly Mean.	Needles 1—2.	Remarks.
1906.		h.	m.		°	′	° ′	° ′	′	
May	3	9	46·	1	30	24·9	No. 1. Mean			
"	3	9	46·	2	30	24·5	30 25·0			
"	7	9	4·0	1	30	25·0		30 24·7	+0·6	
"	7	9	4·0	2	30	24·5				
"	24	12	6	...		...	No. 2. Mean			
"	24	12	6	2	30	25·9	30 24·4			
"	24	12	24	1	30	26·2				
"	28	9	16	1	30	23·4				
"	28	9	16	2	30	23·0				
"	31	9	54	1	30	25·3				
"	31	9	54	2	30	24·1				
June	4	11	13	1	30	26·6	No. 1. Mean			
"	4	11	13	2	30	26·5	30 26·1			
"	7	11	7	1	30	26·7				
"	7	11	7	2	30	24·8		30 25·6	+1·1	
"	18	11	45	1	30	27·1	No. 2. Mean			
"	18	11	45	2	30	25·8	30 25·0			
"	21	11	49	1	30	24·2				
"	21	11	49	2	30	23·9				
"	25	11	18	1	30	25·5				
"	25	11	18	2	30	24·0				
"	28	12	18·	1	30	26·4				
"	28	12	18·	2	30	25·2				
July	2	13	41	1	30	26·0				
"	2	13	41	2	30	25·3				
"	5	14	3	1	30	26·9	No. 1. Mean			
"	5	14	3	2	30	24·6	30 27·0			
"	9	13	28	1	30	25·4		30 26·3	+1·4	
"	9	13	28	2	30	23·6	No. 2. Mean			
"	12	12	56	1	30	27·3	30 25·6			
"	12	12	56	2	30	25·9				
"	16	14	46	1	30	25·7				
"	16	14	46	2	30	24·3				
"	20	16	36	1	30	28·2				
"	20	16	36	2	30	25·9				
"	23	14	23	1	30	26·6				
"	23	14	23	2	30	25·3				

Observations of Dip at Barrackpore Observatory taken with Barrow's Dip, Circle No. 45, Needles Nos. 1 and 2 by Dover—contd.

1		2		3	4		5		6		7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly mean for each Needle.		Monthly Mean.		Needles 1—2.	Remarks.
1906.		h.	m.		°	′	°	′	°	′	′	
July	26	13	46	1	30	26·2						
„	26	13	46	2	30	24·2						
„	30	16	17	1	30	31·1						
„	30	16	17	2	30	30·0						
August	2	15	32	1	30	27·4						
„	2	15	32	2	30	27·6	No. 1. Mean					
„	6	14	25	1	30	26·9						
„	6	14	25	2	30	24·3	30	27·8				
„	16	12	41	1	30	26·9						
„	16	12	41	2	30	26·6						
„	20	13	53	1	30	29·0			30	27·2	+1·2	
„	20	13	53	2	30	27·4	No. 2. Mean					
„	23	13	44	1	30	28·3	30	26·6				
„	23	13	44	2	30	26·2						
„	27	12	38	1	30	28·5						
„	27	12	38	2	30	27·7						
September	20	12	33	1	30	26·5	No. 1. Mean					
„	20	12	33	2	30	25·5	30	27·6				
„	24	14	56	1	30	29·1						
„	24	14	56	2	30	28·2			30	26·9	+1·4	
„	27	12	43	1	30	27·1						
„	27	12	43	2	30	25·0	No. 2 Mean					
October	2	12	59	1	30	28·4	30	26·2				
„	2	12	59	2	30	27·5						
„	4	16	9	1	30	29·5	No. 1. Mean					
„	4	16	9	2	30	27·2	30	28·7				
„	8	14	28	1	30	29·3						
„	8	14	28	2	30	28·6			30	28·1	+1·3	
„	11	16	13	1	30	27·5						
„	11	16	13	2	30	26·9	No. 2. Mean					
„	15	14	26	1	30	29·2	30	27·4				
„	15	14	26	2	30	28·5						
„	18	12	27	1	30	28·9						
„	18	12	27	2	30	28·5						
„	22	14	8	1	30	27·9						
„	22	14	8	2	30	26·5						
„	25	13	30	1	30	29·8						

Observations of Dip at Barrackpore Observatory taken with Barrow's Dip, Circle No. 45, Needles Nos. 1 and 2 by Dover—contd.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly mean for each Needle.	Monthly Mean.	Needles 1—2.	REMARKS.
1906.		h.	m.		°	′	° ′	° ′	′	
October	25	13	30	2	30	26·5				
”	29	13	25	1	30	28·0				
”	29	13	25	2	30	26·8				
November	1	12	29	1	30	27·6	No. 1. Mean			
”	1	12	29	2	30	26·5	30 28·0			
”	5	12	29	1	30	27·8				
”	5	12	29	2	30	27·1	No. 2. Mean	30 27·3	+1·5	
”	8	14	44	1	30	27·7	30 26·5			
”	8	14	44	2	30	26·6				
”	12	13	32	1	30	28·7				
”	12	13	32	2	30	26·1				
”	15	12	34	1	30	27·7				
”	15	12	34	2	30	25·6				
”	19	13	38	1	30	26·4				
”	19	13	38	2	30	25·5				
”	22	13	27	1	30	29·9				
”	22	13	27	2	30	27·8				
December	9	14	5	1	30	27·3				
”	9	14	5	2	30	28·2				
”	9	14	24	1	30	28·4	No. 1. Mean			
”	9	14	24	2	30	27·5	30 28·3			
”	9	14	45	1	30	34·3				
”	9	14	45	2	30	32·4				
”	9	15	8	1	30	34·5		30 28·4	−0·1	
”	9	15	8	2	30	33·5				
”	9	15	29	1	30	28·8				
”	9	15	29	2	30	31·4	No. 2. Mean			
”	9	15	49	1	30	31·9	30 28·4			
”	9	15	49	2	30	29·1				
”	13	15	16	1	30	26·7				
”	13	15	16	2	30	26·5				
”	13	15	53	1	30	26·4				
”	13	15	53	2	30	28·0				
”	13	15	34	1	30	26·5				
”	13	15	34	2	30	28·2				
”	21	13	43	1	30	26·6				
”	21	13	43	2	30	27·1				

Observations of Dip at Barrackpore Observatory taken with Barrow's Dip, Circle No. 45, Needles Nos. 1 and 2 by Dover—concld.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly mean for each Needle.	Monthly Mean.	Needles 1—2.	REMARKS.
1906.		h.	m.		°	′				
December	21	14	1	1	30	27·3				
„	21	14	1	2	30	26·2				
„	25	8	54	1	30	28·3				
„	25	8	54	2	30	28·2				
„	27	13	38	1	30	24·5				
„	27	13	38	2	30	25·3				
„	27	13	53	1	30	26·0				
„	27	13	53	2	30	25·8				
„	31	13	56	1	30	27·4				
„	31	13	56	2	30	28·2				

Hourly Means of Horizontal Force in C. G. S. Units (corrected for temperature) at Barrackpore from the selected quiet days in 1906.

0·37000 C. G. S. +

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Means.
Winter.																									
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January . .	239	240	241	241	241	242	243	245	249	253	254	254	252	251	251	251	250	246	245	244	243	240	241	244	246
February . .	238	239	235	238	238	240	242	247	253	260	265	265	266	261	254	247	241	240	239	239	237	235	236	241	246
March . .	246	246	244	244	245	245	246	251	259	271	283	289	292	288	280	268	258	251	250	249	245	242	242	247	257
October . .	262	261	260	259	260	260	258	256	255	261	273	287	295	295	286	272	266	261	260	259	259	259	260	261	266
November . .	259	259	260	261	260	260	262	264	268	273	282	289	287	282	271	265	260	257	256	256	255	255	256	259	265
December . .	254	254	254	255	257	257	260	265	272	277	279	276	270	266	260	257	259	258	257	256	257	256	258	259	261
Means .	250	250	249	250	250	251	252	255	259	266	273	277	277	274	267	260	256	252	251	251	249	248	249	252	257
Summer.																									
April . . .	250	249	251	251	254	252	254	254	260	276	296	304	306	302	291	279	268	260	257	256	254	252	253	254	266
May . . .	252	253	253	253	253	254	255	258	265	276	288	301	305	300	281	269	258	250	256	254	254	255	255	254	265
June . . .	247	245	245	245	247	250	249	253	255	259	270	275	279	278	275	267	259	251	249	246	245	245	246	248	255
July . . .	247	248	.250	248	248	249	251	254	255	265	277	285	289	285	278	268	260	256	252	251	253	253	257	256	260
August . .	252	255	254	253	254	255	256	257	257	262	271	275	280	278	274	269	263	259	259	256	255	254	255	257	261
September . .	251	251	251	252	252	253	254	249	244	251	265	274	282	283	279	272	266	261	259	257	256	256	256	256	260
Means .	250	250	251	250	251	252	253	254	256	265	278	286	290	288	280	271	262	256	255	253	253	253	254	254	261

Diurnal Inequality of the Horizontal Force at Barrackpore as deducted from the preceding Table.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23
Winter.																								
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	−7	−6	−5	−5	−5	−4	−3	−1	+3	+7	+8	+8	+6	+5	+5	+5	+4	0	−1	−2	−3	−6	−5	−2
February	−8	−7	11	−8	−8	−6	−4	+1	+7	+14	+19	+19	+20	+15	+8	+1	−5	−6	−7	−7	−9	−11	−10	−5
March	−11	−11	−13	−13	−12	−12	−11	−6	+2	+14	+26	+32	+35	+31	+23	−11	+1	−6	−7	−8	−12	−15	−15	−10
October	−4	−5	−6	−7	−6	−6	−3	−10	−11	−5	−7	+21	+29	+29	+20	+6	0	−5	−6	−7	−7	−7	−6	−5
November	−6	−6	−5	−4	−5	−5	−3	−1	+3	+8	+17	+24	+22	+17	+6	0	−5	−8	−9	−9	−10	−10	−9	−6
December	−7	−7	−7	−6	−4	−4	−1	+4	+11	+16	+18	+15	+9	+5	−1	−4	−2	−3	−4	−5	−4	−5	−3	−2
Means	−7	−7	−8	−7	−7	−6	−5	−2	+2	+9	+16	+20	+20	+16	+10	+3	−1	−5	−16	−6	−7	−9	−8	−5
Summer.																								
April	−16	−17	−15	−15	−12	−14	−12	−12	−6	+10	+30	+38	+40	+36	+25	+13	+2	−6	−9	−10	−12	−14	−13	−12
May	−13	−12	−12	−12	−12	−11	−10	−7	0	+11	+23	+36	+40	+35	+16	+4	−7	−15	−9	−11	−11	−10	−10	−11
June	−8	−10	−10	−10	−8	−5	−6	−2	0	+4	+15	+20	+24	+23	+20	+12	+4	−4	−6	−9	−10	−10	−9	−7
July	−13	−12	−10	−12	−12	−11	−9	−6	−5	+5	+17	+25	+29	+25	+18	+8	0	−4	−8	−9	−7	−7	−3	−4
August	−9	−6	−7	−8	−7	−6	−5	−4	−4	+1	+10	+14	+19	+17	+13	+8	+2	−2	−2	−5	−6	−7	−6	−4
September	−9	−9	−9	−8	−8	−7	−6	−11	−16	−9	+5	+14	+22	+23	+19	+12	+6	+1	−1	−3	−4	−4	−4	−4
Means	−11	−11	−10	−11	−10	−9	−8	−7	−5	+4	+17	+25	+29	+27	+19	+10	+1	−5	−6	−8	−8	−8	−7	−7

N.B.—When the sign is + the Force is more and when − less than the mean value for the month.

Hourly Means of the Declination as determined at Barrackpore from the selected quiet days in 1906.

Declination 0°+

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Means.
Winter.																									
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	15·6	15·6	15·6	15·5	15·5	15·3	15·2	15·6	16·5	17·3	17·3	15·7	14·7	14·1	13·7	14·3	15·4	15·6	15·2	15·5	15·6	15·6	15·5	15·5	15·5
February	15·5	15·4	15·4	15·2	15·2	14·9	14·8	15·1	16·5	17·7	17·8	16·6	15·3	14·6	14·5	14·7	15·2	15·4	15·3	15·6	15·4	15·5	15·4	15·5	15·5
March	15·3	15·3	15·4	15·3	15·1	14·9	14·7	15·4	16·6	17·6	17·6	16·4	14·7	13·3	13·3	14·2	15·0	15·3	15·2	15·2	15·2	15·3	15·1	15·2	15·3
October	13·1	13·1	13·2	13·1	13·0	13·0	13·2	14·2	14·8	14·4	13·3	11·6	10·7	10·8	11·7	12·8	13·5	13·5	13·0	12·9	13·0	12·9	12·9	13·0	13·0
November	12·9	12·8	12·8	12·8	12·6	12·5	12·5	12·8	13·4	13·4	12·8	11·8	11·6	12·2	12·6	12·7	12·8	12·7	12·7	12·7	12·6	12·6	12·7	12·8	12·7
December	12·6	12·6	12·4	12·3	12·2	12·1	11·8	11·4	11·8	12·4	12·7	12·4	11·3	11·3	11·8	12·2	12·6	12·5	12·3	12·4	12·4	12·3	12·3	12·4	12·2
Means	14·1	14·2	14·1	14·0	13·9	13·8	13·7	14·1	14·9	15·5	15·2	14·1	13·1	12·7	12·9	13·5	14·1	14·2	14·0	14·1	14·0	14·0	14·0	14·1	14·0
Summer.																									
April	15·0	15·1	15·0	15·0	14·7	14·8	15·9	17·5	17·9	17·1	15·5	13·5	12·2	12·1	13·1	14·3	15·2	15·3	14·9	14·6	14·6	14·6	14·6	14·7	14·9
May	14·5	14·6	14·7	14·7	14·7	14·9	16·2	17·5	17·8	16·9	14·9	13·0	11·5	11·2	11·6	12·3	13·4	14·3	14·6	14·1	14·0	14·0	14·1	14·3	14·3
June	14·2	14·6	14·6	14·7	14·7	14·8	15·9	16·8	16·9	16·6	15·5	13·7	12·5	12·0	12·0	12·5	13·1	13·7	14·3	14·1	13·9	14·0	14·2	14·3	14·3
July	14·2	14·2	14·2	14·4	14·7	15·0	16·5	17·8	17·8	16·2	14·7	12·3	11·3	11·5	12·2	12·7	13·4	14·1	14·4	14·0	13·9	13·8	13·9	14·1	14·2
August	13·8	13·8	13·9	14·0	14·1	14·4	16·1	17·1	16·9	15·3	13·5	12·1	11·6	11·4	11·7	12·6	13·9	14·3	14·1	13·8	13·8	13·5	13·4	13·5	13·9
September	13·8	14·0	14·1	14·1	14·0	14·0	14·7	16·4	17·0	16·1	14·4	12·3	10·8	10·5	11·4	13·1	14·3	14·6	13·7	13·6	13·4	13·4	13·5	13·5	13·8
Means	14·3	14·4	14·4	14·5	14·5	14·6	15·9	17·2	17·4	16·4	14·7	12·8	11·6	11·4	12·0	12·9	13·9	14·4	14·3	14·1	13·9	13·9	14·0	14·1	14·2

Diurnal Inequality of the Declination at Barrackpore as deduced from the preceding Table.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23
Winter.																								
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	+0·1	+0·1	+0·1	0·0	0·0	−0·2	−0·3	+0·1	+1·0	+1·8	+1·8	+0·2	−0·8	−1·4	−1·8	−1·2	−0·1	+0·1	−0·3	0·0	+0·1	+0·1	0·0	0·0
February	0·0	−0·1	−0·1	−0·3	−0·3	−0·6	−0·7	−0·4	+1·0	+2·2	+2·3	+1·1	−0·2	−0·9	−1·0	−0·8	−0·3	−0·1	−0·2	+0·1	−0·1	0·0	−0·1	0·0
March	0·0	0·0	−0·1	0·0	−0·2	−0·4	−0·6	+0·1	+1·3	+2·3	+2·3	+1·1	−0·6	−2·0	−2·0	−1·1	−0·3	0·0	−0·1	−0·1	−0·1	0·0	−0·2	−0·1
October	+0·1	+0·1	+0·2	+0·1	0·0	0·0	+0·2	+1·2	+1·8	+1·4	+0·3	−1·4	−2·3	−2·2	−1·3	−0·2	+0·5	+0·5	0·0	−0·1	0·0	−0·1	−0·1	0·0
November	+0·2	+0·1	+0·1	+0·1	−0·1	−0·2	−0·2	+0·1	+0·7	+0·7	+0·1	−0·9	−1·1	−0·5	−0·1	0·0	+0·1	0·0	0·0	0·0	−0·1	−0·1	0·0	+0·1
December	+0·4	+0·4	+0·2	+0·1	0·0	−0·1	−0·4	−0·8	−0·4	+0·2	+0·5	+0·2	−0·9	−0·9	−0·4	0·0	+0·4	+0·3	+0·1	+0·2	+0·2	+0·1	+0·1	+0·2
Means	+0·1	+0·2	+0·1	0·0	−0·1	−0·2	−0·3	+0·1	+0·9	+1·5	+1·2	+0·1	−0·9	−1·3	−1·1	−0·5	+0·1	+0·2	0·0	+0·1	0·0	0·0	0·0	+0·1
Summer.																								
April	+0·1	+0·2	+0·1	+0·1	−0·2	−0·1	+1·0	+2·6	+3·0	+2·2	+0·6	−1·4	−2·7	−2·8	−1·8	−0·6	+0·3	+0·4	0·0	−0·3	−0·3	−0·3	−0·3	−0·2
May	+0·2	+0·3	+0·4	+0·4	+0·4	+0·6	+1·9	+3·2	+3·5	+2·6	+0·6	−1·3	−2·8	−3·1	−2·7	−2·0	−0·9	0·0	+0·3	−0·2	−0·3	−0·3	−0·2	0·0
June	−0·1	+0·3	+0·3	+0·4	+0·4	+0·5	+1·6	+2·5	+2·6	+2·3	+1·2	−0·6	−1·8	−2·3	−2·3	−1·8	−1·2	−0·6	0·0	−0·2	−0·4	−0·3	−0·1	0·0
July	0·0	0·0	0·0	+0·2	+0·5	+0·8	+2·3	+3·6	+3·6	+2·0	+0·5	−1·9	−2·9	−2·7	−2·0	−1·5	−0·8	−0·1	+0·2	−0·2	−0·3	−0·4	−0·3	−0·1
August	−0·1	−0·1	0·0	+0·1	+0·2	+0·5	+2·2	+3·2	+3·0	+1·4	−0·4	−1·8	−2·3	−2·5	−2·2	−1·3	0·0	+0·4	+0·2	−0·1	−0·1	−0·4	−0·5	−0·4
September	0·0	+0·2	+0·3	+0·3	+0·2	+0·2	+0·9	+2·6	+3·2	+2·3	+0·6	−1·5	−3·0	−3·3	−2·4	−0·7	−0·5	+0·8	−0·1	−0·2	−0·4	−0·4	−0·3	−0·3
Means	+0·1	+0·2	+0·2	+0·3	+0·3	+0·4	+1·7	+3·0	+3·2	+2·2	+0·5	−1·4	−2·6	−2·8	−2·2	−1·3	−0·3	+0·2	+0·1	−0·1	−0·3	−0·3	−0·2	−0·1

N.B.—When the sign is + the Magnet points to the East and when − to the West of the mean position for the month.

E.—Tables of results at Kodaikanal Observatory for 1906.

LIST OF TABLES.

1. Absolute observations of Dip.
2. Hourly means of Horizontal Force.
3. Diurnal inequality of Horizontal Force deduced from 2.
4. Hourly means of Declination.
5. Diurnal inequality of Declination deduced from 4.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikanal Observatory taken with Barrow's Dip, Circle No. 46, Needles Nos. 2—3c by Dover.

1		2		3	4	5	6	7	8
Date.		L. M. T.		Needle Nos.	Observed Dip.	Monthly Mean for each Needle.	Monthly Mean.	Needle 2—3c.	REMARKS.
1907.		h.	m.		° ′	° ′	° ′	° ′	
January	1	12	35	2	3 18·9				
„	1	12	35	3C	3 20·0				
„	3	12	23	2	3 16·5				
„	3	12	23	3C	3 17·8	No. 2			
„	4	13	20	2	3 16·0	3 17·1			
„	4	13	20	3C	3 14·6				
„	8	12	30	2	3 17·6				
„	8	12	30	3C	3 19·4				
„	10	12	31	2	3 21·1				
„	10	12	31	3C	3 21·7				
„	11	12	28	2	3 23·1				
„	11	12	28	3C	3 19·4		3 17·2	—0 0·1	
„	13	12	43	2	3 19·1				
„	13	12	43	3C	3 20·2				
„	15	12	50	2	3 20·0				
„	15	12	50	3C	3 18·1				
„	27	12	23	2	3 13·5				
„	27	12	23	3C	3 11·3	No. 3C			
„	29	13	49	2	3 14·2				
„	29	13	49	3C	3 17·9	3 17·2			
„	30	13	51	2	3 14·5				
„	30	13	51	3C	3 11·7				
„	30	14	17	2	3 10·8				
„	30	14	17	3C	3 14·5				
February	1	13	49	2	3 19·0				
„	1	13	49	3C	3 15·1				
„	1	14	49	2	3 20·8	No. 2			
„	1	14	49	3C	3 23·6				
„	5	13	25	2	3 22·8	3 19·5			

Observations of Dip at Kodaikanal Observatory taken with Barrow's Dip, Circle No. 46, Needles Nos. 2—3c by Dover—contd.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle Nos.	Observed Dip		Monthly Mean for each Needle.	Monthly Mean.	Needle 2—3c.	Remarks.
1906.		h.	m.		°	′	° ′	° ′	° ′	
February	5	13	25	3C	3	21·0				
"	6	13	38	2	3	20·5				
"	6	13	38	3C	3	22·5				
"	8	13	19	2	3	20·0				
"	8	13	19	3C	3	20·4				
"	12	13	9	2	3	18·8				
"	12	13	9	3C	3	18·2				
"	13	12	47	2	3	16·8				
"	13	12	47	3C	3	15·9				
"	14	13	23	2	3	20·0				
"	14	13	23	3C	3	18·1		3 19·4	+0 0·2	
"	16	13	29	2	3	14·5				
"	16	13	29	3C	3	16·1				
"	23	12	30	2	3	22·8				
"	23	12	30	3C	3	21·8	No. 3C			
"	24	13	23	2	3	19·7	3 19·3			
"	24	13	23	3C	3	19·4				
"	26	13	30	2	3	18·7				
"	26	13	30	3C	3	19·4				
"	27	13	30	2	3	18·8				
"	27	13	30	3C	3	19·9				
March	8	13	39	2	3	19·3				
"	8	13	39	3C	3	16·5	No. 2			
"	9	13	36	2	3	18·1	3 17·3			
"	9	13	36	3C	3	19·0				
"	12	13	29	2	3	17·0				
"	12	13	29	3C	3	19·1				
"	13	13	31	2	3	18·6				
"	13	13	31	3C	3	17·9				
"	15	13	29	2	3	16·1				
"	15	13	29	3C	3	20·4		3 17·8	—0 0·9	
"	17	13	22	2	3	15·0				
"	17	13	22	3C	3	16·7				
"	19	13	26	2	3	18·3	No. 3C			
"	19	13	26	3C	3	18·6	3 18·2			
"	22	13	27	2	3	14·3				

Observations of Dip at Kodaikanal Observatory taken with Barrow's Dip, Circle No. 46, Needles Nos. 2—3c by Dover—contd.

1		2		3	4	5	6	7	8
Date.		L. M. T.		Needle Nos.	Observed Dip.	Monthly Mean for each Needle.	Monthly Mean.	Needle, 2—3c.	REMARKS.
1906.		h.	m.		° ′	° ′	° ′	° ′	
March	22	13	27	3C	3 15·7				
,,	26	12	25	2	3 19·3				
,,	26	12	25	3C	3 19·5				
April	2	13	27	2	3 17·3	No. 2.			
,,	2	13	27	3C	3 18·9	3 18·9			
,,	5	13	22	2	3 18·4				
,,	5	13	22	3C	3 20·3				
,,	9	13	29	2	3 17·9				
,,	9	13	29	3C	3 17·9				
,,	12	13	28	2	3 19·4		3 19·4	−0 0·9	
,,	12	13	28	3C	3 19·5				
,,	17	13	25	2	3 20·7				
,,	17	13	25	3C	3 22·0				
,,	20	13	19	2	3 19·3	No. 3C			
,,	20	13	19	3C	3 22·5	3 19·8			
,,	23	13	32	2	3 19·0				
,,	23	13	32	3C	3 17·7				
May	3	13	18	2	3 18·2				
,,	3	13	18	3C	3 20·4	No. 2			
,,	7	13	26	2	3 23·5	3 20·7			
,,	7	13	26	3C	3 26·8				
,,	8	13	28	2	3 18·3				
,,	8	13	28	3C	3 17·5				
,,	14	13	23	2	3 21·7				
,,	14	13	23	3C	3 23·6				
,,	18	13	26	2	3 19·7		3 21·1	—0 0·7	
,,	18	13	26	3C	3 20·9				
,,	21	13	25	2	3 20·7				
,,	21	13	25	3C	3 21·4				
,,	24	13	29	2	3 19·8				
,,	24	13	29	3C	3 21·3	No. 3C			
,,	28	13	25	2	3 24·0	3 21·4			
,,	28	3	25	3C	3 22·8				
,,	31	13	26	2	3 20·3				
,,	31	13	26	3C	3 17·6				

Observations of Dip at Kodaikanal Observatory taken with Barrow's Dip, Circle No. 46, Needles Nos. 2—3c by Dover—contd.

1		2		3	4	5	6	7	8
Date.		L. M. T.		Needle Nos.	Observed Dip.	Monthly Mean for each Needle.	Monthly Mean.	Needle, 2—3c.	REMARKS.
1906.		h.	m		° ′	° ′	° ′	° ′	
June	4	13	31	2	3 19·4				
"	4	13	31	3C	3 22·4	No. 2			
"	7	13	22	2	3 21·1	3 20·2			
"	7	13	22	3C	3 22·5				
"	11	13	27	2	3 20·0				
"	11	13	27	3C	3 20·7				
"	14	13	21	2	3 21·2				
"	14	13	21	3C	3 20·3				
"	18	13	29	2	3 21·3				
"	18	13	29	3C	3 21·7				
"	21	13	23	2	3 18·0		3 20·8	—0 1·2	
"	21	13	23	3C	3 21·5				
"	22	13	21	2	3 19·0				
"	22	13	21	3C	3 21·2	No. 3C			
"	25	11	31	2	3 23·6				
"	25	11	31	3C	3 21·8	3 21.4			
"	26	13	33	2	3 18·4				
"	26	13	33	3C	3 21·1				
"	28	13	38	2	3 20·4				
"	28	13	38	3C	3 20·5				
July	2	13	27	2	3 19·3				
"	2	13	27	3C	3 23·0	No. 2			
"	6	14	33	2	3 20·5				
"	6	14	33	3C	3 23·0	3 21·1			
"	9	13	30	2	3 20·6				
"	9	13	30	3C	3 18·3				
"	12	13	25	2	3 22·2				
"	12	13	25	3C	3 24·0				
"	16	13	36	2	3 21·2				
"	16	13	36	3C	3 22·7		3 21·8	—0 1·4	
"	20	13	21	2	3 21·4				
"	20	13	21	3C	3 22·2				
"	23	13	29	2	3 21·7				
"	23	13	29	3C	3 23·1	No. 3C			
"	26	13	24	2	3 19·7				
"	26	13	24	3C	3 22·1	3 22·5			

Observations of Dip at Kodaikanal Observatory taken with Barrow's Dip, Circle No. 46, Needles Nos. 2—3c by Dover—contd.

1		2		3	4	5	6	7	8
Date.		L. M. T.		Needle Nos.	Observed Dip.	Monthly Mean for each Needle.	Monthly Mean.	Needle, 2—3c.	Remarks.
1906.		h.	m.		° ′	° ′	° ′	° ′	
July	30	13	21	2	3 23·3				
,,	30	13	21	3C	3 23·9				
August	6	13	28	2	3 20·0	No. 2			
,,	6	13	28	3C	3 22·3				
,,	10	13	31	2	3 20·4	3 20·6			
,,	10	13	31	3C	3 23·7				
,,	13	13	24	2	3 20·9				
,,	13	13	24	3C	3 23·9				
,,	14	13	29	2	3 20·7				
,,	14	13	29	3C	3 22·7				
,,	16	13	28	2	3 18·7				
,,	16	13	28	3C	3 21·3		3 21·7	—0 2·2	
,,	20	13	38	2	3 21·0				
,,	20	13	38	3C	3 22·1				
,,	23	13	34	2	3 21·6				
,,	23	13	34	3C	3 24·2				
,,	27	13	31	2	3 21·4				
,,	27	13	31	3C	3 24·5	No. 3C			
,,	28	13	28	2	3 22·5	3 22·8			
,,	28	13	28	3C	3 21·7				
,,	30	13	28	2	3 19·2				
,,	30	13	28	3C	3 21·9				
September	3	13	25	2	3 22·7				
,,	3	13	25	3C	3 24·1	No. 2			
,,	4	13	30	2	3 18·8				
,,	4	13	30	3C	3 21·7	3 21·1			
,,	7	13	36	2	3 22·7				
,,	7	13	36	3C	3 22·3				
,,	10	13	33	2	3 21·7				
,,	10	13	33	3C	3 21·9				
,,	13	13	26	2	3 21·5				
,,	13	13	26	3C	3 21·2	No. 3C	3 21·7	—0 1·2	
,,	17	13	38	2	3 23·8	3 22·3			
,,	17	13	38	3C	3 25·3				
,,	20	13	28	2	3 16·9				
,,	20	13	28	3C	3 20·0				
,,	21	13	22	2	3 18·9				

Observations of Dip at Kodaikanal Observatory taken with Barrow's Dip, Circle No. 46, Needles Nos. 2—3c by Dover—contd.

1		2		3	4	5	6	7	8
Date.		L. M. T.		Needle Nos.	Observed Dip.	Monthly Mean for each Needle.	Monthly Mean.	Needl, 2—3c.	REMARKS.
1906.		h.	m.		° ′	° ′	° ′	° ′	
September	21	13	22	3C	3 21·5				
"	24	13	23	2	3 22·2				
"	24	13	23	3C	3 21·8				
"	27	13	20	2	3 22·1				
"	27	13	20	3C	3 23·4				
October	1	13	32	2	3 20·1	No. 2			
"	1	13	32	3C	3 22·2	3 21·7			
"	8	13	29	2	3 19·0				
"	8	13	29	3C	3 20·5				
"	11	13	24	2	3 22·2				
"	11	13	24	3C	3 22·6				
"	22	13	29	2	3 23·1		3 22·3	—0 1·1	
"	22	13	29	3C	3 23·9				
"	25	13	23	2	3 21·6	No. 3C			
"	25	13	23	3C	3 22·2				
"	29	13	23	2	3 24·0	3 22·8			
"	29	13	23	3C	3 25·1				
November	1	13	27	2	3 23·4	No. 2			
"	1	13	27	3C	3 25·4				
"	5	13	28	2	3 23·1	3 24·3			
"	5	13	28	3C	3 25·3				
"	8	13	29	2	3 25·4				
"	8	13	29	3C	3 23·4				
"	9	13	29	2	3 24·0				
"	9	13	29	3C	3 22·8				
"	15	13	45	2	3 25·1				
"	15	13	45	3C	3 22·7				
"	16	13	22	2	3 22·5		3 24·5	—0 0·4	
"	16	13	22	3C	3 24·8				
"	19	13	40	2	3 23·4				
"	19	13	40	3C	3 25·4				
"	20	13	26	2	3 25·8				
"	20	13	26	3C	3 23·9	No. 3C			
"	26	13	24	2	3 25·0				
"	26	13	24	3C	3 25·4	3 24·7			
"	29	13	28	2	3 25·4				
"	29	13	28	3C	3 27·6				

Observations of Dip at Kodaikanal Observatory taken with Barrow's Dip, Circle No. 46, Needles Nos. 2—3c by Dover—concld.

1		2		3	4	5	6	7	8
Date.		L. M. T.		Needle Nos.	Observed Dip.	Monthly Mean for each Needle.	Monthly Mean.	Needle 2—3c.	Remarks.
1906.		h.	m.		° ′	° ′	° ′	° ′	
December	3	13	29	2	3 24·3	No. 2			
"	3	13	29	3C	3 26·8				
"	4	13	31	2	3 24·3	3 25·5			
"	4	13	31	3C	3 26·2				
"	6	13	20	2	3 24·7				
"	6	13	20	3C	3 26·5				
"	10	13	26	2	3 27·8				
"	10	13	26	3C	3 27·3				
"	13	13	25	2	3 27·4				
"	13	13	25	3C	3 27·1				
"	17	13	20	2	3 28·0				
"	17	13	20	3C	3 28·9				
"	20	13	21	2	3 27·6		3 25·8	—0 0·5	
"	20	13	21	3C	3 25·0				
"	21	13	24	2	3 22·8				
"	21	13	24	3C	3 23·5				
"	22	13	28	2	3 25·6				
"	22	13	28	3C	3 25·6				
"	24	13	34	2	3 23·9	No. 3C			
"	24	13	34	3C	3 24·6				
"	27	13	30	2	3 24·1				
"	27	13	30	3C	3 23·9				
"	31	13	26	2	3 25·7	3 26·0			
"	31	13	26	3C	3 26·1				

Hourly Means of Horizontal Force in C. G. S. Units (corrected for temperature) at Kodaikanal from the selected quiet days in 1906.

·37000 C. G. S. +

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Means.
Winter.																									
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	399	400	401	400	400	400	399	406	420	446	473	494	496	484	458	434	418	413	411	409	406	404	404	404	424
February	404	401	403	403	405	403	405	419	441	470	486	494	484	463	439	424	418	416	414	409	406	406	405	406	426
March	397	398	397	398	397	398	396	403	429	467	502	523	519	499	467	441	424	418	414	406	402	399	398	398	429
October	399	401	399	400	400	398	395	403	428	461	486	497	486	460	433	416	409	408	407	404	403	402	400	401	421
November	417	417	417	418	417	417	419	431	449	471	482	482	465	448	434	430	428	424	422	418	416	416	415	416	432
December	408	409	411	411	411	412	415	422	434	446	456	462	464	460	452	439	428	422	420	418	416	416	416	414	427
Means	404	404	405	405	405	405	405	414	434	460	481	492	486	469	447	431	421	417	415	411	408	407	406	407	427
Summer.																									
April	404	406	407	410	408	407	406	423	456	495	520	523	502	473	447	432	426	424	423	417	414	412	411	409	436
May	397	398	399	399	396	394	398	409	432	463	482	488	479	463	442	424	410	406	403	401	399	397	398	398	420
June	405	403	402	403	401	402	404	404	413	435	457	464	465	456	443	428	415	411	408	408	407	408	405	406	419
July	402	404	405	404	403	400	404	410	430	452	468	476	471	453	433	417	406	403	406	407	407	408	407	406	420
August	404	404	404	405	404	404	408	418	434	454	464	464	460	448	437	428	419	415	412	410	406	405	406	406	422
September	404	404	403	405	405	403	402	409	434	468	491	505	494	466	444	426	418	419	418	414	412	411	409	407	428
Means	403	403	403	404	403	402	404	412	433	461	480	487	479	460	441	426	416	413	412	410	408	407	406	405	424

Diurnal Inequality of the Horizontal Force at Kodaikanal as deduced from the preceding Table.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23
Winter.																								
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	−25	−24	−23	−24	−24	−24	−25	−18	−4	+22	+49	+70	+72	+60	+34	+10	−6	−11	−13	−15	−18	−20	−20	−20
February	−22	−25	−23	−23	−21	−23	−21	−7	+15	+44	+60	+68	+58	+37	+13	−2	−8	−10	−12	−17	−20	−20	−21	−20
March	−32	−31	−32	−31	−32	−31	−33	−26	0	+38	+73	+94	+90	+70	+38	+12	−5	−11	−15	−23	−27	−30	−31	−31
October	−22	−20	−22	−21	−21	−23	−26	−18	+7	+40	+65	+76	+65	+39	+12	−5	−12	−13	−14	−17	−18	−19	−21	−20
November	−15	−15	−15	−14	−15	−15	−13	−1	+17	+39	+50	+50	+33	+16	+2	−2	−4	−8	−10	−14	−16	−16	−17	−16
December	−19	−18	−16	−16	−16	−15	−12	−5	+7	+19	+29	+35	+37	+33	+25	+12	+1	−5	−7	−9	−11	−11	−11	−13
Means	−23	−23	−22	−22	−22	−22	−22	−13	−7	+33	+54	+65	+59	+42	+20	+4	−6	−10	−12	−16	−19	−20	−21	−20
Summer.																								
April	−32	−30	−29	−26	−28	−29	−30	−13	+20	+59	+84	+87	+66	+37	+11	−4	−10	−12	−13	−19	−22	−24	−25	−27
May	−23	−22	−21	−21	−24	−26	−22	−11	+12	+43	+62	+68	+59	+43	+22	+4	−10	−14	−17	−19	−21	−23	−22	−22
June	−14	−16	−17	−16	−18	−17	−15	−15	−6	+16	+38	+45	+46	+37	+24	+9	−4	−8	−11	−11	−12	−11	−14	−13
July	−18	−16	−15	−16	−17	−20	−16	−10	+10	+32	+48	+56	+51	+33	+13	−3	−14	−17	−14	−13	−13	−12	−13	−14
August	−18	−18	−18	−17	−18	−18	−14	−4	+12	+32	+42	+42	+38	+26	+15	+6	−3	−7	−10	−12	−16	−17	−16	−16
September	−24	−24	−25	−23	−23	−25	−26	−19	+6	+40	+63	+77	+66	+38	+16	−2	−10	−9	−10	−14	−16	−17	−19	−21
Means	−21	−21	−21	−20	−21	−22	−20	−12	+9	+37	+56	+63	+55	+36	+17	+2	−8	−11	−12	−14	−16	−17	−18	−19

N. B.—When the sign is + the Force is more and when — less than the mean value for the month.

Hourly Means of the Declination as determined at Kodaikanal from the selected quiet days in 1906.

Declination W. 0°+

Winter.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Means.
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January . . .	34·3	34·4	34·4	34·5	34·5	34·5	**34·6**	34·6	**34·2**	33·6	**33·2**	34·0	34·2	34·1	34·6	34·5	34·2	34·1	34·4	34·1	34·2	34·1	34·2	34·2	34·2
February . .	34·6	34·7	34·7	34·8	34·9	35·1	35·3	**35·5**	34·8	33·8	**33·1**	33·3	33·8	34·1	34·4	34·4	34·4	34·6	34·7	34·6	34·6	34·6	34·7	34·7	34·5
March . . .	34·9	34·8	34·8	34·8	35·0	35·1	**35·5**	35·4	34·8	34·2	**33·8**	34·0	34·8	35·3	35·2	34·7	34·4	34·4	34·8	34·8	34·9	34·9	35·0	35·0	34·8
October . . .	37·1	37·1	37·0	37·1	37·2	37·2	36·9	**36·7**	36·9	37·2	38·0	38·8	**39·1**	38·6	37·8	37·3	37·0	37·1	37·2	37·3	37·3	37·4	37·4	37·3	37·4
November . .	37·9	37·9	37·9	38·0	38·1	38·2	38·2	38·2	38·0	38·1	38·5	**38·8**	38·5	37·9	**37·6**	37·6	37·7	37·9	37·9	37·9	37·9	38·0	38·0	37·9	38·0
December . .	38·0	38·0	38·1	38·2	38·3	38·6	38·7	**39·1**	39·0	38·7	38·2	38·0	38·4	38·2	37·9	37·8	**37·8**	37·8	38·1	38·0	38·0	38·1	38·1	38·1	38·2
Means .	36·1	36·2	36·2	36·2	36·3	36·4	36·5	**36·6**	36·3	35·9	**35·8**	36·2	36·5	36·4	36·2	36·1	35·9	36·0	36·2	36·1	36·1	36·2	36·2	36·2	36·2

Summer.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Means.
April . . .	35·4	35·4	35·4	35·4	35·5	35·3	35·0	34·1	**34·0**	34·5	35·3	36·2	**36·8**	36·7	36·1	35·2	34·8	34·8	35·1	35·5	35·8	35·7	35·7	35·6	35·4
May . . .	35·9	35·8	35·8	35·8	35·7	35·5	34·8	34·0	**34·0**	34·6	35·8	36·9	37·6	**37·7**	36·7	36·1	35·9	35·8	35·7	36·0	36·2	36·1	36·0	35·9	35·9
June . . .	36·3	36·2	36·2	36·1	36·1	36·0	35·4	**35·0**	35·1	35·6	35·9	36·8	37·8	**37·9**	37·3	36·9	36·5	36·0	36·2	36·5	36·8	36·7	36·5	36·3	36·3
July . . .	36·4	36·3	36·2	36·2	36·2	36·0	35·2	**34·5**	34·7	35·6	37·0	38·2	**39·3**	39·1	38·5	37·7	37·0	36·7	36·3	36·4	36·7	36·8	36·7	36·6	36·7
August . .	37·9	36·7	36·7	36·6	36·5	36·3	35·3	**34·5**	34·8	35·8	37·4	38·2	**38·4**	38·3	37·7	37·3	36·7	36·3	36·3	36·7	37·0	37·0	37·0	37·0	36·7
September . .	37·1	27·0	37·0	37·0	37·1	37·0	36·3	35·2	**35·2**	36·3	37·4	38·4	**39·2**	39·2	38·5	37·0	36·5	36·5	36·7	37·1	37·3	37·2	37·2	37·1	37·1
Means .	36·3	36·2	36·2	36·2	37·2	36·0	35·3	**34·6**	34·6	35·4	36·4	37·4	**38·2**	38·2	37·5	36·7	36·2	36·0	36·1	36·4	36·6	36·6	36·5	36·4	36·4

Diurnal Inequality of the Declination at Kodaikanal as deduced from the preceding Table.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23
Winter.																								
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	+0·1	+0·2	+0·2	+0·3	+0·3	+0·3	+0·4	+0·4	0	−0·6	−1·0	−0·2	0	−0·1	+0·4	+0·3	0	−0·1	+0·2	−0·1	0	−0·1	0	0
February	+0·1	+0·2	+0·2	+0·3	+0·4	+0·6	+0·8	+1·0	+0·3	−0·7	−1·4	−1·2	−0·7	−0·4	−0·1	−0·1	−0·1	+0·1	+0·2	+0·1	+0·1	+0·1	+0·2	+0·2
March	+0·1	0	0	0	+0·2	+0·3	+0·7	+0·6	0	−0·6	−1·0	−0·8	0	+0·5	+0·4	−0·1	−0·4	−0·4	0	0	+0·1	+0·1	+0·2	+0·2
October	−0·3	−0·3	−0·4	−0·3	−0·2	−0·2	−0·5	−0·7	−0·5	−0·2	+0·6	+1·4	+1·	+1·2	+0·4	−0·1	−0·4	−0·3	−0·2	−0·1	−0·1	0	0	−0·1
November	−0·1	−0·1	−0·1	0	+0·1	+0·2	+0·2	+0·2	0	+0·1	+0·5	+0·8	+0·5	−0·1	−0·4	−0·4	−0·3	−0·1	−0·1	−0·1	−0·1	0	0	−0·1
December	−0·2	−0·2	−0·1	0	+0·1	+0·4	+0·5	+0·9	+0·8	+0·5	0	−0·2	+0·2	0	−0·3	−0·4	−0·4	−0·4	−0·1	−0·2	−0·2	−0·1	−0·1	−0·1
Means	−0·1	0	0	0	+0·1	+0·2	+0·3	+0·4	+0·1	−0·3	−0·4	0	+0·3	+0·2	0	−0·1	−0·3	−0·2	0	−0·1	−0·1	0	0	0
Summer.																								
April	0	0	0	0	+0·1	−0·1	−0·4	−1·3	−1·4	−0·9	−0·1	+0·8	+1·4	+1·3	+0·7	−0·2	−0·6	−0·6	−0·3	+0·1	+0·4	+0·3	+0·3	+0·2
May	0	−0·1	−0·1	−0·1	−0·2	−0·4	−1·1	−1·9	−1·9	−1·3	−0·1	+1·0	+1·7	+1·8	+0·8	+0·2	0	−0·1	−0·2	+0·1	+0·3	+0·2	+0·1	0
June	0	−0·1	−0·1	−0·2	−0·2	−0·3	−0·9	−1·3	−1·2	−0·7	−0·4	+0·5	+1·5	+1·6	+1·0	+0·6	+0·2	−0·3	−0·1	+0·2	+0·5	+0·4	+0·2	0
July	−0·3	−0·4	−0·5	−0·5	−0·5	−0·7	−1·5	−2·2	−2·0	−1·1	+0·3	+1·5	+2·6	+2·4	+1·8	+1·0	+0·3	0	−0·4	−0·3	0	+0·1	0	−0·1
August	+0·2	0	0	−0·1	−0·2	−0·4	−1·4	−2·2	−1·9	−0·9	+0·7	+1·5	+1·7	+1·6	+1·0	+0·6	0	−0·4	−0·4	0	+0·3	+0·3	+0·3	+0·3
September	0	−0·1	−0·1	−0·1	0	−0·1	−0·8	−1·9	−1·9	−0·8	+0·3	+1·3	+2·1	+2·1	+1·4	−0·1	−0·6	−0·6	−0·4	0	+0·2	+0·1	+0·1	0
Means	−0·1	−0·2	−0·2	−0·2	−0·2	−0·4	−1·1	−1·8	−1·8	−1·0	0	+1·0	+1·8	+1·8	+1·1	+0·3	−0·2	−0·4	−0·3	0	+0·2	+0·2	+0·1	0

N. B.—When the sign is — the magnet points to the East and when + to the West of the mean position for the month.

F.—Tables of results at Toungoo Observatory for 1906.

LIST OF TABLES.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Toungoo Observatory taken with Dover's Dip, Circle No. 137, Needle Nos. 1 and 2 by Dover.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly Mean with each Needle.	Monthly Mean.	Needles 1—2.	REMARKS.
1906.		h.	m.		°	′	° ′	° ′	′	
January	1	13	53	1	22	57·1				
„	1	13	53	2	22	59·6				
„	2	11	11	1	22	58·8	Needle No. 1.			
„	2	11	11	2	22	59·9				
„	3	9	50	1	22	58·0	22 58·0			
„	3	9	50	2	23	1·3				
„	8	13	7	1	22	57·4				
„	8	13	7	2	22	59·0	Needle No. 2.	22 58·8	—1·6	
„	12	12	49	1	22	57·2				
„	12	12	49	2	22	58·9				
„	15	13	34	1	22	58·3	22 59·6			
„	15	13	34	2	22	58·4				
„	18	13	11	1	22	58·0				
„	18	13	11	2	22	59·7				
„	22	13	35	1	22	59·2				
„	22	13	35	2	22	59·6				
February	1	13	13	1	23	0·2				
„	1	13	13	2	23	1·9	Needle No. 1.			
„	5	13	30	1	22	58·4				
„	5	13	30	2	23	0·8	22 59·2			
„	8	12	53	1	22	58·2				
„	8	12	53	2	22	59·1		22 59·9	—1·3	
„	12	12	32	1	22	58·6				
„	12	12	32	2	22	59·6	Needle No. 2.			
„	15	12	54	1	22	58·9				
„	15	12	54	2	23	0·9	22 60·5			
„	19	12	31	1	23	0·6				
„	19	12	31	2	23	1·3				
„	22	13	2	1	22	58·9				

Observations of Dip at Toungoo Observatory taken with Dovers Dip, Circle No. 137, Needle Nos. 1 and 2 by Dover—contd.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly Mean with each Needle.	Monthly Mean.	Needle 1—2.	REMARKS.
1906.		h.	m.		°	′	° ′	° ′	° ′	
February	22	13	2	2	22	59·4				
"	26	12	47	1	22	59·7				
"	26	12	47	2	23	1·2				
March	5	12	22	1	22	58·4				
"	5	12	22	2	22	58·9	Needle No. 1. 22 58·4			
"	8	12	31	1	22	59·1				
"	8	12	31	2	22	58·5				
"	12	12	16	1	22	57·7				
"	12	12	16	2	22	59·7		22 58·8	—0 0·8	
"	15	12	50	1	22	58·7				
"	15	12	50	2	22	59·1				
"	19	12	22	1	22	57·9	Needle No. 2. 22 59·2			
	19	12	22	2	22	59·7				
	22	13	2	1	22	57·3				
	22	13	2	2	22	58·1				
	26	13	40	1	22	58·6				
	26	13	40	2	22	59·6				
"	29	13	28	1	22	59·2				
"	29	13	28	2	22	59·8				
April	2	13	19	1	22	59·1				
"	2	13	19	2	22	59·5	Needle No. 1. 22 58·3			
"	6	13	28	1	22	58·4				
"	6	13	28	2	22	59·2				
"	9	13	25	1	22	58·3				
"	9	13	25	2	22	59·9		22 59·0	—0 1·3	
"	12	13	46	1	23	0·2				
"	12	13	46	2	23	1·7				
"	16	12	32	1	22	58·2	Needle No. 2. 22 59·6			
"	16	12	32	2	23	0·1				
"	19	13	50	1	22	58·4				
"	19	13	50	2	22	59·1				
"	23	12	47	1	22	57·1				
"	23	12	47	2	23	0·2				
"	26	12	39	1	22	56·9				
"	26	12	39	2	22	57·4				
"	30	13	12	1	22	58·0				
"	30	13	12	2	22	58·9				

Observations of Dip at Toungoo Observatory taken with Dover's Dip, Circle No. 137, Needle Nos. 1 and 2 by Dover—contd.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly Mean with each Needle.	Monthly Mean.	Needle 1—2.	REMARKS.
1906.		h.	m.		°	′	° ′	° ′	° ′	
May	3	12	43	1	22	59·9				
"	3	12	43	2	22	59·9	Needle No. 1. 22 58·8			
"	7	12	28	1	22	59·6				
"	7	12	28	2	22	59·5				
"	10	13	53	1	22	59·0				
"	10	13	53	2	22	59·6		22 59·2	—0 0·8	
"	14	13	38	1	22	58·7				
"	14	13	38	2	22	59·9				
"	17	12	51	1	22	56·1	Needle No. 2. 22 59·6			
"	17	12	51	2	22	56·3				
"	21	12	52	1	23	0·5				
"	21	12	52	2	23	0·6				
"	24	13	27	1	22	59·5				
"	24	13	27	2	23	1·4				
"	28	12	40	1	22	58·8				
"	28	12	40	2	22	60·1				
"	31	12	40	1	22	57·3				
"	31	12	40	2	22	59·1				
June	4	13	37	1	22	59·7				
"	4	13	37	2	23	2·3	Needle No. 1. 22 58·5			
"	7	12	21	1	22	58·3				
"	7	12	21	2	23	0·1				
"	11	13	6	1	22	58·5				
"	11	13	6	2	22	59·6		22 59·2	—0 1·3	
"	14	13	36	1	22	57·6				
"	14	13	36	2	22	58·4				
"	18	13	8	1	22	59·7	Needle No. 2. 22 59·8			
"	18	13	8	2	23	1·7				
"	21	12	24	1	22	57·8				
"	21	12	24	2	22	57·5				
"	25	12	59	1	22	57·1				
"	25	12	59	2	22	58·9				
"	28	13	40	1	22	59·3				
"	28	13	40	2	23	00·1				
July	2	13	23	1	23	1·1				
"	2	13	23	2	23	1·6	Needle No. 1. 22 58·8			
	5	13	19	1	22	58·4				
"	5	13	19	2	22	59·3				

Observations of Dip at Toungoo Observatory taken with Dover's Dip Circle No. 137, Needle Nos. 1 and 2 by Dover—contd.

1		2		3	4		5	6		7		8
Date.		L. M. T.		Needle No.	Observed Dip.		Monthly Mean with each Needle.	Monthly Mean.		Needle 1—2.		Remarks.
1906.		h.	m.		°	′	° ′	°	′	°	′	
July	9	13	45	1	22	57·1						
"	9	13	45	2	22	57·8		22	58·9	—0	0·1	
"	12	12	48	1	22	59·0						
"	12	12	48	2	22	58·8						
"	20	14	23	1	22	57·5	Needle No. 2. 22 58·9					
"	20	14	23	2	22	58·5						
"	23	13	39	1	22	59·4						
"	23	13	39	2	22	57·7						
"	26	13	31	1	22	59·2						
"	26	13	31	2	22	58·4						
August	1	13	42	1	22	59·0	Needle No. 1. 22 59·3					
"	1	13	42	2	23	0·5						
"	3	13	15	1	22	58·2						
"	3	13	15	2	22	59·7						
"	6	13	35	1	22	58·7		22	59·5	—0	0·3	
"	6	13	35	2	22	59·0						
"	8	12	57	1	22	57·5						
"	8	12	57	2	22	58·1	Needle No. 2. 22 59·6					
"	9	12	16	1	22	58·2						
"	9	12	16	2	22	58·6						
"	13	13		1	23	1·7						
"	13	13	8	2	23	2·2						
"	16	13	46	1	22	59·5						
"	16	13	46	2	22	60·1						
"	20	13	7	1	22	59·7						
"	20	13	7	2	22	59·0						
"	23	13	11	1	23	0·8						
"	23	13	11	2	23	0·2						
"	27	13	44	1	22	59·2						
"	27	13	44	2	22	58·3						
September	4	12	44	1	23	0·5						
"	4	12	44	2	22	59·5	Needle No. 1. 22 59·0					
"	6	13	27	1	22	59·4						
"	6	13	27	2	22	58·6						
"	10	13	49	1	22	58·9						
"	10	13	49	2	22	59·4		22	59·2	—0	0·3	
"	13	13	30	1	22	57·5						

Observations of Dip at Toungoo Observatory taken with Dover's Dip, Circle No. 137, Needle Nos. 1 and 2 by Dover—contd.

1	2	3	4	5	6	7	8
Date.	L. M. T.	Needle No.	Observed Dip.	Monthly Mean with each Needle.	Monthly Mean.	Needle 1—2.	REMARKS.
1906.	h. m.		° ′	° ′	° ′	° ′	
September 13	13 30	2	22 58·8	Needle No. 2.			
„ 17	12 45	1	22 58·4	22 59·3			
„ 17	12 45	2	22 59·7				
„ 20	13 35	1	22 57·7				
„ 20	13 35	2	22 58·7				
„ 24	13 51	1	23 0·8				
„ 24	13 51	2	23 1·1				
„ 27	13 38	1	22 58·5				
„ 27	13 38	2	22 58·6				
October 11	12 40	1	22 58·0				
„ 11	12 40	2	22 58·4	Needle No. 1.			
„ 22	12 51	1	22 59·3	22 59·4			
„ 22	12 51	2	22 60·0		22 59·4	+0 0·1	
„ 26	13 54	1	22 59·7	Needle No. 2.			
„ 26	13 54	2	22 59·1	22 59·3			
„ 27	13 31	1	23 0·1				
„ 27	13 31	2	22 59·7				
„ 29	13 44	1	22 60·0				
„ 29	13 44	2	22 59·3				
November 1	12 52	1	22 59·4				
„ 1	12 52	2	23 0·2				
„ 5	13 38	1	22 59·2				
„ 5	13 38	2	22 57·4				
„ 8	11 45	1	22 58·1	Needle No. 1.			
„ 8	11 45	2	22 59·9				
„ 12	13 39	1	23 01·4	22 59·4			
„ 12	13 39	2	22 58·3				
„ 14	12 29	1	22 58·5		22 59·2	+0 0·4	
„ 14	12 29	2	22 58·5				
„ 19	12 23	1	22 59·6	Needle No. 2.			
„ 19	12 23	2	23 01·1	22 59·0			
„ 29	12 23	1	22 59·3				
„ 29	12 23	2	22 57·8				
December 3	13 55	1	23 1·5				
„ 3	13 55	2	23 1·3	Needle No. 1.			
„ 18	13 01	1	22 58·4	22 59·8			
„ 18	13 01	2	22 56·0				

Observation of Dip at Toungoo Observatory taken with Dover's Dip, Circle No. 137, Needle Nos. 1 and 2 by Dover—concld.

1		2		3	4		5	6		7		8
Date.		L. M. S.		Needle No.	Observed Dip.		Monthly Mean with each Needle.	Monthly Mean.		Needle 1—2.		Remarks.
1906.		h.	m.		°	′	° ′	°	′	°	′	
December	18	13	12	1	22	57·8						
"	18	13	12	2	22	58·6		22	59·1	+0	1·5	
"	24	13	16	1	22	59·6						
"	24	13	16	2	22	57·0						
"	27	11	45	1	23	01·1	Needle No. 2. 22 58·3					
"	27	11	45	2	22	58·2						
"	28	9	31	1	23	0·7						
"	28	9	31	2	22	59·5						
"	29	15	37	1	22	59·5						
"	29	15	37	2	22	57·7						
"	31	10	53	1	22	59·5						
"	31	10	53	2	22	58·2						

Hourly Means of Horizontal Force in C. G. S. Units (corrected for temperature) at Toungoo from the selected quiet days in 1906.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Means.
1906. ·38000 C. G. S. +												Winter.													
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	691	694	694	695	695	695	697	700	706	714	721	724	721	714	711	706	701	699	698	697	696	694	694	697	702
February	693	696	692	693	693	694	698	702	712	720	728	729	728	721	712	705	699	697	697	696	694	693	692	693	703
March	694	694	694	693	693	695	698	701	712	728	745	756	759	750	738	721	709	701	698	698	695	691	689	692	710
October	708	707	708	708	708	708	707	707	708	719	729	739	742	738	728	718	712	710	710	710	709	709	709	708	715
November	713	713	714	714	715	715	716	718	724	733	743	749	746	739	730	721	716	713	712	712	710	709	709	710	721
December	699	698	699	701	702	703	705	710	715	721	726	729	724	718	713	709	706	704	705	704	704	704	705	705	709
Means	700	700	700	701	701	702	704	706	713	723	732	738	737	730	722	713	707	704	703	703	701	700	700	701	710
												Summer.													
April	693	693	693	696	697	697	697	703	717	738	758	767	763	754	741	727	714	705	704	703	700	700	700	700	715
May	695	696	697	698	698	697	698	701	711	722	735	745	746	741	732	720	709	702	700	699	699	699	668	697	710
June	715	714	711	710	712	712	713	717	723	733	748	755	757	753	744	735	724	715	713	715	715	714	715	715	724
July	715	716	716	718	716	716	716	723	732	745	758	765	768	763	751	738	725	719	718	718	718	718	718	719	730
August	713	714	715	715	715	716	717	718	723	729	736	739	744	741	733	729	723	719	718	717	716	713	712	714	722
September	714	712	712	712	713	713	714	710	710	718	733	743	745	741	733	725	720	718	718	718	717	717	716	716	720
Means	708	708	707	708	709	709	709	712	719	731	745	752	754	749	739	729	719	713	712	712	710	710	710	710	720

Diurnal Inequality of the Horizontal Force at Toungoo as deduced from the preceding Table.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23
Winter.																								
1906. Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	−11	−8	−8	−7	−7	−7	−5	−2	+4	+12	+19	+22	+19	+12	+9	+4	−1	−3	−4	−5	−6	−8	−8	−5
February	−10	−7	−11	−10	−10	−9	−5	−1	+9	+17	+25	+26	+25	+18	+9	+2	−4	−6	−6	−7	−9	−10	−11	−10
March	−16	−16	−16	−17	−17	−15	−12	−9	+2	+18	+35	+46	+49	+40	+28	+11	−1	−9	−12	−12	−15	−19	−21	−18
October	−7	−8	−7	−7	−7	−7	−8	−8	−7	+4	+14	+24	+27	+23	+13	+3	−3	−5	−5	−5	−6	−6	−6	−7
November	−8	−8	−7	−7	−6	−6	−5	−3	+3	+12	+22	+28	+25	+18	+9	0	−5	−8	−9	−9	−11	−12	−12	−11
December	−10	−11	−10	−8	−7	−6	−4	+1	+6	+12	+17	+20	+15	+9	+4	0	−3	−5	−4	−5	−5	−5	−4	−4
Means	−10	−10	−10	−9	−9	−8	−6	−4	+3	+13	+22	+28	+27	+20	+12	+3	−3	−6	−7	−7	−9	−10	−10	−9
Summer.																								
April	−22	−22	−22	−19	−18	−18	−18	−12	+2	+23	+43	+52	+48	+39	+26	+12	−1	−10	−11	−12	−15	−15	−15	−15
May	−15	−14	−13	−12	−12	−13	−12	−9	+1	+12	+25	+35	+36	+31	+22	+10	−1	−8	−10	−11	−11	−11	−12	−13
June	−9	−10	−13	−14	−12	−12	−11	−7	−1	+9	+24	+31	+33	+29	+20	+11	0	−9	−11	−9	−9	−10	−9	−9
July	−15	−14	−14	−12	−14	−14	−14	−7	+2	+15	+28	+35	+38	+33	+21	+8	−5	−11	−12	−12	−12	−12	−12	−11
August	−9	−8	−7	−7	−7	−6	−5	−4	+1	+7	+14	+17	+22	+19	+11	+7	+1	−3	−4	−5	−6	−9	−10	−8
September	−6	−8	−8	−8	−7	−7	−6	−10	−10	−2	+13	−23	+25	+21	+13	+5	0	−2	−2	−2	−3	−3	−4	−4
Means	−12	−12	−13	−12	−11	−11	−11	−8	−1	+11	+25	+32	+34	+29	+19	+9	−1	−7	−8	−8	−9	−10	−10	−10

NOTE.—When the sign is + the Force is more and when — less than the mean value for the month.

Hourly Means of the Declination as determined at Toungoo from the selected quiet days in 1906.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Means.
Declination E. 0°+													Winter.												
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January . .	45·2	45·4	45·3	45·2	45·1	45·0	44·9	44·9	45·8	46·7	46·7	45·5	44·5	43·7	43·8	44·4	45·3	45·7	45·3	45·4	45·3	45·3	45·3	45·3	45·2
February . .	45·3	45·2	45·2	45·1	45·1	45·0	44·7	44·9	46·0	46·9	46·9	46·3	45·7	45·2	44·9	44·8	45·1	45·3	45·2	45·3	45·3	45·2	45·2	45·2	45·4
March . .	45·2	45·2	45·3	45·2	45·1	44·9	44·6	45·2	46·1	46·7	46·6	46·0	44·8	43·7	43·6	44·3	45·0	45·3	45·1	45·2	45·1	45·0	44·9	45·0	45·1
October . .	42·3	42·4	42·5	42·5	42·4	42·3	42·5	43·4	43·8	43·4	42·4	41·3	40·5	40·7	41·3	42·1	42·7	42·6	42·2	42·2	42·1	42·0	42·1	42·2	44·2
November . .	41·8	41·8	41·7	41·7	41·6	41·5	41·5	41·8	42·3	42·5	42·2	41·5	41·4	41·7	41·8	41·9	41·9	41·7	41·7	41·8	41·7	41·5	41·6	41·8	41·8
December . .	41·8	41·7	41·6	41·4	41·2	41·2	41·0	40·7	41·2	42·0	42·5	42·2	41·3	41·3	41·5	41·6	42·0	42·1	41·9	41·9	41·9	41·8	41·7	41·8	41·6
Means . .	43·6	43·6	43·6	43·5	43·4	43·3	43·2	43·5	44·2	44·7	44·6	43·8	43·0	42·7	42·8	43·2	43·7	43·8	43·6	43·6	43·6	43·5	43·5	43·6	43·6
													Summer.												
April . . .	44·4	44·5	44·6	44·5	44·4	44·4	45·4	46·3	46·6	46·0	45·1	43·5	42·5	42·2	42·9	43·8	44·7	44·9	44·6	44·2	44·1	44·1	44·1	44·1	44·4
May . . .	44·6	44·6	44·7	44·7	44·7	45·0	46·3	47·0	46·9	45·7	44·4	43·2	42·2	42·2	42·3	43·0	43·8	44·4	44·6	44·4	44·3	44·3	44·4	44·4	44·4
June . . .	43·8	44·0	44·0	44·0	44·0	44·2	45·2	46·1	46·3	45·7	44·7	43·1	42·3	42·1	41·9	42·3	43·4	43·9	44·0	43·5	43·4	43·4	43·5	43·7	43·8
July . . .	43·4	43·5	43·5	43·5	43·6	43·9	45·2	46·4	46·5	45·5	44·2	42·4	41·8	41·7	41·4	41·8	42·7	43·3	43·8	43·2	43·2	43·1	43·1	43·2	43·5
August . .	42·9	42·9	43·0	43·0	43·1	43·4	45·0	46·1	45·3	43·7	42·5	42·0	41·7	41·6	42·0	42·6	42·8	43·0	43·1	42·9	42·9	42·6	42·7	42·6	43·1
September . .	42·7	42·8	42·8	42·9	42·8	42·7	43·6	44·8	45·3	44·7	43·4	41·6	40·0	39·8	40·8	42·0	42·9	43·3	42·8	42·8	42·6	42·4	42·5	42·6	42·7
Means . .	43·6	43·7	43·8	43·8	43·8	43·9	45·1	46·1	46·2	45·2	44·1	42·6	41·8	41·6	41·9	42·6	43·4	43·8	43·6	43·5	43·4	43·3	43·4	43·4	43·7

Diurnal Inequality of the Declination at Toungoo as deduced from the preceding Table.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23
Winter.																								
1906. Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	0·0	+0·2	+0·1	0·0	−0·1	−0·2	−0·3	−0·3	+0·6	+1·5	+1·5	+0·3	−0·7	−1·5	−1·4	−0·8	+0·1	+0·5	+0·1	+0·2	+0·1	+0·1	+0·1	+0·1
February	−0·1	−0·2	−0·2	−0·3	−0·3	−0·4	−0·7	−0·5	+0·6	+1·5	+1·5	+0·9	+0·2	−0·2	−0·5	−0·6	−0·3	−0·1	−0·2	−0·1	−0·1	−0·2	−0·2	−0·2
March	+0·1	+0·1	+0·2	+0·1	0·0	−0·2	−0·5	+0·1	+1·0	+1·6	+1·5	+0·9	−0·3	−1·4	−1·5	−0·8	−0·1	+0·2	0·0	+0·1	0·0	−0·1	−0·2	−0·1
October	+0·1	+0·2	+0·3	+0·3	+0·2	+0·1	+0·3	+1·2	+1·6	+1·2	+0·2	−0·9	−1·7	−1·5	−0·9	−0·1	+0·5	+0·4	0·0	0·0	−0·1	−0·2	−0·1	0·0
November	0·0	0·0	−0·1	−0·1	−0·2	−0·3	−0·3	0·0	+0·5	+0·7	+0·4	−0·3	−04	−0·1	0·0	+0·1	+0·1	−0·1	−0·1	0·0	−0·1	−0·3	−0·2	0·0
December	+0·2	+0·1	0·0	−0·2	−0·4	−0·4	−0·6	−0·9	−0·4	+0·4	+0·9	+0·6	−0·3	−0·3	−0·1	0·0	+0·4	+0·5	+0·3	+0·3	+0·3	+0·2	+0·1	+0·2
Means	0·0	0·0	0·0	−0·1	−0·2	−0·3	−0·4	−0·1	+0·6	+1·1	+1·0	+0·2	−0·6	−0·9	−0·8	−0·4	+0·1	+0·2	0·0	0·0	0·0	−0·1	−0·1	0·0
Summer.																								
April	0·0	+0·1	+0·2	+0·1	0·0	0·0	+1·0	+1·9	+2·2	+1·6	+0·7	−0·9	−1·9	−2·2	−1·5	−0·6	+0·3	+0·5	+0·2	−0·2	−0·3	−0·3	−0·3	−0·3
May	+0·2	+0·2	+0·3	+0·3	+0·3	+0·6	+1·9	+2·6	+2·5	+1·3	0·0	−1·2	−2·2	−2·2	−2·1	−1·4	−0·6	0·0	+0·2	0·0	−0·1	−0·1	0·0	0·0
June	0·0	+0·2	+0·2	+0·2	+0·2	+0·4	+1·4	+2·3	+2·5	+1·9	+0·9	−0·7	−1·5	−1·7	−1·9	−1·5	−0·4	+0·1	+0·2	−0·3	−0·4	−0·4	−0·3	−0·1
July	−0·1	0·0	0·0	0·0	+0·1	+0·4	+1·7	+2·9	+3·0	+2·0	+0·7	−1·1	−1·7	−1·8	−2·1	−1·7	−0·8	−0·2	+0·3	−0·3	−0·3	−0·4	−0·4	−0·3
August	−0·2	−0·2	−0·1	−0·1	0·0	+0·3	+1·9	+3·0	+2·2	+0·6	−0·6	−1·1	−1·4	−1·5	−1·1	−0·5	−0·3	−0·1	0·0	−0·2	−0·2	−0·5	−0·4	−0·5
September	0·0	+0·1	+0·1	+0·2	+0·1	0·0	+0·9	+2·1	+2·6	+2·0	+0·7	−1·1	−2·7	−2·9	−1·9	−0·7	+0·2	+0·6	+0·1	+0·1	−0·1	−0·3	−0·2	−0·1
Means	−0·1	0·0	+0·1	+0·1	+0·1	+0·2	+1·4	+2·4	+2·5	+1·5	+0·4	−1·1	−1·9	−2·1	−1·8	−1·1	−0·3	+0·1	+0·1	−0·2	−0·3	−0·4	−0·3	−0·3

NOTE.—When the sign is + the magnet points to the East and when — to the West of the mean position for the month.

G.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1906-07.

Serial No.	Name of Station.	Survey No.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C. G. S.	Remarks.
959	Gahmar . .	[illegible] 13	25 29 0	83 48 10	36 6	E 1 42	0·3603	
960	Dumraon . .	" 14	25 34 40	84 7 30	36 1	" 0 19	0·3547	
961	Mandalay .	[illegible] 1	21 59 50	96 6 30	29 10	" 0 51	0·3801	
962	Wunbye . .	" 2	21 56 10	95 32 20	29 6	" 0 55	0·3794	
963	Alôn . .	" 3	22 13 30	95 4 50	29 35	" 1 4	0·3792	
964	Maymyo . .	" 4	22 2 20	96 28 0	29 20	" 0 54	0·3787	
965	Gokteik Viaduct	" 5	22 20 10	96 51 30	29 59	" 0 50	0·3787	
966	Hsipaw .	[illegible] 1	22 36 40	97 17 50	30 33	" 0 54	0·3777	
967	Manpwe .	" 2	22 50 40	97 35 30	30 58	" 0 57	0·3766	
968	Paukhan . .	[illegible] 6	22 14 10	95 52 10	29 44	" 1 2	0·3785	
969	Shwébo . .	" 7	22 35 0	95 41 50	30 22	" 0 57	0·3780	
970	Kanbalu . .	[illegible] 1	23 13 10	95 32 40	31 47	" 0 58	0·3748	
971	Kawlin .	" 2	23 47 30	95 41 10	32 39	" 0 42	0·3747	
972	Naba . .	" 3	24 15 0	96 11 10	33 37	" 0 57	0·3727	
973	Mohnyin . .	" 4	24 46 30	96 21 20	34 52	" 0 7	0·3720	
974	Taungni . .	[illegible] 1	25 10 20	96 44 20	36 6	W 0 21	0·3707	
975	Myitkyina .	[illegible] 1	25 23 20	97 24 10	36 7	E 1 43	0·3619	
976	Sinbo . .	[illegible] 1	24 46 40	97 2 50	34 56	" 1 31	0·3703	
977	Bhamo . .	" 2	24 15 30	97 13 10	33 42	" 1 4	0·3731	
978	Sikaw . .	" 3	23 50 0	97 4 0	32 50	" 1 11	0·3734	
979	Namkham .	" 4	23 50 0	97 40 10	32 52	" 0 54	0·3740	
980	Hsenwi (Theinni)	" 5	23 17 40	97 57 10	31 56	" 0 57	0·3753	
981	Mantôn . .	" 6	23 15 0	97 7 0	31 47	" 0 51	0·3758	
982	Mogôk . .	[illegible] 8	22 56 0	96 31 20	30 59	" 0 53	0·3776	
983	Wainglon .	[illegible] 5	23 27 50	96 36 30	32 15	" 1 18	0·3727	
984	Tagaung .	" 6	23 30 20	96 0 50	32 25	" 1 9	0·3738	
985	Thabeikkyin	[illegible] 9	22 52 50	95 58 20	31 6	" 1 1	0·3765	
986	Sin-gu (Nga-Sin-gu).	" 10	22 32 50	95 59 30	30 36	" 1 11	0·3784	
987	Yeshin . .	[illegible] 7	23 43 10	95 7 20	32 42	" 0 56	0·3736	
988	Manyu .	" 8	24 19 20	95 33 40	33 35	" 1 13	0·3736	
989	Nánanton .	" 9	24 45 30	95 40 30	34 39	" 1 0	0·3702	
990	Homalin . .	[illegible] 1	24 51 50	94 54 30	35 0	" 1 10	0·3693	
991	Paungbyin .	" 2	24 16 0	94 48 20	33 47	" 1 8	0·3708	
992	Kindat . .	" 3	23 44 10	94 26 0	32 43	" 1 10	0·3730	
993	Kaléwa . .	" 4	23 11 20	94 18 20	31 36	" 1 2	0·3756	
994	Peginma . .	[illegible] 1	22 43 50	94 42 30	30 41	" 1 3	0·3769	
995	Ghazipur .	[illegible] 15	25 33 50	83 33 20	...	" 1 37	0·3600	Dip not observed.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1906-07—contd.

Serial No.	Name of Station.	Survey No.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C. G. S.	REMARKS.
996	Zahúrabad	[illegible] 16	25 44 40	83 43 30	36 11	E 1 31	0·3573	
997	Ballia	„ 17	25 45 10	84 9 10	36 42	„ 1 10	0·3550	
998	Digwara	[illegible] 10	25 44 30	85 0 40	36 5	„ 1 22	0·3590	
999	Ekma	[illegible] 18	25 58 10	84 32 10	37 22	„ 1 5	0·3492	
1000	Ranisankail	[illegible] 10	25 5 10	88 15 10	36 29	„ 1 32	0·3600	
1001	Tariya	„ 11	26 15 40	88 23 40	36 49	„ 1 33	0·3617	
1002	Cherpanguri	[illegible] 9	26 33 0	93 8 10	37 51	„ 1 30	0·3588	
1003	Bijni	„ 10	26 28 50	90 42 10	37 25	„ 1 24	0·3621	
1004	Patacharkuchi	[illegible] 10	26 30 40	91 14 10	37 49	„ 2 12	0·3571	
1005	Jia Bor	„ 11	26 43 30	91 42 30	38 3	„ 1 38	0·3603	
1006	Udalgiri	„ 12	26 45 50	92 6 50	38 8	„ 1 29	0·3598	
1007	Maokersa	„ 13	25 31 10	91 25 0	35 10	„ 1 9	0·3633	
1008	Nongshobar	[illegible] 11	25 32 10	90 52 50	35 31	„ 1 38	0·3674	
1009	Rongrengiri	„ 12	25 33 0	90 33 20	35 40	„ 1 9	0·3657	
1010	Damalgiri	„ 13	25 31 40	90 6 50	36 9	„ 2 19	0·3654	
1011	Nalitabari	„ 14	25 5 10	90 11 10	34 39	„ 0 55	0·3667	
1012	Asma	[illegible] 11	24 54 10	90 53 20	34 41	„ 1 16	0·3671	
1013	Ajmiri or Abidábád.	[illegible] 6	24 33 50	91 14 10	34 5	„ 1 16	0·3691	
1014	Sunámganj	[illegible] 14	25 4 10	91 23 30	34 55	„ 1 23	0·3676	
1015	Sylhet	[illegible] 7	24 53 0	91 52 0	34 40	„ 1 17	0·3678	
1016	Mokakchúng	[illegible] 8	26 19 40	94 31 50	37 31	„ 1 11	0·3639	
1017	Wokhá	„ 9	26 5 40	94 15 40	36 59	„ 1 11	0·3656	
1018	Kohimá	„ 10	25 40 10	94 6 40	36 12	„ 1 15	0·3656	
1019	Kairong	„ 11	25 18 40	94 2 30	35 32	„ 1 9	0·3670	
1020	Manipur	[illegible] 5	24 48 30	93 56 30	34 31	„ 1 4	0·3697	
1021	Lengbu	„ 6	24 44 40	93 24 10	34 27	„ 1 8	0·3698	
1022	Kolosib	[illegible] 8	24 15 20	92 42 10	33 29	„ 1 12	0·3714	
1023	Aijal	„ 9	23 43 30	92 43 10	32 27	„ 1 6	0·3730	
1024	Tenzol	„ 10	23 18 20	92 47 10	31 44	„ 1 7	0·3734	
1025	Lungleh	[illegible] 2	22 [illegible] 40	92 44 50	30 56	„ 1 5	0·3753	
1026	Rangamati	„ 3	22 38 10	92 11 50	30 24	„ 1 4	0·3762	
1027	Bhatiyari	„ 4	22 26 10	91 45 0	29 56	„ 1 0	0·3766	
1028	Mirsarai	„ 5	22 46 40	91 37 50	30 38	„ 1 4	0·3753	
1029	Silli	[illegible] 13	23 21 10	85 50 40	32 1	„ 1 14	0·3673	
1030	Ranchi	„ 14	23 22 40	85 19 30	31 52	„ 1 25	0·3667	
1031	Jariagarh	„ 15	23 2 40	85 1 0	31 3	„ 1 0	0·3689	
1032	Kolebira	[illegible] 10	22 42 20	84 42 0	30 30	„ 1 6	0·3714	
1033	Chakarkend	„ 11	21 18 10	83 30 30	27 48	„ 0 51	0·3725	
1034	Pátnagarh	[illegible] 10	20 42 20	83 8 20	26 14	„ 0 44	0·3759	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1906-07—contd.

Serial No.	Name of Station.	Survey No.		Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
				° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
1035	Khariár . .	20/82	10	20 17 40	82 46 0	25 35	E 0 23	0·3758	
1036	Nawapara .	„	11	20 48 40	82 31 50	26 54	„ 0 38	0·3725	
1037	Saraipali . .	21/83	12	21 18 20	83 0 30	27 52	„ 1 2	0·3725	
1038	Pithora . .	21/82	14	21 15 20	82 31 10	27 32	„ 0 49	0·3712	
1039	Tumgaon .	„	15	21 11 40	82 7 20	27 30	„ 0 46	0·3722	
1040	Chimúr . .	20/80	11	20 29 0	79 22 10	25 46	„ 0 43	0·3710	
1041	Garhchiroli .	„	12	20 11 0	80 0 40	25 17	„ 0 48	0·3736	
1042	Jaroundi . .	„	13	19 59 40	80 26 20	25 0	„ 0 39	0·3739	
1043	Parlákot . .	„	14	19 47 0	80 41 10	24 29	„ 0 35	0·3750	
1044	Koilibeda .	„	15	19 57 40	80 59 0	24 40	„ 0 36	0·3748	
1045	Narainpur	20/82	12	19 43 10	81 14 50	24 5	„ 0 44	0·3752	
1046	Kondagaon .	„	13	19 35 10	81 40 10	24 5	„ 0 31	0·3768	
1047	Kilepal . .	18/82	10	18 58 40	81 36 40	23 4	„ 0 29	0·3765	
1048	Barsur . .	20/82	14	19 8 10	81 23 20	23 19	„ 0 23	0·3760	
1049	Bhairamgarh .	„	15	19 0 30	81 2 40	22 56	„ 0 24	0·3774	
1050	Bijaipur . .	18/80	14	18 47 20	80 49 0	22 15	„ 0 23	0·3789	
1051	Pothikel . .	„	15	18 32 30	80 54 0	22 15	„ 0 19	0·3754	
1052	Chintulnár .	18/81	11	18 20 50	81 11 10	21 41	„ 0 34	0·3793	
1053	Maded . .	18/80	16	18 46 20	80 33 10	23 6	„ 0 37	0·3737	
1054	Malimurka .	„	17	18 59 30	80 16 50	23 1	„ 0 32	0·3746	
1055	Kumargura .	20/80	16	19 26 30	80 32 30	23 38	„ 0 37	0·3771	
1056	Aheri . .	„	17	19 24 40	79 59 50	23 54	„ 0 38	0·3749	
1057	Ghot . .	„	18	19 49 0	79 59 20	24 40	„ 0 32	0·3737	
1058	Kondasthana .	18/82	12	17 46 0	82 33 40	19 56	„ 0 51	0·3816	
1059	Parlakimedi .	18/84	6	18 47 10	84 5 0	22 27	„ 0 25	0·3803	
1060	Jagganathpuram	20/84	11	19 1 50	83 46 30	22 57	„ 0 29	0·3794	
1061	Sirgudi . .	„	12	19 25 20	83 49 0	23 43	„ 0 30	0·3785	
1062	Govindapur .	„	13	19 29 50	84 25 20	23 54	„ 0 40	0·3789	
1063	Ghúrsari . .	26/84	19	25 22 30	84 9 10	35 37	„ 1 0	0·3653	
1064	Arrah . .	„	20	25 33 0	84 40 20	35 46	„ 1 30	0·3602	
1065	Palón . .	18/96	1	17 26 20	95 56 0	19 41	„ 0 39	0·3900	
1066	Minhla . .	„	2	17 58 30	95 42 20	20 52	„ 0 39	0·3890	
1067	Paungdè . .	„	3	18 29 50	95 29 50	22 1	„ 0 41	0·3882	
1068	Prome . .	„	4	18 49 40	95 13 20	22 41	„ 0 39	0·3874	
1069	Henzada shore	„	5	17 38 30	95 29 10	20 14	„ 0 43	0·3893	
1070	Athók . .	„	6	17 12 10	95 5 0	19 4	„ 0 41	0·3904	
1071	Bassein . .	16/94	1	16 46 20	94 44 30	18 7	„ 0 35	0·3909	
1072	Pegu . .	18/96	7	17 20 30	96 28 40	19 32	„ 0 47	0·3903	
1073	Pyuntaza .	„	8	17 53 0	96 43 20	20 52	„ 0 29	0·3884	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1906-07—contd.

Serial No.	Name of Station.	Survey No.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C. G. S.	REMARKS.
1074	Nyaungbintha .	18/96 9	18 24 20	96 27 20	22 1	E 0 41	0·3873	
1075	Myohla . .	20/96 1	19 24 40	96 16 10	24 5	„ 0 49	0·3870	
1076	Pyokkwe . .	„ 2	19 57 10	96 13 30	25 19	„ 0 46	0·3846	
1077	Shweda . .	„ 3	20 31 10	96 4 50	26 18	„ 0 54	0·3837	
1078	Thèdaw . .	22/96 11	21 5 10	96 3 50	27 28	„ 0 48	0·3818	
1079	Kyauksè . .	„ 12	21 36 30	96 8 0	28 30	„ 0 47	0·3799	
1080	Mahlaing .	„ 13	21 5 40	95 38 40	27 24	„ 0 52	0·3816	
1081	Myingyan .	„ 14	21 28 30	95 23 40	28 11	„ 0 55	0·3806	
1082	Pakôkku . .	„ 15	21 20 0	95 5 30	28 4	„ 0 33	0·3799	
1083	Sabè . .	22/94 2	21 27 20	94 35 0	28 22	„ 0 52	0·3802	
1084	Pasôk . .	„ 3	21 23 0	94 11 0	28 3	„ 0 53	0·3799	
1085	Shwegôndaing .	„ 4	21 49 10	94 6 30	28 59	„ 0 56	0·3783	
1086	Thitkyidaing .	„ 5	22 1 20	94 32 10	29 15	„ 0 55	0·3784	
1087	Salingyi . .	22/96 16	21 58 30	95 4 40	28 30	„ 0 43	0·3818	
1088	Seikpyu . .	20/94 1	20 54 20	94 47 30	27 0	„ 0 48	0·3820	
1089	Kyaukyè . .	„ 2	20 34 40	94 48 30	26 22	„ 0 46	0·3826	
1090	Minbu . .	„ 3	20 10 0	94 53 20	25 31	„ 0 43	0·3837	
1091	Sinbaungwè .	20/96 4	19 43 0	95 9 30	24 31	„ 0 43	0·3850	
1092	Thayetmyo .	„ 5	19 19 30	95 11 10	23 45	„ 0 40	0·3859	
1093	Mindôn . .	20/94 4	19 21 10	94 44 10	24 0	„ 0 40	0·3857	
1094	Myothit . .	„ 5	12 45 20	94 38 10	24 41	„ 0 45	0·3841	
1095	Ngapè . .	„ 6	20 4 50	94 28 0	25 29	„ 0 42	0·3837	
1096	Sidôktaya .	„ 7	20 25 50	94 14 0	26 10	„ 0 45	0·3824	
1097	Tauksôk . .	„ 8	20 43 30	94 8 10	26 45	„ 0 50	0·3818	
1098	Kyindwè . .	„ 9	20 58 10	93 50 10	27 5	„ 1 0	0·3806	
1099	Thônlábye .	22/94 6	21 4 20	94 16 10	27 26	„ 0 50	0·3811	
1100	Chaunggya .	20/96 6	20 44 0	95 13 30	26 49	„ 0 37	0·3818	
1101	Myindègyi .	„ 7	20 26 30	95 36 30	26 0	„ 0 49	0·3837	
1102	Taungdwingyi .	„ 8	20 0 0	95 32 50	25 13	„ 0 40	0·3846	
1103	Nget-pyaw-gyin	„ 9	19 34 20	95 39 20	24 17	„ 0 45	0·3860	
1104	Taunglè .	18/96 10	18 53 30	95 40 20	22 46	„ 0 44	0·3872	
1105	Thamaing .	16/96 1	16 51 50	96 7 0	18 27	„ 0 37	0·3911	
1106	Myohaung .	20/92 10	20 35 20	93 11 20	26 22	„ 0 53	0·3816	
1107	Myebôn . .	„ 11	20 4 0	93 22 20	25 18	„ 0 43	0·3835	
1108	Rathedaung .	20/92 1	20 29 10	92 45 10	26 3	„ 0 48	0·3822	
1109	Maungdaw .	„ 2	20 49 50	92 21 40	26 50	„ 0 53	0·3810	
1110	Chakiria . .	22/92 6	21 46 0	92 5 50	28 41	„ 0 55	0·3785	
	Deolali . .		19 53 10	73 48 50	24 57	„ 0 12	0·3639	

Abstract showing the approximate Magnetic values at stations observed at by No. 26 Party during season 1906-07—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
1111	Nushki No. 1		29 33 10	66 1 0	...	E. 2 17	...	Declination only observed.
1112	" No. 2		29 32 0	66 0 40	...	" 2 15	...	"
1113	Kuchaki . .		29 4 20	65 29 50	...	" 2 27	...	"
1114	Padag No. 1		29 1 20	65 18 10	...	" 2 52	...	"
1115	" No. 2		29 1 30	65 17 30	...	" 3 12	...	"
1116	Chahar Sar .		28 57 0	65 0 10	...	" 1 58	...	"
1117	Yadgar . .		28 57 30	64 56 0	...	" 2 7	...	"
1118	Karodak . .		28 57 10	64 40 50	...	" 2 32	...	"
1119	Dalbandin No. 1		28 54 10	64 25 30	...	" 2 34	...	"
1120	" No. 2		28 54 30	64 25 40	...	" 2 32	...	"
1121	Kisanen Chapper.		29 4 0	64 22 40	...	" 2 38	...	"
1122	Malik Siah Kōh		29 12 20	63 55 0	...	" 2 35	...	"
1123	" Teznan H. S.		29 24 40	63 40 50	...	" 1 47	...	"
1124	Gat-i-Barot .		28 57 10	63 35 10	...	" 2 30	...	"
1125	Gharibo . I		29 20 30	62 58 30	...	" 7 43	...	"
1126	" . II		29 20 10	62 58 10	...	" 3 1	...	"
1127	" . II		29 19 30	62 58 0	...	" 3 51	...	"
1128	Malik Shah .		29 1 40	62 59 0	...	" 4 58	...	"
1129	Kondi No. 1		28 50 20	62 36 0	...	" 2 45	...	"
1130	" No. 2		28 49 40	62 35 40	...	" 2 40	...	"
1131	Tuzgi H. S.		28 53 10	62 15 0	...	" 2 50	...	"
1132	Shuri H. S.		29 11 0	62 29 50	...	" 2 38	...	"
1133	Nil Dik . .		29 15 40	62 42 20	...	" 2 55	...	"
1134	Miri Sultan H. S.		29 7 10	62 48 20	...	" 2 38	...	"

Repeat Stations.

Serial No.	Name of Station.	Survey No.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C. G. S.	REMARKS.
I	Udaipur . .		24 35 33	73 41 57	33 43	E 1 25	0·3533	
II	Karachi . .		24 49 50	67 2 2	34 5	„ 1 41	0·3458	
III	Quetta . .		30 11 52	67 0 20	42 58	„ 2 57	0·3232	
IV	Bahâwalpur .		29 23 27	71 40 37	41 59	„ 2 53	0·3319	
V	Râwalpindi .		33 35 16	73 3 6	48 8	„ 3 46	0·3123	
VI	Bharatpur .		27 13 31	77 29 28	38 43	„ 2 0	0·3460	
VII	Bangalore .		12 59 35	77 35 58	9 45	W 0 35	0·3815	
VIII	Dhârwâr . .		15 27 26	74 59 35	15 17	„ 0 10	0·3763	
IX	Porbandar .		21 38 20	69 37 6	28 39	E 1 16	0·3601	
X	Fyzabad . .		26 47 27	82 7 40	37 49	„ 1 50	0·3534	
XI	Sambalpur .		21 28 3	83 58 26	27 48	„ 0 53	0·3731	
XII	Waltair . .		17 42 54	83 19 1	21 8	„ 0 21	0·3786	
XIII	Darjeeling .		26 59 49	88 16 39	38 19	„ 1 40	0·3566	
XIV	Gaya . .		24 46 30	84 58 54	34 12	„ 1 13	0·3663	
XV	Secunderâbad .		17 27 11	78 29 16	20 8	„ 0 22	0·3791	
XVI	Bhusâval .		21 2 46	75 47 18	26 53	„ 0 52	0·3681	
XVII	Jubbulpore .		23 8 57	79 56 44	30 55	„ 1 6	0·3648	
XVIII	Tavoy . .		14 4 50	98 12 30	12 12	„ 0 38	0·3954	
XIX	Lashio . .		22 56 47	97 44 40	31 19	„ 0 51	0·3762	
XX	Akyab . .		20 7 53	92 53 18	25 28	„ 0 52	0·3828	
XXI	Silchar or Cachar		24 49 43	92 47 21	34 40	„ 1 16	0·3692	
XXII	Dibrugarh .		27 29 24	94 55 40	39 28	„ 1 23	0·3585	
	Vizianagram .		18 6 49	83 24 10	21 4	„ 0 13	0·3812	

NOTE.—The above values of Dip, Declination and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered as preliminary values only.

Where blanks occur, values have been already found during previous field seasons, or the observations have not been completed.

The survey numbers refer to the published chart: thus No. $\frac{26}{76}$ 3 denotes No. 3 Station in the dotted square, the spherical co-ordinates of whose centre are 26° North Latitude and 76° East Longitude.

All Longitudes are referable to that of Madras Observatory taken at the value 80° 14′ 47″ East from Greenwich.

II.

THE PENDULUM OPERATIONS.

Extracted from the Narrative Report of Major G. P. Lenox Conyngham, R.E., in charge of No. 23 Party (Pendulums), for the season 1906-07.

The programme of pendulum observations for this season was framed in order to obtain more information about variations in the force of gravity in submontane regions.

The stations which I selected were Rajpur and Kalsi at the foot of the Himalayas, Fatehpur in the Dun, Hardwar, Asarori and Mohan in the Siwaliks, Roorkee and Nojli outside the Siwaliks. To these were added Kaliana, Meerut and Gesupur, situated at or near stations of the Great Arc of Meridian.

The addition of the last three was made in order to make a beginning in the search for the crest of the "hidden range," the existence of which was deduced by Colonel Burrard, R.E., F.R.S., from a discussion of the latitude observations. To discover the exact position and form of this range is one of the most important tasks that lie before the Pendulum Party.

The decision arrived at after the experience of the season 1904-05, namely, that the observations should not be made in a tent, was adhered to, and it was therefore necessary to select places at which houses were available.

I received ready assistance from all to whom I applied for the loan of Bungalows and rooms and I am glad here to offer them my warmest thanks. Taking the stations in the order in which they were visited the buildings occupied were :—

Hardwar.—A Bungalow belonging to the Irrigation Department, a short distance down the canal from the Maiapur bridge, on the right bank.

Roorkee.—A large room in the Public Works Department Inspection House, called the Malakpur Bungalow. This was one of the best pendulum rooms that I have had.

Nojli.—The ground floor room of the Tower which is the station of the Great Trigonometrical Survey. This room was very small, and the apparatus was with difficulty set up in it. The temperature was not very steady. Nojli was one of Basevi's stations : he had a hut built for his apparatus near the Tower.

Kaliana.—The observatory built by Everest in 1836 is still in very fair preservation and I occupied the Eastern room. This room was the Base station for Basevi's pendulum work, and Captain Heaviside also made a series of observations in it in 1870.

Meerut.—It appeared at first that there was likely to be some difficulty about finding a suitable room. Meerut is one of the stations which is increasing in size and in which consequently there are very few unoccupied houses, but I happened to mention the matter in conversation with Colonel Tinley and Colonel Hamilton, Assistant Adjutant Generals of the Meerut Division, and they instantly offered me the use of a vacant room in the house which they were conjointly occupying. It was a very suitable room and I accepted the offer most gratefully. The Bungalow in question is situated on the south side of the Mall near its western end.

Gesupur.—I had to find a station somewhere near the meridian of Meerut and 30 to 40 miles further south. I noticed that the main Ganges canal crossed the region in which I wished to place my station. Mr. A. M. Close, Assistant Engineer in charge of the sub-division of the canal in question, most generously offered me a choice of several of the rest houses under his control and I selected Gesupur. It proved an excellent place and Mr. Close rendered me much valuable assistance in making my arrangements.

Mohan.—The Forest Department have a Bungalow at this place and they very kindly gave me permission to occupy it.

The Bungalow is situated a little above the road from Saharanpur to Dehra Dun, on its western side, just where the road enters the Siwalik Range.

Asarori.—There is a small Bungalow of this name, belonging to the Public Works Department, close to the above-mentioned road, about half a mile beyond the tunnel which has been cut through the crest of the range.

The Engineer in charge of roads and buildings in the Dehra Dún District kindly allowed me the use of this Bungalow.

The next station was Fatehpur and, as it was necessary to pass through Dehra Dún on the way thither, I determined to make one set of observations at the base station before going on.

Fatehpur.—There is a very good Inspection Bungalow belonging to the Military Works Service at this place. Major Sorsbie, R.E., A.C.R.E. Garhwal Brigade, kindly allowed me to occupy it.

Kalsi.—Here also there is a good Military Works Inspection Bungalow and this too Major Sorsbie placed at my disposal.

Rajpur.—I was anxious to place my station as close as I could to the Himalayas but it was difficult to find any suitable situation as most of the houses are some way from the foot of the hills. The nearest buildings to the point whence the steep ascent to Mussoorie begins belong to the Himalaya Glass Works and I decided to ask the Secretary whether he could lend me any room which would answer the purpose. My application met with a most courteous response and an excellent room was placed at my disposal.

Rajpur was the last of the stations on the programme and after finishing work there I returned to Dehra Dún and made the closing observations.

A good deal of bad weather was met with during the season, causing delay and some discontinuity in the observations, but no serious mis-adventure of any kind occurred and the results obtained are on the whole more accordant than those of any previous series.

The dummy pendulum, to contain the thermometer for indicating the temperature of the pendulum under observation, was taken into use and gave satisfactory results.

Throughout the season an iron pedestal was used to support the pendulum stand instead of a brick pillar.

The pedestal was cemented to the floor, and the granite slab to the pedestal, with plaster of Paris. The stability of the arrangement is not greater than that of the brick pillar, but it is much more quickly made and the troubles that occasionally arose, owing to the cement in the pillar not being dry, are obviated by the use of the iron stand.

In other respects the arrangements were the same as during 1905-06, and call for no comment.

The star observations throughout were made by Extra Assistant Superintendent Hanuman Prasad, the method introduced last year of reversing the transit in the middle of the observation of each star was followed. The results were satisfactory. The average probable error of the value of the daily rate of the clock, depending on observations of one star on two successive nights, was ± 0.ˢ050 and the average probable error of the mean rate was ± 0.ˢ012.

Six of the stations were near enough to the hills to require an orographical correction.

The amount of labour involved in their calculation was considerable and the magnitude of the correction was in most cases very small: but it is as important to prove that a correction is small as that it is large, so that the labour has not been thrown away.

In the future it will I think generally be possible to estimate the orographical corrections for most stations situated at or near the foot of the Himalayas by analogy with one of those for which the analysis has been performed and without going through the full calculation. It may be useful to have all the corretcions computed in the last four years collected together in one place and I have therefore drawn up the following table.

	Height ft.	Orographical correction.
Mussoorie (Dunseverick)	7131	0·024
„ (Camel's Back)	6924	0·025
Rajpur	3321	0·010
Kalsi	1684	0·010
Dehra Dún	2240	0·003
Fatehpur	1434	0·002
Asarori	2467	0·002
Mohan	1660	0·003
Hardwar	949	0·003
Simla	7043	0·016
Kalka	2202	0·004
Pathankot	1088	0·002
Quetta	5520	0·002
Mach	3522	0·006
Sibi	434	0·002
Sandakphu	11766	0·053
Darjeeling	6966	0·026
Kurseong	4913	0·018
Siliguri	387	0·002

The results of the season observations are given in the following table :—

Station.	Latitude.			Height above sea level.	Observed g	g reduced to sea level $=g_0''$	Theoretical value at sea level $=\gamma_0$	$g_0''-\gamma_0$
	°	′	″	Feet.	Dynes.	Dynes.	Dynes.	Dynes.
Rajpur	30	24	12	3321	979·002	979·206	979·330	— 0·124
Kalsi	30	31	0	1684	979·131	979·240	979·339	— 0·099
Fatehpur	30	25	57	1415	979·147	979·232	979·332	— 0·101
Asarori	30	14	25	2467	979·059	979·205	979·317	— 0·112
Mohan	30	10	53	1660	979·109	979·209	979·313	— 0·104
Hardwar	29	56	29	949	979·122	979·180	979·294	— 0·114
Roorkee	29	52	20	868	979·129	979·181	979.288	— 0·107
Nojli	29	53	28	879	979.143	979·195	979·290	— 0·095
Kaliana	29	30	55	810	979·154	979·202	979·260	— 0·058
Meerut	29	0	26	734	979·151	979·194	979·221	— 0·027
Gesupur	28	33	2	691	999·125	979·166	979·186	— 0·020

It is to be noticed that there is everywhere a deficiency in gravity, which is considerable near the hills and grows rapidly less as we move southwards.

It is also to be noticed that the defect is less at western stations than at similarly situated points further to the East. Thus at Kalsi we have a defect of 0·099 at Rajpur one of 0·124; at Fatehpur one of 0·101 and at Dehra one of 0·127; at Mohan one of 0·104 and at Hardwar one of 0·114; at Nojli one of 0·095 and at Roorkee one of 0·107.

These amounts are all larger than that found at Kalka, where the situation is similar to that at Kalsi or at Rajpur, but much less than the defect at Pathankot, which is in a position comparable to that of a place half way between Nojli and Mohan. At Kalka the defect was 0·085 and at Pathankot 0·179; at Siliguri again, which may be compared with Roorkee, the defect was 0·137.

The evidence of this year then confirms that obtained in former years in proving that at the base of the hills there is always a deficiency in the force of gravity, and the regular lessening of the amount of this defect at the stations of Kaliana, Meerut and Gesupur indicate the probability that a point will soon be reached, when the observations are continued southwards, at which g_0'' will equal or exceed γ_0 in the same way as was found to be the case on the Calcutta Meridional series at Kisnapur, and on the line from Simla to Quetta at Mian Mir, Montgomery and Jacobabad.

During recess I have been principally occupied in preparing for publication the whole of the observations that have so far been made with the new pendulum apparatus.

In September I received from Professor Dr. Hecker, who observed with me at Jalpaiguri in February 1905, the details of the results of his observations.

From Jalpaiguri Dr. Hecker returned to Potsdam and there swung his set of pendulums again. He thus obtained a value of g at Jalpaiguri in terms of g at Potsdam in an entirely independent way.

My value of g was also based on the value at Potsdam, being connected therewith,

(1) By Mr. Putman's observations connecting Kew to Potsdam.

(2) By my observations connecting Dehra Dún to Kew.

(3) By my observations connecting Jalpaiguri to Dehra Dun.

Dr. Hecker's value of g at Jalpaiguri is . . .	979,624 C. G. S.
My value is	979,622 "

The difference is less than the probable error of observation, and the accordance is therefore very satisfactory.

Throughout the season the different members of the party worked efficiently and well.

The party was inspected by the Superintendent of Trigonometrical Surveys in September.

III.

TIDAL AND LEVELLING OPERATIONS.

Extracted from the Narrative Report of Mr. C. F. Erskine in charge of No. 25 Party (Tidal and Levelling) for Season 1906-07.

Personnel.

Imperial officer.

Mr. C. F. Erskine.

Provincial Officers.

Messrs J. P. Barker, H. G. Shaw, E. H. Corridon, Munshi Sayed Zille Hasnain, Messrs. A. M. Talati, O. N. Pushong, Babu P. N. Sur and Mr. D. H. Luxa.

Subordinate Establishment.

1 Surveyor, 25 Computers, 2 Native Artificers, 4 Tidal Observatory Clerks.

The personnel of the party during the year under report was as shown in the margin. Mr. C. F. Erskine held charge of the party throughout the year.

TIDAL OPERATIONS.

2. *Work of the year.*—During the past year tidal registrations by self-registering tide gauges, were taken at the ports of Aden, Karachi, Apollo Bandar (Bombay), Prince's Dock (Bombay), Madras, Kidderpore, Rangoon and Port Blair. In addition, tide-pole readings of high and low water were taken during daylight at the ports of Bhavnagar, Akyab, Chittagong and Moulmein, with the object of comparing the actual times and heights with the predictions ; the observations were made under the direction of this Department and the immediate control of the Port Officers concerned.

The reduction by harmonic analysis of the observations for 1906 of the 8 stations named above has been completed. The work of publication of tide-tables for 40 ports for the years 1908 and 1909 is in progress in England. Data for these predictions were despatched from the Office in Dehra Dun in December 1905 and 1906, respectively; for the tide-tables for 1910 they are in course of preparation.

3. *List of Tidal Stations.*—The following table gives a list of the 42 ports at which tidal observations have been registered, together with the periods of observation from 1874 when tidal operations were begun, up to the present time.

The permanent stations are shown in italics; the others are minor stations which were closed on the completion of the requisite observations.

	Stations.	Automatic or personal observations.	Date of commencement of observations.	Date of closing of observations.	No. of years of observations.	Remarks.
1	Suez . . .	Automatic .	1897	1903	7	
2	Perim . . .	Ditto .	1898	1902	5	
3	*Aden* . . .	Ditto .	1879	Still working	27	
4	Maskat . . .	Ditto .	1893	1898	5	

	Stations.	Automatic or personal observations.	Date of commencement of observations.	Date of closing of observations.	No. of years of observations.	REMARKS.
5	Bushire . . .	Automatic .	1892	1901	8	
6	*Karachi* . .	Ditto .	1881	Working up to 6th June 1907	26	Wrecked on 6th June 1907. Being re-erected.
7	Hanstal . . .	Ditto .	1874	1875	1	Tide Tables not published.
8	Nowanagar . .	Ditto .	1874	1875	1	
9	Okha Point . .	Ditto	1874 re-started 1904	1875 1906	1 1 } 2	Year 1904-05 is excluded.
10	Porbandar . .	Personal .	1893	1894	2	
10A	Porbandar . .	Automatic .	1898	1902	5	With certain interruptions.
11	Port Albert Victor (Káthiáwár).	Personal .	1881	1882	1	
11A	Port Albert Victor (Káthiáwár).	Automatic .	1900	1903	4	
12	Bhavnagar . .	Ditto .	1889	1894	5	Tide-pole readings taken.
13	*Bombay (Apollo Bandar).*	Ditto .	1878	Still working	29	
14	*Bombay (Prince's Dock).*	Ditto .	1888	Ditto	19	Property of Port Trust.
15	Mormugao (Goa) .	Ditto .	1884	1889	5	
16	Karwar . . .	Ditto .	1878	1883	5	
17	Beypore . . .	Ditto .	1878	1884	6	
18	Cochin . . .	Ditto .	1886	1892	6	
19	Tuticorin . .	Ditto .	1888	1893	5	
20	Minicoy . . .	Ditto .	1891	1896	5	
21	Galle . . .	Ditto .	1884	1890	6	
22	Colombo . .	Ditto .	1884	1890	6	
23	Trincomalee . .	Ditto .	1890	1896	6	
24	Pamban Pass . .	Ditto .	1878	1882	4	
25	Negapatam . .	Ditto .	1881	1888	6	Year 1884-85 is excluded.

	Stations.	Automatic or personal observations.	Date of commencement of observations.	Date of closing of observations.	No. of years of observations.	REMARKS.
26	*Madras* . . .	Automatic	1880 re-started 1895	1890 Still working	10 12 } 22	
27	Cocanada . .	Ditto .	1886	1891	5	
28	Vizagapatam . .	Ditto .	1879	1885	6	
29	False Point . .	Ditto .	1881	1885	4	
30	Dublat (Saugor Island).	Ditto .	1881	1886	5	
31	Diamond Harbour .	Ditto .	1881	1886	5	
32	*Kidderpore* . .	Ditto .	1881	Still working	26	
33	Chittagong . .	Ditto .	1886	1891	5	Tide-pole readings taken.
34	Akyab . . .	Ditto .	1887	1892	5	Tide-pole readings taken.
35	Diamond Island .	Ditto .	1895	1899	5	
36	Bassein (Burma) .	Ditto .	1902	1903	2	
37	Elephant Point .	Ditto	1880 re-started 1884	1881 1888	1 5 } 6	
38	*Rangoon* . .	Ditto .	1880	Still working	27	
39	Amherst . .	Ditto .	1880	1886	6	
40	Moulmein . .	Ditto .	1880	1886	6	Tide-pole readings taken.
41	Mergui . . .	Ditto .	1889	1894	5	
42	*Port Blair* . .	Ditto .	1880	Still working	27	

4. *Inspection of observatories.*—The eight tidal observatories now working were inspected during the year. Portable meteorological instruments were taken on the tours of inspection and compared with those working locally.

5. *Working of observatories.*—The following account contains a detailed description of the working of the instruments and other incidental information pertaining to the observatories. It has been taken from reports of Inspecting Officers, from information furnished by Port Officers and from the registrations themselves.

6. *Aden.*—This observatory was inspected by Mr. C. F. Erskine in January 1907. All the instruments were thoroughly overhauled and cleaned and left in good working order and in adjustment. During the past year there was only one interruption, of a few hours, in the registration of the tide-gauge, the gauge having stopped working for want of oiling. The auxiliary instruments have worked well throughout the year.

7. *Karachi.*—This observatory was inspected by Mr. C. F. Erskine in December 1906. All the instruments were cleaned and left in good working order.

On 6th June, the tidal observatory was wrecked by a cyclone which swept the cabin, tidal and meteorological instruments bodily into the sea. This occurred about 10-30 A.M.

The high water morning tide rose to 5 feet 3 inches higher than the predicted height for that tide, the actual being 12 feet 8 inches and the prediction 7 feet 5 inches.

The force of the wind was greatest between the hours of 9 A.M. and noon, the velocity being 85 miles per hour. The rainfall at Manora was 1·3 inches. On the occurrence being reported, instructions were immediately sent to the Port Engineer to have tide-pole readings taken, and to start the re-erection of the cabin. The necessary tidal instruments were at once got ready and shortly after, at the request of the Port Engineer, were despatched to Karachi. There was some delay in letting the contract for the erection of the cabin and pile work. This matter was settled in the last week of July, and the Port Engineer expects to have the cabin ready for the installation of the instruments by the end of September 1907.

The tide-gauge had been at work since 1881 and for the past 26 years gave a continuous and excellent record.

8. *Apollo Bandar (Bombay).*—This observatory was inspected by Mr. C. F. Erskine in December 1906. The tide-gauge was cleaned and left in adjustment. With the exception of a short break, when the pencil failed to mark on the diagram, the tide-gauge has worked well during the past year.

9. *Prince's Dock (Bombay).*—This observatory was inspected by Mr. C. F. Erskine in January 1907. The tide-gauge was thoroughly over-hauled and cleaned and left in good working order. With the exception of a few unimportant interruptions, there have been no breaks in the tidal registrations during the year.

10. *Madras.*—This observatory was inspected by Mr. C. F. Erskine in January 1907. All instruments were cleaned and left in good working order. There was one interruption only, of a few hours, in the tidal registrations, due to the driving clock stopping; otherwise the tide-gauge and auxiliary instruments have worked well during the year.

Owing to the contemplated enlargement of the Madras Harbour, the Port Engineer has stated that in all probability it will be necessary to remove the Tidal Observatory from its present position to some point on the new arm of the Harbour which will project northwards. It will be impossible to define the exact position of the new observatory until the proposed new arm of the Harbour has been completed and the present entrance to the Harbour closed.

No official intimation on the subject has been communicated to this office.

11. *Kidderpore.*—This observatory was inspected by Mr. H. G. Shaw in January 1907. The tide-gauge and auxiliary instruments were cleaned and left in adjustment and in good working order. During the past year there have been no breaks in the tidal registrations, and only one short interruption in the working of

the self-registering Aneroid. The self-registering Anemometer has been frequently out of order.

12. *Rangoon.*—This observatory was inspected by Mr. H. G. Shaw in January and February 1907. The tide-gauge and auxiliary instruments were cleaned and left in good working order. During the inspection, Mr. Shaw found that there was a large rent in the lowest length of the iron cylinder. The matter was promptly reported by him to the Deputy Conservator of the Port Rangoon, and steps were taken to remedy the defect.

On 15th March, at 10-15 A.M. the gauge was dismantled, and restarted on 16th March at 1-22 P.M.; during this interval the lower half of the cylinder was removed and renewed. With the exception of this interruption there has been no break in the tidal registrations. With reference to the auxiliary instruments the self-registering Aneroid worked well throughout the year; the self-registering Anemometer was out of order and under repairs at the Port Trust workshops, from 15th to 21st November 1906, since which date it has worked well.

13. *Port Blair.*—This observatory was inspected by Mr. H. G. Shaw in December 1906. The instruments were thoroughly cleaned and left in good working order. There were no interruptions in the registrations of the tide-gauge and the self-registering Aneroid; the self-registering Anemometer was out of order and under repairs from 23rd to 30th July 1907.

14. *Tidal wave recorded by tide-gauges.*—

(*i*) *Port Blair.*—At this station the tidal wave was more conspicuous than at any of the other Indian tidal stations where tide-gauges are at work. The first disturbance appeared to have commenced at 1-45 P.M., on 4th January 1907; the oscillations of the pencil due to the tidal wave, were slight up to 2-40 P.M., after which they increased in frequency and in height up to 6-30 P. M., the time of slack water at low tide, when the wave was greatest, the height being 5 inches. After this the curve showed a diminishing of the wave until it ceased at 10-20 P.M. on 6th instant. The oscillations were most marked at each slack water at low and high tides.

(*ii*) *Madras.*—Oscillations due to the tidal wave are traceable on the tidal diagram between midnight of 4th and midnight of 5th January. They are insignificant.

(*iii*) *Bombay* (*Apollo Bandar*).—The effect of the tidal wave is noticeable between 7 P.M. on 4th, and 9 P.M. on 5th January, the oscillations of the pencil occurring only at or about the time of slack water at low and high tides. The greatest movement of the pencil out of the normal was 2 inches at 2-50 A. M. on 5th.

(*iv*) *Karachi.*—The disturbance commenced at 5 P.M. on 4th January, about the time of slack water at low tide and lasted till 10 A.M. on 6th. It was distinctly noticeable between 11 P.M. on 4th and 9 P.M. on 5th; at 1-15 A. M. at slack water at high tide on the 5th, the pencil showed an abnormal movement of the wave of 3 inches.

(*v*) *Aden.*—The tidal wave was not perceptible at this port.

(*vi*) There is no trace of the tidal wave on the diagrams, at the riverain ports of Rangoon and Kidderpore.

(*vii*) It was reported by the Director, Royal Alfred Observatory, Mauritius, that a tidal wave occurred at Mauritius, Rodrigues and Réunion on the afternoon of the 4th January 1907. The Director General of Observatories in India reported that the Simla seismograph recorded a large distant earthquake on the 4th January at 10-55 A.M. The distance of its centre from Simla was computed to be about 2,400 miles.

15. *Proposed tidal observatories.*—

(*i*) *Moulmein.*—It was hoped that the tidal observatory at Moulmein would be ready early in this year. Mr. Shaw was sent there in January to see what had been done and found that the work had not been commenced. The delay was due to a revision of plans and estimates which required the official sanction of Government before the Port Officer could under take the project. In a letter No. 541—2 P.-21, dated 18th April 1907, the Secretary to the Government of Burma informed the Superintendent, Trigonometrical Surveys, that the observatory would probably be completed in 3 months' time. But now owing to the rains the work has again to be suspended; the Executive Engineer, Amherst Division, in a letter No. 2867, dated 9th August 1907, addressed to the Port Officer, Moulmein, reports that the state of the river due to floods, etc., impedes construction and enhances the cost, and advises that the work be held over until after the monsoon. A set of the required instruments is ready for despatch at a moment's notice.

(*ii*) *Koweit and Bahrein.*—A scheme for the establishment of tidal observations at Koweit and Bahrein in the Persian Gulf, is under the consideration of Government.

(*iii*) *Suakim.*—The last mention of the proposed tidal observatory at Suakim appears in para. 5 of extract from Narrative Report of No. 25 party, for season 1904-05. Nothing has been done since and the matter remains *in statu quo*.

16. *Tidal diagrams and daily reports.*—The tidal, aneroid and anemometer diagrams, and daily reports have been submitted regularly to the office at Dehra Dún.

17. *Tidal constants.*—The tidal observations for a year at 8 stations have been reduced and the tabulated values of the tidal constants thus derived are appended. There are no arrears.

VALUES OF THE TIDAL CONSTANTS, ADEN, 1906.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1906 Observations at Aden; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1906 Observations:—

Short Period Tides.

A_0=5·613 feet.

S_1 { H = R =	·073	M_6 { R =	·005	Q_1 { R =	·130	T_2 { R =	·041
S_1 { κ = ζ =	177°·66	M_6 { ζ =	69°·59	Q_1 { ζ =	135°·47	T_2 { ζ =	297°·13
S_2 { H = R =	·671	M_6 { H =	·005	Q_1 { H =	·148	T_2 { H =	·041
S_2 { κ = ζ =	245°·00	M_6 { κ =	356°·86	Q_1 { κ =	39°·03	T_2 { κ =	298°·35

Short Period Tides—contd.

Tide	R	ζ	H	κ
S_4	·009	258°·08	·009	258°·08
S_6	·006	213°·43	·006	213°·43
S_8	·001	216°·87	·001	216°·87
M_1	·048	104°·12	·036	151°·91
M_2	1·589	11°·54	1·548	227°·30
M_3	·024	67°·13	·023	210°·77
M_4	·004	164°·98	·004	236°·50
M_8	·002	36°·87	·002	179°·90
O_1	·579	1°·26	·657	37°·76
K_1	1·213	211°·89	1·307	34°·83
K_2	·138	59°·40	·168	246°·08
P_1	·398	225°·48	·398	35°·38
J_1	·053	82°·66	·058	34°·86
L_2	·025	98°·85	·024	257°·10
N_2	·446	142°·13	·435	224°·94
λ_2	...	...	...	...
ν_2	·072	334°·33	·071	180°·33
μ_2	·070	103°·96	·066	175°·47
R_2	...	...	...	...
$(MS)_4$	·017	338°·20	·017	193°·96
$(2SM)_2$	·016	292°·00	·016	76°·25
$2N_2$	·087	239°·81	·084	189°·68
$(M_2N)_4$	·011	264°·08	·011	202°·65
$(M_2K_1)_3$	·014	45°·61	·014	84°·31
$(2M_2K_1)_3$	·013	144°·46	·014	33°·03

(For S_4, S_6, S_8: H = R and κ = ζ.)

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·016	122°·83	·015	255°·77
„ Fortnightly „	·048	59·31	·063	22·07
Luni-Solar „ „	·027	84·58	·026	228·82
Solar-Annual „	·396	81·03	·396	1·14
„ Semi-Annual „	·123	274·20	·123	114·41

Values of the Tidal Constants, Karachi, 1906.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1906 Observations at Karachi; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1906 Observations :—

Short Period Tides.

A_0 = 7·224 feet.

Tide	R	ζ	H	κ
S_1	·087	187°·92	·087	187°·92
S_2	·969	321°·71	·969	321°·71
S_4	·014	9°·46	·014	9°·46
S_6	·010	298°·94	·010	298°·94
S_8	·001	216°·57	·001	216°·57
M_6	·046	266°·36	·042	198°·10
M_8	·006	34°·70	·005	183°·68
O_1	·589	8°·66	·667	46°·71
Q_1	·133	147°·18	·151	53°·09
L_2	·069	150°·97	·066	309°·91
N_2	·649	195°·01	·633	280°·11
T_2	·083	13°·34	·083	14°·63
$(MS)_4$	·043	106°·89	·042	324°·13
$(2SM)_2$	·012	313°·60	·011	96°·36

(For S_1, S_2, S_4, S_6, S_8: H = R and κ = ζ.)

Short Period Tides—contd.

M_1	R =	·040
	ζ =	99°·32
	H =	·030
	κ =	147°·84
M_2	R =	2·653
	ζ =	75°·73
	H =	2·586
	κ =	292°·98
M_3	R =	·047
	ζ =	171°·54
	H =	·046
	κ =	317°·41
M_4	R =	·025
	ζ =	252°·69
	H =	·024
	κ =	327°·18

K_1	R =	1·222
	ζ =	222°·65
	H =	1·317
	κ =	45°·53
K_2	R =	·217
	ζ =	136°·00
	H =	·263
	κ =	322°·56
P_1	R =	·404
	ζ =	235°·58
	H =	·404
	κ =	45°·54
J_1	R =	·040
	ζ =	98°·31
	H =	·045
	κ =	49°·65

λ_2	R =	...
	ζ =	...
	H =	...
	κ =	...
ν_2	R =	·119
	ζ =	22°·96
	H =	·116
	κ =	231°·13
μ_2	R =	·060
	ζ =	164°·40
	H =	·057
	κ =	238°·89
R_2	R =	...
	ζ =	...
	H =	...
	κ =	...

$2N_2$	R =	·089
	ζ =	288°·52
	H =	·086
	κ =	241°·47
$(M_2N)_4$	R =	·027
	ζ =	39°·26
	H =	·025
	κ =	341°·61
$(M_2K_1)_3$	R =	·019
	ζ =	70°·31
	H =	·020
	κ =	110°·44
$(2M_2K_1)_3$	R =	·010
	ζ =	149°·04
	H =	·010
	κ =	40°·64

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·071	270°63	·065	42°77
,, Fortnightly ,, ...	·034	4·26	·045	325·41
Luni-Solar ,, ,, ...	·045	113·24	·044	256·00
Solar-Annual ,, ...	·239	196·48	·239	116·53
,, Semi-Annual ,, ...	·176	323·81	·176	163·90

VALUES OF THE TIDAL CONSTANTS, BOMBAY (APOLLO BANDAR), 1906.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1906 Observations at Bombay (Apollo Bandar); and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1906 Observations :—

Short Period Tides.

A_0 = 10·141 feet.

S_1	H = R =	·064
	κ = ζ =	197°·81
S_2	H = R =	1·564
	κ = ζ =	3°·91
S_4	H = R =	·008
	κ = ζ =	193°·33
S_6	H = R =	·005
	κ = ζ =	135°·00
S_8	H = R =	·002
	κ = ζ =	143°·75
M_1	R =	·045
	ζ =	86°·53
	H =	·034
	κ =	135°·24
M_2	R =	4·059
	ζ =	113°·40
	H =	3·956
	κ =	331°·05
M_3	R =	·073
	ζ =	247°·00
	H =	·070
	κ =	33°·47
M_4	R =	·105
	ζ =	251°·84
	H =	·099
	κ =	327°·13

M_6	R =	·018
	ζ =	77°·14
	H =	·017
	κ =	10°·07
M_8	R =	·010
	ζ =	180°·68
	H =	·009
	κ =	331°·26
O_1	R =	·580
	ζ =	10°·47
	H =	·658
	κ =	48°·94
K_1	R =	1·277
	ζ =	222°·53
	H =	1·376
	κ =	45°·40
K_2	R =	·342
	ζ =	172°·70
	H =	·415
	κ =	359°·23
P_1	R =	·413
	ζ =	236°·06
	H =	·413
	κ =	46°·04
J_1	R =	·047
	ζ =	110°·90
	H =	·052
	κ =	62°·01

Q_1	R =	·134
	ζ =	148°·90
	H =	·152
	κ =	55°·44
L_2	R =	·055
	ζ =	187°·03
	H =	·053
	κ =	346°·16
N_2	R =	1·035
	ζ =	232°·09
	H =	1·009
	κ =	317°·80
λ_2	R =	...
	ζ =	...
	H =	...
	κ =	...
ν_2	R =	·187
	ζ =	51°·86
	H =	·182
	κ =	260°·62
μ_2	R =	·188
	ζ =	218°·55
	H =	·179
	κ =	293°·84
R_2	R =	...
	ζ =	...
	H =	...
	κ =	...

T_2	R =	·145
	ζ =	44°·49
	H =	·145
	κ =	45°·79
$(MS)_4$	R =	·119
	ζ =	174°·48
	H =	·116
	κ =	32°·13
$(2SM)_2$	R =	·032
	ζ =	332°·95
	H =	·032
	κ =	115°·31
$2N_2$	R =	·136
	ζ =	336°·71
	H =	·133
	κ =	290°·49
$(M_2N)_4$	R =	·020
	ζ =	20°·11
	H =	·019
	κ =	323°·47
$(M_2K_1)_3$	R =	·075
	ζ =	155°·57
	H =	·079
	κ =	196°·08
$(2M_2K_1)_3$	R =	·039
	ζ =	183°·48
	H =	·040
	κ =	75°·90

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·095	220°·12	·087	352°·05
„ Fortnightly „	·008	19·75	·011	340·47
Luni-Solar „ „	·059	86·94	·058	229·30
Solar-Annual „	·077	220·18	·077	140·21
„ Semi-Annual „	·152	333·87	·152	173·93

VALUES OF THE TIDAL CONSTANTS, BOMBAY (PRINCE'S DOCK), 1906.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1906 Observations at Bombay (Prince's Dock); and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1906 Observations:—

Short Period Tides.

A_0=7·989 feet.

S_1 H = R =	·068	M_6 R =	·007	Q_1 R =	·129	T_2 R =	·146
S_1 κ = ζ =	197°·31	M_6 ζ =	309°·56	Q_1 ζ =	150°·53	T_2 ζ =	47°·11
S_2 H = R =	1·578	M_6 H =	·006	Q_1 H =	·146	T_2 H =	·146
S_2 κ = ζ =	4°·99	M_6 κ =	242°·49	Q_1 κ =	57°·06	T_2 κ =	48°·41
S_4 H = R =	·015	M_8 R =	·003	L_2 R =	·049	$(MS)_4$ R =	·123
S_4 κ = ζ =	196°·85	M_8 ζ =	238°·24	L_2 ζ =	165°·88	$(MS)_4$ ζ =	183°·67
S_6 H = R =	·005	M_8 H =	·003	L_2 H =	·047	$(MS)_4$ H =	·120
S_6 κ = ζ =	171°·09	M_8 κ =	28°·82	L_2 κ =	325°·00	$(MS)_4$ κ =	41°·32
S_8 H = R =	·002	O_1 R =	·567	N_2 R =	1·026	$(2SM)_2$ R =	·047
S_8 κ = ζ =	113°·96	O_1 ζ =	10°·34	N_2 ζ =	232°·85	$(2SM)_2$ ζ =	335°·99
		O_1 H =	·642	N_2 H =	1·000	$(2SM)_2$ H =	·046
		O_1 κ =	48°·80	N_2 κ =	318°·56	$(2SM)_2$ κ =	118°·34
M_1 R =	·049	K_1 R =	1·262	λ_2 R =	...	$2N_2$ R =	·119
M_1 ζ =	86°·12	K_1 ζ =	222°·45	λ_2 ζ =	...	$2N_2$ ζ =	337°·13
M_1 H =	·037	K_1 H =	1·360	λ_2 H =	...	$2N_2$ H =	·116
M_1 κ =	134°·84	K_1 κ =	45°·31	λ_2 κ =	...	$2N_2$ κ =	290°·91
M_2 R =	4·078	K_2 R =	·328	ν_2 R =	·164	$(M_2N)_4$ R =	·013
M_2 ζ =	113°·68	K_2 ζ =	176°·79	ν_2 ζ =	52°·52	$(M_2N)_4$ ζ =	38°·66
M_2 H =	3·975	K_2 H =	·398	ν_2 H =	·160	$(M_2N)_4$ H =	·013
M_2 κ =	331°·33	K_2 κ =	3°·31	ν_2 κ =	261°·29	$(M_2N)_4$ κ =	342°·02
M_3 R =	·075	P_1 R =	·398	μ_2 R =	·184	$(M_2K_1)_3$ R =	·078
M_3 ζ =	251°·94	P_1 ζ =	235°·53	μ_2 ζ =	226°·71	$(M_2K_1)_3$ ζ =	154°·48
M_3 H =	·072	P_1 H =	·398	μ_2 H =	·175	$(M_2K_1)_3$ H =	·082
M_3 κ =	38°·40	P_1 κ =	45°·51	μ_2 κ =	302°·00	$(M_2K_1)_3$ κ =	194°·99
M_4 R =	·102	J_1 R =	·049	R_2 R =	...	$(2M_2K_1)_5$ R =	·047
M_4 ζ =	259°·54	J_1 ζ =	108°·40	R_2 ζ =	...	$(2M_2K_1)_5$ ζ =	186°·15
M_4 H =	·097	J_1 H =	·055	R_2 H =	...	$(2M_2K_1)_5$ H =	·048
M_4 κ =	334°·83	J_1 κ =	59°·51	R_2 κ =	...	$(2M_2K_1)_5$ κ =	78°·57

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·100	219°·48	·092	351°·41
„ Fortnightly „	·009	44·63	·012	5·35
Luni-Solar „ „	·043	90·90	·042	233·26
Solar-Annual „	·096	221·27	·096	141·30
„ Semi-Annual „	·162	329·80	·162	169·86

VALUES OF THE TIDAL CONSTANTS, MADRAS, 1906.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1906 Observations at Madras; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1906 Observations :—

Short Period Tides.

A_0 = 2·446 feet.

S_1	H = R =	·019	M_6	R =	·003	Q_1	R =	·006	T_2	R =	·013
	κ = ζ =	80°·73		ζ =	182°·05		ζ =	222°·21		ζ =	319°·30
S_2	H = R =	·454		H =	·003		H =	·007		H =	·013
	κ = ζ =	270°·75		κ =	116°·48		κ =	129°·53		κ =	320°·63
S_4	H = R =	·002	M_8	R =	·003	L_2	R =	·036	$(MS)_4$	R =	·004
	κ = ζ =	78°·11		ζ =	41°·99		ζ =	108°·13		ζ =	54°·87
S_6	H = R =	·001		H =	·003		H =	·034		H =	·003
	κ = ζ =	17°·10		κ =	194°·57		κ =	267°·48		κ =	273°·01
S_8	H = R =	·000	O_1	R =	·082	N_2	R =	·257	$(2SM)_2$	R =	·017
	κ = ζ =	135°·00		ζ =	288°·75		ζ =	149°·54		ζ =	93°·86
				H =	·093		H =	·250		H =	·016
				κ =	327°·73		κ =	236°·02		κ =	235°·72
M_1	R =	·025	K_1	R =	·270	λ_2	R =	...	$2N_2$	R =	·046
	ζ =	313°·51		ζ =	153°·83		ζ =	...		ζ =	267°·74
	H =	·018		H =	·291		H =	...		H =	·045
	κ =	2°·48		κ =	336°·67		κ =	...		κ =	222°·57
M_2	R =	1·111	K_2	R =	·099	ν_2	R =	·050	$(M_2N)_4$	R =	·004
	ζ =	23°·29		ζ =	88°·36		ζ =	340°·14		ζ =	178°·26
	H =	1·083		H =	·120		H =	·049		H =	·003
	κ =	241°·43		κ =	274°·84		κ =	189°·03		κ =	122°·89
M_3	R =	·005	P_1	R =	·094	μ_2	R =	·042	$(M_2K_1)_3$	R =	·009
	ζ =	253°·18		ζ =	168°·45		ζ =	95°·97		ζ =	97°·51
	H =	·004		H =	·094		H =	·040		H =	·010
	κ =	40°·40		κ =	338°·44		κ =	172°·27		κ =	138°·51
M_4	R =	·008	J_1	R =	·020	R_2	R =	...	$(2M_2K_1)_3$	R =	·002
	ζ =	119°·84		ζ =	354°·41		ζ =	...		ζ =	53°·13
	H =	·008		H =	·022		H =	...		H =	·002
	κ =	196°·13		κ =	305°·23		κ =	...		κ =	306°·58

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·051	303°·33	·047	74°·99
,, Fortnightly ,, ...	·065	34·43	·086	354·60
Luni-Solar ,, ,, ...	·017	15·05	·017	156·90
Solar-Annual ,, ...	·446	263·91	·446	183·91
,, Semi-Annual ,, ...	·220	270·42	·220	110·44

VALUES OF THE TIDAL CONSTANTS, KIDDERPORE, 1906.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1906 Observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epoch (κ) for each particular tide evaluated from the 1906 Observations :—

Short Period Tides.

A_0 = 10·722 feet.

S_1	H = R =	·086	M_6	R =	·195	Q_1	R =	·012	T_2	R =	·193
	κ = ζ =	204°·21		ζ =	21°·89		ζ =	112°·38		ζ =	172°·43
S_2	H = R =	1·548		H =	·180		H =	·002		H =	·193
	κ = ζ =	96°·71		κ =	317°·06		κ =	20°·57		κ =	173°·77
S_4	H = R =	·088	M_8	R =	·086	L_2	R =	·189	$(MS)_4$	R =	·675
	κ = ζ =	98°·71		ζ =	113°·18		ζ =	243°·85		ζ =	215°·69
S	H = R =	·006		H =	·078		H =	·180		H =	·658
	κ = ζ =	342°·22		κ =	267°·95		κ =	43°·46		κ =	74°·38

Short Period Tides—contd.

S_8	H = R =	·009	O_1	R =	·196	N_2	R =	·738	$(2SM)_2$	R =	·089
	κ = ζ =	296°·29		ζ =	344°·26		ζ =	319°·76		ζ =	238°·07
				H =	·222		H =	·719		H =	·086
				κ =	23°·82		κ =	47°·08		κ =	19°·38
M_1	R =	·046	K_1	R =	·389	λ_2	R =	...	$2N_2$	R =	·146
	ζ =	19°·30		ζ =	230°·60		ζ =	...		ζ =	26°·83
	H =	·035		H =	·419		H =	...		H =	·143
	κ =	68°·53		κ =	53°·42		κ =	...		κ =	342°·79
M_2	R =	3·865	K_2	R =	·407	ν_2	R =	·231	$(M_2N)_4$	R =	·281
	ζ =	197°·65		ζ =	270°·80		ζ =	152°·59		ζ =	76°·33
	H =	3·767		H =	·494		H =	·225		H =	·267
	κ =	56°·34		κ =	97°·24		κ =	2°·89		κ =	22°·35
M_3	R =	·055	P_1	R =	·145	μ_2	R =	·212	$(M_2K_1)_3$	R =	·124
	ζ =	146°·01		ζ =	234°·73		ζ =	104°·65		ζ =	328°·24
	H =	·053		H =	·145		H =	·202		H =	·130
	κ =	294°·05		κ =	44°·74		κ =	182°·04		κ =	9°·76
M_4	R =	·790	J_1	R =	·021	R_2	R =	...	$(2M_2K_1)_3$	R =	·023
	ζ =	315°·94		ζ =	28°·03		ζ =	...		ζ =	46°·78
	H =	·751		H =	·024		H =	...		H =	·024
	κ =	33°·32		κ =	338°·53		κ =	...		κ =	301°·34

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide	·324	263·25	·297	34·62
„ Fortnightly „	·174	100·32	·229	59·91
Luni-Solar „ „	·956	256·75	·932	38·06
Solar-Annual „	2·705	234·03	2·705	154·01
„ Semi-Annual „	·969	137·53	·969	337·50

VALUES OF THE TIDAL CONSTANTS, RANGOON, 1906.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1906 Observations at Rangoon; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1906 Observations:—

Short Period Tides.

A_0 = 10·285 feet.

S_1	H = R =	·117	M_6	R =	·264	Q_1	R =	·017	T_2	R =	·188
	κ = ζ =	129°·10		ζ =	145°·26		ζ =	140°·37		ζ =	197°·19
S_2	H = R =	2·174		H =	·244		H =	·019		H =	·188
	κ = ζ =	166°·86		κ =	82°·94		κ =	49°·40		κ =	198°·56
S_4	H = R =	·085	M_8	R =	·099	L_2	R =	·408	$(MS)_4$	R =	·455
	κ = ζ =	263°·09		ζ =	298°·19		ζ =	329°·25		ζ =	349°·12
S_6	H = R =	·009		H =	·089		H =	·388		H =	·443
	κ = ζ =	31°·28		κ =	95°·10		κ =	129°·11		κ =	208°·35
S_8	H = R =	·004	O_1	R =	·250	N_2	R =	1·066	$(2SM)_2$	R =	·162
	κ = ζ =	57°·53		ζ =	345°·26		ζ =	31°·67		ζ =	271°·25
				H =	·284		H =	1·069		H =	·158
				κ =	25°·37		κ =	119°·81		κ =	52°·03
M_1	R =	·080	K_1	R =	·658	λ_2	R =	...	$2N_2$	R =	·323
	ζ =	57°·93		ζ =	209°·99		ζ =	...		ζ =	104°·29
	H =	·060		H =	·709		H =	...		H =	·314
	κ =	107°·44		κ =	132°·80		κ =	...		κ =	61°·35
M_2	R =	6·088	K_2	R =	·535	ν_2	R =	·310	$(M_2N)_4$	R =	·182
	ζ =	270°·30		ζ =	345°·03		ζ =	237°·41		ζ =	213°·66
	H =	5·934		H =	·648		H =	·302		H =	·173
	κ =	129°·53		κ =	171°·43		κ =	88°·49		κ =	161°·03
M_3	R =	·045	P_1	R =	·186	μ_2	R =	·562	$(M_2K_1)_3$	R =	·168
	ζ =	194°·55		ζ =	239°·30		ζ =	211°·60		ζ =	18°·62
	H =	·043		H =	·186		H =	·534		H =	·177
	κ =	343°·39		κ =	49°·34		κ =	290°·05		κ =	60°·66

Short Period Tides—contd.

M_4	R =	·476	J_1	R =	·023	R_2	R =	...	$(2M_2K_1)_3$	R =	·105
	ζ =	86°·99		ζ =	167°·99		ζ =	...		ζ =	152°·38
	H =	·453		H =	·025		H =	...		H =	·107
	κ =	165°·44		κ =	118°·20		κ =	...		κ =	48°·02

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide	·221	249·35	·203	20·43
„ Fortnightly „	·164	91·73	·216	50·74
Luni-Solar „ „	·458	269·47	·447	50·24
Solar-Annual „	1·321	229·56	1·321	149·52
„ Semi-Annual „	·173	147·53	·173	347·46

Values of the Tidal Constants, Port Blair, 1906.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1906 Observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1906 Observations:—

Short Period Tides.

A_0 = 4·782 feet.

S_1	H = R =	·016	M_6	R =	·002	Q_1	R =	·012	T_2	R =	·079
	κ = ζ =	60°·21		ζ =	97°·60		ζ =	307°·54		ζ =	359°·49
S_2	H = R =	·955		H =	·002		H =	·014		H =	·079
	κ = ζ =	314°·78		κ =	34°·58		κ =	216°·20		κ =	0°·84
S_4	H = R =	·004	M_8	R =	·002	L_2	R =	·056	$(MS)_4$	R =	·017
	κ = ζ =	355°·82		ζ =	273°·81		ζ =	110°·85		ζ =	86°·49
S_6	H = R =	·001		H =	·002		H =	·053		H =	·017
	κ = ζ =	246°·04		κ =	69°·79		κ =	270°·60		κ =	305°·48
S_8	H = R =	·001	O_1	R =	·134	N_2	R =	·423	$(2SM)_2$	R =	·021
	κ = ζ =	135°·00		ζ =	266°·08		ζ =	189°·64		ζ =	16°·62
				H =	·151		H =	·412		H =	·021
				κ =	305°·95		κ =	277°·43		κ =	157°·63
M_1	R =	·031	K_1	R =	·363	λ_2	R =	...	$2N_2$	R =	·062
	ζ =	328°·21		ζ =	143°·14		ζ =	...		ζ =	292°·43
	H =	·023		H =	·391		H =	...		H =	·060
	κ =	17°·60		κ =	325°·96		κ =	...		κ =	249°·01
M_2	R =	2·074	K_2	R =	·216	ν_2	R =	·080	$(M_2N)_4$	R =	·005
	ζ =	61°·36		ζ =	129°·81		ζ =	21°·92		ζ =	327°·62
	H =	2·021		H =	·262		H =	·078		H =	·005
	κ =	280°·35		κ =	316°·23		κ =	232°·66		κ =	274°·40
M_3	R =	·004	P_1	R =	·132	μ_2	R =	·063	$(M_2K_1)_3$	R =	·017
	ζ =	247°·93		ζ =	159°·78		ζ =	208°·29		ζ =	155°·27
	H =	·004		H =	·132		H =	·060		H =	·018
	κ =	36°·42		κ =	329°·81		κ =	286°·28		κ =	197°·08
M_4	R =	·005	J_1	R =	·023	R_2	R =	...	$(2M_2K_1)_3$	R =	·008
	ζ =	129°·81		ζ =	0°·10		ζ =	...		ζ =	318°·07
	H =	·005		H =	·025		H =	...		H =	·008
	κ =	207°·79		κ =	310°·44		κ =	...		κ =	213°·24

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide	·029	212·83	·027	344·03
„ Fortnightly „	·034	52·86	·045	12·12
Luni-Solar „ „	·014	152·39	·014	293·40
Solar-Annual „	·251	247·69	·251	167·67
„ Semi-Annual „	·104	323·75	·104	163·69

18. *Other computations.*—The actual times and heights of high and low water for 1906 at 12 ports have been compared with the predicted values published in the tide-tables and the results tabulated.

19. *Auxiliary reports.*—Reports on the operations carried on in the Bombay Presidency and in Burma were prepared and submitted, the former to the Government of Bombay and the latter to the Principal Port Officer in Burma, Rangoon.

20. *Receipt and Issue of tide-tables*—The tide-tables for 1907 were received in the office in time for circulation and were duly distributed.

21. *Datum of tide-tables for 1906.*—The datum for the tide-tables for 1906 is the datum of soundings in the most recent Admiralty Charts, with the exception of Bassein, the datum for which port is "Indian Spring Low Watermark" which has not been connected with the Admiralty datum.

22. *Sale of tide-tables.*—The amount realised on the sale of tide-tables during the financial year ending 30th September 1907 is Rs. 1,417-9-9.

23. *Data forwarded to England.*—The following data were supplied to the Tidal Assistant, National Physical Laboratory, Teddington, England :—

(*i*) Values of the tidal constants for the tide-tables for 1909, ready for use in the tide predicting machine.

(*ii*) Actual values during 1905 of every high and low water measured in duplicate from the tidal diagrams at 9 stations, and of tide-pole observations taken during daylight at 4 closed stations, the latter under the supervision of the Port Officers and supplied by them to this office.

(*iii*) Comparisons of the above with predicted values for 1905, the errors being tabulated in such form as to be of aid in improving the predictions.

24. *Errors in prediction.*—The 5 tabular statements which are appended show the percentage and amount of errors in the predicted times and hieghts of high and low water for the year 1906 at 12 stations, as determined by comparisons of the predictions given in the tide-tables with actual values measured from the tidal diagrams at 8 stations, and from tide-poles at 4 stations, the former are made in this office and the latter by the Port Officials.

No. 1.

Statement showing the percentage and the amount of the errors in the Predicted Times of High water at the various Tidal Stations for the year 1906.

STATIONS.	Automatic or Tide-pole observations.	Number of comparisons between actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	Au.	693	42	43	7	5	3
Karachi	Au.	703	37	44	9	7	3
Bhavnagar	T. P.	365	23	74	1	1	1
Bombay { Apollo Bandar	Au.	705	50	42	4	3	1
Bombay { Prince's Dock.	Au.	695	31	49	12	6	2
Madras	Au.	701	37	45	9	7	2
Kidderpore	Au.	705	16	35	15	20	14
Chittagong	T. P.	365	28	35	13	14	10
Akyab	T. P.	364	100	...	...	...	...
Rangoon	Au.	704	25	42	13	16	4
Moulmein	T. P.	365	10	83	7	...	...
Port Blair	Au	706	44	43	8	4	1

No. 2.

Statement showing the percentage and the amount of the errors in the Predicted Times of Low water at the various Tidal Stations for the year 1906.

Stations.	Automatic or Tide-pole observations.	Number of comparisons between actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	Au.	689	38	44	10	6	2
Karachi	Au.	705	25	41	15	14	5
Bhavnagar	T. P.	365	13	77	7	2	1
Bombay { Apollo Bandar	Au.	705	42	44	9	4	1
Bombay { Prince's Dock	Au.	695	34	47	12	6	1
Madras	Au.	700	44	45	6	4	1
Kidderpore	Au.	706	18	30	13	22	17
Chittagong	T. P.	365	25	34	10	14	17
Akyab	T. P.	365	100	...	...	...	...
Rangoon	Au.	705	23	35	12	16	14
Moulmein	T. P.	365	10	73	14	3	...
Port Blair	Au.	705	27	54	10	8	1

No. 3.

Statement showing the percentage and the amount of the errors in the Predicted Heights of High Water at the various Tidal Stations for the year 1906.

Stations.	Automatic or Tide-pole observations.	Number of comparisons between actual and predicted values.	Mean range at springs in feet.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
				Per cent.	Per cent.	Per cent.	Per cent.
Aden	Au.	693	6·7	98	2	...	...
Karachi	Au.	703	9·3	78	17	4	1
Bhavnagar	T. P.	365	31·4	41	31	14	14
Bombay { Apollo Bandar	Au.	705	13·9	73	21	6	...
Bombay { Prince's Dock	Au.	695	13·9	72	22	6	...
Madras	Au.	701	3·5	65	28	6	1
Kidderpore	Au.	705	11·7	41	24	14	21
Chittagong	T. P.	365	13·3	41	25	16	18
Akyab	T. P.	364	8·3	75	23	2	...
Rangoon	Au.	704	16·4	54	29	11	6
Moulmein	T. P.	365	12·7	26	21	20	33
Port Blair	Au.	706	6·6	96	4	...	...

No. 4.

Statement showing the percentage and the amount of the errors in the Predicted Heights of Low Water at the various Tidal Stations for the year 1906.

Stations.	Automatic or Tide-pole observations.	Number of comparisons between actual and predicted values.	Mean range at springs in feet.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
				Per cent.	Per cent.	Per cent.	Per cent.
Aden	Au.	689	6·7	97	3	...	...
Karachi	Au.	705	9·3	74	23	3	...
Bhavnagar . . .	T. P.	365	31·4	39	41	13	7
Bombay { Apollo Bandar .	Au.	705	13·9	67	28	5	...
Bombay { Prince's Dock .	Au.	695	13·9	62	31	6	1
Madras	Au.	700	3·5	69	27	3	1
Kidderpore . . .	Au.	706	11·7	45	28	16	11
Chittagong . . .	T. P.	365	13·3	58	21	7	14
Akyab	T. P.	365	8·3	76	21	3	...
Rangoon . . .	Au.	705	16·4	29	25	20	26
Moulmein . . .	T. P.	365	12·7	45	20	11	24
Port Blair . . .	Au.	705	6·6	96	4	...	...

No. 5.

Table of average errors in the Predicted Times and Heights of High and Low Water at the several Tidal Stations for the year 1906.

Stations.	Automatic or Tide-pole observations.	Mean range at springs in feet.	Average errors: of Time in Minutes.		of Height in terms of the range.		of Height in inches.	
			H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
Open Coast.								
Aden	Au.	6·7	9	9	·025	·025	2	2
Karachi	Au.	9·3	10	13	·027	·027	3	3
Bhavnagar	T. P.	31·4	8	10	·019	·016	7	6
Bombay { Apollo Bandar .	Au.	13·9	7	8	·018	·024	3	4
Bombay { Prince's Dock .	Au.	13·9	10	10	·018	·024	3	4
Madras	Au.	3·5	10	8	·095	·095	4	4
Akyab	T. P.	8·3	3	3	·030	·030	3	3
Port Blair	Au.	6·6	8	10	·025	·025	2	2
General Mean			8	9	·032	·033	...	...
Riverain.								
Kidderpore	Au.	11·7	17	18	·050	·043	7	6
Chittagong	T. P.	13·3	14	18	·050	·038	8	6
Rangoon	Au.	16·4	13	16	·025	·046	5	9
Moulmein	T. P.	12·7	10	11	·066	·052	10	8
General Mean			14	16	·048	·045	...	...

The foregoing statements for the year 1906, may be thus summarised :—

Percentage of Time Predictions within 15 minutes of actuals.

		High Water. Per cent.	Low Water. Per cent.
Open Coast Stations.	6 at which predictions were tested by S. R. Tide-gauge .	85	81
	2 " " " Tide-pole . .	99	95
Riverain Stations.	2 " " " S. R. Tide-gauge .	59	53
	2 " " " Tide-pole . .	78	71

Percentage of Height Predictions within 8 inches of actuals.

		High Water. Per cent.	Low Water. Per cent.
Open Coast Stations.	6 at which predictions were tested by S. R. Tide-gauge .	96	97
	2 " " " Tide-pole . .	85	89
Riverain Stations.	2 " " " S. R. Tide-gauge .	74	64
	2 " " " Tide-pole . .	57	72

Percentage of Height Predictions within one-tenth of mean range at springs.

		High Water. Per cent.	Low Water. Per cent.
Open Coast Stations.	6 at which predictions were tested by S. R. Tide-gauge .	94	95
	2 " " " Tide-pole . .	100	100
Riverain Stations.	2 " " " S. R. Tide-gauge .	92	95
	2 " " " Tide-pole . .	84	88

25. *Comparisons of the predictions at riverain stations.*—The predictions for the riverain stations for the year 1906 were compared with those for the year before with the following results :—

At Kidderpore they are practically the same for high water times, but a little worse for the low water times; for the heights of high and low water they are about the same as in the previous year. At Chittagong they are about the same for times and heights. At Rangoon there is a slight improvement in the predictions for high water times, they are the same for time of low water; with regard to the heights, they are the same for high water and a little better for low water. At Moulmein there is an improvement for the times of high water, for times of low water there is no appreciable change; they are a very little worse for heights of high and low water.

At Kidderpore the greatest difference between the actual and predicted heights of low water for 1906 was 2 feet 7 inches on 28th August, the prediction being higher. At Chittagong it was 3 feet 2 inches on 29th September, the prediction being higher. At Rangoon it was 2 feet 6 inches on 2nd December, the prediction being lower. At Moulmein it was 3 feet on 18th and 19th August, the predictions being lower.

LEVELLING OPERATIONS.

26. *Strength of Levelling Section.*—During the past year three detachments were engaged on spirit levelling operations.

The combined strength of the Levelling Detachments in the field was as detailed below :—

Detachment No. 1 :—2 levellers: Mr. E. H. Corridon, 1st leveller: Mr. O. N. Pushong, 2nd leveller; 3 recorders; 30 menials, there being 1 leader or guide whose duty it is to keep ahead and select the stations for observation and to control the men both in camp and on work; and 29 others, made up of staff-men, chain-men, peg-men and carriers.

Detachment No. 2 :—Same strength as for Detachment No. 1. The levellers were: Munshi Syed Zille Hasnain, 1st leveller; Mr. D. H. Luxa, 2nd leveller.

Detachment No. 3 :—Equivalent strength to the other Detachments, the levellers being: Mr. A. M. Talati, 1st leveller; Babu P. N. Sur, 2nd leveller.

In each instance the 1st Leveller had charge of the Detachment.

At the close of field operations, the menial establishment was discharged, all but a few men who were required for service in recess.

27. *Programme for Past Field season.*—The following is the programme of work which had been allotted to the Levelling Detachments :—

Detachment No. 1 :—

(i) To revise the old line of levels between Bombay and Sholapur, along the G. I. P. Railway.

(ii) To connect the Standard Bench-marks at Bombay, Deolali, Ahmednagar, Kirkee, Poona and Sholapur.

(iii) To connect Lal Tibba in Landour with the Mussoorie levels.

Owing to a great deal of sickness in this camp during the field season, the programme had to be subsequently curtailed and instructions were accordingly issued to close work at Barsi Road and to leave out the connection of the standard Bench-marks at Deolali and Sholapur.

Detachment No. 2 :—

(i) To level from Gwalior to Jhansi with the object of connecting the Standard Bench-mark at the latter place.

(ii) To level from Segra Tower Station, across the Indus River to Dera Ismail Khan, in order to fix permanent marks from which the Standard Bench-mark which was to be erected could be levelled to.

(iii) To continue the main line of levels from Rawalpindi to Chach Base line, and thence to extend the line to Peshawar and connect the Standard Bench-mark both there and at Attock.

(iv) To connect the Standard Bench-marks at Jhelum, Ferozepur, Ludhiana, Umballa, and Delhi, with the old lines of levels.

(v) To revise the line of levels from Sahâranpur to Dehra Dun connecting Nojli G. T. S. Tower Station and Dehra Dun Base Line by branch lines.

Detachment No. 3 :—

(i) To revise the old line of levels between Sholapur and Gooty.

(ii) To level to Banog in Mussoorie.

This was subsequently altered in consequence of the curtailment of Mr. Corridon's programme. The gap that would have been left between Barsi Road and Sholapur had to be filled up. To enable this to be done, the portion of Mr. Talati's programme, from Kosgi to Gooty, was cancelled and he was instructed to proceed to Sholapur, after levelling up to Kosgi, and from Sholapur to level on to Barsi Road and there join hands with Mr. Corridon. The connection of the Standard Bench-marks at Sholapur and Deolali was added to his original programme.

28. *Duration of Field Season and work performed.*

No. 1 Detachment.—This detachment left Dehra Dun for Bombay on 13th October, arriving there on 16th idem. After all preliminary arrangements were completed, work was started on 22nd from the Bench-mark of Reference at the Tidal Observatory, Apollo Bandar, and closed at Barsi Road on 7th April. The detachment then returned to headquarters at Dehra Dun, arriving on 13th April, and proceeded to Mussoorie on 6th May to carry out a branch line of levels from Mussoorie to Lal Tibba in Landour, closing work on 30th May.

No. 2 Detachment.—This detachment left Dehra Dun for the field on 21st October and the several sections of the work allotted to it were executed in the order given in the programme. The season's operations were finally closed at Dehra Dun on 16th May.

No. 3 Detachment.—The Officers of this detachment with a few men left Dehra Dun for the field on 29th October and arrived on 1st November at Poona where it was intended to recruit the menial establishment. Men were not obtainable there and after a few days' halt in Poona, the levellers proceeded to their field of operations. Men were recruited from Sholapur and Dhond; great difficulty was experienced in obtaining the requisite number, and the starting of field operations was in consequence delayed. The work of levelling eventually commenced on 9th November, the line to Kosgi being completed on 9th March. The detachment then proceeded to Sholapur, resumed operations there on 11th March and closed at Barsi Road on 9th April, immediately after which the Standard Bench-mark at Deolali was connected. The detachment then returned to Dehra Dun, arriving on 19th April; it proceeded to Mussoorie on 6th May to connect Banog Hill Station and closed its field season on 4th June.

Outturn.—The outturn of work of Detachment No. 1 amounted to 257·4 miles of double levelling, in the course of which the instrument was set up at 3,407 stations, the total rises and falls being 8,021 feet. The marks connected by levelling were 5 Standard (including 1 old one at Bombay), 30 embedded, 202 inscribed, 2 Public Works Department Bench-marks, 2 Great Trigonometrical Survey Stations and 1 Great Trigonometrical Intersected Point.

Between Bombay and Barsi Road the rises amounted to 4243·809 feet the falls to 2637·155 feet, the total rises and falls being 6880·964 feet; the distance was 236 miles.

On the line Mussoorie to Lal Tibba, a distance of 3·2 miles, the rises were 989·609 feet and falls 150·600 feet, making a total of 1140·209 feet.

For Detachment No. 2, the outturn was 283·8 miles of double levelling; the instrument was set up at 3,986 stations; the heights of 11 Standard, (including 3 previously connected) 20 embedded and 270 inscribed Bench-marks were determined ; in addition, 14 Railway, 4 Public Works Department Bench-marks and 7 Great Trigonometrical Survey Stations were connected. The total rises and falls amounted to 7,692 feet. The opportunity was taken to inspect 3 Great Trigonometrical Survey Stations, in addition to those connected by levelling.

The rises and falls on the Section Saharanpur to Dehra Dun were: rises 2,075·938 feet, falls 750·603 feet, total 2,826·541 feet; distance 44½ miles.

Detachment No. 3 completed 263·9 miles of double levelling; the instrument was set up at 4,161 stations; the total rises and falls amounted to 8,433 feet; the heights of 2 Standard, 20 embedded, 205 inscribed, 24 Irrigation and 2 Railway Bench-marks were obtained; 6 Great Trigonometrical Survey Stations were connected and 5 others visited.

The rises and falls on the line Barsi to Kosgi were: rises 2,670·758 feet, falls 3,053·282 feet, total 5,724·040 feet; distance 236 miles.

On the branch line to Banog H. S. in Mussoorie the rises were 1,542·737 feet and the falls 1,036·652 feet; total 2,579·389 feet, distance 5½ miles.

The total levelling executed amounted to 805 miles, of which 288½ miles was new levelling and 516½ miles, revision work. The Bench-marks connected were 18 Standard, including 4 previously determined, 70 Embedded, 677 Inscribed, and 46 others, such as Railway, Irrigation, etc., 16 Trigonometrical Stations were also connected.

30. *Bombay-Madras Error.*—The revision of the level line Bombay to Madras, was, during the past season, carried as far as Kosgi, a Station on the Madras Railway, distant 472 miles from Bombay.

The table below shows the discrepancies between the levelling of 1877-81 and 1906-07.

The mean Sea Level at Bombay derived from tidal observations taken in 1876-77 is 10·141 feet above the present Zero of the gauge. The observed heights of 1877-81 are reduced to this datum.

The Mean Sea Level at Bombay deduced from tidal observations taken between 1878 and 1904 is 10·236 feet above the Zero of the gauge. The observed heights of 1906-07 have been reduced by the levellers to this datum. In order to make the observed values obtained in 1877-81 comparable with those of 1906-07, a common datum line is required, which, in the following table, is the Mean Sea Level of 1876-77. The difference ·095 has, therefore with its proper sign, been applied to the heights of 1906-07.

Approximate distance in miles from Bombay.	Name of Bench-mark.	Observed Heights above Mean Sea level (1876-77) in feet.		Difference with sign for new value against old.	Heights published in pamphlet in feet.	Remarks.
		Seasons 1877-81.	Seasons 1906-07.			
0	G. T. S. ○ at Town Hall Bombay. B. M.	19·859	19·843	—·016	19·80	
2	G. T. S. □ at Prince's Dock. B. M.	10·855	10·815	—·040	10·72	
33	G. T. S. □ at Kalyán Railway Station. B. M.	25·270	25·242	—·028	24·91	

Approximate distance in miles from Bombay.	Name of Bench-mark.	Observed Heights above Mean Sea level (1870-77) In feet.		Difference with sign for new value against old.	Heights published in pamphlet in feet.	Remarks.
		Seasons 1877-81	Seasons 1906-07			
71	G. T. S. □ at Kámpuli Railway Station. B. M.	232·240	232·312	+·072	231·73	This is over the Borghat.
77	G. T. S. □ at Khandála Railway Station. B. M.	1790·885	1790·754	—·131	1790·36	
153	G. T. S. □ at Kedgaon Railway Station. B. M.	1776·889	1776·773	—·116	1776·18	
165	G. T. S. ○ at Dhond Railway Station. B. M.	1693·296	1693·108	—·188	1692·41	
183	G. T. S. □ at Diksál Railway Station. B. M.	1658·706	1658·507	—·199	1657·72	
236	G. T. S. □ at Bársi Road Railway St. B. M.	1678·540	1678·066	—·474	1677·38	
286	G. T. S. □ at Sholapur Railway Station. B. M.	1493·351	1492·526	—·825	1492·07	
357	G. T. S. ○ at Gulbarga Railway Station. B. M.	1490·924	1489·987	—·937	1489·50	
441	G. T. S. ○ at Bridge near Raichur Railway Station. B. M.	1288·655	1286·786	—1·869	1286.78	
472	G. T. S. □ at Kosgi Railway Station. B. M.	1239·957	1238·016	—1·941	1238·10	

The differences between the old and new levelling throughout the line from Bombay to Kosgi, are cumulative; no large individual error has been disclosed. On the section Gulbarga to Raichur which shows the greatest discrepancy, the error is likewise of a cumulative nature.

The average discrepancy per mile beween Bombay and Raichur is 0·004 foot.

That between Gulbarga and Raichur 0·011 foot.

The cause of the discrepancy between the old and new levelling cannot be discussed until the whole line Bombay to Madras has been revised.

31. *Bombay-Karwar error.*—The closing discrepancy between the mean Sea Level at Bombay and the mean Sea Level at Karwar, using the earliest values was 0·93 foot, Karwar being higher than Bombay. The levelling route was Bombay, Kedgaon, Hubli, Karwar.

The closing error now obtained by the same route is 0·814 foot for Karwar, using the new value for Kedgaon.

By the line Bombay, Kedgaon, Gulbarga, Raichur, Bellary, Hubli, Karwar, the error now computed is 0·175 foot at Karwar, introducing the new value for Raichur.

32. *Panjab circuit, closing error.*—The levelling from Lahore to Chach Base, part of which, to Rawalpindi, was done in season 1905-06, and the remainder in the past season, forms a link between the old levelled heights obtained at these

points and completes the circuit Moorghai, Chach, Lahore, Ferozepore, Moorghai. The closing error derived from the observed heights of seasons 1858-62, 1905-06, and 1906-07 works out to—7½ inches. The mileage of this circuit being 1,023 miles, the average error per 100 miles is ·06 foot.

The difference between the two levellers from Lahore to S. W. End of Chach Line was as follows :—

		First Leveller (—) Second Leveller
From Lahore to 50th mile		+ · 105 foot.
" " " 100th "		— · 001 " .
" " " 150th "		+ · 080 " .
" " " 178th "	(Rawalpindi)	+ · 125 " .
" " " 228th "	S. W. End Chach Base	+ · 076 " .

33. *Levelling Saharanpur-Dehra-Mussoorie.*—Levelling to Mussoorie was first done in April-May 1904.

Owing to the earthquake on 4th April, 1905, the line was revised in April-May of this year.

The difference obtained at the terminal point, which is a Bench-mark at "Dunseverick," Vincent's Hill, was 0·468 foot, or 5½ inches, the height determined in 1905 being lower than in 1904, showing apparent sinking of Mussoorie. As a portion of the line, Kolukhet to Mussoorie, was executed by single-levelling, in May 1905, the difference in height obtained could not be finally accepted and it was therefore decided to revise this portion by double-levelling. This was done in October of the same year.

The general result showed an apparent sinking of Mussoorie of 5 inches instead of 5½ inches.

With the object of testing this conclusion, the section Saharanpur to Dehra Dun was re-levelled, in April-May 1907, the levels starting from the embedded Bench-mark at Saharanpur and closing on a mark at the Dehra Survey office, the identical mark from which the levels to Mussoorie emanated.

Assuming the old Bench-mark at Saharanpur to be unchanged, the results of the present levelling seem to indicate that a gradual upheaval took place towards the Siwaliks. This is first noticeable at the embedded Bench-mark at Mohan (27 miles from Saharanpur). Unfortunately two old Bench-marks at Kailaspur and Bhatpura, 6 and 16 miles respectively from Saharanpur, could not be found.

The following figures show the difference in height of Bench-marks along the line between the old and new levelling, the values of 1906 being higher than the old values :—

		ft.
Saharanpur	... ...	0·000
Mohan	27 miles from Saharanpur Southern side of the Siwaliks	0·330
Mohabawala	37 miles from Saharanpur Northern side of the Siwaliks	0·065
E. End Dehra Base Line	38 miles from Saharanpur	0·394
Dehra Survey Office	44 Do. do.	0·444

The difference found after the earthquake in the height of Mussoorie, accepting Dehra as correct, was 04.18 foot. By accepting Saharanpur as unchanged we now find that Dehra appears to have risen by an almost equal amount.

Combining the results, if Dehra is said to be unchanged then Mussoorie and Saharanpur have both sunk by 5 inches; if Saharanpur has not been disturbed then Mussoorie may be said to remain unaltered and Dehra raised by 5 inches.

34. *Levels used.*—The levels employed on the line Bombay to Barsi Road, were Cylindrical Level No. 4, used by Mr. Corridon and Cylindrical Level No. 1 by Mr. Pushong. From Barsi Road to Kosgi the levels used were Cylindrical Level No. 3, by Mr. Talati and Cylindrical Level No. 2 by Babu Sur.

In Mussoorie the levels used to connect Lal Tibba, were Cushing's Level No. 1151 by Mr. Corridon and Cooke's Level No. 8522, by Mr. Pushong; to connect Banog, Bolton's Reversible Level No. 8574, by Mr. Talati and Watt's Level No. 1143 by Babu Sur.

The levels used by No. 2 Detachment throughout the field season were American "Binocular Precise Levels." On the lines Gwalior to Jhansi and Darya Khan to Dera Ismail Khan, No. 2626 was used by Munshi Zille Hasnain and No. 2625 by Mr. Luxa. On the lines Rawalpindi to Peshawar and Saharanpur to Dehra Dun, Munshi Zille Hasnain used Level No. 2697 and Mr. Luxa No. 2626.

35. *The American Level.*—American Levels, known as the "Binocular Precise Level," constructed after the design in use by the United States Coast and Geodetic Survey, manufactured and supplied to this Department, by George N. Saegmüller, Washington, United States, America, have, for the first time, been used by Indian Survey levellers during the past field season. The levellers found them to be light instruments and easy to work with and to fully bear out their reputation for accuracy and the attainment of speed in levelling.

Their employment involved certain alterations in the Indian methods, the procedure adopted being a combination of the American and Indian systems.

These instruments are fitted with three horizontal wires so placed that the upper and lower wires are equidistant from the centre wire, and the mean of the three wire readings is equal to the centre wire reading. By this means the errors of reading the staff are effectively checked. The principal departure from the Indian system was that observations were taken to only one face of the staves with all three wires, the mean being adopted as the final reading. The second face of the staves was not used at all throughout the season's work.

The party is now in possession of four of these levels. Their acceptance from the makers was on the condition that they were proved to be satisfactory by the Superintendent of the United States Coast and Geodetic Survey.

36. *Staves used.*—No. 1 Detachment used staves of Captain Cowie's pattern those employed being Nos. 01, 03, 04 and 05.

The staves employed by Detachment No. 2 were Great Trignometrical pattern Nos. 11, 12, 0, B3 and B5. B3 was used up to 4th January, when levelling reached Dera Ismail Khan. B5 was substituted for B3 at Rawalpindi on 13th January and was used for the remainder of the season.

Great Trignometrical pattern staves No. B1, No. B2, No. 1111 and No. 4 were employed throughout the season by Detachment No. 3.

37. *Unit correction for staves.*—During the actual progress of the work, weekly comparisons of the staves with portable 10 foot standard steel bars were made with the object of determining the correction for difference in unit of pairs of staves, to be applied to the observed heights in order to obtain the absolute heights.

Tables of these comparisons are appended.

38. *Horizontal Levelling Bar.*—The Horizontal Bar method devised last year, for ascending steeps where it was impossible to use levelling instruments, was employed last field season in the Punjab.

The apparatus and method of working it are described in the Annual Narrative Report of No. 25 Party for 1905-06.

39. *River Crossing by three methods.*—(I) In the course of levelling operations in the Punjab, the Indus River was crossed by three distinct methods of levelling, these being:—

(1) By means of the old and long-standing tide-pole, or water-gauge method.

(2) By vertical angles.

(3) By actual levelling of precision.

The place where the river was crossed was between Darya Khan and Dera Ismail Khan.

The time of year was late in December, when the width of the main channel was at its narrowest, being about ½ mile.

The following extracts from the Leveller's report explain how the operations were conducted and give comparative results of the observations:—

"The crossing was done during the course of the levelling operations which emanated from Segra T. S. of the Great Indus Series, situated about 8 miles east of the Indus River, and were carried on across the river to Dera Ismail Khan with the object of connecting the Great Trigonometrical Survey Standard Bench-mark to be built in that town. Before taking the work in hand I had placed myself in communication with the Garrison Engineer, Dera Ismail Khan, to ascertain from him the best time of the year and the most suitable place for the crossing of the river. He had advised me to undertake the work about the middle of December and had kindly supplied me with a rough sketch of the place selected for a crossing.

"The entire bed of the river between Darya Khan and Dera Ismail Khan is nearly five miles in breadth. I was informed that from April to August the whole of this space was covered with water. But in the middle of December the main channel shrinks down to a breadth of from ¼ to ¾ of a mile. The place selected by the Garrison Engineer for my work was near the boat-bridge where the channel was narrowest, nearly ½ a mile from bank to bank.

"When I first arrived on the scene on the 20th December 1906 and examined the river, there seemed to be no possibility of working across it by direct levelling operations. The boat-bridge was tested and found so shaky that it was out of the question to level over it. I therefore arranged to cross the river (1) by means of the tide-pole method, and (2) by the vertical angles method. For this purpose wooden piles 6 feet in length and 4 inches in thickness were embedded in the ground at both banks of the river for the vertical angles, and two staves were erected in the water near both banks on top of similar piles sunk under water for water-level readings at right angles to the current.

"Simultaneous readings of the water-level were taken on the staves by the two observers: 51 readings with an interval of two minutes between each successive reading were taken in the forenoon, after which the observers changed places and took an equal number of readings in the afternoon, both observers reading at the same time by a prearranged signal. The relative heights of the piles driven in, and the referring piles out of the water at both banks were checked before and after the readings of the water-levels to ensure that no sinking or rising of the piles had taken place during the intervals. The height of the pile on the east bank above the pile on the west bank deduced from the mean water-levels read in the forenoon differed from the height deduced from the mean water-levels read in the afternoon by 0·009 foot.

"Reciprocal vertical angles were taken between the referring piles with an 8″ Micrometer theodolite to two discs fixed 10 feet apart on a 14-foot vertical bar: 8 values for each angle were determined.

"The difference of height between the two piles deduced from the vertical angles was found to differ from the height obtained by water-levels by 0·278 foot. This discrepancy appeared to me too large to be passed over. I could not ascertain whether it was due to the vertical angles or the water-levels or both. I had certainly greater faith in the vertical angles, but, on the other hand, there was no apparent reason for finding fault with the water-levels. This question could only be satisfactorily solved if the levels could be carried across the river by direct levelling operations. With this object in view, I made another attempt at reconnoitring the river for some miles up and down stream. Fortunately I came upon a spot about a mile down from the boat-bridge where a small island was beginning to form in the centre of the stream. The overseer in charge of the boat-bridge led me to believe that the river was fast silting up and that there would soon be small islands cropping up in the stream here and there. He advised me to wait for a few days. His predictions proved to be only too true, for when I repaired to the above spot three days later, I found that three or four islands at very convenient distances apart had been formed in the stream, which enabled me to level across the river without any great difficulty. It was of course necessary to use large wooden pegs 4 to 5 feet in length both for the staves and the tripod of the level to stand upon, as the upper surface of the islands was very loose and unsteady. The total distance actually levelled over from bank to bank was 43 chains which was sub-divided into 5 stations: the longest shot taken was 7 chains and the terminal difference between the two levellers over the above distance was 0·004 foot. This work necessitated a couple of miles of extra levelling to connect the piles already embedded on both banks of the river in connection with the water-levels and the vertical angle observations.

"The difference of height between the above piles determined by actual levelling as detailed above was found to agree within 0·007 foot with that deduced from the vertical angles.

"The values of height obtained by the three methods are shown in the table below.

Table showing difference of height between referring pile on East bank and referring pile on West bank of the Indus River.

By Tide-pole method		By Vertical angles		By actual levelling.	
From forenoon observations .	1·201 ft.	From forward angles . .	0·938 ft.	By First Leveller .	0·930 ft.
From afternoon observations . .	1·192 ft.	From back angles . .	0·900 ft.	By Second Leveller .	0·922 ft.
Mean . .	1·197 ft.	Mean . .	0·919 ft.	Mean .	0·926 ft."

(II) In December 1899 experiments were made on the Ganges River at Damukdia, to determine the best way of carrying levels of precision across large rivers. Captain H. L. Crosthwait, R.E., who conducted the levelling, has contributed an interesting account of the operations to the Survey of India "Professional Papers, 1903, Serial No. 7, Miscellaneous Papers."

The three methods of "vertical angles," "levelling" and "water-gauges (tide-pole)," were employed.

The distance across the river between the referring marks was 1·28 miles.

The result of the operations was that the difference of heights between the referring Bench-marks was found to be :—

By Vertical Angles	2·139 ft.
By Levelling	2·132 ft.
By Water-Gauges	2·212 ft.

Here the resultant differences by the three separate methods are nearly coincident with those obtained on the Indus at Darya Khan.

(III) Over half a century ago experiments were made to test the accuracy of the tide-pole method of taking levels across water. Levelling of precision was then in its initial and experimental stage. The operations were conducted by levellers under the superintendence of General Walker, R.E. The following is a paragraph on the subject extracted from the introduction to the pamphlet of "Tables of Heights in Sind, the Punjab, North-West Provinces and Central India, to May 1862":—

"In 1856 the River Chenab was crossed at three points, where experiments were made to determine the amount of error to which one is liable in referring to the surface of a river, at the opposite extremities of a section across, when the breadth is too great for a staff, on one bank, to be read from the other. Sections were selected at right angles to the stream, and pools were dug in the sand on each side, to obtain an unagitated surface of water for reference. The results, by direct levelling, differed from those referred to the margin of the stream, by 0·032, 0·039 and 0·074 feet, respectively, in the three instances, giving the average error of ·048, the average breadth of river being 12 chains."

Difference between results by tide-pole method and by levelling:—

On the Chenab, 1856	·048
On the Ganges, 1900	·080
On the Indus, 1906	·271

40. *Standard Bench-marks.*—The Standard Bench-mark scheme originated in 1903; in 1904 steps were taken for the selection of suitable stone, designs were planned, and in fact all such measures as might aid the furtherance of the scheme, which suggested themselves at the time, were adopted. (For full particulars see Annual Narrative Report, 25 Party, 1904-05.)

In 1905 the actual work of erection of the Bench-marks was begun and the levelling to them was commenced in the same year.

Up to date the number of Standard Bench-marks completed is 41; of these 36 have been connected, 5 remain to be levelled to. The number under construction is 27. In all 68 have been dealt with.

Years before the present scheme of having Standard Bench-marks scattered all over India had been evolved, marks, recognised as "Standard Bench-marks," were constructed in the chief cities of Calcutta, Bombay and Madras. They are not of uniform design and are all unlike the pattern now established. There are 1 in Calcutta, 2 in Bombay and 1 in Madras. Their descriptions are given in the Levelling Pamphlets which deal with their heights.

Though uniformity of design in the construction of the present Standard Bench-marks is aimed at, yet it cannot always be attained and the plan has occasionally to be altered, the alteration being dependent on local conditions.

The following table gives particulars of the Standard Bench-marks dealt with during the past, or with which the Department is at present concerned:—

List of Standard Bench marks.

Erected.		Under construction.	To be connected next field season.	Proposed for erection.
Connected.	Not yet connected.			
1 in Calcutta.	1 in Madras.	1 in Karachi.	1 in Madras.	
2 in Bombay.	1 in Bangalore.	1 in Hyderabad (Sind).	1 in Cuddapah.	
1 in Madras.	1 in Belgaum.	1 in Sukkur.	1 in Dera Ismail Khan.	
1 in Saharanpur.	1 in Multan.	1 in Jacobabad.	1 in Bikanir.	

List of Standard Bench marks.

Erected.		Under construction.	To be connected next field season	Proposed for erection.
Connected.	Not yet connected.			
1 in Dehra Dun.	1 in Dera Ismail Khan.	1 in Bikanir.	1 in Raichur.	
1 in Muzaffarnagar.		1 in Jodhpur.	3 in Secunderabad.	
2 in Meerut.		1 in Deesa.	1 in Multan.	
1 in Aligarh.		1 in Ahmedabad.		
1 in Bareilly.		1 in Mhow.		
1 in Shahjahanpur.		1 in Saugor.		
1 in Lucknow.		1 in Jubbulpur.		
1 in Sitapur.		1 in Nagpur.		
1 in Fyzabad.		1 in Akola.		
2 in Allahabad.		1 in Hinganghat.		
1 in Mirzapur.		3 in Secunderabad.		
1 in Benares.		1 in Raichur.		
1 in Ghazipur.		1 in Bellary.		
1 in Gorakhpur.		1 in Cuddapah.		
1 in Muttra.		1 in Salem.		
1 in Agra.		1 in Trichinopoly.		
1 in Gwalior.		1 in Negapatam.		
1 in Lahore.		1 in Madura.		
1 in Rawalpindi.		1 in Tinnevelly.		
1 in Jhansi.		1 in Calicut.		
1 in Delhi.		1 in Satara.		
1 in Ambala.				
1 in Ludhiana.				
1 in Ferozepur.				
1 in Jhelum.				
1 in Attock.				
1 in Peshawar.				
1 in Deolali.				
1 in Ahmednagar.				
1 in Kirkee.				
2 in Poona.				
1 in Sholapur.				

41. *Slab bearing height of Bench-mark.*—The stone slab bearing an inscription to indicate the height above Sea Level of the Standard Bench-mark and described in the Annual Narrative Report for 1905, has been modified. In the new design the dimensions are 2′×1′×2″ which makes it lighter and reduces the cost of transit. The inscription has also somewhat altered; the stone now bears the legend "The height of the top of this pillar is feet above the mean level of the sea," arranged in the manner shown below:—

THE HEIGHT OF THE TOP OF THIS PILLAR IS ABOVE THE MEAN LEVEL OF THE SEA

48 such slabs have been prepared and are stored in this office. The lettering has been engraved but a space has been left for the true height, which will hereafter be inscribed when the final values of the Bench-marks shall have been assigned to them. Simultaneously with the inscribing of the height, the name of the place where the Bench-mark has been erected, and to which the height refers, will be carved on the back of each stone.

The slabs will then be forwarded to their respective destinations and the officers entrusted with the care of the Bench-marks will be requested to have them embedded in masonry at the foot of the monoliths.

The slabs are prepared by a local stone-cutter who imports the stone from Agra.

The supply is kept abreast of the work of erection of the Bench-marks.

42. *Destruction of Bench-marks.*—On the line Bombay to Kosgi, 8 embedded and 141 inscribed Bench-marks have been lost or destroyed, out of a total of 461. This is owing to the extension of railway stations and platforms, the renewal of bridges and culverts, duplication of railway lines, etc. At Ahmednagar, when connecting the Standard Bench-mark there, 14 old Bench-marks could not be found; the bridge copings all along the railway were either being renewed or re-cobbled, and many Bench-marks were found to have been destroyed by this means.

The total number of Bench-marks reported during the past year as lost is 205.

43. *Recess Duties.*—The levelling computations have been completed. Manuscript pamphlets of heights and level charts have been brought up to date. In addition, site plans of all the embedded Bench-marks connected have been prepared, for embodiment in the pamphlets of heights which include these Bench-marks.

44. *Tables.*—Tabular statements relating to the past season's operations are appended.

45. *Health of Field Party.*—During the field season, the health of the Levelling Detachments was good, with the exception of No. 1 Detachment, which suffered much from malarial fever; there were however no casualties.

46. *Programme for Field season 1907-08.*—The levelling operations to be performed during the coming field season are:—

For No. 1 Detachment: to level from Gooty to Madras, about 258 miles, closing on the bed-plate of the tide-gauge at Madras, and to connect the Standard Bench-marks at Cuddapah and Madras.

No. 2 Detachment: to level from Ferozepore, along the railway line, towards Ahmedabad as far as Bikanir, about 257 miles, and to connect the Standard Bench-marks at Bikanir, Multan and Dera Ismail Khan.

No. 3 Detachment: to connect the Standard Bench-mark at Raichur, to level from Kosgi to Gooty, about 68 miles; then to go on to Hyderabad (Deccan), connect the 3 Standard Bench-marks at Secunderabad and level towards Wardha, partly by rail and partly by road, over a distance of about 200 miles.

47. *Hand-books.*—The Hand-books and Service books of the Party have been brought up to date.

48. *Inspection by Superintendent, Trigonometrical Surveys.*—The Superintendent of Trigonometrical Surveys inspected the Party in September.

No. 1.—Levelling Detachment.

List of Great Trigonometrical Survey Stations connected by Spirit Levelling—Season 1906-07.

Name of Station.	Height in feet above Mean Sea Level.		Difference in height by Triangulation in feet.	Remarks.
	By Spirit Levelling.	By Triangulation.		
Colaba S. (At Observatory) of the Bombay Longitudinal Series.	79·87	75	−4·87	Top of Electrometer Tower which is 46 feet high.
Dadar S. Bombay Longitudinal Series.	11·61	*11·63	...	* Height obtained by Spirit-Levelling—Season 1877-80.

No. 1.—Levelling Detachment.

Result of Comparison of Staves—Season 1906-07.

Place and Date of Comparison.			Number of Staff.			
			04	05	01	03
Bombay . .	October	24, 1906	+ ·0012175	+ ·0030002	— ·0016155	— ·0019636
Matunga . .	„	30, „	·0011815	·0026947	·0017236	·0018469
Bhandup . .	November	8, „	·0016354	·0027719	·0014608	·0021964
Diva . .	„	15, „	·0011086	·0021413	·0023917	·0029305
Kalyan . .	„	30, „	·0005478	·0012116	·0032150	·0034948
Vangani . .	December	9, „	— ·0002441	·0007629	·0041294	·0045861
Karjat . .	„	18, „	·0001621	·0012225	·0034727	·0042195
Dasturi . .	„	29, „	·0004826	·0007690	·0042124	·0048153
Lonavla . .	January	9, 1907	·0008274	·0003210	·0042460	·0050287
Talegaon . .	„	16, „	·0003330	·0008311	·0037638	·0048641
Chinchvad .	„	23, „	·0009818	— ·0000225	·0049132	·0057209
Poona . .	„	31, „	·0011007	+ ·0000070	·0049587	·0057898
Uruli . .	February	9, „	·0007504	·0002121	·0048459	·0059004
Patas . .	„	19, „	·0013479	— ·0003479	·0056245	·0061418
Ahmednagar .	March	2, „	·0014818	·0007273	·0058206	·0071171
Diksal . .	„	12, „	·0019293	·0009889	·0064062	·0076709
Washimbe .	„	21, „	·0029221	·0021455	·0076237	·0089548
Kem . .	„	31, „	·0025691	·0017655	·0073350	·0090024
Barsi Road .	April	7, „	·0027313	·0017063	·0071249	·0090489
Mussoorie .	May	7, „	·0029242	·0020399	·0075149	·0088697
ditto	„	17, „	·0021711	·0013493	·0067150	·0082227
ditto	„	22, „	·0028896	·0022476	·0074319	·0084662
ditto	„	30, „	·0026892	·0017706	·0070065	·0083065

No. 1 Levelling Detachment.

Tabular Statement of Outturn of Work—Season 1906-07.

Section.	Month.	No. of Miles Double Levelling. Main Line. Ms. chs. lks.	Branch Line. Ms. chs. lks.	Total. Ms. chs. lks.	Total No. of Feet. Rise.	Fall.	No. of stations at which instrument was set up.	No. of Bench Marks Connected. Old. Embedded.	Old. Inscribed.	Standard.	Embedded.	Inscribed.	G. T. Survey.	Railway.	P. W. D. and Irrigation.	Remarks.
Bombay to Barsi Road	October 1906	9 26 96	3 34 56	12 61 52	85·804	87·903	182	6	4	1*	...	9	2	...	...	* 1 Old at Bombay.
	November "	26 0 74	0 13 36	26 14 10	212·266	197·002	323	3	12	...	...	4	...	...	...	
	December "	42 8 16	0 22 64	42 30 80	1,664·457	303·696	652	2	20	...	1	7	...	...	...	
	January 1907	47 34 92	0 63 78	48 18 70	1,191·771	659·560	587	5	14	3	...	22	...	...	...	
	February "	47 66 94	0 31 24	48 18 18	390·149	638·343	567	4	18	...	...	19	...	...	...	
	March "	53 12 89	8 55 36	61 69 25	641·989	510·371	721	8	22	1	...	22	...	...	2	
	April "	14 36 56	0 6 30	14 42 86	57·373	240·280	167	1	5	...	...	10	...	...	...	
	Totals	240 27 17	13 68 24	254 15 41	4,243·809	2,637·155	3,199	29	95	5*	1	93	2	...	2	
Mussoorie to Landour	May 1907	2 54 76	0 40 64	3 15 40	98,609	150·600	208	...	2	...	...	12	...	...	...	
	Totals	2 54 76	0 40 64	3 15 40	989·609	150·600	208	...	2	...	...	12	...	...	...	
	Grand Totals	243 01 93	14 28 88	257 30 81	5,233·418	2,787·755	3,407	29	97	5*	1	105	2	...	2	

No. 2 Levelling Detachment.

List of Great Trigonometrical Survey Stations connected by Spirit-Levelling—Season 1906-07.

Name of Station.	Height in feet above mean sea level.		Difference in height by Triangulation in feet.	Remarks.
	By Spirit Levelling.	By Triangulation.		
Segra T. S. Great Indus Series	605·670	...	...	Already connected by Spirit Levelling in 1858-62.
S. W. end of Chach Base Line, Great Indus Series.	1015·226	...	...	
O. on turret of N. E. bastion of Attock Fort. Great Indus Series (Intersected Point).	1193·521	...	...	
Gurkatri S. Great Indus Series	1158·588	1165	+6·412	Upper mark stone.
Pirghaib T. S. Great Arc Series.	828·275	833	+4·725	Do. do.
Nojli T. S. Great Arc Series .	937·915	929	−8·915	Do. do.
E. end of Dehra Dun Base Line.	1959·464	...	...	Already connected by Spirit Levelling in 1862.

No. 2 Levelling Detachment.

Table showing the Railway and Public Works Department Bench marks connected—Season 1906-07.

Description of Bench-marks.	Railway Height feet.	G. T. Survey Spirit-levelled Height feet.	Difference feet.	Remarks.
$\frac{783·59}{\uparrow}$ on Culvert No. 339 near T. P. No. $\frac{754}{2}$	783·59	785·105	−1·515	
$\frac{701·02}{\uparrow}$ on Culvert No. 303 near T. P. No. $\frac{738}{9}$	701·02	702·601	−1·581	
$\frac{679·37}{\uparrow}$ on Culvert No. 297 near T. P. No. $\frac{736}{16}$	679·37	680·994	−1·624	
$\frac{786·46}{\uparrow}$ on Bridge No. 247 near T. P. No. $\frac{709}{19}$	786·46	787·791	−1·331	
$\frac{810·84}{\uparrow}$ on Culvert No. 235 near T. P. No. $\frac{702}{19}$	810·84	812·084	−1·244	
$\frac{752·66}{\uparrow}$ on Bridge No. 346 near T. P. No. $\frac{757}{8}$	752·66	754·262	−1·602	
$\frac{835·00}{\uparrow}$ on Platform Antri Railway Station .	835·00	836·653	−1·653	
$\frac{801·42}{\uparrow}$ on Culvert No. 313 near T. P. No. $\frac{743}{1}$	801·42	803·787	−2·367	
$\frac{680·20}{\uparrow}$ at Platform Dabra Railway Station .	680·20	681·589	−1·389	
$\frac{676·16}{\uparrow}$ on Bridge No. 2[illegible]4 near T. P. No. $\frac{727}{13}$	676·16	677·734	−1·574	

No. 2 Levelling Detachment—*contd.*

Table showing the Railway and Public Works Department Bench marks connected—Season 1906-07.

Description of Bench-marks.	Railway Height feet.	G. T. Survey Spirit levelled Height feet.	Difference feet.	Remarks.
688·00 ↑ on Platform Sanagir Railway Station .	688·00	689·174	—1·174	
862·96 ↑ on Platform Datia Railway Station .	862·96	864·218	—1·258	
808·57 ↑ at Culvert No. 257 near T. P. No. 714/3	808·57	809·934	—1·364	
850·50 ↑ in centre of main platform Jhansi Railway Station.	850·50	852·907	—2·407	
592·40 / 574·52 at station Thomas Church, Dera Ismail Khan.	*592·40 / 574·52	568·252	+24·148 / +6·268	* P. W. D. Height.

No. 2 Levelling Detachment.

Results of comparison of staves season 1906-07.

Place and date of Comparison.	Number of Staff.					Remarks.
	12	11	0	B 3.	B 5.	
Gwalior 29th October 1906	+0·0034086	+0·0037901	+0·0012905	+0·0013846	—0·0007615	
Antri 5th November „	+0·0024401	+0·0021582	+0·0008047	...	—0·0008538	
Dabra 18th „ „	+0·0010259	+0·0007572	—0·0005017	...	—0·0020564	
Datia 28th „ „	+0·0017199	+0·0012160	+0·0000805	...	—0·0018952	
Jhansi 9th December „	+0·0011305	+0·0007566	+0·0000141	...	—0·0018482	
Darya Khan 20th „ „	+0·0016591	+0·0015218	+0·0001055	...	—0·0019136	
Dehra Ismail Khan 4th January 1907.	+0·0012265	+0·0007366	—0·0007755	...	—0·0025244	
Rawalpindi 13th „ „	+0·0022917	+0·0018512	+0·0000535	—0·0003742	...	
Golra 20th „ „	+0·0025837	+0·0021256	+0·0000867	+0·0008270	...	
Hasan Abdal 28th „ „	+0·0024593	+0·0025252	+0·0002855	+0·0012358	...	
Lawrencepur 5th February „	+0·0027243	+0·0025200	+0·0002879	+0·0011904	...	
Kutlu 12th „ „	+0·0030015	+0·0027566	+0·0004775	+0·0016008	...	
Khairabad 19th „ „	+0·0039261	+0·0032558	+0·0008809	+0·0025590	...	
Nowshera 26th „ „	+0·0038901	+0·0036788	+0·0015491	+0·0018564	...	
Peshawar 9th March „	+0·0031615	+0·0031782	+0·0009339	+0·0014896	...	
Peshawar 15th „ „	+0·0028877	+0·0030872	+0·0008241	+0·0015830	...	
Ferozepore 22nd „ „	+0·0028109	+0·0028666	+0·0003167	+0·0008624	...	
Ludhiana 29th „ „	+0·0030743	+0·0038466	+0·0015467	+0·0020524	...	
Umballa 4th April „	+0·0028209	+0·0028370	+0·0008201	+0·0005356	...	
Delhi 13th „ „	+0·0018327	+0·0019762	+0·0003121	—0·0003752	...	
Balia Kheri 18th „ „	+0·0021729	+0·0021780	+0·0000871	—0·0000024	...	
Nanakgarh 29th „ „	+0·0013413	+0·0013262	+0·0005831	—0·0006240	...	
Mohabawala 6th May „	—0·0005803	—0·0007372	—0·0013881	—0·0027712	...	
Mohabawala 11th „ „	—0·0006091	—0·0010672	—0·0016437	—0·0032618	...	
Dehra Dun 16th „	—0·0007141	—0·0012130	—0·0016107	—0·0035006	...	

No. 2 Levelling Detachment.

Tabular statement of Outturn of Work—
Season 1906-07.

Section.	Month.	No. of Miles Double Levelling. Main Line. Ms.	Chs.	Lks.	Branch Line. Ms.	Chs.	Lks.	Total. Ms.	Chs.	Lks.	Total No. of feet. Rise.	Fall.	No. of stations at which instrument was set up.	No. of Bench Marks Connected. Old. Embedded.	Old. Inscribed.	Standard.	Embedded.	Inscribed.	G.T. Survey.	Railway.	P.W.D. & Irrigation.	Remarks.
Gwalior to Jhansi	October 1906	...	...	...	0	54	32	0	54	32	...	...	10	...	1	...	...	...	...	...	...	Check levelling of old work.
	November „	44	55	16	0	31	70	45	06	86	478·236	357·505	655	...	1	...	5	28	...	10	...	
	December „	14	44	76	0	68	94	15	33	70	175·625	189·188	224	...	...	1	2	15	...	4	...	
	Totals	59	19	92	1	74	96	61	14	88	653·861	546·693	889	...	2	1	7	43	...	14	...	
Segra* T. S. to Dera Ismail Khan	December 1906	11	73	98	0	2	0	11	75	98	78·267	127·718	174	...	...	...	...	2	1	...	...	
	January 1907	6	05	16	4	14	68	10	19	84	39·631	28·203	152	...	...	...	1	13	...	...	3	
	Totals	17	79	14	4	16	68	22	15	82	117·898	155·921	326	...	...	...	1	15	1	...	3	
Rawal Pindi to Chach Base Line S. W. End.	January 1907	34	25	80	0	70	56	35	16	36	504·268	880·777	427	1	5	1	3	25	...	...	...	
	February „	15	54	14	0	4	90	15	59	4	153·600	415·553	184	...	...	...	2	11	1	...	...	
	Totals	49	79	94	0	75	46	50	75	40	657·868	1,296·330	611	1	5	1	5	36	1	...	...	
Chach Base Line S. W. End to Peshawar.	February 1907	34	3	20	0	78	2	35	01	22	484·946	502·197	468	...	...	1	3	35	1	...	...	
	March „	23	67	48	3	45	64	27	33	12	312·793	137·339	345	...	...	1	2	35	1	...	1	
	Totals	57	70	68	4	43	66	62	34	34	797·739	639·536	813	...	...	2	5	70	2	...	1	
Connection of G.T.S. Standard Bench-marks.	March 1907	...	...	...	21	12	58	21	12	58	......	......	260	2	...	2	...	29	...	...	...	
	April „	...	...	...	12	5	56	12	5	56	......	......	219	...	2	2	...	31	1	...	...	
	Totals	...	...	...	33	18	14	33	18	14	......	......	479	2	2	4	...	60	1	...	...	
Saharanpur to Dehra Dun	April 1907	27	2	70	7	19	98	34	22	68	675·384	104·857	408	1	...	1*	1	15	1	...	...	* Old.
	May „	17	40	66	2	0	46	19	41	12	1,400·554	645·746	460	2	3	3	1	31	1	...	...	
	Totals	44	43	36	9	20	44	53	63	80	2,075·938	750·603	868	3	3	4	2	46	2	...	...	
	Grand Totals	229	53	4	54	9	34	283	62	38	4,303·304	3,389·083	3,986	6	12	13	20	270	7	14	4	

No. 3 Levelling Detachment.

List of Great Trigonometrical Survey Stations connected by Spirit Levelling—Season 1906-07.

Name of Station.	Height in feet above Mean Sea Level.		Error of Height by triangulation in feet.	Remarks.
	By Spirit levelling.	By Triangulation.		
	Feet.	Feet.	Feet.	
Wapla H. S. (of Bombay Longitudinal Series.)	1743·655	1749	−5·345	* To new upper mark-stone 5 feet 8½ ins. above the lower one.
Hiraj S. (of Bombay Longitudinal Series.)	1591·062	1591	+0·062	
Badadol H. S. (of Bombay Longitudinal Series.)	1714·171	1718	−3·829	
Maliabad H. S. (of Great Arc Meridional Series.)	1764·763	1764	+0·763	
Banog H. S. (of Dehra Dun Base Line Figure.	7430·297*	7433	−2·703	* Top of nail of upper markstone.

No. 3 Levelling Detachment.

Results of Comparisons of Staves—Season 1906-07.

Place and date of Comparison.		Staff No. B1.	Staff No. B2.	Staff No. IIII.	Staff No. 4.	Remarks.
Sholapur,	8th November 1906	+0·0049974	+0·0015222	+0·0035156	+0·0019385	
Hotgi,	18th " "	+0·0040515	+0·0006494	+0·0013113	+0·0008499	
Tilati,	26th " "	+0·0042210	+0·0007586	+0·0022587	+0·0017272	
Kadabgaon,	4th December "	+0·0034071	+0·0003112	+0·0012399	+0·0008106	
Dudhni,	12th " "	+0·0035707	+0·0004863	+0·0008505	+0·0007097	
Ghangapur,	19th " "	+0·0040457	+0·0005984	+0·0020544	+0·0009902	
Gulbarga,	27th " "	+0·0033750	+0·0000610	+0·0017126	+0·0006673	
Gulbarga,	3rd January 1907	+0·0041799	+0·0007816	+0·0032707	+0·0013581	
Wadi,	10th " "	+0·0039828	+0·0007141	+0·0037517	+0·0018891	
Nalvar,	18th " "	+0·0041137	+0·0007697	+0·0030166	+0·0013056	
Yadgiri,	27th " "	+0·0040801	+0·0005882	+0·0018511	+0·0008241	
Saidapur	3rd February "	+0·0033571	+0·0000589	+0·0020375	+0·0008720	
Kistna	11th " "	+0·0035823	−0·0000121	+0·0019955	+0·0007893	
Raichur,	24th " "	+0·0034619	−0·0001555	+0·0007273	+0·0000474	
Matmarri,	3rd March "	+0·0029297	−0·0003253	+0·0007433	−0·0002866	
Kosgi,	9th " "	+0·0030410	−0·0005398	+0·0001946	−0·0003116	
Pakni,	18th " "	+0·0026521	−0·0004278	−0·0004684	−0·0007326	
Mohol,	25th " "	+0·0025574	−0·0006645	−0·0009535	−0·0005552	
Angar,	2nd April "	+0·0021312	−0·0011205	−0·0005127	−0·0007410	
Madha,	8th " "	+0·0020762	−0·0010842	−0·0009508	−0·0009365	
Mussoorie,	7th May "	+0·0021079	−0·0014599	−0·0002135	−0·0011389	
Banog,	27th " "	+0·0023463	−0·0015376	+0·0012470	−0·0009528	
Banog,	5th June "	+0·0025175	−0·0008574	+0·0015551	−0·0005376	

NO. 3 LEVELLING DETACHMENT.

Tabular Statement of outturn of work for Season 1906-07.

Section.	Month.	No. of Miles of Double Levelling. Main. Ms.	Main. Chs.	Main. lks.	Branch. Ms.	Branch. Chs.	Branch. lks.	Totals. Ms.	Totals. Chs.	Totals. lks.	Rises. Feet.	Falls. Feet.	No. of stations at which Instrument was set up.	Bench-Marks Connected. Old. Emb.	Old. Ins.	Old. Irrig.	New. Emb.	New. Ins.	New. Irrig.	Standard.	G. T. S.	Railway.	Remarks.
Shalopur to Kosgi	November 1906	24	76	74	0	58	86	25	55	60	363·617	468·785	393	2	7	10	...	6	3	...	...	...	
	December "	51	59	20	2	47	50	54	26	70	799·255	724·794	813	3	29	...	1	12	...	...	1*	...	* Secondary Station.
	January 1907	49	58	90	1	29	20	51	08	10	456·808	706·768	730	4	31	...	...	12	...	...	...	...	
	February "	41	19	62	4	78	28	46	17	90	462·994	436·312	719	3	32	...	...	7	...	...	1*	...	* Principal Station.
	March "	18	33	72	0	37	88	18	71	60	204·848	205·320	257	2	13	...	...	...	...	1	...	2	
	TOTALS	186	08	18	10	11	72	196	19	90	2,287·522	2,541·979	2,912	14	112	10	1	37	3	1	2	2	
Sarol Road to Sholapur	March 1907	33	48	46	8	08	52	41	56	98	334·180	355·253	588	3	20	7	...	7	...	...	1*	...	* Secondary Station.
	April "	11	69	58	2	21	70	14	11	28	49·056	156·050	200	1	6	4	...	3	...	...	1*	...	* Principal Station.
	TOTALS	45	38	04	10	30	22	55	68	26	383·236	511·303	788	4	26	11	...	10	...	...	2	...	
Devlali	April 1907	...	...	...	6	23	26	6	23	26	90·379	39·156	95	1	2	...	—	10	...	1	...	...	
	TOTALS	...	...	...	6	23	26	6	23	26	90·379	39·156	95	1	2	...	...	10	...	1	...	...	
Mussoorie	May 1907	...	...	...	4	21	90	4	21	90	1,542·737	1,036·652	252	...	1	...	...	5	...	...	1*	...	* Secondary Station.
	June "	...	...	...	1	17	84	1	17	84			114	...	...	...	...	2	...	...	1*	—	* Principal Station.
	TOTALS	...	...	...	5	39	74	5	39	74	1,542·737	1,036·652	366	...	1	...	...	7	...	...	2	...	
	GRAND TOTALS	231	46	22	32	24	94	263	71	16	4,303·874	4,129·090	4,161	19	141	21	1	64	3	2	6	2	

IV.

TRIANGULATION IN BALUCHISTAN.

Extracted from the Narrative Report of Captain C. M. Browne, D.S.O., R.E., in charge of No. 24 Party (Triangulation) for Season 1906-07.

1. The programme of the party was to continue westwards the Kalat Longitudinal series, from where it had been left off in season 1904-05.

2. The party assembled at Nushki by the 9th October and after some days spent in making the necessary arrangements for supplies, escorts, etc., marched along the Seistan Trade Route to Dalbandin. From Dalbandin I went to Pragi H. S. the first station at which observations had to be taken, where the instrument was adjusted, and the values of the Equatorial intervals of the wires of the Diaphragm, and the value of one division of the eyepiece micrometer, were determined: these were found to be in close accordance with those of previous years. These observations and those of the horizontal and vertical angles were finished by the 12th November, thus completing the figure Kopadhar-Pulchotau-Kisanen Chapper-Pragi.

3. In 1904-05 Captain Turner, R.E., had observed the triangle Kopadhar-Pulchotau-Kisanen Chapper of this figure and had obtained the abnormal triangular error of 2·46″; he noted in his narrative report that he considered re-observations should be made at Pulchotau and Kisanen Chapper and that the latter station should be raised. The small triangular errors obtained by the observations at Pragi namely 0·129″ and 0·252″, however, point to the improbability of the error being at Kisanen Chapper or Pragi and make it almost certain that the error mainly lies at Kopadhar or Pulchotau.

A full report on the question has been made to the Superintendent, Trigonometrical Surveys and with his approval it is proposed to re-observe at the last two mentioned stations at the commencement of next field seasons as both stations are close to the trade route by which the party will proceed to their next season's work.

If the error is not found there, the third angle can be re-observed when Kisanen Chapper is revisited for the commencement of the southern connection down the meridian of 64°.

4. At the station of Kisanen Chapper an Astronomical Azimuth was observed: while the observations were in progress, news was received that Mr. Simons was seriously ill with laryngitis and I had to leave at once for Merui. Mr. Simons died before I could arrive, and it was the 26th November before observations could be recommenced. This sad event cast a gloom over the party; Mr. C. D. Simons was an officer of great promise and his loss has been keenly felt.

5. Subsequently observations were continued without interruption until Gat-i-Barot was left on the 4th January. The country then became more open and the dust-laden wind blew almost incessantly; causing great annoyance and frequently obscuring even the nearest objects.

At Gharibo though it was some hundreds of feet above the level of the sandhills, the sand was driven right over the hill and banked up against it: in a day or two large sandhills entirely changed their position.

During the storms life was a burden and one ate and breathed sand which, besides causing much trouble to the eyes, penetrated into the working parts of the instruments which required the most constant attention.

6. At the next station (Malik Shah) nearly every tent was torn to pieces: the observatory tent had to be struck in a gale to save it from destruction, and the instrument had to be put out in the open as no tent was safe.

At this station Koh-i-Taftan, the active volcano in Persia was first observed: it had been previously seen from Gat-i-Barot but was not clear enough for observation. It was again observed from Kondi, Tuzgi, Nildik- and Miri-Sultan, and although the intersections are rather acute, I hope that its position has been accurately determined. Observed from the nearest station (Tuzgi) volumes of smoke could be seen constantly rising and spreading over the two snow capped peaks; as the height of the highest peak is about 13,250 feet it towers over all the other peaks in the neighbourhood and presents a magnificent spectacle.

Another very distant peak (Khan Nashin) near the banks of the Helmand river was also observed and many points of importance on or near the Afghan border; by means of these it is hoped to conjoin with great precision the work of the various boundary commissions.

7. Owing to the configuration of the country the triangulation west of the line Gharibo-Malik Shah was very difficult to carry out; Koh-i-Sultan with its group of high peaks rose alone to the west; to the north lay an immense sandy desert stretching to the Helmand while to the south a wide stony plain gradually sloped down to the Hamun-i-Maskhel, a hexagonal figure was designed of which one station Kondi was situated in the open plain and others on low hills; the central station was on the highest point of Koh-i-Sultan (7,656 feet).

The peculiar shape of the Sultan mass rendered its exploration very difficult, and there were no paths intersecting it. Though it is only 11 miles from Nildik to Miri-Sultan, it took the observing party 4 days to move from one place to the other owing to the impassibility of the outer walls of the crater (for Koh-i-Sultan is without doubt an old volcano, and can only have been extinct for a comparatively short period).

The station in the plains gave a lot of trouble; when it was being observed from Malik Shah, it was unsteady and appeared very large, and a great number of observations (130) had to be taken to get a satisfactory value; but the results were still worse when observations had to be taken from it owing to the effects of mirage.

The helio at Tuzgi, though the distance was over 21 miles and the diameter had been stopped down to 3 inches, would in the middle of the day appear like a light-house at "sea" with a reflection in the "water" larger than itself, and at times there would be luminous reflection reaching almost up to the station of observation which appeared to be an island.

The apparent diameter of the helio at times subtended 4 minutes of arc which would correspond to a diameter of about 120 feet: often two and on one occasion three helios were seen side by side. In the morning and evening the signal became fairly steady and small, and by taking a very large number of measures under as greatly differing conditions as possible, good values of the horizontal angles have been obtained and the triangular error is moderate.

The vertical angles are not, I fear, worth much but as two good values have been obtained from Miri-Sultan and from Shuri they are not of great importance; strange to say, no trouble was experienced in observing the same ray from the other end; it would appear therefore that even in the middle of the day, the more distant the point where a ray is being refracted the less effect it has on the observer, since at Kondi most of the grazing took place near Kondi itself.

8. At times during December, January and February the most bitter cold was experienced not so much on account of the lowness of the temperature (which was never as low as it is in Quetta district) but from the piercing wind which is a marked characteristic of the country.

Sudden falls in the temperature of the air of extraordinary amounts used to occur and with them very marked changes in the vertical angles: there seems to be a direct connection between the two, and if the computations bear out this I will submit a further report on the matter.

Most abnormal conditions of terrestrial refraction were met with at the plain station of Kondi and it may be of interest if their effects as observed were described in greater detail: on one day the bungalow at Kondi which is under ten miles distant was clearly seen and observed, although there is not the slightest doubt that the ground in between is considerably higher, while on the subsequent days, which were of marvellous clearness and when points 100 miles distant were being successfully observed, the bungalow was never visible again even to the telescope.

While the observations were proceeding in the plains great difficulty was being experienced in the building of the station on the summit of the old volcano (Sultan): for some time all stone used to split when wetted owing no doubt to the presence of unslaked lime; when this was overcome by bringing the stone from a distance, the station was twice seriously cracked by what were undoubtedly earth tremors; when I was observing at this station I had to stop several times as I could see that the instrument had suddenly begun to quiver. These tremors were not of long duration; they would commence at any time of the day or night irrespective of atmospheric conditions.

After the more serious vibrations I had frequently to relevel the instrument. I fear in consequence that the station will not long remain intact but the peripheral stations of the figure should be unaffected.

After I had completed the observations at this station (Miri-Sultan) permission was received from the Superintendent, Trigonometrical Surveys, to close the field work in Baluchistan, and the party left for Nushki on the 16th March arriving there on the 5th April.

9. Some mention should be made of drinking water to guide others who may have to carry out survey operations in that country. The *Official Routes in Baluchistan* give information about the water on the Trade Route only and is, I venture to say, not couched in sufficiently strong language to give an adequate idea of the deleterious effects of several of the waters, if drunk for any length of time; some of the wells do not appear so bad to a person who drinks them only for a day or so, but it is after a week that they begin to tell. There is also an uncertainty about the supply, which one does not learn from the books; for instance, at Kachakki where good water is shewn in the route, I found during my outward march practically speaking none at all, and what there was quite unfit for human consumption; whereas on my return journey I found an ample supply of good water.

Generally speaking all the water which comes down from the mass of Koh-i-Sultan is as bad as it can be; the main places affected besides the actual mountain itself, are Tratoh, Kondi, Borghar, and Ware Sahib Chah. None of these waters can be drunk for more than a day without very bad effects; in fact the water at the last mentioned place is practically undrinkable and at Borghar there is only water just after rain. Recourse has to be had to distilling; the distillers used were very successful; they were of copper of the simplest make and practically unbreakable; they were designed by myself and made to my specification by Messrs. Walter Locke of Calcutta; the pattern generally used in the Chagai Agency is quite useless for supplying a large number of men, besides being fragile and very extravagant in fuel.

It is undoubtedly in a great measure due to these distillers that there were no deaths among the Khalassees or even any serious cases of dysentery and they will be found most useful to any one who has charge of any large body of men in this region.

10. With Mr. Tresham I proceeded by rapid marches to Kalat district to select the stations for the first figure for the proposed Toba Series.

It was at first hoped to start from the side Mahr—Zibra of the Kalat Longitudinal Series but on revisiting Mahr it was found that no view whatever to the north was obtainable from that station. After visiting such other hills as the time allowed the decision was arrived at that the series would have to emanate from the side Istarab—Zawa of the Kalat Longitudinal Series using Zibra as a central station of a Tetragon with Ting and Koh-i-Maran.

Owing to the great elevation of most of the stations of this new series (many of which are over 10,000 feet high and some over 11,000 feet) it will be impossible to carry on the work except in the summer or early autumn so that in order to be able to start the observing next spring Mr. Wainwright was sent on the 20th September 1907 to build the station and to continue the reconnaissance into the Toba plateau.

11. Having seen to the departure of the party from Nushki for Dehra Dun which took place on the 9th April, I went to Quetta to interview Sir H. McMahon concerning the question of the proposed programme of Principal Triangulation in Beluchistan for next year and afterwards went to the Khojak and Harnai with the Officer in charge Quetta party to select further possible stations for the Toba Series arriving at Dehra Dun on the 17th April.

Five Imperial Officers were then attached for instruction; the programme decided on was the re-observation of certain stations of the great arc and the fixing of two new stations at Shorpur and Top-Tiba, also the observation of an Astronomical Azimuth at Banog: the observations at Doiwala and Shorpur were postponed as it is probable that further stations on the south side of the Siwaliks will be required. Field work was closed on the 22nd June, the outturn of the party is given below.

12. In recess the computation of the season's work was completed. Orders were received to make arrangements for the re-starting of the Great Salween Series in Burma next year without stopping the work in Baluchistan which was to include the reconnaissance of the Toba Series in addition to the work on the Kalat Longitudinal Series. This has necessitated the considerable strengthening of the party, and the revised Budget Estimate has accordingly been increased, as well as the Budget Estimate for the year 1908-09.

The health of the party was no worse than was to be expected from the character of the country in which it was working, beyond Nushki fresh vegetables were unobtainable, and the constant drinking of distilled water increased the difficulty of digestion: there were 110 cases of scurvy.

The country in which the work lay is about as desolate and barren as a land can be; it is practically uninhabited and uninhabitable except for a few nomad shepherds and the residents of the Thanas maintained along the Trade Route: but it is full of interest to the Geologist.

The first figure of the southern connection down the meridian of 64 was reconnoitred and the stations built by Mr. Tresham. The second figure will, I fear, give a good deal of trouble as a desert of over 80 miles has to be crossed within which it is impossible to get any site for a station. Special lamps are being made and by employing them and a 12 inch helio it is hoped that by waiting for clear weather the observations will be practicable.

OUTTURN OF WORK.

(A) *Kalat Longitudinal Series.*

Number of stations at which observations were taken .	12
Do. do. newly fixed	11
Figures completed, Two triangles, one Quadrilateral, one Tetragon, & one Hexagon.	
Length of series in miles	150
Area of triangulation in square miles	3,390
Stations at which an Astronomical Azimuth was observed .	1
Astro. minus Geodetic	+3·38″
Average triangular error	·41″

(B) *Dehra Dun Triangulation.*

Number of stations at which observations were taken . .	4
Do. do. newly fixed	1
Figures completed one quadrilateral	
Length of series in miles	15
Area of triangulation in square miles	118
Stations at which an Astronomical Azimuth was observed .	1
Astro. minus Geodetic	14·15
Average triangular error	·604″

In Baluchistan in accordance with the instructions of the Superintendent, Trigonometrical Surveys, a large number of hills were fixed by intersection.

Observations for magnetic declination were taken at several points along the Trade Route and all the Great Trigonometrical Stations. The results were handed over to the Officer in charge No. 26 Party for computation and incorporation in his report, it is unnecessary therefore to do more than mention them here. The Party was inspected in recess by the Superintendent, Trigonometrical Surveys on the 24th September.

Appended is a Statement of the Latitudes, Longitudes and heights compared with those obtained on the Inde-Afghan Boundary Commission in 1895-96 and Mr. Tale's work in 1889-99.

In four cases, namely, Teznan, Gharibo, Sultan, Nildik the Great Trigonometrical Stations have been built on the exact sites of Mr. Tates' stations and the other points given are such as were unmistakable.

Comparative list of Stations and Intersected Points of the Kalat Longitudinal Series.

	G. T. Values			Mr. Tates Values					
Station	Latitude	Longitude	Height	Latitude	Diff	Longitude	Diff	Height	Diff
	° ′ ″	° ′ ″		° ′ ″		° ′ ″			
Malik Teznan H.S.	29 24 38.042	63 43 15.565	7684.6	29 24 32.9	— 5.142	63 43 08.8	— 6.765	7686	+ 1.4
Gharibo H.S.	29 19 56.824	63 00 34.521	3950.0	29 19 58.9	+ 2.076	63 00 37.8	+ 3.279	3948	— 2.0
Miri Sultan H.S.	29 07 07.174	62 50 42.663	7655.8	29 07 9.6	+ 2.426	62 50 47.0	+ 4.337	7660	+ 4.2
Nildik H. S.—(Amir chah)	29 16 3.616	62 44 19.523	4734.9	29 16 5.2	+ 1.784	62 44 22.8	+ 3.277	4733	— 1.9
Arbu	29 47 16.75	63 58 59.14	5719.8	29 47 14.9	— 1.85	63 58 59.9	+ .76	5733	+ 13.2
Malik Dokund	29 38 58.97	63 34 34.56	7337.9	29 38 58.0	— .97	63 34 36.8	+ 2.24	7332	+ 5.9
Rabat	29 33 14.17	63 33 58.50	5561.9	29 33 13.5	— .67	63 34 00.3	+ 1.8	5575	+ 13.1
Mahik	29 25 48.35	63 31 23.61	6570.2	29 25 48.3	— .05	63 31 25.8	+ 2.19	6581	+ 10.8
Lorai	29 28 50.93	63 23 49.72	5099.9	29 28 50.8	— .15	63 23 52.5	+ 2.78	5109	+ 9.1
Kamarigarh	29 29 08.02	63 11 26.46	4500.2	29 29 7.7	— .32	63 11 29.8	+ 3.34	4507	+ 6.8
Gidan Koh	29 29 22.08	63 08 09.77	4391.6	29 29 22.8	+ .72	63 08 13.1	+ 3.33	4493	+ 101.4
Sultan E. Peak	29 07 10.19	62 52 36.07	7550.4	29 07 12.7	+ 2.51	62 52 40.7	+ 4.63	7553	+ 2.6
Koh-i-Kansuri	29 12 43.69	62 45 21.97	6392.0	29 12 44.8	+ 1.11	62 45 26.0	+ 4.03	6395	+ 3.0
Mitkoh	29 16 51.23	62 27 54 75	4133.8	29 16 53.4	+ 2.17	62 27 59.7	— 4.95	4140	+ 6.2
Koh-i-Dalil	29 08 16.87	62 14 27.66	4870.6	29 08 19.2	+ 2.33	62 14 32.4	— 4.14	4624	— 246.6
Koh-i-Tajtan.—(S. Peak)	28 35 59.00	61 10 26.85	13267.9	28 36 1.4	+ 2.40	61 10 33.5	+ 6.65	13034	— 233.9

V.

ASTRONOMICAL LATITUDES.

Extracted from the Narrative Report of Captain H. M. Cowie, R.E., in charge No. 22 Party (Astronomical) for Season 1906-07.

Personnel.
Imperial Officer.
Captain H M. Cowie, R.E.
Subordinate Establishment.
3 Surveyors and Computers.

During the season 1906-1907, No. 22 Party visited eleven stations in Kathiawar and round the Gulf of Cambay. In the area lying south and west of a line passing through Karachi, Deesa, Neemuch and thence to Colaba, only one station, Sonada, had previously been visited.

1. Between Karachi and Deesa nine stations had been visited in 1900-1901. The latitude observations at these points revealed deflections generally of small amount. Eight stations gave negative results averaging about 2″. The observations at the ninth station, Khankharia, the most easterly, showed a positive deflection of 2″. As we move through Deesa towards Neemuch, we find the northerly deflection increasing rapidly. At Khankharia the deflection, as has been said, is 2″ to the south. At Deesa, 35 miles south south-east of Khankharia, the Plumb-line is deflected 8″ to the north. The change is thus one of 10″ in a little over 30 miles; at Chaniana, 20 miles east of Deesa and 50 miles south-east of Kankharia, the deflection is over 11″ N; at Guru Sikkar, we find a little less than 4″ N; at Aramlia, near Neemuch 5″ N; at Khamor, north of Aramlia, and at Sonada, south of Chaniana, the deflection is over 4″ N. To the north of Deesa, however, we again find small deflections of varying sign, at Samdari there is less than 1″ to the north; at Thob 3″ to the north; at Chamu the deflection is less than 1″ to the south and at Jambo 3″ to the south. In the neighbourhood of Ahmednagar, Aurangabad and Dhulia, on the Neemuch-Colaba line, the deflection is 5″ to the north. At Colaba itself the deflection is 10″ to the north. At only one of the Stations visited on the Khanpisura series, Thikri in the Nerbadda valley, was a southerly deflection of 1″ found. There seem to be thus two tracts, one of small, the other of relatively large northern deflection between which, in the Deesa locality, there is a sharply defined dividing line.

Generally speaking, there lies to the north of Kathiawar, an area of deflection of small amount and indefinite sign, covering Sind and a great portion of the Punjab, while to the east there is an area of relatively large northerly deflection. This suggested a question as to the area in which the Kathiawar Peninsula lay. Were we to classify it with the sandy deserts to the north or with the hilly tracts to the east? Another point on which we require information is the size of the area about Deesa in which abnormally large northerly deflections occur. To use a familiar simile, shall we find Chaniana like an isolated high peak in a region of relatively low hills, or will it resemble a knoll on a high plateau, and if the latter is the case, how extensive is this plateau? The results of the season's work, given in the following table, show that the Kathiawar Peninsula cannot be classified with the Sind deserts; that it falls in the area of relatively large northerly deflections which extends from the south west, through Ahmedabad, to Agra in the north-east and, it is probable, that the defining line between the areas of low and high deflections, runs south-west from Deesa, roughly speaking towards the Gulf of Cutch. It is interesting that the sudden change in the value of the deflection of the Plumb-line should occur along a tract, corresponding roughly with the dividing line between the hill regions of west Central India and the sandy deserts of Sind and the Southern Punjab.

3. As regards the northerly deflections within the Kathiawar Peninsula itself, it appears that along a central belt indicated by the stations of Kunkavav and Chamardi, they are relatively smaller than those to the north and south. This, in combination with the fact that at Dangarvadi, the most southerly station, there is a larger northerly deflection than at Dungarpur, the most northerly; that is, that the Plumb-lines at the northern and southern stations are relatively inclined to one another while the value of the deflection at the central station, Kunkavav, is less than either northern or southern value, indicates that within the Peninsula itself there exists a source of attraction. The general character of the deflections in the peninsula is what the geology of the region would lead us to expect. The central portion of the peninsula is covered with basalt. Dangarvadi and Dungarpur are, respectively, close to the southern and northern edges, while Kunkavav is roughly over the centre of the basalt overflow. It was therefore to be expected that the plumb-line at the two former stations would be found to be inclined inwards and that the value at Kunkavav would probably be outside the range of the values at the two other stations.

4. The first portion of the season's work dealt, thus, with the deflection of the plumb-line in the Kathiawar peninsula. The second part had for its object the investigation of the character and rate of change of deflections between Ahmedabad and Bombay. At Colaba we find the comparatively large value of 10″N, while at Sonada, near Ahmedabad, there is 4″N, the change is thus 6″ in a meridian distance of 4° 13′, or about 290 miles. At Mandvi, 50 miles east of Colaba, there is a northerly deflection of 3″; 90 miles east, at Dhuleshwar we find 1″ to the south. These values show changes of 7″ in 50 miles and 11″ in 90 miles on the parallel, respectively. There is thus, to the east of Colaba, a rapid fall in the value of the northerly deflection. The mean deflection of the plumb-line in Western India (Region No. 7) is 4·7″ to the north. Excepting the Colaba and Chaniana results, there are in this area 42 values ranging from 8·9″ North to 1·2″ South. The following table exhibits the general character of deflections in this region :—

	″			″		
Between	2	South	and	1	South	2 values.
	1	"		0	"	1
	0	"		1	North	1
	1	North		2	"	1
	2	"		3	"	4
	3	"		4	"	8
	4	"		5	"	10
	5	"		6	"	5
	6	"		7	"	4
	7	"		8	"	3
	8	"		9	"	3
	9	"		10	"	*nil*
	10	"		11	"	1 (Colaba)
	11	"		12	"	1 (Chaniana)

There is thus some indication that the large deflection at Colaba is due to local abnormal conditions and one object of the latter part of the season's work was to investigate the nature of these conditions by ascertaining the effect produced; to provide results which would enable us to define approximately the area affected by these abnormal conditions and to locate the tract where the maximum effects are produced. The rapid fall in the value to the east of Colaba seems to indicate that the mass disturbing the plumb-line here is more probably small and not deep seated, than large and at a comparatively great depth. To the east of Colaba latitude observations have been made at several points; but to the north the nearest latitude station is Sonada, near Ahmedabad. The stations on the Singi Series visited last season and the results attained at each are shown below :—

			″	
Sonada	visited	previously	—4·3	north.
Páldi	„	in 1906-07	—5·5	
Ghorarao	„	„	—3·1	
Pavagad	„	„	—4·4	
Sidhpur	„	„	—3·4	
Alamvadi	„	„	—3·7	
Tarbhan	„	„	—5·8	
Colaba	„	previously	—10·3	

These results show that the country covered by the operations exhibits no great variation from the average for Region No. 7 and that the locality of abnormal effects has not yet been reached. On the Singi series, south of Tarbhan, and on the south Konkan Coast series, south of Colaba, there remains a full season's work to be done before the Colaba abnormal area can be defined.

5. During the recess, I commenced the task of computing the Orographical correction for each latitude station visited up to date. The investigation, it is intended, shall include all masses within 3,000 miles of Kalianpur. To lighten the labour and to shorten the time which must elapse before the work is completed, it is proposed to classify the masses within this area as—

(1) Oceanic
(2) Asiatic (more than 1,100 miles from Kalianpur)
(3) Indian (within 1,100 of Kalianpur)

and to then compute for as many suitably situated stations as may be found necessary, probably 25, the deflections of the plumb-line due respectively to the masses under classes (1) and (2), Oceanic and Asiatic. From these data will be constructed a chart of "isoclines," of loci of points at which the same deflection occurs. Having this chart of isoclines, we can easily, by interpolation, find for any other station in India, the deflection due to masses (1) and (2) and all that will remain to be done for that station will be to compute the effect of masses of class (3).

6. The formula I am using is that given by Clarke in his "Geodesy." The method of computation given there is as follows. Divide the area covered by the masses, whose effect at a chosen station is to be determined, into compartments bounded on two sides by radial lines drawn from the station and on the other two sides by circles having the station as centre. The expression for the deflection of the plumb-line in the meridian, due to the masses within the compartment is—

$$12{\cdot}44'' \ K \ (\text{Sin}\ a^1 - \text{Sin}\ a_1),\ \log_e \frac{r^1}{r_1}\ (h - H)$$

where K is a constant depending on the ratio of the surface density to the mean density of the earth.

a_1 and a^1 the azimuths of the radial lines.

r_1 and r^1 the radii of the circles.

h the mean height of the compartment above M. S. L.

H the height of the station, h and H being expressed in miles.

7. The values adapted for the mean and surface densities are those used in Professional Paper No. 5, *viz.*, 5·2 and 2·6 respectively.

In this connection, I give below the densities of rock specimens from five of the stations visited last season.

Dungarpur, 1 specimen	density	2·948
Chamardi		2·559
Ghorarao, 1 specimen density		2·565
Pavagad, 3 specimens	(*a*)	2·416
	(*b*)	2·50
	(*c*)	2·561
Tarbhan, 1 specimen		2·936

These densities, it is to be noted, are those of weathered rocks, exposed on the surface. These must certainly differ in density from the rock *in situ*, which has not been affected by exposure to the weather and it is of masses of this latter nature that we wish to ascertain the effect.

8. To the deflection computed as described above a small correction has to be applied for the curvature of the earth's surface. The expression for this reduction for curvature is also given by Clarke.

9. When it is not necessary to make the compartments represent a certain definite area, the computations are much simplified by arranging them in zones, as regards distance from the station and also in sectors as regards the azimuths a^1 and a_1 so that for all compartments lying in the same zone $\log_e \frac{r^1}{r_1}$ is constant and for all compartments in the same sector ($\sin a^1 - \sin a_1$) is constant.

But when the compartments have to be regulated to suit a definite area, when their boundaries have to be adapted to represent, with a certain degree of accuracy, the coast line, for instance, then the azimuths and radii, a^1, a_1, r^1, r cannot be fixed arbitrarily but must be selected to best suit conditions, varying from compartment to compartment.

10. At present the computation of the Oceanic deflection is in hand for 25 stations. The results will show whether these will be sufficiently numerous or not to ensure the requisite accuracy of the isoclines to be drawn therefrom.

Approximate results are given below for seven stations.

Station.	Latitude.	Longitude.	Deflection.	Deflection with respect Kalianpur vertical.
	° ′	° ′	″	″
Dehra Dun	30–19	78–6	18 N.	6 S.
Etora	26–54	80–42	17 ,,	7 ,,
Deesa	24–15	72–14	23 ,,	1 ,,
Kalianpur	24–7	77–42	24 ,,	0
Colaba	18–54	72–51	29 ,,	5 N.
Damargida	18–3	77–43	30 ,,	6 ,,
Bangalore	13–5	77–42	37 ,,	13 ,,

The results now computed for the four stations, Kalianpur, Colaba, Damargida, and Dehra Dun will be found to differ from the values of the effects of the ocean, given in Professional Paper No. 5. The original aim of the investigation of that Paper was the determination of the *total* deflection of the plumb-line, irrespective of the nature of the causative agencies. Hence in laying out the series of compartments round stations, the main desideratum kept in view was the simplicity of the computations. This led to the adoption, all through, of constant values of $(a^1 - a_1)$, the differences of the azimuths of the radial lines and of $\frac{r^1}{r_1}$, the ratio of the outer and inner radii of the circles bounding compartments. At a later stage in the investigation, when it was desired to make some enquiry into the relative effects of ocean and continent, those compartments were classified as Oceanic which, by their position, most nearly represented the actual ocean areas. In consequence of the adoption, as stated above, of fixed values for $(a^1 - a_1)$ and $\frac{r^1}{r_1}$ this representation is only a rough one. Thus, though the values calculated for the total deflection at each station may be considered to be correct, the respective quantities, given in the paper as representing the effects of ocean and continent, are only approximations. The following table shows the differences between the values as given in Professional Paper No. 5 and as now calculated.

Station.	Effect of ocean.	
	Professional Paper No. 5.	As now calculated.
	"	"
Kalianpur	19 N.	24 N.
Colaba	30 "	29 "
Dehra Dun	10 "	18 "
Damargida	26 "	30 "

Table of Results of work of Season 1906-07.

Series.	Station.	Height above M. S. L.	Long.	No. of stars observed.	Astronomical latitude =O.	p. e. of final result.	p. e. of result of unit weight.	Geodetic latitude =C.	Deflection of plumb-line O—C.
			° ′		° ′ ″	″	″	° ′ ″	″
Kathiawar Meridional	Dangarvadi, H. S. XLII	96	70 59	52	20 42 52·01	±0·043	±0·218	20 43 0·53	−8·52
" "	Kunkavav, T. S. XXXIV	591	70 59	80	21 39 10·31	±0·055	±0·328	21 39 11·96	−1·65
" "	Dungarpur, H. S. XX	404	71 2	49	22 48 8·85	±0·063	±0·302	22 48 13·54	−4·69
Kathiawar Minor Longitudinal	Chamardi, H. S.	42	71 58	63	21 49 23·91	±0·045	±0·246	21 49 26·68	−2·77
Gujerat Longitudinal	Ingrodi, T. S. XXX	118	71 51	61	22 57 2·50	±0·047	±0·245	22 57 7·58	−5·08
" "	Paldi, H. S. XX	208	72 34	55	22 53 51·60	±0·042	±0·221	22 53 57·07	−5·47
Singi Meridional	Ghorarao, H. S. XVI	323	73 24	49	22 52 8·05	±0·044	±0·213	22 52 11·17	−3·12
" "	Pavagad, H. S. XX	2,721	73 33	43	22 27 39·95	±0·057	±0·271	22 27 44·33	−4·38
" "	Sidhpur, H. S. XXIII	169	73 31	54	22 4 11·77	±0·046	±0·236	22 4 15·21	−3·44
" "	Alamvadi, H. S. XXVII	848	73 33	33	21 34 30·45	±0·045	±0·182	21 34 34·13	−3·68
" "	Tarbhan, H. S. XXX	140	73 6	31	21 0 28·36	±0·088	±0·337	21 0 34·13	−5·77
Great Arc Meridional	Dehra Dun (Haig Observatory)	2,240	78 6	30	30 18 52·05	±0·084	±0·298	30 19 28·73	−36·68

VI.

TOPOGRAPHICAL SURVEYS IN KARENNI.

Extracted from the Narrative Report of Captain C. P. Gunter, R.E., in charge, No. 3 Party, for season 1906-07.

6. *Remarks on the country surveyed.*—The northern half of the area surveyed lay in Karenni and the southern in the Salween district with a small portion of Toungoo on the west. The Salween river runs through the sheet from north to south and in the southern half, this formed the external boundary between India and Siam :—

(*a*) The country in Karenni to the east of the Salween is rocky, barren and almost waterless with a very few villages, covered with mostly scrub and small tree jungle and presented no difficulties to the surveyor. However, the scarcity of water and supplies hampered the work ; all rice even had to be imported from Siam and the surveyors had often to camp long distances from their work owing to want of water. The highest ground rose only to some 3,000 feet.

(*b*) The country to the west of the Salween was of the opposite character, very densely wooded, mountains rising to over 8,000 feet on the west, with very precipitous slopes. The high ground was covered with oaks, firs and rhododendron. A good deal of jungle cutting was necessary, but owing to the boldness of the features generally sketching was possible. A portion of the ground was very intricate and the surveyors were at first puzzled by large perennial streams disappearing into devils-chaldrons. Where these depressions are common, the hills are very pointed and cliffs of 500 feet and more in height are quite common: one pillar of rock measured by me was over 500 feet high with a cliff of some 400 feet at its base; these features are very difficult to show on the one inch scale. This ground was fairly well populated, but roads are non-existant except one bridle path from Toungoo to Pasawng and from there to Papun and to Mèsè. A small industry in washing for tin has been for many years the means of supporting Moko village. There is a large outcrop of tin there and the ore is crushed by rude methods and roughly washed and sent to Toungoo on bullocks.

A syndicate (Chinese) has now brought up a claim here and expects to start work soon.

There are one or two interesting springs, throwing up a large volume of water some 2 or 3 feet into the air, which apparently are the outlets of the various streams before mentioned as disappearing into devils-chaldrons.

(*c*) The Heng of Mèsè did his best to help us by providing coolies and supplies, but otherwise there was not much help obtained from the inhabitants, but considering that it was an independent state this is not to be wondered at. Some half dozen khalasees decamped from this desolate part of the country during the beginning of the field season.

(*d*) The country in the north of the Salween district was of a very varied description; on the west the general height of the country is about 3,000 with hills rising to 6,000, covered with fir forest and in the lower ground dense jungle, this part of the district is quite thickly populated in parts where the valleys have been cultivated with wet paddy; as one goes eastwards the hills become more precipitous and rocky and the jungle is of the usual Indaing. After February water becomes scarce, except in the larger streams and the Salween; but in the high valleys on the west, which are mostly at 3,000 feet elevation water is plentiful and most suitable places could be found for a sanitarium especially in the valley near "Tapawdo" where the stream Se-law-klo flows through it, the hills all round are covered with fir forest and the climate even in April was very pleasant, there could be easy access to the place from the Toungoo side. All this ground was excellent for plane tabling, but the work was somewhat hindered by not being able to obtain labour for clearing jungle for plane table fixings and the difficulties of obtaining supplies.

(*e*) Going southwards we find the character of the country entirely changed: it becomes very difficult for the plane tabler, as the jungle is of the most dense tropical nature and were it not for the various clearings made by the inhabitants for cultivation, the progress would have been very poor. The Yunzalin and the Bilin rivers both traverse this ground from north to south with the Salween on the extreme east, forming the boundary with Siam. The country rises suddenly between these rivers to hills varying in height from 5,000 to 3,000 feet, whereas the valleys are only some 200 feet above sea level. The whole of this tract proved very unhealthy especially Papun itself which is the head-quarters of the district; it seems curious that a place like Papun situated as it is on the Yunzalin, only 200 feet above sea level and surrounded by hills 3,000 feet high covered with the most impenetrable jungle, should have been chosen as a residence for Europeans, especially when there are places within a few miles which have a fairly good climate at a height of 1,500 to 2,000 feet.

The rains in this portion of the district start early in May and we also had rain in April. This delayed the work so that plane tabling had to be carried on in spite of the heavy rain up to the second week in July.

(*f*) The help afforded by the Karens in the Salween district was very indifferent and they do not appear to possess that regard for the Deputy Commissioners "parwana" which is met with elsewhere in Burma. But it must also be remembered that villages are very few and far between, supplies non-existant and means of communication very difficult.

Even rice had to be imported for the khalasees from Moulmein.

(*g*) A few words might be said about the Salween river: in the north of the sheet it has a fairly slow current and is suitable for the navigation of small launches and its banks are low with villages close to the water. But below the junction of the Nga Choung the river narrows between precipitous rocks and a series of rapids make it quite useless for navigation purposes until we get to the junction of the Thoungyin Ch, some 8 miles below Dagwin. The only craft on the river are small country boats.

From Lieutenant Crosthwait's description a journey through these rapids is something to remember for years; the first intimation of the approach to a rapid is indicated by the rigid stare and absolute silence of the six boatmen necessary to navigate the boat, then the sudden rush through the rapid, the boat men working like mad-men and when the danger is past their faces relax and they all start laughing. Most of the dangerous rapids have a whirl-pool and the difficulty is to steer between the rocks and the edge of this whirl-pool; if either are touched there is an end to the boat and its occupants. The width of the river varies from about 200 yards to 600 yards in this year's area and the fall is from 450 to 160 feet above sea level, that is a drop of 290 feet in about 100 miles.

VII.

Extract from the Narrative Report of Captain R. H. Philimore, R.E, in charge No. 11 Party (Shan States) for season 1906-07.

To the south of *Kēngtūng* work lay along the main range that forms the watershed between the *Salween* and the *Mè-hkong*, and across its eastern slopes. This range runs north and south through sheets 93 O/12 and P/9 with a general height of from 5,000 to 7,000 feet. Its hightest point is *Loi Hsamhsum*, 7,702 feet in sheet P/9; it falls to 4,256 feet at a point where the road between *Möng Lūng* and *Möng Kōk* crosses it. Further south in sheet P/10, *Loi Nanghkang* rises to 6,508 feet, but from here the watershed does not follow the higher hills but runs a devious course to the east for about 20 miles, being as low as 3,062 feet at one point.

From this main water-parting range springs, in sheet 93 O/12, a very prominent range of hills that runs in an easterly direction, rising to over 6,000 feet in sheet O/16, and to over 8,000 feet at a peak *Loi Pangnaw* further east still. This range seems to form a barrier to the *Nam Lwè*, this large river deviating from its original north and south course a short distance north of *Kēngtūng* and flowing away to the north-east, rounding *Loi Pangnaw*, and then south once more to join the *Mè-hkong*.

It is on this east and west range that the new civil station *Loi Mwè* is situated, at a height of 5,600 feet and a distance of 16 miles by mule road from *Kēngtūng* city. *Loi Mwè* means "the mountain of mist." Ice and snow are of course unknown even on these higher hills, but the temperature occasionally falls very near freezing point, and a slight hoar frost sometimes does occur. First class masonry barracks have been built for the Military Police, and offices and residences for the political staff are now under construction. The site was only discovered about six years ago, and it is doubtful indeed whether in the whole of *Kēngtūng* state another spot could be found on the hills to accommodate even fifty men.

The climate of *Loi Mwè* is exceedingly bracing during the dry season and fires are appreciated as late as April. During the rains there is a good deal of mist, and the station remains enveloped in clouds several days together.

The *Loi Mwè* range parts the waters that flow northwards into the *Nam Lwè* from those that flow southwards through the *Möng Hpayāk* plain into the *Mè-hkong*. There is another flow to the east into the *Mè-hkon* through the *Möng Yawng* plain, but that lies in next season's work.

The *Nam Lwè* flows in a south-easterly direction right through sheet O/15, it is not fordable anywhere in this sheet but is crossed by ferries at numerous points; its current is very rapid in November after the rains. The valley of the *Nam Lwè* is shut in by high hills and is terribly hot during April and May; its lowest height fixed this season was 1,770 feet. There are very few villages along the valley, for nowhere do the hills stand back to leave room for cultivation along the river banks; such few patches of cultivation as do occur appear to be most unproductive.

A very well known hill rises from the banks of the *Nam Lwè* in this sheet—*Loi Hsamtao*. There are several *Tai-loi* villages on this hill, and in the two largest of these, *Pang-yūng* and *Wan Pyu*, are made the guns that are seen from one end of the Shan States to the other. These guns are of the gaspipe variety, some fitted with flintlocks, but for the most part they are made for cap-ignition. The iron used in their manufacture is brought up from *Mandalay*. The output of these weapons must be very large, for the Shans and all the hill tribes are great hunters, and every man who can possesses a *Hsamtao* gun; the cost of a gun in the district is from five to ten rupees only.

In the sheets to the south, the most important place is *Möng Hpayāk*, the headquarters of the *Hpyā* of the district of that name. The *Möng Hpayāk* plain is about 30 square miles in area, and is thickly populated. Several rivers draining the sheets to the north and west here unite, forming the *Nam Lin*, a large and unfordable river that flows in a south-easterly direction.

Mong Hpayāk is an important centre and roads radiate from it in every direction. The general level of the plain is 1,600 feet; the hills immediately surrounding it, though intricate, steep and thickly wooded, do not rise to a greater height than three to four thousand feet.

Other large valleys met with this season are *Möng Lūng* and *Möng Kōk*. The *Möng Lūng* valley (in sheet 93 P/10) is drained by the *Nam Hōk*, which flows in an easterly direction to *Möng Hai* and then south to *Hawnglük*. *Möng Lūng* is not a very prosperous district; the valley is apparently unhealthy and more than half the terraced land is lying fallow for lack of labour. *Möng Kōk* lies to the west of the main water parting range; the *Nam Kōk* is a swift mountain torrent, becoming quite a considerable river at *Möng Hsat* twenty miles to the south-west. It eventually joins the *Mi Nam* in *Siam*.

The hot sulphur springs near *Wan Pangniu*, four miles south of *Kēngtūng* city, have a great reputation. According to a Shan story, a former chief of *Kēngtūng* was cured of leprosy by bathing here, and his spirit now presides at the springs. Every year the ruling *Sawbwa* bathes at the springs three times during the third month (about February), making his journeys to and fro in great pomp and state.

The whole country surveyed this season is very thickly wooded. The upper slopes of the high ranges are covered with heavy oak and chestnut forest with thick tangled undergrowth. The lower spurs are as a rule grown with pine trees, and here there is no undergrowth. These pine-clad spurs are invariably more easy to survey, for their features, though intricate, are definite and bold and the spurs sharply ridged. The upper ranges covered with chestnut are generally rounded, and the ravines and watercourses are not so deeply cut into the hill sides; this, added to the difficulty of finding clearings for setting up the planetable, makes these hills difficult to sketch.

The low hills round the *Mong Hpayāk* plain, and those in the south west of sheet 93 P/10, are very thickly covered with bamboo, a small branched variety that the Shans call *Mai Lai*; this is quite the most tiresome ground of all to survey on a small scale, and it is only where villagers have been clearing for hill cultivation that work can progress at a normal rate. The country now left to the south is very thickly covered with this bamboo; and the monthly outturn next season will be small in these parts. However the triangulators report that the ground to the east towards *Möng Yawng*, and northwards to the Chinese frontier, is excellent sketching country, the forest being mostly pine.

The people met in the east of *Kēngtūng* state are most interesting in every way. Three distinct divisions of the Shan race are found; Western Shans, *Hkön*, and *Lü*. The *Hkön* are the ruling race and occupy the *Kēngtūng* plain; the *Hkön* dialect is practically identical with Western Shan, though there are several new words and expressions to learn; the written character is, however, entirely distinct, being the same as that used by the *Lü*; this latter race is found in the *Mong Hpayāk* valley, and eastwards up to and beyond the *Mè-hkong*. The dialect spoken by the *Lü* is very different from Shan, being more akin to that of the *Lao*, a people of northern Siam. Western Shans are particularly numerous to the south east, in the country between *Möng Lin* and *Hawng Luk*. These races are all of Shan stock and inhabitants of the valleys.

Of the hill tribes, the *Kaw*, the *Tai Loi*, and the *Mu-hsö* were most frequently met this season, besides occasional villages of *Pyen*, *En*, *Akö Hsenhsum*, *Li-hsaw*, *Kwi*, and *Kang* (*Kachin*). The *Tai Loi* are Bhuddists; they were mostly met with in sheet 93 P/15. They do not move their villages from place to place as other hill tribes are always doing, but build substantial houses and *Kyaungs*, besides being great road makers. The *Pyen*, *En*, and *Hsenhsum* are all of similar stock to the *Tai Loi*, but are not so advanced in ideas and customs; they are all nominally Bhuddists.

The *Kaw*, or *Akha* as they call themselves, talk quite a distinct language and are a distinct race altogether. They, as well as the *Mu-hsö*, are a fine manly people, splendid at hill climbing and great hunters; they are quite illiterate and are classed as spirit worshippers. The *Mu-hsö* call themselves *Lahu-na*, and with the *Kwi*, have again distinct language and customs.

All these different tribes are most friendly, and always ready to turn out to work when called on. So long as villagers are not asked to work out side the limits of their circle, and are approached through their proper headmen they are ready to do anything wanted; on occasions surveyors have to camp away in the hills miles from any village, and have to shift camp every three or four days; there were always villagers willing to spend a week or a fortnight out, with just the hire of eight annas paid them on each shifting of camp. Where the headman of the circle had not first been approached it was not so easy to get help. The officer in charge made a point of meeting all the headmen of circles and as many of the village headmen as he could; by getting to know these men personally, and explaining the object of the work, he got them to exert themselves over the matter of supplies and provision of labour. Each surveyor had two villagers working constantly with his squad, filling the place of Hazaribagh Khalasis. The officer in charge, as well as each of the triangulators, was accompanied by a Shan official from *Kēngtūng*; these, being men of influence, were of great assistance in every way, especially in getting roads constructed and cleared in advance of a march. The official who accompanied the Officer in charge was a most accomplished person; he was a water colour artist and could turn out paintings of any tribal type asked for; he could write Shan as well as Hkön, and talked Burmese; he proved invaluable in helping to draw out the village lists correctly. Sad to say, shortly after his dismissal at the end of the season, he died at his home.

Special care was taken over the collection and transliteration of place names. Vernacular revenue registers which were obtained from the *Sawbwa's* court at *Kēngtūng*, showed all villages arranged according to circles. These were transliterated by the Officer in charge in consultation with the political auhorities, and each planetabler was then supplied with a correct list in English of all villages likely to fall in his work. Names of hills and streams were collected by the planetablers, and verified by the officer in charge or one of the assistants by enquiries in the immediate neighbourhood. In previous seasons too much reliance has been placed on names written in Burmese or Shan by illiterate *hpongyis* and interpreters. Even had the names always been correctly recorded in Shan, accurate transliteration would not follow without local enquiry; for the Shan character has no signs to distinguish the closed series of vowels from the open series; and thus "*Lŭng*" and "*Lōng*" would appear written alike, as also would "*Lĕng*" and "*Ling.*" The *Hkön* character, however, not only shows all these distinctions, but shows distinctions in the vowel tones; and the pronunciation of a word follows directly from its spelling.

The village names are now so recorded and printed on the map that the tribal name of the inhabitants is embodied in the full name of the village. This change is regarded as of great value by the political authorities. Before last season nothing regarding the distribution of the hill tribes was contained on the maps; last season the tribal names were shown in brackets below the village name proper; but the vernacular village registers embody the tribal names in that of the village, so this course has now been adopted for the maps.

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