EXTRACTS

FROM

NARRATIVE REPORTS

OF OFFICERS OF THE

Survey of India

FOR THE SEASON

1905-06.

PREPARED UNDER THE DIRECTION OF

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CONTENTS.

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1908

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
8 HASTINGS STREET

CONTENTS.

I.

THE MAGNETIC SURVEY OF INDIA.

Extracted from the Narrative Report of Captain R. H. Thomas, R.E., in charge No. 26 Party (Magnetic) for season 1905-06.

THE MAGNETIC SURVEY IN 1905-06.

INTRODUCTION.

The present report deals with the work of the Magnetic Survey in 1905-06. The report is divided into four main heads as follows :—

Note.—For convenience of reference the table of preliminary values and index chart are placed at the end of Part IV.

I.—FIELD OPERATIONS IN 1905-06.

TABLE OF CONTENTS.

Work of the field detachments.

1. The field season opened on October 19th, 1905, and closed early in May 1906.

Four detachments were employed during the year under report, of which three were utilized in extending field operations into Chota Nagpur, Orissa, the Agency Tracts of the Vizagapatam District (including Bastar and Jeypore States) and Eastern Bengal and Assam. Operations in Eastern Bengal and Assam were mainly confined to the railway systems and the observer there was, therefore, able to complete his programme, but elsewhere difficulties of country and transport proved a bar to the more rapid progress of former years. One observer moreover and the greater part of his detachment suffered severely from the climate while working in Orissa and was withdrawn from field work for nearly two months.

A fourth detachment was employed in filling up gaps left in the work of previous seasons but was withdrawn early in March to observe at repeat stations. Many of these had not been visited during the previous field season for the reasons noted in last year's report, and as the number of these stations is practically a minimum for the correct appreciation of the secular change, it was considered inadvisable to leave them unvisited for another year.

The withdrawal from field work of this detachment was not originally contemplated, but the retransfer in February of the second R.E. Officer, who had been temporarily posted to the party in November, left no alternative.

For the reasons stated above the total number of new stations of observation was 130 only, as compared to the 206 of the previous season. This diminution in the rate of progress had, however, already been forecasted with the gradual completion of areas where railways afforded a means of rapid transport, and it would be unsafe therefore to count on a greater average outturn than 150 stations for the remaining two seasons of the preliminary survey.

The total number of new stations to date is 958, which will at the end of 1907-08 give a final total of about 1,200 as compared with the 1,100 to 1,200, which the fundamental survey was estimated to require.

Work of the Imperial Officers.

2. A second Imperial Officer, Lieut. C. M. Browne, D.S.O., R.E., was posted to the party at the end of November. On completion of his training he assisted the officer in charge in carrying out temperature co-efficient experiments for the H. F. instrument at Toungoo, and subsequently observed at four repeat stations. His services, however, were lost in February when he was transferred.

With the assistance of the field detachment alluded to above and a new detachment under the spare observer formed when instruments became available, the officer in charge was enabled to have all the repeat stations (22 in number) revisited.

He also personally inspected the four observatories making extended comparative observations at each and also at Colaba.

Magnetic observations have now been discontinued at Colaba after many years uninterrupted work, and comparative observations will in future be made at the new observatory at Alibag, between which and Colaba prolonged comparisons have been made by the Director of Colaba Observatory.

In October 1906 a second R. E. Officer, Lieut. H. J. Couchman, R.E., was posted to the party. His training has been now completed and he will be employed in observing at repeat stations during the next field season.

Work during recess.

3. During the recess season of 1906 the computations of the previous season's field work and the reductions and tabulations of the base station results for 1905 have been completed. (See tables, Part IV).

Observations for log π^2K have been taken and computed with all observatory and field magnets with the exception of those at Barrackpore and Toungoo observatories, which will be carried out during the cold weather. Reference will be made to these later under the heading "Moment of Inertia;" page 11.

The field instruments were all compared with the standard at the beginning and end of the field season (see page 4).

The balance indented for last year has arrived and has been utilized to determine the weights of the inertia bars and magnets before the detachments proceeded to the field.

In July 1906 the Officer in charge proceeded to Barrackpore to instal the V. F. instrument there. Defects, however, in the driving clock necessitating prolonged repairs caused the postponement of the work, but it is hoped to complete it shortly.

Further experiments were carried out at Dehra Dun with the V. F. instrument there with the object of reducing the high temperature co-efficient: these will be further alluded to later in the report on that observatory.

The earth inductor No. 30 by Schulze has been used in the later experiments; on arrival the suspension belonging to the galvanometer was found to be broken and, in the absence of spare fibres a strip of fine phosphor bronze was mounted. Some initial difficulty was experienced in obtaining the requisite sensitiveness with the galvanometer, on account of the higher torsion coefficient of this suspension the auxiliary magnets supplied being insufficient for the purpose; by the addition of extra magnets, this difficulty was overcome, and the instrument as now set up is sufficiently sensitive to detect a change of $0''\cdot1$ in inclination, which is ample for all practical purposes.

The earth inductor will replace the survey standard dip circle as soon as spare flexible axes can be obtained, that supplied with the instrument having proved deficient in strength.

Behaviour of instruments.

4. The magnetometers behaved uniformly well during the season under report and the results from them are fully up to the standard established in previous years: the dip circles, however, in some instances gave needle differences differing widely from those found in Dehra Dun; in such cases observations were repeated, or a third needle used as a check.

The cause of these discrepancies in the dip circle is undoubtedly traceable to defects in the axes of the needles, the divergencies as a rule disappearing above or below certain limits of magnetic latitude.

A more serious source of trouble, and one which may appear more frequently later, is the deterioration of the object-glasses of some of the collimator magnets.

No. 1 A magnet which had been used for the Kew-Colaba comparisons in 1900-01 and whose magnetic moment had shown a high degree of stability was found to be useless from this cause in October 1905 and several of the spare magnets have since been found equally defective.

In all cases the inner sides of the lenses have been attacked, the surface being covered with an extremely thin film extending nearly to the outer edges of the lens, rendering it almost opaque. This film is probably not of fungoidal origin, but seems rather to be due to chemical action in the glass. Various remedies have proved of no avail, and it seems probable that nothing short of repolishing will be effective.

The main cause of this deterioration may be the damp climate of the rains, but it is not improbable that the softness of the glass is an important contributory factor. Whatever the cause, the effect is that the magnet is rendered temporarily useless until a new object glass can be fitted and this by requiring a new determination of log π^2K implies a break in the continuity of the record of any particular magnet. All reasonable precautions are taken in the storage of magnets during the recess season during which they are inspected weekly: the frequent removal of the cells containing the object glasses is moreover objectionable, while the object glasses themselves, being held in position by the metal rim being spun over, cannot be detached from the cells: the only remedy, therefore, appears to lie in the use of a harder glass.

A number of object glasses with aluminium cells complete to fit the Cooke magnets have been since indented for, to avoid any stoppage of work from this cause.

Comparisons of Instruments with the Survey Standards.

5. At the beginning and end of each field season a series of comparisons were made to determine the differences between the standard and field instruments.

In the case of Declination and Horizontal Force these comparisons were made through the magnetograph curves, in Dip by direct simultaneous comparisons with the standard Dip Circle No. 44.

As in former years, Declination observations have been confined to the North and South absolute houses while four extra sites (as shown in the report for 1903-04) have been used for Horizontal Force and Dip.

Hitherto the site errors have been assumed negligible, but a new system of interchanging sites has now been introduced by which the site errors may be eliminated. This system which was confined to the comparisons of Dip during 1905-06 has now been extended to Declination and Horizontal Force comparisons: it has the further advantage that the differences between individual instruments obtained by this method are a check on the differences from the standard computed through the curves and a test of the accuracy of the observations. The following statements show the results of the comparisons in 1905-06:—

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

Magnetometer.	Declination.		Horizontal Force.		Remarks.
	End of field season 1904-05.	Beginning of field season 1905-06.	End of field season 1904-05.	Beginning of field season 1905-06.	
17— 1 (1 A)	+0''2	No comparison	+6γ	No comparison	1. The figures in brackets after the number of each magnetometer indicate the magnets used in the comparisons.
(2 A)	No comparison	+0''5	No comparison	No comparison	
3 (3 A)	+0''3	+0''2	+40γ	+21γ	
4 (4 A)	+1''1	−0''5	+35γ	−8γ	2. No alteration has been made for the present in the accepted values of log $\pi^2\kappa$ as published in the report for 1903-04.
5 (5 A)	±0	+0''1	+20γ	+29γ	
6 (6 A)	+0''1	+0''3	+19γ	−3γ	
10 (10)	No comparison	+0''2	No comparison	+32γ	

Comparison of field Dip Circles with the Standard No 44.

Instrument.		End of field season 1904-05.	Beginning of field season 1905-06.
$44_{1\cdot2}$—	$135_{2\cdot3}$	+ 2'·7	− 0'·5
	$136_{2\cdot3}$	+ 1'·2	+ 1'·0
	$138_{2\cdot3}$	− 1'·0	+ 2'·2
	$139_{1\cdot3}$	− 0'·6	+ 1'·0
	$140_{1\cdot3}$	+ 0'·2	+ 1'·4
	$170_{1\cdot2}$	Not compared	+ 1'·4

At the beginning of the present season observations for Dip gave the following site errors :—

SH − NH = − 0′·3
− Site 1 = ± 0
− „ 2 = − 0′·3
− „ 3 = − 0′·4
− „ 4 = − 0′·6

All of these errors are less than the probable errors of observation and the assumption hitherto made that their errors were negligible is thus justifiable.

Values of P obtained during the year.

6. The following table shows the value of the distribution constant P for all the Survey magnets during the past year:—

TABLE A.

Number of magnets.	P from 22·5 and 30 cms. Mean from all observations.	Adopted mean value.	Total number of observations.	Number of rejected observations.	Number of observations used in finding mean.	P from 30 and 40 cms. Mean from all observations.	Adopted mean value.	Total number of observations.	Number of rejected observations.	Number of observations used in finding mean.	Remarks.
2 A	7·21	7·14	83	15	68	9·02	9·20	93	23	70	
3 A	6·20	6·19	61	3	58	7·22	7·14	67	15	52	
4 A	7·55	7·53	91	4	87	8·55	8·53	92	10	82	
5 A	7·27	7·27	70	1	69	8·06	8·17	69	6	63	
6 A	8·00	8·00	89	0	89	8·01	7·98	86	8	78	
10	5·72	5·75	69	9	60	7·50	7·46	62	16	46	
16	7·06	7·04	73	3	70	8·49	8·56	73	23	50	From January to 14th June 1905.
„	7·03	7·02	67	3	64	8·99	9·03	70	24	46	From 15th June to December 1905.
17	7·46	7·47	43	1	42	8·66	8·59	43	10	33	From January to 27th May 1905.
„	7·52	7·52	43	0	43	8·13	8·18	46	10	36	From 31st May to October 1905.
„	7·47	7·47	21	2	19	7·93	7·14	25	9	16	From November to December 1905.
20	6·86	6·86	108	0	108	7·70	7·65	119	15	104	

In the last three reports tables were published, showing the values of p and q derived from the values of $P_{22\cdot5,30}$ and $P_{30,40}$ by means of the formulæ—

$$P_{1\cdot2} - P_{2\cdot3} = q\left(\frac{1}{r_1^2} - \frac{1}{r_3^2}\right) \text{ and } \qquad (1)$$

$$P_{1\cdot2} = p + q\left(\frac{1}{r_1^2} + \frac{1}{r_2^2}\right) + \frac{pq}{r_1^2\, r_2^2} \qquad (2)$$

(See extracts from Narrative Reports for season 1902-03.)

These tables are not published this year owing to the uncertainty as to the correct value of P obtained under the present system of deflection observations.

Observations are taken at three distances, *viz.*, 22·5, 30 and 40 cms. of which the observations at 22·5 cms. are grouped together in the centre, above and below this are the observations at 30 cms. while those at 40 cms. are at the beginning and end of the experiment. As the percentage error of observation varies inversely as the size of the deflection angle, the value of $\frac{m}{H}$ derived from the nearest distance must necessarily have the greatest weight, and the above arrangement was designed with the object of still further increasing the weight at this distance, the value of $\frac{m}{H}$ derived from which is then alone used in the evaluation of m and H, in preference to the mean value of m and H from two or three of the distances.

It would however be only possible to combine the values from 22·5 and 40 cms. when the third term in the distribution co-efficient $\left(1+\frac{P}{r^2}+\frac{q}{r^4}\cdots\cdots\right)$ is nil. This, however, is far from the case with the Cooke magnets which are known to have a considerable Q term, to evaluate which observations at the distance 40 cms. are made.

From equation (1) it will be seen that q is obtained by multiplying the difference $P_{1\cdot2}$—$P_{2\cdot3}$ by 740; any error in $P_{2\cdot3}$ thus largely affects the resulting value of q. The present arrangement of the deflection observations has, as far as the determination of Q is concerned, the serious defect of further diminishing the weight of the observations at 40 cms. except when the temperature and horizontal intensity vary uniformly or are constant throughout the observation, conditions which are exceptional, while the percentage error of observation is about six times as great as at the shortest distance. Errors of observation are moreover influenced by changes in declination during the period occupied by the deflection experiment, which again diminishes the weight of P from 30 and 40 cms.

Consider the two arrangements of the deflection distances below:—

	I	II
Magnet E	40	22·5
	30	30
	22·5	40
Magnet W	22·5	40
	30	30
	40	22·5

The average time occupied by a single deflection observation at 3 distances is 20 minutes. Apart from disturbances, 30″ would be a very common change of declination during this period. With such a change in declination, in I the deflection angle at 40 cms. is likely to be altered by 7″ or 8″ in II the angle at 22·5 would differ by the same amount. In I, $P_{30\cdot40}$ will be altered by 1·0, in II, $P_{22\cdot5,\ 30}$ will be changed by 0·08, $\frac{m}{H}$ by ·00005, H by 2γ and m by 0·05 C.G.S.

An inspection of the mean values of P for No. 19 magnetometer at Toungoo Observatory in 1905 (see page 30) show that there have been marked changes

(1) between April and May,

(2) between July and August,

in the former both P's rising, in the latter both falling.

The means of all observations without rejection are—

$$P_{1\cdot2} = 7\cdot12$$
$$P_{2\cdot3} = 8\cdot06$$

Rejecting 9 values in $P_{1\cdot2}$ and 42 in $P_{2\cdot3}$ within 5 and 10 % limits respectively of the mean values these means remain unaltered.

This tends to show that the changes are not real.

On the other hand if we divide the P's into three groups we obtain—

I $P_{1 \cdot 2}$ = 7·12 (mean of 77 values rejecting 6)
$P_{2 \cdot 3}$ = 8·93 (mean of 41 values rejecting 14)
II $P_{1 \cdot 2}$ = 7·21 (mean of 50 values)
$P_{2 \cdot 3}$ = 8·93 (mean of 23 values rejecting 7)
III $P_{1 \cdot 2}$ = 7·01 (mean of 72 values rejecting 3)
$P_{2 \cdot 3}$ = 7·62 (mean of 41 values rejecting 5)

In the first P the total number of rejected values remains the same, *viz.*, q and while for the second P 26 are rejected against 42.

The error introduced by using a mean $P_{1 \cdot 2}$ throughout the year will be 3γ in group II and 4γ in group III, quantities of the order of the error of observation. We have not however yet considered the effect of the q term by using p and q instead of P. The values of log $1-\frac{p}{r^2}-\frac{q}{r^4}$ are as follows:

A. From yearly mean values $\bar{1}$. 99320
B. Using 3 groups
I $\bar{1}$. 99320
II $\bar{1}$. 99254
II $\bar{1}$. 99351

The error introduced by using the mean for the whole year will be $+25\gamma$ in group II and -12γ in group III. If these changes are real, the instrumental error must have altered by $+25\gamma$ between April and May and by no less than -37γ between July and August. Changes such as these should be detected by the base line values of the magnetograph but unfortunately in this instance nothing can be expected from that source owing to the unsatisfactory condition of the magnetograph before the "ageing" of the magnet. It is however highly improbable, especially under observatory conditions, that the above instrumental changes should occur.

At Dehra Dun we are also confronted with similar changes in P during 1905 as shown below :—

	P_1's	P_2's	Log $1-\frac{p}{r^2}$	Log $1-\frac{p}{r^2}-\frac{q}{r^4}$	Change in H	Remarks.
I	7·47	8·59	$\bar{1}$. 99354	$\bar{1}$. 99275	$+ 30\gamma$	Up to 27th May 1905
Magnet 17 II	7·52	8·18	$\bar{1}$. 99350	$\bar{1}$. 99303	$+ 18\gamma$	31st May 1905 to 31st October 1905.
III	7·47	7·14	$\bar{1}$. 99354	$\bar{1}$. 99378	$- 9\gamma$	November and December.

It will be seen that in all these groups the value of $P_{1 \cdot 2}$ is practically the same, but the changes in $P_{2 \cdot 3}$ are considerable. An inspection of the abstract of P's seems moreover to show that the changes in $P_{2 \cdot 3}$ are real. The changes in H due to these changes in $P_{2 \cdot 3}$ are -12γ and -27γ respectively.

Between May and June the base line value altered apparently by -6γ between October and November by $+5\gamma$, while if the changes in force due to change in $P_{2 \cdot 3}$ were real we should have had alterations in base line of -18γ and -22γ. These discrepancies in the base line values are large and appear to indicate that we do not obtain a sufficiently accurate determination of $P_{2 \cdot 3}$.

Fluctuations in the differences of the field instruments from the standard after correcting for the Q term may also be attributed to this cause.

A more serious consideration is that we have differences indicated by the Survey Standard Instrument of whose reality or otherwise we are at present uncertain: if the changes were real it would be difficult to connect past and present values, and the instrument as a standard of reference would be of doubtful utility.

It seems obvious therefore that, if the values of q are to be considered satisfactory, the weight of the $P_{30\cdot 40}$ must be increased and also if possible the number of observations.

The field observers are, however, already restricted to the hours before 9 A.M. and after 3 P.M. for force observations; to add considerably to their work would mean delaying the progress of the field work, while it is not contemplated to abandon the order of observation which has been in force from the beginning of the Survey. It is therefore impossible in their case to increase the number of observations at 30 and 40 cms., but a value of $P_{2,3}$ with greater weight will be obtained by observing in the following order:—

Magnet	E	40	I
		30	
		22·5	
Magnet	W	22·5	II
		30	
		40	
Magnet	E	40	III
		30	
		22·5	

Of these I and II are combined to form one deflection observation, II and III a second deflection, a vibration experiment being made before I and after III. Hitherto I and II only have been observed and the extra time occupied in III will be 10 to 12 minutes only.

These two deflections will give one value each of $P_{1,2}$ $P_{2,3}$ of equal weight so far as the elapsed time is concerned.

In the case of observatories, the base line values have been hitherto obtained by bi-weekly observations of one single deflection experiment at these distances preceded and followed by a vibration experiment: in future a second deflection will be taken immediately after the first as follows:—

Magnet	E	22·5	I
		30	
		40	
Magnet	W	40	II
		30	
		22·5	
Magnet	E	22·5	III
		30	
		40	
Magnet	W	40	IV
		30	
		22·5	

Of these I and II, II and III, III and IV will be combined to make three deflection observations and we obtain 1 value of $P_{1\cdot 2}$, 2 values of $P_{2\cdot 3}$ of equal weight in consideration of the elapsed interval. These values will be compared with those obtained by the method hitherto followed, when it is hoped some light may be thrown on the discrepancies in value encountered in recent years.

The secular change in India.

7. Pending the precise reduction of the repeat station observations which cannot be corrected for perturbation until data for the variations in Vertical Force are available from the Survey base stations, it was considered that a preliminary reduction, using approximate corrections for diurnal variation and

instrumental differences only, might prove interesting and at the same time give a reasonably close approximation to the true secular change. This has been done for such repeat stations as had been established for over three seasons.

In the case of declination, however, it was found that a period of even four years was too short, this approximate method not being sufficiently precise for the appreciation of the small changes involved.

The only reliable data at present are those from the base stations which give the following changes—

Dehra Dun	(Easterly Declination)	− 1·1	per annum.
Barrackpore	(Easterly Declination)	− 4·5	"
Kodaikanal	(Westerly Declination)	+ 5·0	"

This portion of the investigation was therefore abandoned: it appears probable, however, that Easterly Declination is decreasing and Westerly increasing over the whole of India at a very small average rate probably 2 to 3 minutes per annum, the rate of change being greater in the south of India than in the North.

Secular change in H. F.

In Horizontal Intensity, however, the results are more promising and indicate that the annual changes are large. From the base station results we find the following average changes in the periods noted :—

Dehra Dun	− 18 γ	per annum.
Barrackpore	+ 21 γ	"
Kodaikanal	+ 12 γ	"

The following average changes are found at the repeat stations given below. They are, however, only to be regarded as preliminary approximations as in many cases the period used is two years only and in some, especially in South India, the corrections for diurnal variation and instrumental differences are at times large.

N.-W. India and Baluchistan.

Quetta	− 43 γ	per annum.
Karachi	− 37 γ	"
Rawalpindi	− 37 γ	"
Bahawalpur	− 34 γ	"

Kathiawar and Rajputana.

Porebunder	− 24 γ	per annum.
Oodeypore	− 19 γ	"

N. E. India.

Fyzabad	+ 8 γ	per annum.
Bhurtpore	− 18 γ	"

Central India.

Bhusawal	− 4 γ	per annum.
Jubbulpore	− 1 γ	"

E. India.

Gaya	+ 13 γ	per annum.
Sambalpur	+ 27 γ	"
Darjeeling	+ 14 γ	"

S. India.

Secunderabad	+ 11 γ	per annum.
Waltair	+ 26 γ	"
Bangalore	+ 12 γ	"
Dharwar	+ 2 γ	"

No corrections for diurnal variation have been made in the observed results in computing the secular change in Dip, but the errors arising from this cause are likely to be small; the instrumental differences are also mainly of the order of the average error of observation, while the annual changes in Dip are so large as to render these omissions of little moment.

Secular change in Dip.

The base station results give the following average changes :—

Dehra Dun	+ 4′·8 min. per annum.
Kodaikanal	+ 5·7 ,,
Barrackpore	+ 2·8 ,,

The following average rates of annual change are found for repeat stations :—

N.-W. India and Baluchistan.

Quetta	+ 6·5 min. per annum.
Karachi	+ 7·4 ,,
Rawalpindi	+ 5·4 ,,
Bahawalpur	+ 6·6 ,,

Kathiawar and Rajputana.

Porebunder	+ 6·0 min. per annum.
Oodeypore	+ 7·4 ,,

N.-E. India.

Fyzabad	+ 5·3 min. per annum.
Bhurtpore	+ 5·9 ,,

Central India.

Bhusawal	+ 5·5 min. per annum.
Jubbulpore	+ 5·8 ,,

E. India.

Gaya	+ 2·7 min. per annum.
Sambalpore	+ 6·1 ,,
Darjeeling	+ 3·2 ,,

S. India.

Secunderabad	+ 6·0 min. per annum.
Waltair	+ 6·5 ,,
Bangalore	+ 8·1 ,,
Dharwar	+ 8·3 ,,

The values of declination found in India proper range from 3°50′E in the extreme north (Dargai, Malakand) to 1° 5′ W at Cape Comorin, the general trend of the true isogonals being in an east-west direction. The location of the line of no declination (*i.e.* where the magnetic coincides with the geographical meridian) is approximately as follows:— passing from the coast near Karwar northwards to near Belgaum it turns south through Dharwar whence, passing near Guntakul junction it runs sharply south to Tumkur. From Tumkur it again turns sharply north to a point near and south of Secunderabad, thence south to near Cumbum whence it passes to the sea through a point near and south of Ongole.

Values in declination in India.

Isolated cases of westerly Declination are met with north of this line in Lat. 19°, Long. 74°, near Bijapur, Bidar and Yelgondal.

The true isogonals have been plotted approximately on a chart on the scale of 80 miles to the inch, an inspection of which seems to show that most of the irregularities in the lines are confined to the regions where the Deccan trap is the distingushing geological feature and the districts adjoining.

The more striking abnormalities in value are, however, outside this area of which the following examples are note worthy:—

Harpanahalli (Mysore), 1° 55′W. where the normal appears to be 0° 0′.
Ongole (Madras), 2° 10°E. where we should expect 0° 5′W.
Kuvoy near Cannanore (Madras), 1°35′E. the normal of the district being 0° 50′W.
Quilon (Travancore), 0° 10′E. where we should expect 1° 5′W.
Near Pokaran (Rajputana) where a change from 3° 5′E. to 0°15′E. is found in 40 miles.
Ganges Valley {Buxar 3° 35′E / Saran 0° 45′E} where the normal of the district is 1″ 40′E.

Of these the values at Ongole and Harpanahalli are probably due to the known hematite ores of the former and the Sandur magnetites in the case of the latter.

Moment of Inertia.

8. During the recess season of 1906, observations for determining the moments of inertia of the survey magnets have been carried out with the inertia bars to which reference was made in last year's report. The moments of inertia of magnets at Barrackpore and Toungoo observatories still remain to be determined. Observations will be made during the ensuing field season.

The gilt bar, S. G. (Standard Gilt), presented by Dr. Watson, F.R.S., is regarded as the Survey standard : this bar has been used in the new determinations throughout : but in order to investigate the reasons for the changes in log π^2K found in 1904 and noted in the annual report for 1903-04 it has been found necessary in addition to carry out full determinations with bars 17 and 2.

This investigation has also involved the opening up of old determinations for the correction of erroneous values of expansion in the case of bar 2, the determination of the mean probable errors and where observations extended over two or more days the determination of the most probable values from the weighted mean values of each day.

It is disappointing to find that series of observations on different days while affording accordant values *inter se* often give largely discordant mean values : for this reason there is in some cases uncertainty as to the correctness of the mean values of former years when log π^2K was often determined from observations confined to a single day.

The final values this year have been obtained by taking several series of observations with each magnet on several days (each day's observations giving three or more determinations of log π^2K) and weighting them by means of their mean errors, irrespective of the accordance or otherwise of their mean values, provided there exists no good reasons for rejecting any particular set or sets of observations, for disturbance, rapid temperature changes, etc.

Where observations extend over more than one day in former years the same procedure has been followed.

It is, however, to be noted that these discrepancies in the mean values for different series are not such as to greatly alter the value of H (mean differences of more than ·000200 in the value of log π^2K are exceptional, this amount being equivalent to about $\pm 7\ \gamma$ in H at Dehra Dun) ; the extra series of determinations being made more in the interests of the investigation into and the elucidation of the changes in log π^2K, which were noted in 1904.

It may here be stated that the determinations made this year with bar 2 have proved unsatisfactory ; in four cases the resulting determination of log π^2K has proved to be higher than that given by bar S. G. by amounts varying from ·000204 to ·000324 and in two others lower by ·000292 and ·000017 respectively. The discrepancies may be due to want of uniformity in the density of the bar. The check weighment of the bar carried out when the Oertling balance arrived showed a loss of ·008 grammes on the Kew weight of 63·857 grammes in 1905, but as the two determinations of log π^2K which gave values smaller than the S. G. bar were numerically the first and last experiments carried out with this bar, the loss of weight is of no assistance in explaining the discrepancies.

The loss of weight is probably true, as the weight of 17 bar was found to be the same as at Kew in 1905 : it was found, however, when observations were first made with bar 2 this year that the fit in the stirrup was very tight and the bar was very carefully cleaned with cotton wool moistened with kerosine oil when matters were improved: this may account for the observed loss of weight.

The log π^2K of the standard magnet No. 17 was determined with both bars 17 and S. G., the final results from which accorded well—they are as follows :—

Bar S. G.	3·4150099 ± 15
Bar 17	3·4150046 ± 39

The determinations with bar 2 have therefore been neglected for the present and the values with S. G. bar accepted.

The final discussion of the results is deferred for the present until the determinations of log π^2K with the magnets at Barrackpore and Toungoo are made : these links in the chain of evidence are required to complete the investigation into the changes (if any) which have taken place in bar 17.

From the log π^2K of magnet 16 at Kodaikanal it appears that the bar 17 had in 1902 the same weight and dimensions as at present, and should this be confirmed by the observations at Barrackpore and Toungoo it will be of material assistance in the investigation of the changes in bar 2, one magnet having been used with both bars 17 and 2 in 1902 and 3.

At present the results appear to show that the loss in weight and length of bar 2 occurred between October and December 1903.

The table below gives the results of the determinations recently made with the S. G. bar together with the accepted values which have hitherto been used.

Number of magnet.	Accepted.	New.	New—accepted.
3A	3·38733	3·38731	—·00002
4A	3·37972	3·37903	—·00069
5A	3·37894	3·37899	+·00005
6A	3·39887	3·39877	—·00010
10	3·40173	3·40162	—·00011
16	3·38717	3·38672	—·00045
17	3·41579	3·41509	—·00070

NOTE.—The accepted value of 4A was adopted only in 1904; the original value was 3·37936 which agrees much better with the new value.

General remarks.

10. During the ensuing field season four detachments will be employed of which one will work in Assam, a second in the difficult country lying between the rivers Godavery, Waingunga and Mahanuddy, while the remaining two will work in Burma.

The two R. E. officers will be employed in observing at repeat stations, in the erection of V. F. magnetographs at Barrackpore, Toungoo and Kodaikanal and the inspection of observatories and field detachments.

A table showing the approximate preliminary values (uncorrected) at the field and repeat stations is appended to this report, together with an index chart showing the positions of all stations of observations to date.

The tabulations of the results obtained at Dehra Dun, Barrackpore, Kodaikanal and Toungoo observatories are published for 1905.

II.—Brief Review of the Progress of the Magnetic Survey.

§1. At the present time when the preliminary magnetic survey is drawing to a close it seems a not inopportune moment to briefly pass in review the history and operations of the Survey since its inception, to outline the essential features of the general scheme of the survey and to record how far the ideals of this scheme have been fulfilled or unattained.

§2. A Magnetic Survey of India was first proposed in 1896 by Sir John Eliot and General Strahan and was recommended by the Astronomers who visited India in 1898. There was at the outset some uucertainty as to the agency to be employed. Eventually it was decided that the field work should be carried out by the Survey of India, the fixed observatories remaining under the Director General of Observatories: subsequently, however, the latter condition was modified and four of the five observatories are now under the control of the Magnetic Survey.

Captain (now Major) H. A. D. Fraser, R.E., of the Survey of India, was deputed to Europe to consult Professor Rücker in regard to preliminary details connected with the survey and the supply of instruments: with his return to India in December 1900, the Magnetic Survey may be said to have begun.

§3. The immediate aim of a Magnetic Survey is to determine the Declination, Dip and Intensity of the earth's magnetic force at various points throughout the area involved and to measure the several changes which are taking place in these elements.

The distance between stations of observation depends upon the special purpose to be accomplished with the means at hand and the magnetic character of the area involved. The quantities experimentally determined in a magnetic survey are incessantly undergoing changes, some periodic, others non-periodic: a magnetic survey thus must be made to refer to some particular moment of time, and such means must be taken as will enable one to reduce all the measurements, not only to the selected epoch of the survey, but also to some other epoch in the near past or future. Measures must also be taken for the elimination of such errors as are to be referred to the particular magnetic instrument used, *i.e.*, instrumental errors.

These requirements call for—

(*a*) Elimination of all variations of short period or of brief duration by means of continuous records at observatories or "base stations" suitably situated and in sufficient number for the area under survey.

(*c*) Elimination of the secular variation.

The secular variation is by no means constant throughout an area of any considerable extent: for its determination we require, in addition to the observatories, a number of well selected stations distributed over the area, where observations must be made with special care and repeated at intervals.

These are known as "repeat stations."

(*b*) Elimination of instrumental errors.

This involves the selection of a standard instrument with which every instrument must be periodically compared. Comparisons should also be made at the beginning and during the survey as often as possible between the India standard and the standard instruments of other countries.

A comparison was made with the Kew standard at the beginning of the survey but has not yet been repeated.

No. 17 magnetometer, the Dehra Observatory instrument, has been selected as the standard instrument for the Magnetic Survey of India

General scheme of the Magnetic Survey of India.

§4. The Indian Magnetic Survey has been modelled on the lines of the two surveys of Great Britain and Ireland carried out in 1886 and 1891 by Rücker and Thorpe. The full scheme consists of two parts—

(1) The preliminary survey.
(2) The detail survey.

The preliminary survey has for its objects, firstly, the approximate determination of the lines of equal declination, force and dip and, secondly, the indication of localities affected by local magnetic attraction.

The detail survey will be based on and a development of the preliminary survey and will entail the thorough investigation of such local peculiarities as are revealed by the preliminary survey, and the determination of the direction and magnitude of the disturbing forces. Observations will also be taken at repeat stations.

The preliminary survey is now in progress and will be completed in 1908.

Density of stations.

§5. The density of stations must be a minimum provided the objects of the preliminary survey are fulfilled, provided also that the survey can be completed within a reasonably short interval, say ten years at most.

In the English survey of 1886 the density was one station to 900 square miles or $\frac{1}{900}$, in 1891 the density was $\frac{1}{139}$. It was found, moreover, that the results of 1886 were almost entirely confirmed by the detailed survey of 1891, the chief areas of magnetic attraction being defined with considerable accuracy. On the assumption based on the Geological maps, that India was less likely to be effected proportionally to its area, a density of about $\frac{1}{1200}$ was decided upon for the preliminary survey or a distance between stations of 35 to 40 miles. Allowing for inaccessible tracts it was estimated that a total number of about 1,200 stations would be required, and with five field detachments could be finished in five years.

The Magnetic Survey as conducted in India differs from similar surveys in Europe inasmuch as, in India, the year is sharply divided into two seasons the cold weather when field work is possible and the rains when field work cannot be carried on and the field observers are utilized for carrying on computations.

The base stations.

§6. The requisite number of these stations was decided by Sir Arthur Rücker and the Indian Committee of the Royal Society. The number fixed upon was five. There already existed a magnetic observatory in operation at Colaba and the remaining four were to be located at Dehra Dun, Alipur, Kodaikanal and Rangoon.

The sites at Alipur and Rangoon were, however, later found to be threatened by the advent of electric tram lines and other sites had to be selected at Barrackpore and Toungoo.

It was originally intended that the base stations should be all in working order before the commencement of the field work, but the delay involved in the abandonment of the original sites and the provision of new buildings, the belated arrival of some of the variation recording instruments and certain preliminary investigations which had to be undertaken have prevented the attainment of this ideal course.

The following are the dates from which each observatory commenced working :—

Dehra Dun	March 1902.
Kodaikanal	August 1902.
Barrackpore	August 1903.
Toungoo	December 1904.

The field work commenced in November 1901.

The original equipment contemplated for these four observatories consisted of Horizontal Force and Declination magnetographs only; it was believed that Vertical Force instruments would be available at Bombay and Alipur and the general scheme of Sir A. Rücker was based on this supposition.

When Alipur, however, was found wanting as a site for a magnetic observatory, a V. F. instrument was ordered for Dehra Dun. It was expected to arrive in 1903 but actually did so late in 1904: it was erected last year but for the reasons stated on page 19 of this report has not yet proved satisfactory. After this instrument was ordered other counsels prevailed and it was decided to equip all four observatories with V. F. magnetographs as a simpler form of V. F. magnetograph had been designed by Professor Watson and could be obtained. Two of these have arrived and the third has recently been despatched: it is hoped that all four instruments will be working within the next nine months.

The non-provision of V. F. magnetographs in the beginning has proved most unfortunate: it has an important bearing on the reductions of the field observations, as the scheme outlined by Sir A. Rücker for the treatment of corrections for perturbation cannot be tested until data from these instruments are available.

Repeat stations.

§7. The number of repeat stations eventually decided upon was 23 or an average of 1 to about 75,000 square miles, this compares very unfavourably with the 1 in 10,000 square miles of the American Survey.

The number, however, is limited by the staff available to visit them annually: the distances involved are so great that even with two officers their time is fully occupied for six months in visiting observatories and the repeat stations.

The description, however, of all field stations has been preserved and observations can always be repeated at such places where it seems desirable.

The repeat stations could not be established in all parts of India until the various base stations were in working order and the present number of 22 was only attained in 1904-05 after the instruments at Toungoo were installed.

In 1901-02, 4 "Repeat stations" were observed at, in 1902-03, 9 stations in 1903-04, 18 stations and in 1904-05 22 stations had been established.

The requirements of a repeat station are :—

1. It should be situated in a district free from local disturbances.
2. Several sets of observations extending over several days should be taken with the utmost care.
3. The exact site of the instrument must be permanently marked.
4. Observations should be taken at two or more such spots a few miles apart to guard against purely local disturbances.

The progress of the field work.

§8. Field operations were commenced in November 1901.—

1901-02.—Three detachments were employed, but as the magnetographs at Colaba only were at this time in working order observations were confined to a district west of the line joining Bombay and Dehra Dun, the three detachments being concentrated in the southern portion of this area.

163 stations were established, but 37 of these had to be revisited next season for further determinations of H. F. owing to the inexperience of the previous observer.

1902-03.—Four detachments were employed from November and a fifth for one month at the end of the season when instruments became available.

The total outturn of new stations was 204.

1903-04.—Five detachments were employed from November, but two observers were obliged to be withdrawn from field work for two and three months respectively to carry on observatory work owing to the sickness of the permanent incumbents.

255 field stations were established.

1904-05.—Four detachments were employed. The total outturn of new stations was 206.

1905-06.—Four detachments were again available, but for the reasons detailed in Part I of this report the total outturn of stations was 130 only.

The total number of field stations to date is therefore 958 in five years with an average of four detachments per year against the estimate of about 1,200 to 1,300 stations in five years with five detachments. With four detachments, an average which has rarely been exceeded, the estimate becomes 6½ years or two more field seasons.

In order then to keep within the original estimate of time we have to maintain an average of 130 field stations for the next two seasons. This average should be maintained though not without difficulty, the districts in which the detachments will work being more or less inaccessible where, especially in Burma, difficulties of country and transport are an insuperable bar to rapidity of movement.

The original scheme moreover made no provision for the extension of the preliminary survey into Kashmir and the more accessible tracts of the Himalayas nor for such partial revision as may, from the coincidence of times of observation with phases of large disturbance, be necessary, but in default of the extension of the preliminary survey for another working season, the investigation of these areas must be postponed to the detail survey.

Reduction of the observations.

§9. The question of the reduction of the observations was early considered and the advice of Sir A. Rücker was asked as to the best method of utilizing the results from the five base stations.

It is not intended to enter into any discussion of the subject here: it will suffice to say that Sir A. Rücker formulated schemes for correcting for diurnal variation and disturbance to be tested when sufficient data became available. For diurnal variation these have been worked up by Mr. J. Eccles, M.A., with the satisfactory result that a simple relation has been found to connect change in the diurnal variation of Declination and Horizontal Force with changes in Latitude.

For the investigation of the variation from point to point of Disturbances, data are required from V. F. instruments which are not yet in working order; until these are available the investigation is necessarily postponed.

III.—THE MAGNETIC OBSERVATORIES IN 1905-06.

CONTENTS.

A.—General Remarks on the Observatories.

§ 1. Positions of Observatories.
§ 2. Equipment of „
§ 3. Routine magnetic work at Observatories.
§ 4. Tabulations how compiled.
§ 5. Curves, how classified.

§ 1. The Magnetic Survey has now in operation four magnetic observatories at which the ceaseless variations of the Earth's magnetism are being continuously recorded photographically. In the last of these, Toungoo, the instruments were installed only in December 1904. There is also in addition a magnetic observatory at Alibag (Bombay) the results from which will be utilized in the reduction of the field observations to a common epoch; this observatory is however not under the control of the Magnetic Survey and reference to it is outside the field of this report.

The four Survey base stations are situated at Dehra Dún, Barrackpore, Kodaikanal and Toungoo, the geographical co-ordinates of which are given in Part IV, TABLE A. At Dehra Dún the Observatory is wholly underground, at Kodaikanal partly so, while the remaining two are above ground.

Equipment.

§ 2. *Variation Instruments.*—Each Observatory is equipped with Horizontal Force and Declination magnetographs of the Watson pattern. It was not originally contemplated to instal Vertical Force magnetographs but since the inception of the Survey other views have prevailed and it is hoped that in the course of the next year Vertical Force instruments will be working at all four stations.

Absolute Instruments.—Each Observatory is provided with a magnetometer of the Kew pattern and a dip circle. The dip circles will be replaced by Earth Inductors of the Schulze pattern shortly: the instruments have been despatched from England and are expected daily.

Barrackpore and Toungoo Observatories are provided also with a theodolite for the determination of time by astronomical observations. Observations are taken as often as practicable and necessary for the rating of the Chronometers: at Dehra Dún and Kodaikanal the rate is obtained direct by comparison with the siderial clock and telegraphic signal from Madras respectively.

Routine magnetic work.

§ 3. The routine magnetic work at Observatories is briefly as follows:—Absolute observations for Horizontal Force, Dip and Declination are taken on two days a week for each.

The temperatures of the H. F. magnetograph are read thrice a day at 10, 13, and 16 hours. Eye deflection readings for the determination of the scale value of the H. F. magnetograph are taken on alternate days while once a month this is registered photographically. Photographic papers are changed every second day.

§ 4. Tabulations are published in Part IV of the hourly means and diurnal inequality of Horizontal Force and Declination derived from 5 quiet days per month. These days are selected by the Director of Colaba Observatory.

The observations for Dip are published *in extenso*, all the observations are made as far as possible at about the same hour.

Method used in the classification of curves.

§ 5. In classifying the traces, the intensity of the disturbance, the rapidity with which the changes occur, the frequency of the changes and the duration of the disturbance are taken as the four determining factors. A day is *calm* so long as there is no sudden and frequent change of H by more than 5γ. In a *slight* disturbance day, H does not suddenly change by more than 15 or 20 γ, but a disturbance is regarded as *slight*, even if the intensity of the sudden changes be 30 or even 40 γ if the duration is not more than 2 or 3 hours. Disturbances of this intensity lasting for several hours are regarded as *moderate*.

In a *great* disturbance H changes very rapidly from 50 to 150 γ and the disturbance lasts for more than 6 to 8 hours. Any disturbance of higher magnitude than this is taken as *very great*.

B.—Dehra Dún Observatory.

§ 1. General remarks on the working.
The V. F. magnetograph, defects in.
§ 2. Mean value of magnetic elements (D, H, I) at Dehra Dún in 1905.
§ 3. Declination constants and mean monthly base lines.
§ 4. H. F. constants and mean monthly base lines.
§ 5. Mean scale values and temperatures of H. F. magnetograph.
§ 6. Mean monthly values of magnetic elements and secular change, 1904-05.
For hourly mean values and diurnal inequality, see Part IV, pp. 38-41.
§ 7. Statement of loss of magnetograph records in 1905.

§ 1. The observatory has remained in charge of observer K. N. Mukerji throughout the year. The magnetographs have continued to give good results and have not required readjustment: the H. F. instrument again shows a slight gradual decrease in the base line value.

The Vertical Force magnetograph erected last year has, however, proved very unsatisfactory: after numerous experiments it has been found impossible with the compensation arrangement supplied to reduce the temperature co-efficient below the high value of $+10\gamma$ per 1° F., and a number of records have been lost owing to the beam of light moving off the scale in a horizontal direction. This is probably due to the fact that, in this instrument, no arrangement was made for moving the magnet box as a whole through a small angle independently of the foot-screws. Some such arrangement is necessary as the magnet mirror is not capable of adjustment; the defect has been remedied in later instruments, but in the Dehra instrument it was found necessary to "rimer" out the brass collars through which the foot-screws pass, any small slip in which is sufficient to cause the loss of record.

It is hoped however to be able to utilize the curves to some extent later on in the reductions of field observations, though it will probably not be practicable to publish tabulations for 1906. In correspondence with Dr. Chree, F.R.S., during the recess season it was ascertained that a new form of temperature compensation arrangement has been devised for the two later instruments destined for Toungoo and Kodaikanal. These instruments were under examination at Kew for over a year: they were fitted originally with compensation bars similar to the V. F. instrument at Dehra. With these bars the temperature phenomena were most puzzling, consistent results could not be obtained and it became clear that with this arrangement it was practically impossible to reduce the temperature co-efficient to a sufficiently low figure. After various trials the new form of device alluded to above was adopted: with this, approximately consistent results were obtained with an entire absence of the "lag" with falling temperature which is a marked feature of the experiments carried out with the Dehra Dún magnet fitted with the original device. With the first magnet fitted with the new arrangement the Kew authorities were enabled to vary the temperature co-efficient per degree Fahrenheit from $+25\gamma$ to -60γ, and with the experience thus gained the dimensions were modified for the Toungoo instrument in order to reduce these limits. On receipt of this information temperature compensation bars of the new design were indented for for the V. F. magnets for Dehra and Barrackpore, but on arrival of the Kodaikanal instrument in October it was found that it would be difficult to fit the new device to those magnets: sanction has therefore been asked to the purchase of two new magnets complete. Meanwhile it is proposed to mount the Kodaikanal magnet at Dehra Dún, while on arrival the two new magnets will be allotted to the Kodaikanal and Barrackpore instruments.

Mean values of the magnetic elements (D. H., I.) at Dehra Dún in 1905.

§ 2. The mean values of the magnetic elements at Dehra Dún for 1905 are as follows :—

Declination	2° 39′·9 E
Horizontal Force	·33383C. G. S.
Dip	43° 24′·2

Declination constants and mean monthly base lines.

§ 3. The following table gives the mean magnetic collimation of Magnet 17 (the Survey standard) for each month in 1905, also the mean monthly base line of the Declination magnetograph, showing the number of observations used in deriving the accepted value.

Columns 7 and 8 give the probable errors of the mean base line values and of a single value and are a test of the accuracy of the absolute declination Observations.

DEHRA DÚN OBSERVATORY.

Monthly Mean Value of the Declination Constants of the Survey Standard and Base Line values.

Months, 1905.	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 . .	—8:25	1°+42·54	26	0	26	±0·02	±0·13	
February . .	:28	42·66	27	3	24	±0·03	±0·13	
March . . .	:27	42·57	18	3	15	±0·03	±0·13	
April . . .	:28	41·29	13	5	8	±0·02	±0·06	The magnetograph was re-adjusted after the earthquake on the 16th.
May . . .	:21	41·05	25	1	24	±0·03	±0·15	
June . . .	:22	40·98	26	0	26	±0·02	±0·11	
July . . .	:23	41·06	19	0	19	±0·03	±0·14	
August . . .	:26	41·13	23	3	20	±0·02	±0·10	Up to 14th September, when the magnetograph was re-adjusted.
September . .	:21	41·27	24	6	18	±0·03	±0·15	From 15th September.
October . . .	:25							
November . .	:24	41·32	25	2	23	±0·03	±0·13	
December . .	:28	41·32	24	1	23	±0·03	±0·14	

H. F. constants and mean monthly base lines.

§ 4. The following table shows the mean monthly values of the constants of the Survey Standard together with the mean monthly base lines of the H. F. magnetograph.

DEHRA DÚN OBSERVATORY.

Monthly Mean Value of H. F. Constants of Survey Standard and Mean Monthly Base Line values.

Months.	Mean value of m° for the month.	Monthly mean value of P. from 22·5 + 30 cms.	Monthly mean value of P. from 30 and 40 cms.	Mean value of Base Line.	Total number of value of Base Line.	Num be of values rejected.	Number of value from which the Base Line is derived.	Probable error of the mean value of Base Line.	Probable error of a single value.	REMARKS.
January . .	915·36	7·40	8·67	·33179 C.G.S.	18	0	18	±0·8γ	±3·2γ	
February . .	·40	·48	·38	·33177 "	15	0	15	±0·9γ	±3·6γ	
March . .	·29	·45	·67	·33175 "	15	1	14	±1·2γ	±4·6γ	
April . .	·37	·50	·95	·33174 "	17	1	16	±0·8γ	±3·3γ	
May. . .	·30	·53	·40	·33179 "	20	0	20	±0·8γ	35γ	
June. . .	·08	·65	·15	·33173 "	22	0	22	±0·7γ	±3·4γ	
July. . .	·02	·47	·06	·33169 "	19	0	19	±0·9γ	±4·0γ	
August . .	·10	·44	·37	·33163 "	17	0	17	±0.9γ	±3·7γ	
September .	·22	·59	·35	·33154 "	10	0	10	±1·7γ	±5·4γ	
October . .	·22	·49	·14	·33152 "	20	1	19	±1·0γ	±4·2γ	
November. .	·32	·47	6·98	·33157 "	25	2	23	±0·8γ	±3·7γ	
December .	·47	·47	7·42	·33164 "	22	1	21	±1·0γ	±4·8γ	

Mean scale values temperature of the Horizontal Force magnetograph.

§ 5. The mean scale value for the year 1905 was found to be 4·07γ for a change in ordinate of 0·04″. The minimum monthly value was 4·05γ and the maximum 4·08γ but these values bear no relation to the differences of the mean monthly temperatures of the magnetograph and do not support the view that the sensitiveness increases with the temperature.

The mean Temperature for the year was 25·1°C, the minimum temperature 24·0° C being found in March, the maximum 25·9°C. in August.

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

Monthly mean values of and secular change in magnetic elements for 1904 to 1905.

§ 6. The following table gives the mean monthly values of Horizontal Force, Declination and Dip for 1904 and 1905 with secular changes deduced therefrom.

Months.	HORIZONTAL FORCE ·33000 + 10⁻⁵.			DECLINATION E 2° +			DIP 43° +		
	Values of H.F. 1904.	Values of H.F. 1905.	Secular change 1904-05.	Values of D 1904.	Values of D 1905.	Secular change 1904-05.	Values of I 1904.	Values of I 1905.	Secular change 1904-05.
	C.G.S.	C.G.S.	γ	′	′	′	′	′	′
Janu ry . . .	405	381	—24	41·4	40·3	—1·1	17·0	20·1	+3·1
February . . .	410	376	—34	41·7	40·6	—1·1	16·5	20·4	+3·9
March . . .	416	384	—32	41·4	40·3	—1·1	15·4	21 6	+6·2
April . . .	411	392	—19	41·3	39·8	—1·5	16·4	21·1	+4·7

Months.	Horizontal Force ·33000 + 10−5.			Declination E 2° +			Dip 43° +		
	Values of H. F. 1904.	Values of H. F. 1905.	Secular change 1904-05.	Values of D 1904.	Values of D 1905.	Secular change 1904-05.	Values of I 1904.	Values of I 1905.	Secular change 1904-05.
	C.G.S.	C.G.S.	γ	′	′	′	′	′	
May	414	399	−15	41·2	39·9	−1·3	16·4	22·5	+6·1
June	409	392	−17	40·9	39·8	−1·1	16·8	22·8	+6·0
July	407	388	−19	40·3	39·3	−1·0	17·4	23·2	+5·8
August	407	386	−21	40·0	39·6	−0·4	17·2	25·7	+8·5
September	399	373	−26	40·4	39·5	−0·9	17·6	26·9	+9·3
October	397	377	−20	40·3	39·8	−0·5	19·0	27·0	+8·0
November	389	373	−16	40·5	39·8	−0·7	20·0	29·8	+9·8
December	394	375	−29	40·2	39·8	−0·4	19·9	28·7	+8·8
Means	405	383	−22γ	40·8	39·9	−0·9	17·5	24·2	+6·7

§ 7. *The Statement of loss of Magnetograph records at Dehra Dún during the year 1905.*

Horizontal Force.					Declination.					Remarks.
From	On	To	On	Period of break.	From	On	To	On	Period of break.	
H. M.		H. M.		H. M.	H. M.		H. M.		H. M.	
16 0	10th Jan.	10 0	11th Jan.	18 0	16 0	10th Jan.	10 0	11th Jan.	18 0	The shutters fell at 4 P. M.
					6 0	4th April	14 30	16th April	296 30	The magnet mirror was thrown out of its position by the earthquake.
12 43	16th April	14 30	16th April	1 47						The declination Magnetograph was under re-adjustment.
10 0	19th June	13 0	19th June	3 0	10 0	19th June	13 0	19th June	3 0	The shutters were not opened by mistake.
9 51	13th July	13 35	14th July	27 44	9 51	13th July	13 35	14th July	27 44	Erecting the V. F. pillars.
7 43	19th „	10 0	19th „	2 17	7 43	19th „	10 0	19th „	2 17	Testing the above pillars.
10 0	23rd „	16 10	23rd „	6 10	10 0	23rd „	16 10	23rd „	6 10	Plastering the above pillars.
10 0	24th „	14 55	24th „	4 55	10 0	24th „	14 55	24th „	4 55	Ditto.
					14 55	24th „	3 0	25th „	12 5	Lamp was burning badly.
10 0	30th „	15 0	30th „	5 0						The paper was previously exposed.
10 0	31st „	14 0	31st „	4 0						
12 23	17th Aug.	14 3	17th Aug.	1 40	12 23	17th Aug.	14 3	17th Aug.	1 40	
11 4	19th „	16 36	19th „	5 32	11 4	19th „	16 36	19th „	5 32	Erecting the V. F. instrument.
13 10	24th „	14 16	24th „	1 6	13 10	24th „	14 16	24th „	1 6	
					9 51	27th „	9 51	29th „	48 0	The lamp was not moved to the 2nd position on the 28th.
10 0	4th Sept.	16 0	4th Sept.	6 0	10 0	4th Sept.	16 0	4th Sept.	6 0	
11 18	6th „	13 43	6th „	2 25	11 18	6th „	13 43	6th „	2 25	
					9 51	13th „	14 0	13th „	4 9	Light from the Magnet Mirror went too high.
					14 0	14th „	10 0	15th „	20 0	
8 30	16th „	9 55	16th „	1 25	8 30	16th „	9 55	16th „	1 25	Adjusting the V. F. instrument.
					10 26	7th Oct.	13 5	7th Oct.	2 39	
7 52	22nd Oct.	10 46	22nd Oct.	2 54	7 52	22nd „	10 46	22nd „	2 54	Ditto.
			Total .	93 55				Total .	466 31	

C.—Barrackpore Observatory.

§ 1. The observatory was under the charge of observer Shri Dhar throughout the year.

General remarks.

It was noted in the report for 1903-04 that considerable difficulty was found in maintaining uniformity of temperature in the magnetograph room; to improve the temperature conditions the walls of the inner room have been doubled and packed with saw dust and the open verandah round the building has been enclosed. This was carried out in May and June 1906: the work unfortunately necessitated a considerable loss of records.

The V. F pillars were also erected in April. The magnetographs worked well throughout the year and required no readjustment. The declination instrument, was however affected by the Calcutta earthquake of the 29th September, the magnet adhering to the side of the damping box; the record was lost for 53 hours, when the observer with the aid of a bar magnet was able to restore the magnet to its normal position.

In July 1906, the officer in charge proceeded to Barrackpore to erect the V. F. magnetograph, but defects in the driving clock necessitating prolonged repairs have delayed the installation which will be completed shortly.

Mean values of Magnetic elements for 1905.

§ 2. The mean values for the magnetic elements at Barrackpore observatory for 1905 are as follows:—

Horizontal intensity	·37242 C. G. S.
Declination	1° 18′·0 E
Dip	30° 22′·5

Declination constants and mean monthly base lines.

§ 3. The following table gives the mean monthly values of the magnetic collimation of magnet No. 20 and the mean monthly base lines values of the declination magnetograph showing the number of observations used in deriving each value.

Monthly Mean Value of the Declination Constants of Magnetometer No. 20 and Mean Monthly Base Line Values.

Months, 1905.	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 . . .	—6·55	0 15·51	26	0	26	±0·03	±0·13	
February . .	·52	0 15·36	25	0	25	±0·02	±0·12	
March . . .	·52	0 15·33	28	1	27	±0·02	±0·12	
April . . .	·52	0 15·42	24	1	23	±0·02	±0·11	
May . . .	·53	0 15·40	29	2	27	±0·03	±0·14	

Monthly Mean Value of the Declination Constants of Magnetometer No. 20 and Mean Monthly Base Line Values—contd.

Months, 1905.	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.
		° ′					′	
June	·50	0 15·56	13	0	13	±0·04	±0·13	
July	·48	0 15·66	14	1	13	±0·03	±0·11	
August	·51	0 15·56	16	0	16	±0·02	±0·10	
September	·57	0 15·62	11	1	10	±0·04	±0·12	
October	·56	0 15·52	14	0	14	±0·02	±0·09	
November	·54	0 15·69	13	0	13	±0·03	±0·11	
December	·57	0 15·52	13	2	11	±0·04	±0·13	

H. F. constants and mean monthly base line values.

§ 4. The table below gives the mean monthly H. F. constants of magnetometer 20, together with the values of the mean monthly base lines.

Monthly Mean Value of H. F. Constants of Magnetometer No. 20 and Mean Monthly Base Line Values.

Months.	Mean value of M_o. for the month.	Monthly Mean Value of P. from 22·5 & 30 Cms.	Monthly Mean Value of P. from 30 & 40 Cms.	Mean Value of Base Line.	Total number of values of Base Line.	Number of values rejected.	Number of values from which Base Line is derived.	Probable error of the mean value of Base Line.	Probable error of a single value.	REMARKS
January	952·49	6·75	7·73	·36839 C.G.S.	21	0	21	±0·8γ	±3·7γ	
February	·55	·83	7·30	·36831 „	17	0	17	±0·9γ	±3·6γ	
March	·53	·84	·65	·36847 „	24	6	18	±1·1γ	±4·5γ	
April	·50	·84	·53	·36849 „	16	0	16	±0·9γ	±3·8γ	
May	·56	·92	·50	·36849 „	18	0	18	±0·7γ	±3·2γ	
June	·51	·85	·78	·36846 „	16	0	16	±1·6γ	±6·2γ	
July	·55	·92	·77	·36846 „	22	0	22	±0·7γ	±3·1γ	
August	·46	·96	·56	·36849 „	17	0	17	±0·7γ	±3·1γ	
September	·36	·73	·83	·36855 „	13	0	13	±1·0γ	±3·7γ	
October	·15	·90	·76	·36846 „	21	1	20	±1·0γ	±4·4γ	
November	·23	·89	·85	·36845 „	19	0	19	±1·0γ	±4·5γ	
December	·38	·92	·65	·36839 „	24	3	21	±0·9γ	±4·0γ	

§ 5. The mean scale value for H. F. magnetograph for the year 1905 was 4·93γ for 0″·04, the monthly values ranging from 4·91γ to 4·94γ. During the same period the mean temperature was 30°·6 C, the minimum monthly mean value being 30°·0 C in February, and the maximum 32°·1 C in June.

Monthly mean values of D, H, and I in 1905 and secular change in 1904-05.

§ 6. The mean monthly values of Horizontal Force, Declination and Dip are given below for 1904-05 with the secular changes deduced therefrom—

MONTHS.	HORIZONTAL FORCE ·37000+10⁻⁵.			DECLINATION E 1°+			DIP 30°+		
	Values in 1904.	Values in 1905.	Secular change 1904-05.	Values in 1904.	Values in 1905.	Secular change.	Values in 1904.	Values in 1905.	Secular change.
	C. G. S.	C. G. S.	γ	′	′	′	′	′	′
January	210	229	+19	24·4	20·1	−4·3	17·2	21·7	+4·5
February	212	226	+14	24·1	19·8	−4·3	18·0	20·7	+2·7
March	231	243	+12	23·8	19·4	−4·4	17·4	20·4	+3·0
April	222	245	+23	23·4	19·0	−4·4	19·6	21·3	+1·7
May	225	248	+23	23·1	18·4	−4·7	20·7	21·2	+0·5
June	226	246	+20	22·7	18·0	−4·7	20·6	22·1	+1·5
July	226	250	+24	22·1	17·7	−4·4	19·7	22·5	+2·8
August	229	251	+22	22·0	17·3	−4·7	19·8	21·6	+1·8
September	224	235	+11	21·4	17·1	−4·3	19·7	24·1	+4·4
October	226	241	+15	21·0	16·8	−4·2	20·1	24·0	+3·9
November	229	243	+14	20·7	16·4	−4·3	20·8	25·6	+4·8
December	232	244	+12	20·2	16·1	−4·1	20·6	24·7	+4·1
Means	224	242	+17	22·4	18·0	−4·4	20·2	22·5	+3·0

§ 7. *Statement of the loss of Magnetograph records at Barrackpore during the year 1905.*

HORIZONTAL FORCE.					DECLINATION.					REMARKS.
From	On	To	On	Period of break.	From	On	To	On	Period of break.	
h m		h m		h m	h m		h m		h m	
					6 48	4th April	12 27	4th April	5 39	The magnet adhered to side of the box owing to earthquake.
16 57	19th May	7 1	20th May	14 4	16 57	19th May	7 1	20th May	14 4	The clock string broke.
8 8	24th Aug.	10 32	24th Aug.	2 24						Lamp blown out.
					14 48	25th Oct.	7 11	26th Oct.	15 23	The cut off flag got loose and fell.
12 0	23rd Nov.	17 10	23rd Nov.	5 0	12 0	23rd Nov.	17 0	23rd Nov.	5 0	Erecting the V. F. pillar.
		TOTAL		21 28			TOTAL		40 6	

D.—Kodaikanal Observatory.

General remarks.

§ 1. The observatory has been under the charge of Surveyor Ramaswamy Iyengar since January 1906, when the previous incumbent resigned on the ground of ill health.

The magnetographs have given no trouble during the year nor there has been a recurrence of the "interference" trouble in the declination instrument.

The pillars for the V. F. instrument have been built and it is hoped that an opportunity will be afforded of installing the instrument during the ensuing field season. The V. F. magnet will be temporarily installed, pending the arrival of the new magnet which has been indented for.

Thanks are due to the Director of the Solar Physics Observatory for his cordial assistance in all matters pertaining to the magnetic work.

Mean values of magnetic elements (D. H. I.) for 1905.

§ 2. The mean values of the magnetic elements for 1905 at Kodaikanal are as follows:—

H. F.	·37403 C. G. S.
Declination	0° : 31'·9 W
Dip	3° : 16'·7

Declination constants and mean monthly base lines.

§ 3. The following table gives the mean monthly values of the magnetic collimation of magnet No. 16, the mean monthly base line values and the number of observations used in deriving these values.

Kodaikanal Observatory.

Monthly Mean Value of the Declination Constants of the Magnetometer No. 16 and Mean Monthly Base Line Values.

Months, 1905.	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 . .	—2 : 10	1 37·65	11	1	10	±0·03	±0·09	First half up to 13th.
		1 36·10	16	0	16	±0·02	±0·09	From 14th.
February . .	:09	1 36·05	23	0	23	±0·02	±0·08	Up to 27th.
March . . .	:11	1 39·33	27	3	24	±0·03	±0·14	The magnetograph was re-adjusted.
April . . .	:12	1 39·23	20	1	19	±0·02	±0·10	Up to 24th.
May . . .	:09	1 39·09	27	3	24	±0·02	±0·11	
June . . .	:12	1 39·31	27	6	21	±0·02	±0·11	
		1 39·09	12	0	12	±0·04	±0·14	First half up to 13th.
July . . .	:15	1 39·67	9	2	7	±0·05	±0·13	From 14th.
August . .	:19	1 39·85	28	2	20	±0·03	±0·14	
September . .	:18	1 39·82	13	3	10	±0·04	±0·12	
October . .	:17	1 39·63	26	2	24	±0·02	±0·12	
November . .	:17	1 39·73	26	2	24	±0·03	±0·13	
December . .	:16	1 39·76	26	2	24	±0·02	±0·10	

H. F. constants and mean monthly base lines.

§ 4. The table below gives the mean monthly values of the H. F. constants and the mean monthly base lines of the H. F. magnetograph.

KODAIKANAL OBSERVATORY.

Monthly Mean Value of H. F. Constants of Magnetometer No. 16 and Mean Monthly Base Line Values.

Months.	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.	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	926·30	7·06	8·77	·37013 C.G.S.	23	0	23	±0·8γ	±3·8γ	
February	·10	7·04	8·65	·37005 ,,	21	0	21	±1·0γ	±4·7γ	
March	·16	7·01	8·39	·37009 ,,	26	0	26	±0·9γ	±4·4γ	
April	·06	7·00	8·45	·37009 ,,	24	0	24	±0·7γ	±3·5γ	
May	·04	7·13	8·45	·37007 ,,	28	1	27	±0·7γ	±3·7γ	First half up to 14th.
	·00	6·99	8·97							The deflection magnet received a knock after deflection observation.
June	925·60	7·00	9·22	·37008 ,,	25	0	25	±0·7γ	±3·7γ	
July	·49	6·94	9·05	·37004 ,,	24	0	24	±0·8γ	±3·7γ	
August	·27	7·05	9·17	·36999 ,,	28	0	28	±0·7γ	±3·5γ	
September	·21	6·97	9·19	·36998 ,,	10	0	10	±1·5γ	±4·9γ	
October	·25	7·12	8·80	·36996 ,,	18	0	18	±0·8γ	±3·4γ	
November	·23	7·00	9·17	·36995 ,,	21	0	21	±0·7γ	±3·4γ	
December	·17	7·05	8·78	·36992 ,,	21	0	21	±0·9γ	±4·0γ	

Mean scale value and temperature range.

§ 5. The mean scale value for the year 1905 was 6·15γ for 0′′·04, the mean monthly values ranging from 6·13γ to 6·17γ.

The mean temperature of the H. F. magnetograph during the year was 19°·0 C, which was also the mean monthly temperature throughout, with two exceptions (May and June) when the mean was 19°·1 C. The variation was therefore only 0°·1 C throughout the year which is most satisfactory.

Mean monthly values of magnetic elements and secular change in 1904-05.

§ 6. The table below gives the mean monthly values of the magnetic elements in 1904 and 1905, and the secular change deduced therefrom.

Months.	HORIZONTAL FORCE. ·37000 + 10⁻⁵.			DECLINATION. W 0° +			DIP. 3° +		
	Values, 1904.	Values, 1905.	Secular change, 1904-5.	Values, 1904.	Values, 1905.	Secular change, 1904-5.	Values, 1904.	Values, 1905.	Secular change, 1904-5.
	C. G. S.	C. G. S.	γ	′	′	′	′	′	′
January	368	396	+28	25·1	30·0	+4·9	8·4	12·5	+4·1
February	365	388	+23	25·6	30·1	+4·5	9·4	13·7	+4·3
March	370	400	+30	25·2	30·5	+5·3	9·3	15·5	+6·2

Months.	Horizontal Force ·37000 + 10—⁵.			Declination. W 0°+			Dip 3°+		
	Values, 1904.	Values, 1905.	Secular change, 1904-5.	Values, 1904.	Values, 1905.	Secular change, 1904-5.	Values, 1904.	Values, 1905.	Secular change, 1904-5.
	C. G. S.	C. G.S.	γ	′	′	′	′	′	′
April . . .	373	407	+34	26·0	30·8	+4·8	9·6	15·3	+5·7
May . . .	369	411	+42	26·6	31·2	+4·6	10·4	16·3	+5·9
June . . .	376	402	+26	26·9	31·9	+5·0	11·5	17·2	+5·7
July . . .	385	406	+21	27·5	32·3	+4·8	12·2	18·0	+5·8
August . . .	398	405	+ 7	28·0	32·6	+4·6	12·7	18·2	+5·5
September . .	382	397	+15	28·6	32·9	+4·3	11·9	18·2	+6·3
October . . .	391	412	+21	28·7	33·1	+4·4	11·6	18·2	+6·6
November . .	391	411	+20	29·2	33·8	+4·6	12·5	18·5	+6·0
December . .	402	404	+ 2	29·5	33·9	+4·4	13·2	18·5	+5·3
Means . . .	381	403	+22γ	27·2	31·9	+4·7	11·1	16·7	+5·6

§ 7. *The statement of loss of Magnetograph Records at Kodaikanal during the year 1905.*

Horizontal Force.					Declination.					Remarks.
From	On	To	On	Period of break.	From	On	To	On	Period of break.	
H. M.		H. M.		H. M.	H. M.		H. M.		H. M.	
					10 18	27th Feb.	13 24	27th Feb.	3 6	Cleaned and put on new mirrors.
					14 55	4th March	15 50	4th March	0 55	
9 49	22nd July	10 34	30th July	192 45	9 49	22nd July	10 34	30th July	192 45	Erecting V. F. Pillars.
17 18	11th Aug.	9 49	12th Aug.	16 31	17 18	11th Aug.	9 49	12th Aug.	16 31	Clock stopped.
21 55	12th „	9 35	13th „	11 40	21 55	12th „	9 35	13th „	11 40	
13 58	13th „	16 27	13th „	2 29	13 58	13th „	16 27	13th „	2 29	
23 56	13th „	15 38	14th „	15 42	23 56	13th „	15 38	14th „	15 42	
15 5	17th Nov.	8 5	18th Nov.	17 0	15 5	17th Nov.	8 5	18th Nov.	17 10	
			Total .	256 7				Total .	260 8	

E.—Toungoo Observatory.

General remarks.

§ 1. The observatory remained in charge of Surveyor K. K. Dutta throughout the year 1905-06. The declination instrument continued to give good results throughout the year, the Horizontal Force instrument however had shown signs of interference during the latter period of 1905 and it was found necessary to open it up in December 1905, since when the results have been satisfactory. In dismantling the instrument however the quartz fibre suspension was unfortunately broken and a new one had to be mounted. Experiments for the determination of the temperature co-efficient of the H. F. magnetograph were taken but the results were not consistent owing presumably to the system not having thoroughly settled down after mounting the new suspension. They will be repeated in December next: meanwhile a provisional temperature co-efficient (determined in December 1904) of $-4{\cdot}6\,\gamma$ per $+1°F$ has been adopted.

The V. F. instrument for Toungoo is expected to arrive daily, if time allows it will be erected during the field season. The elimination as far as possible of the temperature co-efficient in the V. F. instrument is however apt to be lengthy process as the adjustment of the temperature arrangements usually alters the sensitiveness, while the molecular changes set up by the handling to which it is necessarily subjected are such that the magnet does not take up a permanent position of stability for several days. As there are three V. F. instruments to be erected it is possible that the installation either at Toungoo or Kodaikanal may have to be postponed till the recess season.

Mean values of the magnetic elements in 1905.

§ 2. The mean values of the magnetic elements at Toungoo for 1905 are as follows:—

Horizontal Force	·38675 C. G. S.
Declination	0° : 48′·4 E.
Dip	22° : 58′·3

Declination constants and mean monthly base line values.

§ 3. The table below gives the mean value of the magnetic collimation of magnet No. 16 and the mean monthly base lines.

The object glass of the collimator-magnet is showing some signs of fungoidal growth; the aluminum cell was removed and the object glass cleaned. The magnetic collimation angle changed on these occasions.

TOUNGOO OBSERVATORY.

Monthly mean value of the Declination Constant of the Magnetometer No. 16 and mean monthly Base Line values.

Months, 1905.	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 . .	—17 : 44	—0 9·81	23	1	22	±0·02	±0·11	
February . .	51	—0 10·00	22	3	19	±0·02	±0·10	
March . .	47	—0 10·11	26	2	24	±0·03	±0·14	
April . .	46	—0 10·38	23	4	19	±0·04	±0·16	
May . . .	46	—0 10·27	24	2	22	±0·02	±0·12	
June . . .	46	—0 10·37	23	1	22	±0·03	±0·13	
July . . .	46	—0 10·28	22	4	18	±0·03	±0·11	

Monthly mean value of the Declination Constant of the Magnetometer No. 16 and mean monthly Base Line values—contd.

Months, 1905.	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.
August . .	43 42	–0 10·09	12	0	12	±0·03	±0·11	Magnet cells were opened and cleaned, hence the change—(1) up to 21st. (2) from 22nd.
September . .	13 17 : 16	–0 10·08	15	0	15	±0·03	±0·11	(1) Up to 17th. (2) From 20th.
October . .	16 : 55	–0 10·17	12	0	12	±0·03	±0·11	
November . .	43	–0 10·08	13	0	13	±0·04	±0·13	
December . .	39	–0 10·05	7	0	7	±0·04	±0·11	

H. F. constants.

§ 4. The following are the values of $P_{1\cdot2}$, $P_{2\cdot3}$ for Magnetometer No. 19 for 1905 :—

Month.	$P_{1\cdot2}$.	$P_{2\cdot3}$.	Month.	$P_{1\cdot2}$.	$P_{2\cdot3}$.
January . . .	7·25	8·32	July	7·25	8·74
February . . .	7·00	7·86	August	7·04	7·86
March	7·13	7·52	September . . .	7·02	7·59
April	7·11	7·76	October	7·05	7·56
May	7·26	8·71	November . . .	7·02	7·85
June	7·11	8·86	December . . .	6·95	7·67

The mean monthly base line values are not published. Owing to the rapid fall of magnetic moment of the H. F. magnet consequent on the failure to "age" it during manufacture, separate base line values have had to be taken for every two to three days : the labour involved in computing the hourly means has thus been greatly increased.

Scale values and temperature ranges.

§ 5. The scale values varied from the mean value for the first seven months of 1905 owing to the rapid fall of moment of the H. F. magnet; the mean of 4·80γ for 1904 became 5·50γ after "ageing" the magnet.

The mean temperature of the H. F. magnetograph for the year was 30°·5 C, the minimum mean monthly temperature being 29°·8 in June, the maximum 31°·5 C in November or a range of 1°·7 C. In order to still further reduce the range the observer has been ordered to keep the temperature as near to 89° F (or 31°·7 C) as possible.

Mean monthly values of magnetic elements.

§ 6. The table below gives the mean monthly values of the magnetic elements at Toungoo for 1905.

Months.	Horizontal Force.	Declination	Dip.
	C. G. S.	° ′	° ′
January	·38657	E 0 : 51·0	23 : 2·6
February	656	50·6	22 : 56·1
March	661	50·1	22 : 51·4
April	681	49·4	23 : 0·2
May	682	49·1	22 : 58·6
June	684	48·8	58·2
July	666	48·0	58·7
August	682	47·8	59·4
September	677	47·2	59·3
October	689	46·9	57·4
November	690	46·4	58·7
December	669	46·0	58·9
Means .	·38675	E 0 : 48·4	22 : 58·3

Horizontal Force is apparently increasing Easterly Declination and Dip diminishing.

§ 7. *The statement of loss of Magnetograph records at Toungoo during the year 1905.*

Horizontal Force.					Declination.					Remarks.
From	On	To	On	Period of break.	From	On	To	On	Period of break.	
h. m.		h. m.		h. m.	h. m.		h. m.		h. m.	
7 26	21st Jan.	11 5	21st Jan.	3 39						} Lamp failed.
19 23	10th May	23 58	10th May	4 35						
8 36	4th Aug.	9 18	8th Aug.	96 42						H. F. magnet removed from the box for ageing
23 25	12th „	15 50	14th „	40 25						H. F. mirror out of order.
20 0	10th Sept.	10 32	11th Sept.	14 32						H. F. magnet not moving freely.
1 26	14th „	12 55	14th „	11 29						Faint trace with breaks.
11 5	4th Oct.	13 2	4th Oct.	1 57						H. F. magnetograph opened for cleaning.
1 0	24th Nov.	6 50	24th Nov.	5 50						Flame of H. F. lamp became very low.
13 10	5th Dec.	14 23	6th Dec.	25 13	13 10	5th Dec.	15 36	5th Dec.	2 26	H. F. instrument re-adjusted.
					8 13	6th „	9 48	6th „	1 35	„
					13 0	6th „	14 23	6th „	1 23	„
			Total .	204 22				Total .	5 24	

IV.—Tables of Results.

INDEX TO TABLES.

A.

The mean Value of the Magnetic Elements at the Observatories for the year 1905.

Name.	Latitude.	Longitude.	Declination.	Dip.	Horizontal Force.	Remarks.
	° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
Dehra Dún .	30 19 19	78 3 19	2 39·9 E	43 24·2	·33383	
Kodaikanal .	10 13 50	77 27 46	0 31·9 W	3 16·7	·37403	
Barrackpore .	22 46 29	88 21 39	1 18·0 E	30 22·5	·37242	
Toungoo .	18 55 45	96 27 3	0 48·4 E	22 58·3	·38675	

* 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 H. F. deduced from 2.
4. Hourly means of Declination from 5 selected quiet days per month.
5. Diurnal inequality of Declination deduced from 4.

† Formerly these approximate values were given to the nearest 5′ in Dip and Declination and 50γ in H. F.; this year values in Dip and Declination are to the nearest minute, and 10γ in H. F.

B.

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

K = Kodaikanal . { Lat. 10° 13′ 50″ Long. 77° 27′ 46″ }

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

T = Toungoo . . { Lat. 18° 55′ 45″ Long. 96° 27′ 3″ }

Dates of Magnetic Disturbances, 1905.

Date	January				February				March			
1905	D	K	B	T	D	K	B	T	D	K	B	T
1	C	C	C	...	S	S	S	S	S	S	S	S
2	(C)	C	(C)	...	S	S	S	S	V G	G	G	G
3	C	(C)	C	...	G	G	G	G	G	M	M	M
4	S	S	S	...	M	M	M	M	C	C	C	C
5	M	M	M	...	M	G	M	M	S	S	S	S
6	M	S	S	...	S	S	S	S	S	S	S	S
7	C	C	C	...	C	C	C	C	S	S	S	S
8	(C)	(C)	(C)	...	(C)	(C)	(C)	(C)	C	C	C	C
9	C	C	C	...	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)
10	—	C	C	...	C	C	C	C	C	C	C	C
11	—	S	S	...	S	S	S	S	(C)	(C)	(C)	(C)
12	S	C	C	...	S	S	S	S	C	C	C	C
13	(C)	(C)	(C)	...	(C)	(S)	(C)	(S)	(C)	(C)	(C)	(C)
14	S	S	S	...	S	S	S	S	C	C	C	C
15	S	S	S	...	S	S	S	S	C	S	C	S
16	C	C	C	...	S	S	S	S	S	M	S	S
17	S	S	S	...	C	S	C	S	C	C	C	C
18	S	S	S	...	C	C	C	S	(C)	(C)	(C)	(C)
19	C	C	C	...	(C)	(C)	(C)	(C)	S	S	S	S
20	C	C	C	...	C	C	C	C	C	C	C	C
21	C	C	C	...	C	C	C	C	C	C	C	C
22	S	S	S	...	(C)	(S)	(C)	(S)	C	C	C	C
23	S	S	S	...	S	S	S	S	S	S	S	S
24	S	S	S	...	C	C	C	C	C	C	C	C
25	S	S	S	...	S	C	C	C	C	C	C	C
26	C	C	C	...	C	C	C	C	(C)	(C)	(C)	(C)
27	(C)	(C)	(C)	...	C	S	C	C	S	S	S	S
28	C	C	C	...	C	C	C	C	C	C	C	C
29	S	S	S	...	...	...	...	...	S	S	S	S
30	(C)	(C)	(C)	...	...	...	...	...	S	S	S	S
31	S	S	S	...	...	...	...	...	S	S	S	S
C	15	17	17	...	15	12	16	12	18	17	18	17
S	12	13	13	...	10	13	9	13	11	11	11	12
M	2	1	1	...	2	1	2	2	...	2	1	1
G	...	...	...	...	1	2	1	1	1	2	1	1
V G	...	...	...	...	...	...	...	...	1	...	...	...

Date	April				May				June			
1905	D	K	B	T	D	K	B	T	D	K	B	T
1	V G	G	G	G	C	S	C	C	C	C	C	C
2	M	S	M	M	C	S	C	S	(C)	(C)	(C)	(C)
3	S	C	C	S	C	C	C	C	S	S	S	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	C	C	C	C	C	C	C	S	S	S	S
7	C	C	C	C	C	C	C	C	S	S	S	S
8	(C)	(C)	(C)	(C)	C	C	C	C	S	C	C	C
9	C	C	C	C	C	C	C	C	M	M	M	M
10	C	C	C	C	C	C	C	—	M	M	M	M
11	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	S	S	S	S
12	C	C	C	C	S	S	S	S	S	C	C	C
13	S	S	C	C	S	S	S	S	(C)	(C)	(C)	(C)
14	(C)	(C)	(C)	(C)	S	S	S	S	C	C	C	C
15	S	S	S	S	(C)	(C)	(C)	(C)	S	C	C	C
16	—	S	C	C	C	C	C	C	C	C	C	C
17	C	C	C	C	S	S	C	C	(C)	C	C	C
18	(C)	(C)	(C)	(C)	S	S	S	S	(C)	(C)	(C)	(C)
19	C	C	C	C	S	S	—	S	—	(C)	(C)	(C)
20	S	S	S	S	S	S	—	S	S	S	S	S
21	S	S	S		(C)	(C)	(C)	(C)	S	S	S	S
22	C	S	C	C	C	S	C	S	S	S	S	S
23	C	C	C	C	S	S	S	S	S	S	S	S
24	(C)	(C)	(C)	(C)	S	S	S	S	S	S	S	S
25	C	C	C	C	C	C	C	C	(C)	(C)	(C)	(C)
26	S	S	S	S	(C)	(C)	(C)	(C)	C	C	C	C
27	S	S	S	S	S	S	S	S	C	C	C	C
28	C	C	C	C	S	S	S	S	C	C	C	C
29	S	S	S	S	S	S	C	C	C	C	C	C
30	C	C	C	C	C	C	C	C	S	S	C	—
31	...	...	...	...	S	S	S	S	...	...	...	...
C	19	19	22	21	18	15	20	17	12	16	17	16
S	8	10	6	7	13	16	9	13	15	12	11	11
M	1	...	1	1	...	...	...	...	2	2	2	2
G	...	1	1	1	...	...	...	...	...	...	...	...
V G	1	...	...	...	...	...	...	...	...	...	...	...

Date	July				August				September			
1905	D	K	B	T	D	K	B	T	D	K	B	T
1	S	S	S	S	(C)	(C)	(C)	(C)	C	S	C	C
2	C	C	C	C	M	M	M	M	(C)	(C)	(C)	(C)
3	C	C	C	C	S	S	S	S	M	M	M	M
4	(C)	(C)	(C)	(C)	S	S	S	—	—	S	S	S
5	C	C	C	C	S	S	S	—	S	S	S	S
6	M	M	M	M	C	C	C	—	—	C	C	C
7	S	S	S	S	S	S	S	—	(C)	(C)	(C)	(C)
8	S	S	S	S	S	C	C	—	S	C	C	C
9	S	S	S	S	C	C	C	C	S	S	S	S
10	C	S	C	C	(C)	(C)	(C)	(C)	S	S	C	—
11	(C)	(C)	(C)	(C)	C	—	C	C	C	S	C	—
12	C	C	C	C	S	—	C	C	C	C	C	—
13	—	S	S	S	S	—	S	—	C	C	C	C
14	—	S	C	C	S	—	C	—	C	C	C	—
15	(C)	(C)	(C)	(C)	(C)	C	C	C	—	C	C	C
16	C	C	C	C	S	S	S	S	—	(C)	(C)	(C)
17	S	S	S	S	—	C	C	C	(C)	C	C	C
18	C	S	C	C	(C)	C	C	C	M	M	M	M
19	—	C	C	C	—	(C)	(C)	(C)	S	S	S	S
20	S	C	S	S	S	S	C	C	C	(C)	(C)	(C)
21	(C)	(C)	(C)	(C)	C	(C)	(C)	(C)	(C)	C	C	C
22	C	—	C	C	S	S	C	C	S	C	S	S
23	—	—	S	S	S	S	S	C	C	C	C	C
24	—	—	M	M	—	S	C	C	C	C	C	C
25	C	—	C	C	C	C	C	C	S	C	S	C
26	(C)	—	(C)	(C)	(C)	(C)	(C)	(C)	S	S	C	C
27	C	—	C	C	S	S	S	S	S	S	S	S
28	C	—	C	C	C	C	C	C	C	C	C	C
29	C	—	C	C	S	S	S	S	(C)	(C)	(C)	(C)
30	—	—	C	C	S	S	S	S	C	C	C	C
31	—	(C)	C	C	S	S	S	S	...	...	...	...
C	17	12	21	21	11	13	19	17	15	19	21	18
S	6	9	8	8	16	13	11	6	9	9	7	6
M	1	1	2	2	1	1	1	1	2	2	2	2
G	...	...	...	...	...	...	...	...	...	...	...	...
V G	...	...	..	...	...	...	...	...	...	...	...	...

Date	October				November				December				Remarks.
1905	D	K	B	T	D	K	B	T	D	K	B	T	
1	S	S	S	S	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C	
2	C	C	C	C	C	C	C	C	S	S	C	C	
3	(C)	(C)	(C)	(C)	S	S	C	C	S	C	S	S	
4	C	C	C	—	S	C	S	S	M	M	M	M	
5	S	S	S	S	S	C	S	C	S	S	S	—	
6	S	S	S	S	C	C	C	C	C	C	C	—	
7	S	S	S	C	S	S	S	S	C	C	C	C	
8	C	S	C	C	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	
9	C	C	C	C	C	C	C	C	C	C	C	C	
10	(C)	(C)	(C)	(C)	C	S	C	C	C	C	C	C	
11	C	C	C	C	(C)	(C)	(C)	(C)	C	C	C	C	
12	(C)	(C)	(C)	(C)	M	M	M	M	S	S	S	S	
13	S	S	S	S	M	S	M	S	S	S	S	S	
14	S	S	S	S	S	S	S	S	C	C	C	C	
15	C	C	S	C	M	M	M	M	C	C	C	C	
16	C	C	C	C	G	G	G	G	C	C	C	C	
17	C	S	C	C	S	—	S	S	(C)	(C)	(C)	(C)	
18	S	S	S	S	S	—	S	S	—	C	C	C	
19	S	C	S	S	S	S	S	S	C	C	C	C	
20	S	S	S	S	C	C	C	C	S	C	C	T E	
21	S	S	S	C	C	C	C	C	C	C	C	T E	
22	C	S	C	C	—	C	C	C	(C)	(C)	(C)	(C)	
23	(C)	(C)	(C)	(C)	C	S	—	C	C	C	C	C	
24	S	S	S	S	C	C	C	C	C	C	C	C	
25	C	C	C	C	S	S	S	—	C	C	C	C	
26	S	S	S	C	(C)	(C)	(C)	(C)	C	C	C	T E	
27	C	C	C	C	C	S	C	C	(C)	(C)	(C)	T E	
28	M	S	S	S	C	C	C	C	C	C	C	C	
29	C	C	C	C	C	C	C	C	C	C	C	C	
30	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	C	C	C	(C)	
31	C	C	C	C	...	...	...	..	C	C	C	C	
C	18	16	17	20	16	16	17	19	23	26	26	21	
S	12	15	14	10	9	9	8	7	6	4	4	3	
M	1	...	...	...	3	2	3	2	1	1	1	1	
G	...	...	...	...	1	1	1	1	...	...	...	...	
V G	...	...	...	...	...	...	...	...	...	...	...	...	

NOTE.—The magnitudes of the Disturbances are taken from the H. F. magnetograph. C = Calm. M = Moderate. S = Slight. G = Great. V G = Very Great. The traces were lost on days marked –. The selected quiet days are marked ( ). In January the Toungoo traces could not be classified as the H. F. Magnet was not moving freely. T E = Temperature Co-efficient experiment in progress.

C.

Tables of results at Dehra Dun Observatory for 1905.

LIST OF TABLES.

1. *Observations of Dip, Dehra Dun.*

Circle No. 44 by Barrow.

Mean dip for 1905. 43° 24·2′.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Dip.		Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles 1—2.	Remarks.
1905. Month.		h.	m.		°	′				
January	2	13	17	1	43	20·0				
„	2	13	17	2	43	19·4				
„	5	13	29	1	43	22·4				
„	5	13	29	2	43	20·8	Needle			
„	9	13	26	1	43	19·9	No. 1			
„	9	13	26	2	43	19·1	43° 20·1′			
„	12	13	32	1	45	20·4		43° 20·1′	+0°—1·1′	
„	12	13	32	2	43	19·9				
„	21	11	22	1	43	20·7				
„	21	11	22	2	43	20·6	Needle			
„	23	13	36	1	43	20·6	No. 2			
„	23	13	36	2	43	18·1	43—19·5′			
„	26	13	30	1	43	20·5				
„	26	13	30	2	43	18·4				
February	2	13	35	1	43	20·5				
„	2	13	35	2	43	20·3	Needle			
„	6	13	56	1	43	20·0	No. 1			
„	6	13	56	2	43	20·9	43° 20·7′			
„	9	13	20	1	43	20·1				
„	9	13	20	2	43	17·7				
„	13	12	37	1	43	18·7		43° 20·4′	+0°—0·6′	
„	13	12	37	2	43	19·7				
„	17	13	8	1	43	21·4				
„	17	13	8	2	43	19·7	Needle			
„	23	13	52	1	43	23·4	No. 2			
„	23	13	52	2	43	22·3	43° 20·1′			
„	27	13	43	1	43	20·9				
„	27	13	43	2	43	20·3				

* As deduced from 5 selected quiet days per month.
† Corrected for temperature.

Observations of Dip, Dehra Dun—continued.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Dip.		Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles 1—2.	REMARKS.
1905.		h.	m.		°	′				
Month.										
March	2	13	26	1	43	24·1				
"	2	13	26	2	43	21·6	Needle			
"	6	13	28	1	43	24·0	No. 1			
"	6	13	28	2	43	23·4	43 22·4′			
"	9	13	44	1	43	22·4		43° 21·6′	+0°—1·6′	
"	9	13	44	2	43	20·1				
"	13	13	21	1	43	22·8	Needle			
"	13	13	21	2	43	20·9	No. 2			
"	30	13	31	1	43	18·9	43 20·8			
April	3	13	30	1	43	24·1				
"	3	13	30	2	43	22·6				
"	13	13	35	1	43	22·9	Needle			
"	13	13	35	2	43	20·0	No. 1			
"	18	13	30	1	43	21·2	43° 22·1′			
"	18	13	30	2	43	19·4				
"	24	13	16	1	43	21·7		43° 21·1′	+0° 2·0′	
"	24	13	16	2	43	19·0				
"	24	12	23	1	43	21·6				
"	24	12	23	2	43	20·3	Needle			
"	27	13	23	1	43	20·9	No. 2			
"	27	13	23	2	43	19·5	43° 20·1′			
"	27	13	23	2	43	19·5				
May	5	14	51	1	43	24·6				
"	5	14	51	2	43	23·0				
"	8	14	26	1	43	23·9	Needle			
"	8	14	26	2	43	22·4	No. 1			
"	9	14	28	1	43	24·2	43 23·3			
"	9	14	28	2	43	22·4				
"	16	15	22	1	43	23·8				
"	16	15	22	2	43	22·1				
"	17	12	19	1	43	22·7		43° 22·5′	+0° 1·6′	
"	17	12	19	2	43	20·1				
"	18	12	33	1	43	22·1				
"	18	12	33	2	43	20·6	Needle			
"	22	14	12	1	43	21·5	No. 2			
"	22	14	12	2	43	20·3	43 21·7′			

Observations of Dip, Dehra Dun—continued.

1		2		3	4	5	6	7	8
Date.		L. M. T.		Needle No.	Dip.	Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles 1—2.	Remarks.
1905. Month.		h.	m.		° ′				
May	25	13	34	1	43 23·2				
"	25	13	34	2	43 22·9				
June	1	13	40	1	43 23·0				
"	1	13	40	2	43 22·8	Needle			
"	5	13	31	1	43 25·6	No. 1			
"	5	13	31	2	43 22·3	43° 23·5′			
"	8	13	46	1	43 24·3				
"	8	14	13	2	43 23·1				
"	12	13	50	1	43 24·2		43° 22·8	+0° 1·5′	
"	12	13	39	2	43 23·2	Needle			
"	15	13	47	1	43 21·9	No. 2			
"	15	13	47	2	43 18·6	43 22·0			
"	26	12	32	1	43 23·2				
"	26	12	32	2	43 22·4				
"	29	13	33	1	43 22·5				
"	29	13	33	2	43 21·4				
July	3	13	36	1	43 24·4				
"	3	13	36	2	43 21·4	Needle			
"	13	12	39	1	43 25·2	No. 1			
"	13	12	39	2	43 24·6	43 24·6			
"	20	13	40	1	43 24·4		43 23·2	+0° 2·9′	
"	20	13	40	2	43 20·6				
"	27	13	38	1	43 23·7				
"	27	13	38	2	43 20·9	Needle			
"	29	13	31	1	43 25·4	No. 2			
"	29	13	31	2	43 21·2	43 21·7			
August	1	14	13	1	43 23·9				
"	1	14	13	2	43 22·9	Needle			
"	4	13	31	1	43 27·0	No. 1			
"	4	13	31	2	43 25·9	43 26·6			
"	7	13	45	1	43 28·6				
"	7	13	45	2	43 27·5				
"	11	14	55	1	43 25·4		43° 25·7	+0° 1·8′	
"	11	14	55	2	43 23·9				
"	25	15	24	1	43 27·1				
"	25	15	24	2	43 24·2				
"	28	15	30	1	43 26·4	Needle			

Observations of Dip, Dehra Dun—continued.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Dip.		Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles 1—2.	Remarks.
1905.		h.	m.		°	′				
Month.										
August	28	15	30	2	43	24·5	No. 2			
"	31	13	39	1	43	27·8	43° 24·8			
"	31	13	39	2	43	24·8				
September	4	13	40	1	43	26·3	Needle			
"	4	13	40	2	43	26·8	No. 1			
"	7	12	54	1	43	26·4	43° 27·5′			
"	7	12	54	2	43	26·1				
"	11	13	58	1	43	26·2				
"	11	13	58	2	43	25·5		43° 26·9′	+0° 1·2′	
"	14	13	46	1	43	28·6				
"	14	13	46	2	43	25·9				
"	25	12	32	1	43	29·6				
"	25	12	32	2	43	28·3	Needle			
"	28	14	47	1	43	27·7	No. 2			
"	28	14	47	2	43	25·3	43° 26·3′			
October	2	13	30	1	43	27·6				
"	2	13	30	2	43	24·5				
"	5	12	51	1	43	24·9	Needle			
"	5	12	51	2	43	24·9	No. 1			
"	9	14	4	1	43	28·7	43° 27·8′			
"	9	14	4	2	43	26·5				
"	12	13	29	1	43	28·4				
"	12	13	29	2	43	26·2		43 27·0	+0° 1·6′	
"	16	13	41	1	43	28·7				
"	16	13	41	2	43	27·5				
"	19	13	38	1	43	27·6				
"	19	13	38	2	43	26·8				
"	25	11	29	1	43	28·0	Needle			
"	25	11	29	2	43	25·6	No. 2			
"	30	13	26	1	43	28·8	43° 26·2′			
"	30	13	26	2	43	27·4				
November	2	14	4	1	43	26·4				
"	2	14	4	2	43	26·5				
"	6	13	46	1	43	30.0				
"	6	13	46	2	43	27·7	Needle			
"	10	13	45	1	43	28·5	No. 1			
"	10	13	45	2	43	27·0	43° 30·7′			

Observations of Dip, Dehra Dun—concluded.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Dip.		Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles 1—2.	REMARKS.
1905. Month.		h.	m.		°	′				
November	15	13	37	1	43	30·6				
„	15	13	37	2	43	28·5				
„	16	13	44	1	43	38·6				
„	16	13	44	2	43	35·6		43° 29·8′	+0° 1·8′	
„	20	13	31	1	43	29·4				
„	20	13	31	2	43	27·3				
„	23	13	39	1	43	31·1				
„	23	13	39	2	43	30·0	Needle No. 2 43° 28·9′			
„	27	15	27	1	43	30·3				
„	27	15	27	2	43	29·4				
„	30	14	8	1	43	31·2				
„	30	14	8	2	40	28·3				
December	4	12	34	1	43	27·4				
„	4	12	34	2	43	26·7				
„	7	13	27	1	43	30·1				
„	7	13	27	2	43	28·5	Needle No. 1 43° 29·3′			
„	11	13	15	1	43	27·8				
„	11	13	15	2	43	27·3				
„	14	14	5	1	53	29·7				
„	14	14	5	2	40	28·8		43° 28·7′	+0° 1·3′	
„	19	12	59	1	43	30·5				
„	19	12	59	2	43	28·4				
„	21	13	56	1	43	31·2				
„	21	13	56	2	43	29·0	Needle No. 2 43° 28·0′			
„	25	14	1	1	43	28·5				
„	25	14	1	2	43	27·6				
„	29	13	46	1	43	29·2				
„	29	13	46	2	43	28·0				

Hourly Means of Horizontal Force in C. G. S. Units (corrected for temperature) at Dehra Dún from the selected quiet days in 1905.

0·33000 + 10⁻⁵

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
Winter.																									
Months, 1905.	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	379	374	377	379	380	381	381	384	387	386	380	379	382	384	385	383	381	381	382	381	379	379	383	383	381
February	373	370	371	371	372	373	376	377	381	384	382	378	376	376	377	378	378	376	372	375	373	373	374	378	376
March	380	378	376	377	376	377	378	379	382	389	400	407	407	406	401	389	382	377	378	376	375	376	379	381	384
October	376	373	373	372	374	375	374	374	369	367	371	380	388	389	390	386	380	374	375	376	376	375	376	377	377
November	367	372	370	370	371	372	374	376	376	376	375	380	383	380	375	373	373	370	372	370	367	369	370	370	373
December	372	373	373	373	373	374	376	380	383	382	381	380	379	376	374	372	372	371	372	372	371	370	373	373	375
Means	375	372	373	374	374	375	377	378	380	381	382	384	386	385	384	380	378	375	375	375	374	374	376	37	378
Summer.																									
April	384	383	382	384	385	385	386	386	386	392	399	404	411	415	411	402	395	390	386	385	385	386	389	388	392
May	396	396	395	396	395	395	397	393	387	387	394	400	410	416	416	414	408	400	395	394	394	398	397	397	399
June	386	385	384	384	385	385	389	386	385	384	391	401	410	414	412	405	396	390	387	385	386	389	389	391	392
July	384	383	384	383	383	384	385	382	382	388	391	392	399	404	403	398	392	386	382	383	385	386	386	387	388
August	382	381	381	382	381	382	382	379	374	373	377	389	396	400	401	401	397	391	387	383	387	386	387	387	386
September	375	375	373	376	376	375	372	362	354	355	357	368	378	386	387	386	381	377	372	371	371	370	372	373	373
Means	385	384	383	384	384	384	385	381	378	380	385	392	401	406	405	401	395	389	385	384	385	386	387	387	388

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.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
Months, 1905.	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	−2	−7	−4	−2	−1	0	0	+3	+6	+5	+1	−1	+1	+3	+4	+2	0	0	+1	0	−2	−2	+2	+2
February	−3	−6	−5	−5	−4	−3	0	+1	+5	+8	+6	+2	0	0	+1	+2	+2	0	−4	−1	−3	−3	−2	+2
March	−4	−6	−8	−7	−8	−7	−6	−5	−2	+5	+16	+23	+23	+22	+17	+5	−2	−7	−6	−8	−9	−8	−5	−3
October	−1	−4	−4	−5	−3	−2	−3	−3	−8	−10	−6	+3	+11	+12	+13	+9	+3	−3	−2	−1	−1	−2	−1	0
November	−6	−1	−3	−3	−2	−1	+1	+3	+3	+3	+2	+7	+10	+7	+2	0	0	−3	−1	−3	−6	−4	−3	−3
December	−3	−2	−2	−2	−2	−1	+1	+5	+8	+7	+6	+5	+4	+1	−1	−3	−3	−4	−3	−3	−4	−5	−2	−2
Means	−3	−5	−5	−4	−4	−3	−1	0	+2	+3	+4	+6	+8	+7	+6	+2	0	−3	−3	−3	−4	−4	−2	−1
Summer.																								
April	−8	−9	−10	−8	−7	−7	−6	−6	−6	0	+7	+12	+19	+23	+19	+10	+3	−2	−6	−7	−7	−6	−3	−4
May	−3	−3	−4	−3	−4	−4	−2	−6	−12	−12	−5	+1	+11	+17	+17	+15	+9	+1	−4	−5	−5	−1	−2	−2
June	−6	−7	−8	−8	−7	−7	−3	−6	−7	−8	−1	+9	+18	+22	+20	+13	+4	−2	−5	−7	−6	−3	−3	−1
July	−4	−5	−4	−5	−5	−4	−3	−6	−6	0	+3	+4	+11	+16	+15	+10	+4	−2	−4	−5	−3	−2	−2	−1
August	−4	−5	−5	−4	−5	−4	−4	−7	−12	−13	−9	+3	+10	+14	+15	+15	+11	+5	+1	−3	+1	0	+1	+1
September	+2	+2	0	+3	+3	+2	−1	−11	−19	−18	−16	−5	+5	+13	+14	+13	+8	+4	−1	−2	−2	−3	−1	0
Means	−3	−4	−5	−4	−4	−4	−3	−7	−10	−8	−3	+4	+13	+18	+17	+13	+7	+1	−3	−4	−3	−2	−1	−1

N.B.—When the sign is + the H. F. is greater and when − it is less than the mean value.

Hourly Means of the Declination as determined at Dehra Dún from the selected quiet days in 1905.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
Declination E 2°+ Winter.																									
Months, 1905.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	40·5	40·5	40·3	39·9	39·8	39·7	39·9	40·0	40·6	41·6	41·9	40·8	39·9	39·5	39·3	39·6	40·0	40·2	40·3	40·3	40·4	40·4	40·3	40·3	40·3
February	40·8	40·8	40·6	40·6	40·3	40·2	40·2	40·6	42·2	43·4	43·4	41·9	40·2	39·1	38·7	39·0	39·6	40·3	40·2	40·3	40·3	40·3	40·4	40·4	40·6
March	40·2	40·5	40·5	40·4	40·3	40·1	40·2	41·1	42·4	42·9	42·1	40·4	38·9	38·3	38·5	39·4	40·3	40·5	40·1	40·0	40·2	40·1	40·1	40·4	40·3
October	39·9	39·9	39·9	39·8	39·8	49·8	40·2	41·5	42·5	42·3	41·0	39·0	37·4	37·2	38·1	39·4	40·0	39·7	39·2	39·4	39·4	39·4	39·6	39·9	39·8
November	40·1	40·0	39·9	40·0	39·8	39·8	39·7	40·1	40·7	41·3	40·7	39·8	38·9	38·5	39·0	39·3	39·5	39·4	39·5	39·7	39·7	39·9	39·9	40·1	39·8
December	39·9	39·9	39·9	39·8	39·7	39·6	39·6	39·5	40·0	40·4	40·4	39·5	39·1	39·1	39·4	39·6	39·8	39·8	39·8	39·8	39·8	39·9	39·9	39·9	39·8
Means	40·2	40·3	40·2	40·1	40·0	39·9	40·0	40·5	41·4	42·0	41·6	40·2	39·1	38·6	38·8	39·4	39·9	40·0	39·9	39·9	40·0	40·0	40·0	40·2	40·1
Summer.																									
April	39·8	39·9	40·0	39·9	39·8	39·7	40·1	41·9	43·5	43·6	42·2	39·4	37·4	36·7	37·2	37·6	38·5	39·6	40·1	39·6	39·3	39·5	39·6	39·6	39·8
May	40·0	40·0	40·0	40·0	39·9	40·0	41·3	42·8	43·3	42·7	41·2	39·3	37·6	36·9	37·2	37·9	38·9	39·9	40·2	39·8	39·5	39·6	39·9	39·9	39·9
June	40·0	40·1	40·1	40·0	39·9	40·5	41·8	43·0	42·8	41·9	40·5	38·7	37·3	36·7	36·8	37·5	38·6	39·4	39·9	39·8	39·6	39·6	39·7	39·8	39·8
July	39·8	40·0	39·9	39·8	39·8	40·1	41·4	42·5	42·4	41·4	39·8	37·8	36·4	36·1	36·3	37·0	37·9	38·8	39·6	39·5	39·2	39·4	39·6	39·6	39·3
August	39·7	39·8	39·9	40·0	40·2	40·7	42·4	43·6	43·5	41·8	39·2	37·4	36·1	35·7	36·6	37·9	39·2	39·8	40·1	39·5	39·2	39·3	39·4	39·7	39·6
September	39·8	39·9	39·9	39·8	39·8	40·1	41·5	42·9	42·8	41·3	38·8	36·7	35·7	35·8	36·9	38·4	39·8	40·3	40·0	39·6	39·7	39·8	39·7	39·7	39·5
Means	39·9	40·0	40·0	39·9	39·9	40·2	41·4	42·8	43·1	42·1	40·3	38·2	36·8	36·3	36·8	37·7	38·8	39·6	40·0	39·6	39·4	39·5	39·7	39·7	39·7

NOTE.—In April Means are derived from two selected quiet days only.

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.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
Months, 1905.	′	′		′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	+0.2	+0.2	0.0	−0.4	−0.5	−0.6	−0.4	−0.3	+0.3	+1.3	+1.6	+0.5	−0.4	−0.8	−1.0	−0.7	−0.3	−0.1	0.0	0.0	+0.1	+0.1	0.0	0.0
February	+0.2	+0.2	0.0	0.0	−0.3	−0.4	−0.4	+0.0	+1.6	+2.8	+2.8	+1.3	−0.4	−1.5	−1.9	−1.6	−1.0	−0.3	−0.4	−0.3	−0.3	−0.3	−0.2	−0.2
March	−0.1	+0.2	+0.2	+0.1	0.0	−0.2	−0.1	+0.8	+2.1	+2.6	+1.8	+0.1	−1.4	−2.0	−1.8	−0.9	0.0	+0.2	−0.2	−0.3	−0.1	−0.2	−0.2	+0.1
October	+0.1	+0.1	+0.1	0.0	0.0	0.0	+0.4	+1.7	+2.7	+2.5	+1.2	−0.8	−2.4	−2.6	−1.7	−0.4	+0.2	−0.1	−0.6	−0.4	−0.4	−0.4	−0.2	+0.1
November	+0.3	+0.2	+0.1	+0.2	0.0	0.0	−0.1	+0.3	+0.9	+1.5	+0.9	0.0	−0.9	−1.3	−0.8	−0.5	−0.3	−0.4	−0.3	−0.1	−0.1	+0.1	+0.1	+0.3
December	+0.1	+0.1	+0.1	0.0	−0.1	−0.2	−0.2	−0.3	+0.2	+0.6	+0.6	−0.3	−0.7	−0.7	−0.4	−0.2	0.0	0.0	0.0	0.0	0.0	+0.1	+0.1	+0.1
Means	+0.1	+0.2	+0.1	0.0	−0.1	−0.2	−0.1	+0.4	+1.3	+1.9	+1.5	+0.1	+1.0	−1.5	−1.3	−0.7	−0.2	−0.1	−0.2	−0.2	−0.1	−0.1	−0.1	+0.1
Summer.																								
April	0.0	+0.1	+0.2	+0.1	0.0	−0.1	+0.3	+2.1	+3.7	+3.8	+2.4	−0.4	−2.4	−3.1	−2.6	−2.2	−1.3	−0.2	+0.3	−0.2	−0.5	−0.3	−0.2	−0.2
May	+0.1	+0.1	+0.1	+0.1	0.0	+0.1	+1.4	+2.9	+3.4	+2.8	+1.3	−0.6	−2.3	−3.0	−2.7	−2.0	−1.0	0.0	+0.3	−0.1	−0.4	−0.3	0.0	0.0
June	+0.2	+0.3	+0.3	+0.2	+0.1	+0.7	+2.0	+3.2	+3.0	+2.1	+0.7	−1.1	−2.5	−3.1	−3.0	−2.3	−1.2	−1.4	+0.1	0.0	−0.2	−0.2	−0.1	0.0
July	+0.5	+0.7	+0.6	+0.5	+0.5	+0.8	+2.1	+3.2	+3.1	+2.1	+0.5	−1.5	−2.9	−3.2	−3.0	−2.3	−1.4	−0.5	+0.3	+0.2	−0.1	+0.1	+0.3	+0.3
August	+0.1	+0.2	+0.3	+0.4	+0.6	+1.1	+2.8	+4.0	+3.9	+2.2	−0.4	−2.2	−3.5	−3.9	−3.0	−1.7	−0.4	+0.2	+0.5	−0.1	−0.4	−0.3	−0.2	+0.1
September	+0.3	+0.4	+0.4	+0.3	+0.3	+0.6	+2.0	+3.4	+3.3	+1.8	−0.7	−2.8	−3.8	−3.7	−2.6	−1.1	+0.3	+0.8	+0.5	+0.1	+0.2	+0.3	+0.2	+0.2
Means	+0.2	+0.3	+0.3	+0.2	+0.2	+0.5	+1.7	+3.1	+3.4	+2.4	+0.6	−1.5	−2.9	−3.4	−2.9	−2.0	−0.9	−0.1	+0.3	−0.1	−0.3	−0.2	−0.0	0.0

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

D.—*Tables of results at Barrackpore Observatory in 1905.*

LIST OF TABLES.

Observations of Dip, Circle No. 45, by Barrow.

Mean Dip in 1905—30°: 22·5'.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Dip.		Monthly mean Dip with each Needle.	Monthly mean Dip with both Needles.	Diff. Needles 1—2.	Remarks.
1905.		h.	m.		°	'				
January	2	13	19	1	30	22·0				
"	2	13	33	2	30	20·7				
"	5	13	46	1	30	23·0	Needle No. 1. 30° 22·5'			
"	5	13	46	2	30	21·1				
"	9	13	39	1	30	21·8				
"	9	13	39	2	30	21·3				
"	16	13	45	1	30	24·2				
"	16	13	45	2	30	22·7				
"	21	13	34	1	30	24·3		30° 21·7	0° 1·7'	
"	21	13	34	2	30	22·1				
"	24	11	22	1	30	20·7				
"	24	11	0	2	30	18·5				
"	27	13	6	1	30	22·4	Needle No. 2. 30° 20·8'			
"	27	13	6	2	30	19·1				
"	27	13	13	1	30	22·1				
"	30	13	27	1	30	21·9				
"	30	13	27	2	30	21·0				
February	2	13	33	1	30	21·1				
"	2	13	33	2	30	19·4				
"	3	15	8	1	30	22·5				
"	3	15	8	2	30	21·1				
"	4	14	59	1	30	23·8	Needle No. 1. 30° 21·6'			
"	4	14	59	2	30	21·9				
"	9	13	43	1	30	20·7				
"	9	13	43	2	30	19·3				
"	10	13	22	1	30	20·7				
"	10	13	22	2	30	20·2		30° 20·7'	0° 1·9'	
"	13	13	38	1	30	23·5				
"	13	13	48	2	30	20·0				

* As deduced from five selected quiet days for month.
† Corrected for temperature.

Observations of Dip—contd.

1	2		3	4		5	6	7	8
Date.	L. M. T.		Needle No.	Dip.		Monthly mean Dip with each Needle.	Monthly mean Dip with both Needles.	Diff. Needles 1—2.	Remarks.
1905.	h.	m.		°	′				
February 16	...		2	30	19·4				
" 16	12	50	1	30	20·7				
" 20	13	36	1	30	19·5				
" 20	13	0	2	30	17·9				
" 23	12	55	1	30	20·2	Needle No. 2. 30° 19·7′			
" 23	12	55	2	30	18·2				
" 27	13	33	1	30	22·8				
" 27	13	33	2	30	19·1				
March 2	13	13	1	30	21·9				
" 2	13	13	2	30	20·7	Needle No. 1. 30° 21·4′			
" 6	13	40	1	30	21·2				
" 6	13	40	2	30	18·2				
" 9	12	51	1	30	21·7				
" 9	12	51	2	30	18·7				
" 13	13	51	1	30	21·5				
" 13	13	51	2	30	20·2				
" 16	12	45	1	30	21·2		30° 20·4′	0° 2·0′	
" 16	12	45	2	30	20·5				
" 20	12	54	1	30	20·1				
" 20	12	54	2	30	18·5				
" 23	12	36	1	30	20·9				
" 23	12	36	2	30	18·4				
" 27	13	41	1	30	22·6				
" 27	13	41	2	30	19·7	Needle No. 2. 30° 19·4′			
" 30	13	44	1	30	21·2				
" 30	13	44	2	30	19·6				
April 3	13	51	1	30	23·5				
" 3	13	0	2	30	22·9	Needle No. 1. 30° 22·1′			
" 6	12	58	1	30	23·5				
" 6	12	58	2	30	20·5				
" 13	13	37	1	30	21·7				
" 13	13	37	2	30	18·4				
" 18	13	43	1	30	23·3		30° 21·3	0° 1·6′	
" 18	13	43	2	30	20·1				
" 20	13	46	1	30	20·7				
" 20	13	46	2	30	20·5				
" 24	13	12	1	30	21·0				

Observations of Dip—contd.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Dip.		Monthly mean Dip with each Needle.	Monthly mean Dip with both Needles.	Diff. Needles 1—2.	Remarks.
1905.		h.	m.		°	'				
April	24	13	12	2	30	20·0	Needle No. 2. 30° 20·5'			
"	27	13	28	1	30	20·8				
"	27	13	28	2	30	20·9				
May	1	13	47	1	30	22·7				
"	1	13	47	2	30	21·6	Needle No. 1. 30° 21·3'			
"	4	13	17	1	30	20·9				
"	4	13	17	2	30	19·7				
"	8	13	47	1	30	21·3				
"	8	13	47	2	30	21·1				
"	11	12	57	1	30	20·7				
"	11	12	57	2	30	20·2				
"	15	13	26	1	30	20·0		30° 21·2'	0° 0·3'	
"	15	13	26	2	30	20·3				
"	15	13	45	1	30	20·8				
"	18	12	39	1	30	20·2				
"	18	12	39	2	30	20·2	Needle No. 2. 30° 21·0'			
"	22	13	54	1	30	21·8				
"	22	13	54	2	30	22·8				
"	29	13	28	1	30	23·4				
"	29	13	28	2	30	22·4				
June	1	13	28	1	30	22·5				
"	1	13	28	2	30	19·8	Needle No. 1. 30° 22·9'			
"	5	13	25	1	30	20·2				
"	5	13	25	2	30	19·7				
"	8	12	43	1	30	24·5				
"	8	12	43	2	30	21·0				
"	12	12	49	1	30	24·5				
"	12	12	49	2	30	23·1				
"	15	12	43	1	30	22·3		30° 22·1'	0° 1·7'	
"	15	12	43	2	30	20·5				
"	22	13	34	2	30	24·1				
"	22	13	34	1	30	25·0	Needle No. 2. 30° 21·2'			
"	26	12	51	1	30	20·7				
"	26	12	51	2	30	20·6				
"	29	13	2	1	30	23·2				
"	29	13	2	2	30	20·8				

Observations of Dip—contd.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Dip.		Monthly mean Dip with each Needle.	Monthly mean Dip with both Needles.	Diff. Needles 1—2.	Remarks.
1905.		h.	m.		°	′				
July	3	13	27	1	30	21·7				
„	3	13	27	2	30	22·0	Needle No. 1.			
„	3	13	51	1	30	22·9	30° 23·1′			
„	6	13	10	1	30	21·4				
„	6	13	10	2	30	21·4				
„	10	13	40	1	30	23·3				
„	10	13	40	2	30	21·7				
„	13	13	45	1	30	23·3				
„	13	13	45	2	30	21·8				
„	17	13	45	1	30	22·5		30° 22·5′	0° 1·3′	
„	17	13	45	2	30	19·7				
„	20	13	12	1	30	22·4				
„	20	13	12	2	30	22·2				
„	24	13	45	1	30	25·9				
„	24	13	45	2	30	23·7				
„	27	13	35	1	30	23·7	Needle No. 2.			
„	27	13	35	2	30	22·5	30° 21·8′			
„	31	13	28	1	30	23·6				
„	31	13	28	2	30	21·6				
August	3	13	47	1	30	25·0				
„	3	13	47	2	30	23·4	Needle No. 1.			
„	7	13	41	1	30	23·1	30° 22·2′			
„	7	13	41	2	30	22·4				
„	10	13	30	1	30	21·3				
„	10	13	30	2	30	19·2				
„	14	13	27	1	30	22·1				
„	14	13	27	2	30	20·1		30° 21·6′	0° 1·3′	
„	21	13	34	1	30	20·8				
„	21	13	34	2	30	20·1				
„	24	13	42	1	30	20·5				
„	24	13	42	2	30	17·9	Needle No. 2.			
„	28	13	14	1	30	20·8	30° 20·9′			
„	28	13	43	2	30	20·1				
„	31	13	25	1	30	24·0				
„	31	13	25	2	30	23·8				
September	4	13	42	1	30	25·0				
„	4	13	42	2	30	23·7	Needle No. 1.			
„	7	14	0	1	30	24·5	30° 24·6′			

Observations of Dip—contd.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Dip.		Monthly mean Dip with each Needle.	Monthly mean Dip with both Needles.	Diff. Needles 1—2.	Remarks.
1905.		h.	m.		°	′				
September	7	14	0	2	30	24·5				
"	14	13	17	1	30	23·2				
"	14	13	17	2	30	23·5		30° 24·1′	0° 1·0′	
"	21	9	25	1	30	25·6				
"	21	9	25	2	30	23·7				
"	25	12	50	1	30	24·6	Needle No. 2. 30° 23·6′			
"	25	12	50	2	30	23·7				
"	28	12	56	1	30	24·8				
"	28	12	56	2	30	22·7				
October	5	13	14	1	30	25·9				
"	5	13	14	2	30	22·2	Needle No. 1. 30° 25·1′			
"	9	13	36	1	30	26·4				
"	9	13	36	2	30	23·6				
"	12	12	54	1	30	22·5				
"	12	12	54	2	30	21·6				
"	19	13	21	1	30	25·6		30° 24·0′	0° 2·2′	
"	19	13	21	2	30	22·7				
"	23	13	30	1	30	25·0				
"	23	13	30	2	30	23·3	Needle No. 2. 30° 22·9′			
"	26	13	56	1	30	24·5				
"	26	13	56	2	30	23·5				
"	30	12	26	1	30	25·8				
"	30	12	26	2	30	23·3				
November	2	13	1	1	30	26·4				
"	2	13	1	2	30	22·9	Needle No. 1. 30° 26·6′			
"	6	12	49	1	30	25·2				
"	6	12	49	2	30	23·6				
"	9	12	27	1	30	25·4				
"	9	12	27	2	30	23·8				
"	13	13	27	1	30	25·0				
"	13	13	27	2	30	23·0		30° 25·6′	0° 2·0′	
"	16	12	58	1	30	29·5				
"	16	12	58	2	30	27·9				
"	20	12	59	1	30	28·7				
"	20	12	59	2	30	27·5	Needle No. 2. 30° 2[illegible]·6′			
"	27	13	40	1	30	26·9				
"	27	13	40	2	30	25·3				

Observations of Dip—concld.

1	2		3	4		5	6	7	8
Date.	L. M. T.		Needle No.	Dip.		Monthly mean Dip with each Needle.	Monthly mean Dip with both Needles.	Diff. Needles 1—2.	Remarks.
	h.	m.		°	′				
November 30	12	41	1	30	25·6				
" 30	12	41	2	30	23·1				
December 4	13	44	1	30	24·2				
" 4	13	44	2	30	21·7	Needle No. 1. 30° 25·9′			
" 7	13	30	1	30	25·9				
" 7	13	30	2	30	22·8				
" 11	13	30	1	30	27·1				
" 11	13	30	2	30	23·7				
" 14	13	53	1	30	24·7				
" 14	13	53	2	30	23·8		30° 24·7′	0° 2·4′	
" 18	13	24	1	30	26·0				
" 18	13	24	2	30	23·6				
" 21	12	38	1	30	28·5				
" 21	12	38	2	30	25·5				
" 25	13	49	1	30	26·4				
" 25	13	49	2	30	23·8	Needle No. 2. 30° 23·5′			
" 28	1	44	1	30	24·4				
" 28	1	44	2	30	23·0				

Hourly means of Horizontal Force in C.G.S. Units (corrected for Temperature) at Barrackpore from the selected quiet days in 1905.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
0·37000 + 10⁻⁵													Winter.												
Months, 1905.	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	227	222	220	222	225	226	227	231	237	239	238	237	237	235	235	231	231	229	226	226	224	223	224	229	229
February	217	221	218	217	219	220	222	224	230	236	243	244	244	238	235	231	228	225	223	220	220	218	219	222	226
March	229	233	231	229	231	231	233	233	239	253	267	279	283	277	268	253	240	235	234	234	231	229	230	233	243
October	234	233	231	232	232	234	235	232	233	238	252	268	275	268	257	247	242	237	234	234	234	232	233	237	241
November	230	232	235	234	234	237	238	241	248	256	266	274	276	265	255	246	241	236	237	236	231	229	231	233	243
December	238	239	238	239	238	239	242	246	252	256	259	262	258	253	250	246	242	238	238	239	236	236	237	238	244
Means	229	230	229	229	230	231	233	235	240	246	254	261	262	256	250	242	237	233	232	232	229	228	229	232	238
													Summer.												
April	234	234	232	231	234	235	236	236	241	256	268	274	276	273	267	258	249	341	238	235	236	234	235	237	245
May	243	242	241	241	242	241	241	241	242	248	257	265	271	273	270	263	254	246	243	239	239	241	242	240	248
June	232	233	233	232	233	233	237	244	249	257	265	272	277	275	267	259	251	241	237	236	236	236	236	238	246
July	240	240	239	239	239	240	242	244	247	253	265	272	279	281	273	263	252	245	240	239	240	241	242	241	250
August	237	238	238	239	239	240	241	244	248	256	267	274	282	280	272	264	257	248	244	242	241	242	243	243	251
September	228	231	234	233	232	233	232	223	220	224	231	242	251	253	254	248	242	237	236	235	233	232	231	232	235
Means	236	236	236	236	237	237	238	239	241	249	259	267	273	273	267	259	251	243	240	238	238	238	238	239	246

Diurnal inequality of the Horizontal Force at Barrackpore as deduced from the preceding Table.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
Months, 1905.	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	−2	−7	−9	−7	−4	−3	−2	+2	+8	+10	+9	+8	+8	+6	+6	+2	+2	0	−3	−3	−5	−6	−5	0
February . . .	−9	−5	−8	−9	−7	−6	−4	−2	+4	+10	+17	+18	+18	+12	+9	+5	+2	−1	−3	−6	−5	−8	−7	−4
March	−14	−10	−12	−14	−12	−12	−10	−10	−4	+10	+24	+36	+40	+34	+25	+10	−3	−8	−9	−9	−12	−14	−13	−10
October . . .	−7	−8	−10	−9	−9	−7	−6	−9	−8	−3	+11	+27	+34	+27	+16	+6	+1	−4	−7	−7	−7	−9	−8	−4
November . .	−13	−11	−8	−9	−9	−6	−5	−2	+5	+13	+23	+31	+33	+22	+12	+3	−2	−7	−6	−7	−12	−14	−12	−10
December . . .	−6	−5	−6	−5	−6	−5	−2	+2	+8	+12	+15	+18	+14	+9	+6	+2	−1	−6	−5	−5	−8	−8	−7	−6
Means .	−9	−8	−9	−9	−8	−7	−5	−3	+2	+8	+16	+23	+24	+18	+12	+4	−1	−5	−6	−6	−9	−10	−9	−6
Summer.																								
April	−11	−11	−13	−14	−11	−10	−9	−9	−4	+11	+23	+29	+31	+28	+22	+13	+4	−4	−7	−10	−9	−11	−10	−8
May	−5	−6	−7	−7	−6	−7	−7	−7	−6	0	+9	+17	+23	+25	+22	+15	+6	−2	−5	−9	−9	−7	−6	−8
June	−14	−13	−13	−14	−13	−13	−9	−2	+3	+11	+19	+26	+31	+29	+21	+13	+5	−5	−9	−10	−10	−10	−10	−8
July	−10	−10	−11	−11	−11	−10	−8	−6	−3	+3	+15	+22	+29	+31	+23	+13	+2	−5	−10	−11	−10	−9	−8	−9
August	−14	−13	−13	−12	−12	−11	−10	−7	−3	+5	+16	+23	+31	+29	+21	+13	+6	−3	−7	−9	−10	−9	−8	−8
September . . .	−7	−4	−1	−2	−3	−2	−2	−12	−15	−11	−4	+7	+16	+18	+19	+13	+7	+2	+1	0	−2	−3	−4	−3
Means .	−10	−10	−10	−15	−9	−9	−8	−7	−5	+3	+13	+21	+27	+27	+21	+13	+5	−3	−6	−8	−8	−8	−8	−7

N.B.—When the sign is + the H. F. is greater and when it is less than the mean value.

Hourly means of the Declination as determined at Barrackpore from the selected quiet days in 1905.

Declination E 0°+

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

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.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	+0.1	0.0	−0.1	−0.2	−0.5	−0.5	−0.6	−0.2	+0.6	+1.3	+1.5	+0.5	−0.4	−0.5	−0.6	−0.6	−0.1	+0.2	+0.2	+0.2	+0.2	+0.1	+0.1	−0.1
February	0.0	−0.1	+0.1	−0.2	−0.3	−0.4	−0.6	−0.1	+1.3	+2.4	+2.6	+1.2	−0.5	−1.3	−1.9	−1.6	−0.5	+0.2	−0.3	−0.2	−0.2	−0.2	−0.2	−0.2
March	0.0	−0.2	0.0	−0.2	−0.4	−0.4	−0.3	+0.7	+1.9	+2.0	+1.6	+0.5	−0.7	−1.4	−1.0	−0.3	+0.2	+0.2	−0.4	−0.3	−0.4	−0.3	−0.4	−0.3
October	−0.1	0.0	+0.1	+0.1	0.0	+0.1	+0.5	+1.9	+2.9	+2.4	+0.7	−1.7	−2.9	−2.5	−1.2	0.0	+0.7	+0.3	−0.4	−0.4	−0.4	−0.4	−0.4	−0.3
November	+0.2	+0.2	+0.1	+0.1	0.0	−0.2	−0.2	+0.3	+1.1	+1.3	+0.8	−0.3	−0.9	−0.7	−0.3	0.0	0.0	−0.2	−0.2	0.0	0.0	−0.1	+0.1	+0.1
December	+0.1	+0.1	0.0	0.0	−0.1	−0.3	−0.4	−0.7	+0.2	+0.7	+1.0	+0.5	−0.2	−0.7	−0.7	0.0	+0.2	+0.1	−0.2	0.0	−0.1	−0.2	−0.1	−0.1
Means	+0.1	0.0	0.0	−0.1	−0.2	−0.3	−0.3	+0.3	+1.3	+1.7	+1.4	+0.1	−0.9	−1.2	−0.9	−0.4	+0.1	+0.1	−0.2	−0.1	−0.1	−0.2	−0.1	−0.1
Summer.																								
April	0.0	+0.1	+0.1	0.0	−0.1	−0.2	+0.3	+1.7	+2.7	+3.1	+2.5	+0.3	−1.8	−2.4	−1.9	−1.2	−0.3	+0.2	0.0	−0.5	−0.6	−0.6	−0.4	−0.3
May	0.0	+0.1	0.0	0.0	0.0	+0.1	+1.5	+2.8	+3.3	+2.2	+0.6	−1.1	−2.6	−2.8	−2.3	−1.2	−0.2	+0.4	+0.7	−0.1	−0.4	−0.4	−0.2	0.0
June	+0.2	+0.3	+0.2	+0.1	+0.1	+0.4	+1.6	+2.9	+2.8	+1.8	+0.2	1.0	−2.0	−2.3	−1.8	−1.4	−0.5	+0.2	+0.5	0.0	−0.3	−0.3	−0.2	−0.2
July	+0.2	+0.4	+0.4	+0.3	+0.3	+0.5	+1.8	+3.0	+2.8	+1.7	0.0	−1.6	−2.6	−2.2	−1.7	−1.4	−0.7	0.0	+0.4	+0.1	−0.2	−0.2	−0.1	0.0
August	+0.1	+0.1	+0.1	+0.2	+0.4	+0.8	+2.4	+3.4	+3.1	+1.3	−0.7	−2.2	−2.9	−2.9	−2.0	−1.1	−0.2	+0.6	+0.4	−0.2	−0.3	−0.4	−0.2	−0.1
September	+0.1	+0.1	+0.3	+0.2	+0.2	+0.5	+2.0	+3.5	+3.3	+1.8	−0.5	−2.6	−3.7	−3.8	−2.7	−0.7	+0.8	+1.3	+0.4	+0.1	0.0	0.0	0.0	+0.1
Means	+0.1	+0.2	+0.2	+0.2	+0.2	+0.4	+1.6	+2.9	+3.0	+2.0	+0.4	−1.3	−2.6	−2.7	−2.0	−1.1	−0.2	+0.5	+0.4	−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.

E.—*Tables of results at Kodaikanal Observatory for 1905.*

LIST OF TABLES.

Observations of Dip, Circle No. 46, by Barrow.

1		2		3	4	5	6	7	8
Date, 1905.		L. M. T.		Needle No.	Dip.	Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles, 2—3c.	Remarks.
		h.	m.		° ′			° ′	
January	2	13	31	2	3 13·7				
"	2	13	31	3C	3 12·4				
"	6	13	28	2	3 15·7	Needle No. 2			
"	6	13	28	3C	3 15·3				
"	10	13	30	2	3 13·3	3° 13′·1			
"	10	13	30	3C	3 12·2				
"	12	12	18	2	3 13·1				
"	12	12	18	3C	3 11·7				
"	16	13	25	2	3 12·6		3° 12′·5	0° 1′·2	
"	16	13	25	3C	3 11·5				
"	19	13	31	2	3 12·4				
"	19	13	31	3C	3 11·2				
"	23	12	59	2	3 11·6	Needle No. 3C			
"	23	12	59	3C	3 11·2				
"	26	13	28	2	3 11·6	3° 11′·9			
"	26	13	28	3C	3 10·2				
"	30	13	27	2	3 13·6				
"	30	13	27	3C	3 11·3				
February	2	13	27	2	3 15·6				
"	2	13	27	3C	3 13·0				
"	6	13	22	2	3 12·0	Needle No. 2			
"	6	13	22	3C	3 10·1	3° 14′·3			
"	9	12	27	2	3 13·4				
"	9	12	27	3C	3 13·7				
"	17	13	22	2	3 14·0				
"	17	13	22	3C	3 12·9		3° 13′·7	0° 1′·2	
"	20	13	24	2	3 14·1				
"	20	13	24	3C	3 12·7				
"	23	13	25	2	3 11·5				
"	23	13	25	3C	3 9·9				

* As deduced from 5 selected quiet days per month.
† Corrected for temperature.

Observations of Dip, Circle No. 46, by Barrow—contd.

1		2		3	4		5	6	7	8
Date, 1905.		L. M. T.		Needle No.	Dip.		Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles, 2—3C.	Remarks.
		h.	m.		°	′			° ′	
February	27	8	27	2	3	19·3				
”	27	8	27	3C	3	17·4	Needle No. 3C			
”	28	8	58	2	3	14·2	3° 13′·1			
”	28	8	58	3C	3	15·1				
March	1	8	9	2	3	16·7				
”	1	8	9	3C	3	15·8				
”	3	8	10	2	3	16·1	Needle No. 2			
”	3	8	10	3C	3	15·9	3° 16′·1			
”	4	8	56	2	3	17·3				
”	4	8	56	3C	3	15·7				
”	6	13	36	2	3	15·8				
”	6	13	36	3C	3	13·6				
”	9	13	27	2	3	16·4				
”	9	13	27	3C	3	14·6				
”	13	13	20	2	3	15·1		3° 15′·5	0° 1′·2	
”	13	13	20	3C	3	13·4				
”	16	13	16	2	3	15·9				
”	16	13	16	3C	3	15·2				
”	20	13	23	2	3	17·0				
”	20	13	23	3C	3	14·2				
”	23	12	26	3C	3	15·2				
”	23	12	26	2	3	16·1	Needle No. 3C			
”	28	13	21·0	3C	3	15·8	3° 14′·9			
”	28	13	21·0	2	3	15·7				
”	30	13	22	2	3	15·1				
”	30	13	22	3C	3	14·5				
April	3	13	34	2	3	16·4				
”	3	13	34	3C	3	14·8	Needle No. 2			
”	7	13	19	2	3	13·7				
”	7	13	19	3C	3	13·2	3° 15′·9			
”	10	12	32	2	3	15·1				
”	10	12	32	3C	3	14·9				
”	13	13	40	2	3	18·4				
”	13	13	40	3C	3	17·0				
”	17	13	46	2	3	21·3		3° 15′·3	0° 1′·2	
”	17	13	46	3C	3	20·4				
”	19	12	33	2	3	16·5				

Observations of Dip, Circle No. 46, by Barrow—contd.

1	2	3	4	5	6	7	8
Date, 1905.	L. M. T.	Needle No.	Dip.	Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles, 2—3C.	REMARKS.
	h. m.		° ′			° ′	
April 19	12 33	3C	3 14·7				
„ 20	12 22	2	3 13·8				
„ 20	12 22	3C	3 11·6	Heedle No. 3C			
„ 24	12 22	2	3 13·6				
„ 24	12 22	3C	3 13·1	3° 14′·7			
„ 27	12 22	2	3 14·7				
„ 27	12 22	3C	3 12·8				
May 4	12 54	2	3 18·5				
„ 4	12 54	3C	3 15·6				
„ 8	13 29	2	3 17·3				
„ 8	13 29	3C	3 14·7	Needle No. 2			
„ 10	12 33	2	3 19·5	3° 17′·4			
„ 10	12 33	3C	3 16 9				
„ 11	12 31	2	3 16·7				
„ 11	12 31	3C	8 14·5				
„ 17	12 30	2	3 18·2				
„ 17	12 30	3C	3 15·5				
„ 18	13 29	2	3 16·5		3° 16′·3	0° 2′·2	
„ 18	13 29	3C	3 15·1				
„ 22	13 28	2	3 16·2				
„ 22	13 28	3C	3 14·8				
„ 25	12 28	2	3 17·9	Needle No. 3C			
„ 25	12 28	3C	3 14·9				
„ 26	12 30	2	3 16·7	3° 15′·2			
„ 26	12 30	3C	3 16·2				
„ 29	12 29	2	3 16·2				
„ 29	12 29	3C	3 14·0				
June 1	12 32	2	3 13·3				
„ 1	12 32	3C	3 11·8	Needle No. 2			
„ 5	12 28	2	3 17·9	3° 17′·8			
„ 5	12 28	3C	3 18·2				
„ 8	13 20	2	3 20·1				
„ 8	13 20	3C	3 17·4				
„ 12	12 25	2	3 18·3				
„ 12	12 25	3C	3 16·4		3° 17′·2	0° 1′·2	
„ 15	12 25	2	3 19·0				
„ 15	12 25	3C	3 18·0				

Observations of Dip, Circle No. 46, by Barrow—contd.

1	2	3	4	5	6	7	8
Date, 1905.	L. M. T.	Needle No.	Dip.	Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles, 2—3c.	REMARKS.
	h. m.		° ′			° ′	
June 19	12 28	2	3 20·3				
„ 19	12 28	3C	3 20·5				
„ 23	12 24	2	3 14·2				
„ 23	12 24	3C	3 14·0				
„ 26	12 23	2	3 18·2	Needle No. 3C			
„ 26	12 23	3C	3 15·0				
„ 29	12 23	2	3 18·5	4° 16′·6			
„ 29	12 23	3C	3 17·7				
July 3	13 31	2	3 17·4				
„ 3	13 31	3C	3 15·9	Needle No. 2			
„ 6	12 34	2	3 18·0	3° 18′·5			
„ 6	12 34	3C	3 17·9				
„ 11	12 22	2	3 21·0				
„ 11	12 22	3C	3 19·0		3° 18′·0	0° 1′·1	
„ 14	12 23	2	3 15·7				
„ 14	12 23	3C	3 16·2				
„ 17	12 28	2	3 19·1	Needle No. 3C			
„ 17	12 28	3C	3 18·4	3° 17′·4			
„ 22	12 29	2	3 19·5				
„ 22	12 29	3C	8 17·1				
August 1	13 23	2	3 20·7				
„ 1	13 23	3C	3 18·9				
„ 4	12 30	2	3 18·1	Needle No. 2			
„ 4	12 30	3C	3 16·0	3° 19′·0			
„ 8	12 23	2	3 17·2				
„ 8	12 23	3C	3 15·9				
„ 10	13 17	2	3 20·3				
„ 10	13 17	3C	3 18·4				
„ 15	12 29	2	3 18·3				
„ 15	12 29	3C	3 16·5		3° 18′·2	0° 1′·6	
„ 17	12 25	2	3 19·4				
„ 17	12 25	3C	3 16·3				
„ 21	12 27	2	3 19·9				
„ 21	12 27	3C	3 18·5				
„ 25	12 22	2	3 19·3				
„ 25	12 22	3C	3 18·2	Needle No. 3C			
„ 29	12 24	2	3 16·5	3° 17′·4			
„ 29	12 24	3C	3 16·1				

Observations of Dip, Circle No. 46, by Barrow—contd.

1		2		3	4	5	6	7	8
Date, 1905.		L. M. T.		Needle No.	Dip.	Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles, 2—3C.	REMARKS.
		h.	m.		° ′			° ′	
August	31	12	28	2	3 20·3				
"	31	12	28	3C	3 19·6				
September	4	12	45	2	3 21·7				
"	4	12	45	3C	3 19·9	Needle No. 2 3° 19′·1			
"	7	12	27	2	3 17·1				
"	7	12	27	3C	3 15·3				
"	11	12	16	2	3 18·4				
"	11	12	16	3C	3 17·2		3° 18′·2	0° 1′·8	
"	14	12	24	2	3 20·0				
"	14	12	24	3C	3 17·8				
"	25	13	22	2	3 18·2				
"	25	13	22	3C	3 17·2	Needle No. 3C 3° 17′·3			
"	28	12	28	2	3 19·2				
"	28	12	28	3C	3 16·5				
October	2	13	20	2	3 20·3				
"	2	13	20	3C	3 19·0				
"	5	12	26	2	3 18·8	Needle No. 2 3° 18′·9			
"	5	12	26	3C	3 17·8				
"	9	12	39	2	3 19·7				
"	9	12	39	3C	3 18·6				
"	12	13	27	2	3 18·2				
"	12	13	27	3C	3 17·0				
"	16	12	34	2	3 17·7		3° 18′·2	0° 1′·4	
"	16	12	34	3C	3 16·8				
"	19	13	24	2	3 19·3				
"	19	13	24	3C	3 17·0				
"	23	12	32	2	3 20·9				
"	23	12	32	3C	3 17·9				
"	26	12	28	2	8 18·3	Needle No. 3C 3° 17′·5			
"	26	12	28	3C	3 17·2				
"	30	13	25	2	3 16·5				
"	30	13	25	3C	3 16·5				
November	2	12	32	2	3 22·1				
"	2	12	32	3C	3 19·4				
"	6	12	17	2	3 19·5	Needle No. 2 3° 19′·4			
"	6	12	17	3C	3 17·0				

Observations of Dip, Circle No. 46, by Barrow—concld.

1	2	3	4	5	6	7	8
Date, 1905.	L. M. T.	Needle No.	Dip.	Monthly Mean Dip with each Needle.	Monthly Mean Dip with both Needles.	Diff. Needles, 2—3c.	Remarks.
	h. m.		° ′			° ′	
November 9	12 37	2	3 19·0				
" 9	12 37	3C	3 16·6				
" 13	12 36	2	3 18·9				
" 13	12 36	3C	3 18·2				
" 21	12 27	2	3 19·4		3° 18′·5	0° 1′·8	
" 21	12 27	3C	3 18·4				
" 23	13 3	2	3 18·8				
" 23	13 3	3C	3 17·3	Needle No. 3C			
" 28	13 5	2	3 17·4	3° 17′·6			
" 28	13 5	3C	3 16·7				
" 30	13 13	2	3 19·9				
" 30	13 13	3C	3 17·2				
December 4	13 28	2	3 18·3				
" 4	13 28	3C	3 15·9	Needle No. 2			
" 7	13 26	2	3 20·7	3° 19′·3			
" 7	13 26	3C	3 18·4				
" 11	13 22	2	3 16·3				
" 11	13 22	3C	3 14·5				
" 15	13 10	2	3 21·4				
" 15	13 10	3C	3 20·0		3° 18′·5	0° 1′·7	
" 20	12 43	2	3 19·2				
" 20	12 43	3C	3 17·8				
" 21	12 20	2	3 20·6				
" 21	12 20	3C	3 18·7	Needle No. 3C			
" 27	12 31	2	3 19·9				
" 27	12 31	3C	3 18·2	3° 17′·6			
" 28	12 42	2	3 18·0				
" 28	12 42	3C	3 17·5				

Hourly Means of Horizontal Force in C. G. S. units (corrected for temperature) at Kodaikanal from the selected quiet days in 1905.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
0·37000+10-5												**Winter.**													
	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	374	373	374	377	376	377	378	388	401	422	435	444	441	432	420	409	397	388	385	383	380	379	381	380	396
February	361	360	361	362	363	363	362	370	389	420	448	465	466	446	420	493	379	377	374	370	368	366	365	366	388
March	373	372	373	374	373	374	370	380	406	443	474	489	474	450	427	406	395	391	388	380	375	376	375	375	400
October	384	383	383	384	384	383	379	390	421	463	494	505	488	454	427	408	402	400	395	394	391	389	388	387	412
November	383	387	386	386	385	383	387	399	423	452	474	485	478	458	433	415	406	401	398	392	389	388	387	384	411
December	386	387	386	387	386	386	389	397	413	430	447	454	449	440	424	412	403	397	394	390	389	386	387	386	404
Means	377	377	377	378	378	378	378	387	409	438	462	474	466	447	425	407	397	392	389	385	382	381	381	380	402
												Summer.													
April	379	379	378	380	381	379	376	382	412	452	485	499	488	466	436	409	394	392	391	387	384	382	384	381	407
May	388	390	389	390	388	386	387	394	416	449	476	490	486	467	437	410	395	390	390	390	389	390	389	389	411
June	386	387	386	385	385	384	389	394	414	434	448	452	451	432	413	399	391	389	389	389	389	390	389	390	402
July	390	391	392	382	390	389	394	400	415	439	456	464	457	439	414	393	388	389	393	394	392	392	393	392	406
August	385	385	385	386	386	386	390	398	414	436	444	451	442	432	421	414	405	398	396	393	393	391	391	392	405
September	371	377	375	374	375	375	374	386	417	447	465	469	459	434	408	390	381	384	387	383	379	376	376	376	397
Means	383	385	384	385	384	383	385	392	415	443	462	471	464	445	422	403	392	390	391	389	388	387	387	387	405

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.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
	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	−22	−23	−22	−19	−20	−19	−18	−8	+5	+26	+39	+48	+45	+36	+24	+13	+1	−8	−11	−13	−16	−17	−15	−16
February	−27	−28	−27	−26	−25	−25	−26	−18	+1	+32	+60	+77	+78	+58	+32	+5	−9	−11	−14	−18	−20	−22	−23	−22
March	−27	−28	−27	−26	−27	−26	−30	−20	+6	+43	+74	+89	+74	+50	+27	+6	−5	−9	−12	−20	−25	−24	−25	−25
October	−28	−29	−29	−28	−28	−29	−33	−22	+9	+51	+82	+93	+76	+42	+15	−4	−10	−12	−16	−18	−21	−23	−24	−25
November	−28	−24	−25	−25	−26	−28	−24	−12	+12	+41	+63	+74	+67	+47	+22	+4	−5	−10	−13	−19	−22	−23	−24	−27
December	−18	−17	−18	−17	−18	−18	−15	−7	+9	+26	+43	+50	+45	+36	+20	+8	−1	−7	−10	−14	−15	−18	−17	−18
Means .	−25	−25	−25	−24	−24	−24	−24	−15	+7	+36	+60	+72	+64	+45	+23	+5	−5	10	−13	−17	−20	−21	−21	−22
Summer.																								
April	−28	−28	−29	−27	−26	−28	−31	−25	+5	+45	+78	+92	+81	+59	+29	+2	−13	−15	−16	−20	−23	−25	−23	−26
May	−23	−21	−22	−21	−23	−25	−24	−17	+5	+38	+65	+79	+75	+56	+26	−1	−16	−21	−21	−21	−22	−21	−22	−22
June	−16	−15	−16	−17	−17	−18	−13	−8	+12	+32	+46	+50	+49	+30	+11	−3	−11	−13	−13	−13	−13	−12	−13	−12
July	−16	−15	−14	−14	−16	−17	−12	−6	+9	+33	+50	+58	+51	+33	+8	−13	−18	−17	−13	−12	−14	−14	−13	−14
August	−20	−20	−20	−19	−19	−19	−15	−7	+9	+31	+39	+46	+37	+27	+16	+9	0	−7	−9	−12	−12	−14	−14	−13
September . .	−26	−20	−22	−23	−22	−22	−23	−11	+20	+50	+68	+72	+62	+37	+11	−7	−16	−13	−10	−14	−18	−21	−21	−21
Means .	−22	−20	21	−20	−21	−22	−20	−13	+10	+38	+57	+66	+59	+40	+17	−2	−13	−15	−14	−16	−17	−18	−18	−18

N. P.—When the sign is + the H. F. is greater and when — it is less than the Mean Value.

Hourly Means of the Declination as determined at Kodaikanal from the selected quiet days in 1905.

Declination W. 0°+

Winter.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
Months, 1905.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January . . .	29.7	29.8	30.0	30.0	30.1	30.2	30.4	30.6	30.2	29.1	29.0	29.9	30.1	30.0	30.1	30.0	30.0	29.9	30.0	30.0	29.9	30.0	30.1	30.1	30.0
February . .	30.1	30.0	30.1	30.1	30.4	30.6	30.6	30.6	29.9	29.1	28.3	29.1	29.7	30.3	30.7	30.6	30.3	30.1	30.2	30.1	30.2	30.2	30.3	30.3	30.1
March . . .	30.5	30.5	30.4	30.5	30.6	30.7	30.7	30.4	30.0	29.8	29.9	30.4	30.9	31.3	31.0	30.3	30.0	30.3	30.6	30.5	30.6	30.7	30.8	30.8	30.5
October . . .	33.0	33.0	33.0	33.0	33.0	33.1	32.7	31.9	32.0	32.9	33.7	34.7	34.8	34.3	33.4	32.7	32.2	32.8	33.2	33.0	33.1	33.2	33.4	33.2	33.1
November . .	33.4	33.5	33.6	33.6	33.8	33.8	34.0	34.2	34.1	33.7	34.2	34.6	34.5	34.0	33.6	33.3	33.2	33.8	33.9	33.5	33.5	33.7	33.8	33.6	33.8
December . .	33.9	33.9	33.9	33.9	34.1	34.2	34.3	34.9	34.5	34.3	33.9	33.7	33.7	33.5	33.5	33.4	33.2	33.5	33.9	33.7	33.8	33.8	33.9	34.0	33.9
Means .	31.8	31.8	31.8	31.9	32.0	32.1	32.1	32.1	31.8	31.5	31.5	32.1	32.3	32.2	32.1	31.7	31.5	31.7	32.0	31.8	31.9	31.9	32.1	32.0	31.9

Summer.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
April . . .	30.9	30.9	30.9	30.9	30.9	30.9	30.8	30.2	30.1	29.9	29.9	30.5	31.5	31.7	31.7	31.2	30.7	30.4	30.5	31.0	31.2	31.1	31.1	31.0	30.8
May . . .	31.2	31.2	31.2	31.2	31.1	31.2	30.4	29.4	29.3	30.1	31.1	32.1	32.6	32.8	32.4	31.7	30.9	30.7	30.8	31.3	31.6	31.6	31.4	31.3	31.2
June . . .	31.7	31.7	31.7	31.7	31.7	31.5	31.0	30.2	30.3	31.0	32.1	33.5	33.2	33.4	32.8	32.2	31.7	31.6	31.6	32.1	32.3	32.2	32.2	32.1	31.9
July . . .	32.1	32.0	32.1	32.0	31.8	32.0	31.2	30.4	30.6	31.7	33.1	33.7	34.1	34.1	33.5	32.8	32.1	31.8	31.7	32.2	32.4	32.3	32.2	32.3	32.3
August . .	32.6	32.5	32.4	32.2	32.1	31.9	31.2	30.7	30.8	31.9	33.3	34.2	35.0	34.8	33.9	32.8	32.2	32.0	32.3	32.7	32.9	32.9	32.8	32.8	32.6
September . .	32.9	32.9	32.9	32.8	32.8	32.6	31.3	30.6	31.3	32.4	33.5	34.9	35.3	35.1	34.4	33.3	32.4	32.1	32.4	32.8	32.9	32.9	33.0	32.9	32.9
Means .	31.9	31.9	31.9	31.8	31.8	31.7	31.0	30.3	30.4	31.2	32.2	33.0	33.6	33.7	33.1	32.3	31.7	31.4	31.6	32.0	32.2	32.2	32.1	32.1	32.0

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

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
Months, 1905.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	−0·3	−0·2	0·0	0·0	+0·1	+0·2	+0·4	+0·6	+0·2	−0·9	−1·0	−0·1	+0·1	0·0	+0·1	0·0	0·0	−0·1	0·0	0·0	−0·1	0·0	+0·1	+0·1
February	0·0	−0·1	0·0	0·0	+0·3	+0·5	+0·5	+0·5	−0·2	−1·0	−1·8	−1·0	−0·4	+0·2	+0·6	+0·5	+0·2	0·0	+0·1	0·0	+0·1	+0·1	+0·2	+0·2
March	0·0	0·0	−0·1	0·0	+0·1	+0·2	+0·2	−0·1	−0·5	−0·7	−0·6	−0·1	+0·4	+0·8	+0·5	−0·2	−0·5	−0·2	+0·1	0·0	+0·1	+0·2	+0·3	+0·3
October	−0·1	−0·1	−0·1	−0·1	−0·1	0·0	−0·4	−1·2	−1·1	−0·2	+0·6	+1·6	+1·7	+1·2	+0·3	−0·4	−0·9	−0·3	+0·1	−0·1	0·0	+0·1	+0·3	+0·1
November	−0·4	−0·3	−0·2	−0·2	0·0	0·0	+0·2	+0·4	+0·3	−0·1	+0·4	+0·8	+0·7	+0·2	−0·2	−0·5	−0·6	0·0	+0·1	−0·3	−0·3	−0·1	0·0	−0·2
December	0·0	0·0	0·0	0·0	+0·2	+0·3	+0·4	+1·0	+0·6	+0·4	0·0	−0·2	−0·2	−0·4	−3·4	−0·5	−0·7	−0·4	0·0	−0·2	−0·1	−0·1	0·0	+0·1
Means	−0·1	−0·1	−0·1	0·0	+0·1	+0·2	+0·2	+0·2	−0·1	−0·4	−0·4	+0·2	+0·4	+0·3	+0·2	−0·2	−0·4	−0·2	+0·1	−0·1	0·0	0·0	+0·2	+0·1
Summer.																								
April	+0·1	+0·1	+0·1	+0·1	+0·1	+0·1	0·0	−0·6	−0·7	−0·9	−0·9	−0·3	+0·7	+0·9	+0·9	+0·4	−0·1	−0·4	−0·3	+0·2	+0·4	+0·3	+0·3	+0·2
May	0·0	0·0	0·0	0·0	0·1	0·0	−0·8	−1·8	−1·9	−1·1	−0·1	+0·9	+1·4	+1·6	+1·2	+0·5	−0·3	−0·5	−0·4	+0·1	+0·6	+0·4	+0·2	+0·1
June	−0·2	−0·2	−0·2	−0·2	−0·2	−0·4	−0·9	−1·7	−1·6	−0·9	+0·2	+0·6	+1·3	+1·5	+0·9	+0·3	−0·2	−0·3	−0·3	+0·2	+0·4	+0·3	+0·3	+0·2
July	−0·2	−0·3	−0·2	−0·3	−0·3	−0·5	−1·1	−1·9	−1·7	−0·6	+0·8	+1·4	+1·8	+1·8	+1·2	+0·5	−0·2	−0·5	−0·6	−0·1	+0·1	0·0	−0·1	0·0
August	0·0	−0·1	−0·2	−0·4	−0·5	−0·7	−1·4	−1·9	−1·8	−0·7	+0·7	+1·6	+2·4	+2·2	+1·3	+0·2	−0·4	−0·6	−0·3	+0·1	+0·3	+0·3	+0·2	+0·2
September	0·0	0·0	0·0	−0·1	−0·1	−0·3	−1·6	−2·3	−1·6	−0·5	+0·6	+2·0	+2·4	+2·2	+1·5	+0·4	−0·5	−0·8	−0·5	−0·1	0·0	0·0	+0·1	0·0
Means	−0·1	−0·1	−0·1	−0·2	−0·2	−0·3	−1·0	−1·7	−1·6	−0·8	+0·2	+1·0	+1·6	+1·7	+1·1	+0·3	−0·3	−0·6	−0·4	0·0	+0·2	+0·2	+0·1	+0·1

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

F.—Tables of results at Toungoo Observatory for 1905.

LIST OF TABLES.

Observations of Dip, Toungoo, Circle No. 43, by Barrow and No. 137, by Dover

Mean dip in 1905—22°: 58·3.

1		2		3	4		5	6		7		8
Date.		L. M. T.		Needle No.	Dip.		Monthly Mean Dip with each needle.	Monthly Mean Dip with both the needles.		Difference needles (4c—4d) and (1—2).		Remarks.
1905.		H.	M.		°	′	° ′	°	′	°	′	
January	2	13	11	4c	23	3·0						
,,	,,	13	11	4d	23	3·0						
,,	5	12	53	4c	23	2·7	Needle No. 4c,					
,,	,,	12	53	4d	23	2·3	23 3·1					
,,	9	7	52	4c	23	1·3						
,,	,,	7	52	4d	22	59·3						
,,	19	12	53	4c	23	3·7		23	2·6	+0	1·0	
,,	,,	12	53	4d	23	3·7						
,,	23	13	33	4c	23	6·3						
,,	,,	13	33	4d	23	3·9						
,,	26	13	5	4c	23	1·9						
,,	,,	13	5	4d	23	1·0	Needle No. 4d,					
,,	30	13	52	4c	23	2·6	23 2·1					
,,	,,	13	52	4d	23	1·6						
February	2	13	15	4c	23	1·4						
,,	,,	13	15	4d	23	0·5						
,,	6	13	31	4c	22	58·8	Needle No. 4c,					
,,	,,	13	31	4d	22	57·6	22° 56·5					
,,	13	12	50	4c	22	51·3						
,,	,,	12	50	4d	22	51·0		22°	56·1	+0	0·8	
,,	16	13	53	4c	22	58·1						
,,	,,	13	53	4d	22	56·8						
,,	21	13	17	4c	22	56·4						
,,	,,	13	17	4d	22	57·0	Needle No. 4d,					
,,	23	13	8	4c	22	53·0	22 55·7					
,,	,,	13	8	4d	22	51·0						
March	2	13	21	4c	22	55·5						
,,	,,	12	24	4d	22	54·6						

* As deduced from 5 selected quiet days per month.

† Corrected for temperature.

Observations of Dip, Toungoo—contd.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Needle No.	Dip.		Monthly Mean Dip with each needle.	Monthly Mean Dip with both the needles.	Difference needles (4c—4d) and (1—2).	Remarks.
1905.		H.	M.		°	'	° '	° '	° '	
March	9	13	5	4c	22	53·3	Needle No. 4c, 22 52·0			
„	„	13	5	4d	22	53·8				
„	16	12	57	4c	22	50·2				
„	„	12	57	4d	22	49·4		22 51·4	+0 1·3	
„	20	12	59	4c	22	48·0				
„	„	12	59	4d	22	47·9				
„	23	12	49	4c	22	52·0				
„	„	12	49	4d	22	49·6	Needle No. 4d, 22 50·7			
„	30	13	57	4c	22	54·4				
„	„	13	57	4d	22	51·4				
April	5	13	53	4c	22	50·7				
„	„	13	53	4d	22	48·2				
„	7	13	5	1	23	2·5	Needle No. 1, 23 1·3	...	...	Circle No. 137 from 7th April.
„	„	13	5	2	22	58·5				
„	10	13	15	1	23	2·0				
„	„	13	15	2	22	59·5				
„	13	13	55	1	23	1·9		23 0·2	+0 2·2	
„	„	13	55	2	23	0·7				
„	17	13	51	1	23	1·0				
„	„	13	51	2	22	57·5				
„	24	13	12	1	22	59·3				
„	„	13	12	2	22	58·5	Needle No. 2, 22 59·1			
„	27	12	56	1	23	0·9				
„	„	12	56	2	23	0·1				
May	1	12	59	1	22	59·6				
„	„	12	59	2	23	0·6				
„	4	12	42	1	22	59·5	Needle No. 1, 22 58·5			
„	„	12	42	2	22	58·8				
„	8	13	45	1	22	59·4				
„	„	13	45	2	22	59·9		22 58·6	−0 0·2	
„	11	12	38	1	22	57·4				
„	„	12	38	2	22	58·2				
„	18	12	24	1	22	57·8				
„	„	12	24	2	22	56·4	Needle No. 2, 22 58·7			
„	25	12	53	1	22	57·5				
„	„	12	53	2	22	58·4				
June	1	13	25	1	22	56·0				
„	„	13	25	2	22	58·9				

Observations of Dip, Toungoo—contd.

1		2		3	4		5	6		7		8
Date.		L. M. T.		Needle No.	Dip.		Monthly Mean Dip with each needle.	Monthly Mean Dip with both the needles.		Difference needles (4c—4d) and (1—2).		REMARKS.
1905.		H.	M.		°	′	° ′	°	′	°	′	
June	5	12	57	1	22	58·2	Needle No. 1, 22 57·6					
"	"	12	57	2	22	57·4						
"	8	12	41	1	22	57·4						
"	"	12	41	2	22	59·8						
"	12	12	53	1	22	58·4						
"	"	12	53	2	22	60·4						
"	15	12	40	1	22	57·2		22	58·2	—0	1·2	
"	"	12	40	2	22	57·9						
"	19	12	57	1	22	58·0						
"	"	12	57	2	22	58·5						
"	24	13	20	1	22	56·8						
"	"	13	20	2	22	58·5						
"	26	13	11	1	22	58·2	Needle No. 2, 22 58·8					
"	"	13	11	2	22	59·1						
"	29	12	27	1	22	58·5						
"	"	12	27	2	22	58·4						
July	3	13	15	1	22	57·1						
"	"	13	15	2	22	58·3						
"	8	13	36	1	22	59·8	Needle No. 1, 22 58·9					
"	"	13	36	2	22	59·3						
"	13	13	23	1	22	57·5						
"	"	13	34	2	22	58·6						
"	18	13	46	1	22	60·5						
"	"	13	46	2	22	59·0						
"	20	12	38	1	22	59·5		22	58·7	+0	0·4	
"	"	12	38	2	22	57·9						
"	24	13	16	1	22	60·5						
"	"	13	16	2	22	58·8						
"	27	13	24	1	22	59·0	Needle No. 2, 22 58·5					
"	"	13	24	2	22	57·5						
"	31	12	22	1	22	57·3						
"	"	12	22	2	22	58·7						
August	3	13	46	1	22	60·7	Needle No. 1, 22 59·2					
"	"	13	46	2	22	60·0						
"	14	13	7	1	22	60·6						
"	"	13	7	2	22	60·8						
"	17	13	31	1	22	59·5						
"	"	13	31	2	22	60·2						

Observations of Dip, Toungoo—contd.

1		2		3	4		5	6		7		8
Date.		L. M. T.		Needle No.	Dip.		Monthly Mean Dip with each needle.	Monthly Mean Dip with both the needles.		Difference needles (4c−4d) and (1—2).		Remarks.
1905		H.	M.		°	′	° ′	°	′	°	′	
August	21	13	41	1	22	59·0		22	59·4	−0	0·3	
"	"	13	41	2	22	58·6						
"	24	12	58	1	22	57·8	Needle No. 2,					
"	"	12	58	2	22	59·7	22 59·5					
"	28	12	32	1	22	57·6						
"	"	12	32	2	22	57·8						
September	1	13	43	1	22	59·1						
"	"	13	43	2	22	59·1						
"	4	13	21	1	22	58·7	Needle No. 1,					
"	"	13	21	2	22	60·2	22 59·1					
"	7	13	18	1	22	60·1						
"	"	13	18	2	22	59·5						
"	11	13	37	1	22	60·5						
"	"	13	37	2	22	59·6						
"	14	13	45	1	22	60·6		22	59·3	−0	0·3	
"	"	13	45	2	22	59·5						
"	18	13	16	1	22	57·3						
"	"	13	16	2	22	58·0						
"	21	13	8	1	22	57·5						
"	"	13	8	2	22	58·8	Needle No. 2,					
"	25	12	31	1	22	58·3	22 59·4					
"	"	12	31	2	22	59·0						
"	28	13	20	1	22	60·0						
"	"	13	20	2	22	60·9						
October	2	12	41	1	22	58·0						
"	"	12	41	2	22	59·1						
"	5	13	14	1	22	57·6	Needle No. 1,					
"	"	13	14	2	22	58·9	22 57·0					
"	9	12	27	1	22	56·7						
"	"	12	27	2	22	58·0						
"	12	12	34	1	22	54·6						
"	"	12	34	2	22	56·2						
"	16	12	28	1	22	55·9		22	57·4	−0	0·8	
"	"	12	28	2	22	57·6						
"	21	13	33	1	22	59·6						
"	"	13	33	2	22	59·9						
"	23	12	28	1	22	57·8						

Observations of Dip, Taungoo—concld.

1	2	3	4	5	6	7	8
Date.	L. M. T.	Needle No.	Dip.	Monthly Mean Dip with each needle.	Monthly Mean Dip with both the needles.	Difference needles (4c—4d) and (1—2).	Remarks.
1905.	H. M.		° ′	° ′	° ′	° ′	
October 23	12 28	2	22 57·6	Needle No. 2, 22 57·8			
" 26	13 11	1	22 57·8				
" "	13 11	2	22 58·1				
" 30	13 41	1	22 55·1				
" "	13 41	2	22 55·0				
November 2	13 23	1	22 55·5	Needle No. 1, 22 58·2			
" "	13 23	2	22 58·0				
" 6	13 52	1	22 57·9				
" "	13 52	2	22 58·5				
" 9	13 25	1	22 57·4				
" "	13 25	2	22 57·5				
" 13	13 57	1	22 59·3				
" "	13 57	2	22 58·9				
" 16	13 41	1	22 60·7				
" "	13 41	2	22 62·3		22 58·7	—0 1·0	
" 20	13 18	1	22 57·2				
" "	13 18	2	22 59·5				
" 23	13 37	1	22 58·7				
" "	13 37	2	22 61·3	Needle No. 2, 22 59·2			
" 27	12 53	1	22 59·3				
" "	12 53	2	22 59·0				
" 30	13 9	1	22 57·6				
" "	13 9	2	22 57·6				
December 4	13 35	1	22 57·1				
" "	13 35	2	22 58·3				
" 7	13 31	1	22 58·8	Needle No. 1, 22 58·3			
" "	13 31	2	22 60·0				
" 11	13 34	1	22 58·4				
" "	13 34	2	22 58·0				
" 15	13 2	1	22 59·1		22 58·9	—0 1·2	
"	13 2	2	22 60·8				
" 16	8 49	1	22 59·0				
" "	8 49	2	22 60·4				
" 18	9 28	1	22 57·7				
" "	9 28	2	22 59·8	Needle No. 2, 22 59·5			
" 28	12 47	1	22 58·1				
" "	12 47	2	22 59·3				

Hourly means of Horizontal Force in C. G. S. Units (corrected for temperature) at Toungoo from the selected quiet days in 1905.

Months.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
1905. 0.38000+10γ.												Winter.													
	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 . .	654	654	653	653	651	652	654	660	661	666	670	674	676	672	669	669	662	653	644	650	647	640	636	643	657
February . .	643	645	617	649	648	652	652	654	661	673	684	690	687	678	669	660	649	646	647	645	641	645	643	641	656
March . .	648	646	647	648	647	646	647	650	660	677	696	707	707	698	685	672	660	655	652	649	645	644	642	643	661
October . .	668	670	669	668	669	670	670	669	676	689	705	717	719	712	695	684	678	676	673	674	673	671	670	672	681
November . .	665	666	669	669	670	671	675	679	691	701	710	718	719	711	695	684	675	673	674	675	669	666	667	663	682
December . .	678	672	676	675	676	676	678	683	689	697	702	707	704	696	690	687	683	679	677	680	678	677	675	678	684
Means .	659	659	660	660	660	661	663	666	673	684	695	702	702	695	684	676	663	664	661	662	659	657	656	658	670
												Summer.													
April . . .	656	653	652	653	654	655	657	656	666	684	701	706	705	695	687	677	665	656	653	651	649	648	648	649	666
May . . .	675	675	676	675	675	676	678	681	687	695	706	713	713	709	703	691	682	671	667	667	666	667	667	667	682
June . .	671	671	671	670	671	671	673	676	683	692	703	707	706	704	696	683	673	664	660	664	661	657	661	663	677
July . . .	677	678	678	677	677	679	681	688	696	705	716	721	719	717	708	697	685	678	675	675	674	674	678	676	689
August . .	678	678	679	679	679	680	681	686	694	705	713	717	720	719	708	698	689	682	680	681	679	677	676	674	690
September . .	659	659	660	662	663	666	662	657	657	671	688	694	697	692	685	674	668	662	663	663	664	662	662	660	669
Means .	669	669	669	669	670	671	672	674	681	692	705	710	710	706	698	687	677	669	666	667	666	664	665	665	679

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

Months.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
1905.	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 . . .	−3	−3	−4	−4	−6	−5	−3	+3	+4	+9	+13	+17	+19	+15	+12	+12	+5	−4	−13	−7	−10	−17	−21	−14
February . . .	−13	−11	−9	−7	−8	−4	−4	−2	+5	+17	+28	+34	+31	+22	+13	+4	−7	−10	−9	−11	−15	−11	−13	−15
March	−13	−15	−14	−13	−14	−15	−14	−11	−1	+16	+35	+46	+46	+37	+24	+11	−1	−6	−9	−12	−16	−17	−19	−18
October . . .	−13	−11	−12	−13	−12	−11	−11	−12	−5	+8	+24	+36	+38	+31	+14	+3	−3	−5	−8	−7	−8	−10	−11	−9
November . . .	−17	−16	−13	−13	−12	−11	−7	−3	+9	+19	+28	+36	+37	+29	+13	+2	−7	−9	−8	−7	−13	−16	−15	−14
December . . .	−11	−12	−8	−9	−8	−8	−6	−1	+5	+13	+18	+23	+20	+12	+6	+3	−1	−5	−7	−4	−6	−7	−9	−6
Means	−11	−11	−10	−10	−10	−9	−7	−4	+3	+14	+25	+32	+32	+25	+14	+6	−2	−6	−9	−8	−11	−13	−14	−12
Summer.																								
April	−10	−13	−14	−13	−12	−11	−9	−10	0	+18	+35	+40	+39	+29	+21	+11	−1	−10	−13	−15	−17	−18	−18	−17
May	−7	−7	−6	−7	−7	−6	−4	−1	+5	+13	+24	+31	+31	+27	+21	+9	0	−11	−15	−15	−16	−15	−15	−15
June	−6	−6	−6	−7	−6	−6	−4	−1	+6	+15	+26	+30	+29	+27	+19	+6	−4	−13	−17	−13	−16	−20	−16	−14
July	−12	−11	−11	−12	−12	−10	−8	−1	+7	+16	+27	+32	+30	+28	+19	+8	−4	−11	−14	−14	−15	−15	−11	−13
August	−12	−12	−11	−11	−11	−10	−9	−4	+4	+15	+23	+27	+30	+29	+18	+8	−1	−8	−10	−9	−11	−13	−14	−16
September . . .	−10	−10	−9	7	−6	−3	−7	−12	−12	+2	+19	−25	+28	+23	+16	+5	−1	+7	−6	6	−5	−7	−7	−9
Means	−10	−10	−10	−10	−9	−8	−7	−5	+2	+13	+26	+31	+31	+27	+19	+8	−2	−10	−13	−12	−13	−15	−14	−14

NOTE.—When the sign is + the H. F. is above and when — it is below the mean.

Hourly means of the Declination as determined at Toungoo from the selected quiet days in 1905.

Declination East 0°+

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
Winter.																									
1905. Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	50·8	50·8	50·8	50·7	50·5	50·5	50·5	50·6	51·5	53·1	52·3	51·8	51·1	50·8	50·3	50·3	50·9	51·3	51·0	51·0	51·0	50·9	50·9	50·9	51·9
February	50·5	50·5	50·6	50·5	50·3	50·1	49·8	50·3	51·5	52·5	52·7	51·8	50·6	49·8	49·3	49·6	50·2	50·6	50·3	50·4	50·6	50·4	50·4	50·5	50·6
March	50·0	50·0	50·0	50·0	49·9	49·8	49·8	50·5	51·3	51·5	51·1	50·6	49·8	49·1	49·4	50·2	50·5	50·3	49·9	49·9	49·9	50·0	49·8	49·9	50·1
October	46·8	46·8	46·9	47·0	46·9	46·8	47·4	48·5	49·3	48·7	47·3	45·8	44·8	45·0	45·9	46·9	47·3	47·0	46·5	46·8	46·7	46·5	46·5	46·7	46·9
November	46·4	46·5	46·4	46·3	46·3	46·1	46·1	46·5	17·2	47·5	47·2	46·6	45·8	45·9	46·2	46·5	46·6	46·1	46·0	46·2	46·1	46·1	46·1	46·2	46·4
December	46·1	46·2	46·1	46·0	45·9	45·8	45·6	45·5	45·8	46·4	46·6	46·1	45·6	45·4	45·6	46·1	46·5	46·3	46·1	46·2	46·2	46·0	46·0	46·0	46·0
Means	48·4	48·5	48·5	48·4	48·3	48·2	48·2	48·7	49·4	49·8	49·5	48·8	48·0	47·7	47·8	48·3	48·7	48·6	48·3	48·4	48·4	48·3	48·3	48·4	48·5
Summer.																									
April	49·3	49·5	49·5	49·4	49·3	49·2	49·9	51·3	51·7	51·8	51·0	49·4	47·7	47·5	47·8	48·6	49·4	49·6	49·5	40·2	48·9	48·9	49·0	49·0	49·4
May	49·1	49·1	49·1	49·1	49·1	49·3	50·4	51·6	51·8	51·0	49·6	48·3	47·1	46·8	47·4	48·0	48·9	49·7	49·7	49·0	48·7	48·7	48·9	49·0	49·1
June	48·6	48·8	48·6	48·7	48·6	48·9	50·1	51·2	51·2	50·5	49·6	48·5	47·5	47·2	47·3	47·8	48·6	48·9	49·0	48·6	48·4	48·2	48·2	48·3	48·8
July	47·9	48·0	48·0	48·0	48·1	48·2	49·3	50·2	50·4	49·2	48·2	47·1	46·5	46·3	46·7	47·3	47·7	48·2	48·2	47·9	47·8	47·8	47·8	47·9	48·0
August	47·5	47·6	47·7	47·9	48·1	48·4	49·7	50·6	50·1	48·9	47·6	46·5	45·7	45·8	46·3	47·1	47·9	48·2	48·0	47·4	47·3	47·3	47·3	47·4	47·8
September	47·1	47·2	47·3	47·3	47·4	47·5	49·1	50·3	50·1	48·6	46·9	45·4	44·4	44·3	45·1	46·6	47·9	48·1	47·3	47·2	47·1	47·1	47·1	47·1	47·2
Means	48·3	48·4	48·4	45·4	48·4	48·6	49·8	50·9	50·9	50·0	48·8	47·5	46·5	46·3	46·8	47·6	48·4	48·8	48·6	48·2	48·0	48·0	48·1	48·1	48·4

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.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
1905, Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	−0·2	−0·2	−0·2	−0·3	−0·5	−0·5	−0·5	−0·4	+0·5	+1·1	+1·3	+0·8	+0·1	−0·2	−0·7	−0·7	−0·1	+0·3	0·0	0·0	0·0	−0·1	−0·1	−0·1
February	−0·1	−0·1	0·0	−0·1	−0·3	−0·5	−0·8	−0·3	+0·9	+1·9	+2·1	+1·2	0·0	−0·8	−1·3	−1·0	−0·4	0·0	−0·3	−0·2	−0·0	−0·2	−0·2	−0·1
March	−0·1	−0·1	−0·1	−0·1	−0·2	−0·3	−0·3	+0·4	+1·2	+1·4	+1·0	+0·5	· 0·3	−1·0	−0·7	+0·1	+0·4	+0·2	−0·2	−0·2	−0·2	−0·1	−0·3	−0·2
October	−0·1	−0·1	0·0	+0·1	0·0	−0·1	+0·5	+1·6	+2·4	+1·8	+0·4	−1·1	−2·1	−1·9	−1·0	0·0	+0·4	+0·1	−0·4	−0·1	−0·2	−0·4	−0·4	−0·2
November	0·0	+0·1	0·0	−0·1	−0·1	−0·3	−0·3	+0·1	+0·8	+1·1	+0·8	+0·2	−0·6	−0·5	−0·2	+0·1	+0·2	−0·3	−0·4	−0·2	−0·3	−0·3	−0·3	−0·2
December	+0·1	+0·2	+0·1	0·0	−0·1	−0·2	−0·4	−0·5	−0·2	+0·4	+0·6	+0·1	−0·4	−0·6	−0·4	+0·1	+0·5	+0·3	+0·1	+0·2	+0·2	0·0	0·0	0·0
Means	−0·1	0·0	0·0	−0·1	−0·2	−0·3	−0·3	+0·2	+0·9	+1·3	+1·0	+0·3	−0·5	−0·8	−0·7	−0·2	+0·2	+0·1	−0·2	−0·1	−0·1	−0·2	−0·2	−0·1
Summer.																								
April	−0·1	+0·1	+0·1	0·0	−0·1	−0·2	+0·5	+1·9	+2·3	+2·4	+1·6	0·0	−1·7	−1·9	−1·6	−0·8	0·0	+0·2	+0·1	−0·2	−0·5	−0·5	−0·4	−0·4
May	0·0	0·0	0·0	0·0	0·0	+0·2	+1·3	+2·5	+2·7	+1·9	+0·5	−0·8	−2·0	−2·3	−1·7	−1·1	−0·2	+0·6	+0·6	−0·1	−0·4	−0·4	−0·2	−0·1
June	−0·2	0·0	−0·2	−0·1	−0·2	+0·1	+1·3	+2·4	+2·4	+1·7	+0·8	−0·3	−1·3	−1·6	−1·5	−1·0	−0·2	+0·1	+0·2	−0·2	−0·4	−0·6	−0·6	−0·5
July	−0·1	0·0	0·0	0·0	+0·1	+0·2	+1·3	+2·2	+2·4	+1·2	+0·2	−0·9	−1·5	−1·7	−1·3	−0·7	−0·3	+0·2	+0·2	−0·1	−0·2	−0·2	−0·2	−0·1
August	−0·3	−0·2	−0·1	+0·1	+0·3	+0·6	+1·9	+2·8	+2·3	+1·1	−0·2	−1·3	−2·1	−2·0	−1·5	−0·7	+0·1	+0·4	+0·2	−0·4	−0·5	−0·5	−0·5	−0·4
September	−0·1	0·0	+0·1	+0·1	+0·2	+0·3	+1·9	+3·1	+2·9	+1·4	−0·3	−1·8	−2·8	−2·9	−2·1	−0·6	+0·7	+0·9	+0·1	0·0	−0·1	−0·1	−0·1	−0·1
Means	−0·1	0·0	0·0	0·0	0·0	+0·2	+1·4	+2·5	+2·5	+1·6	+0·4	−0·9	−1·9	−2·1	−1·6	−0·8	0·0	+0·4	+0·2	−0·2	−0·4	−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.

G.

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season, 1905-06.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
809	Diamond Harbour.	[illegible] 5	22 11 20	88 11 40	29 12	E 1 12	0·3744	
810	Canning . .	" 6	22 18 20	88 39 50	29 35	" 1 10	0·3742	
811	Bangaon . .	[illegible] 7	23 1 50	88 50 20	30 57	" 1 11	0·3728	
812	Jessore . .	[illegible] 1	23 9 50	89 12 40	31 15	" 1 12	0·3717	
813	Khulna . .	[illegible] 1	22 49 0	89 33 20	30 40	" 1 11	0·3727	
814	Barisál . .	" 2	22 41 10	90 22 0	30 17	" 1 5	0·3743	
815	Morelganj .	" 3	22 27 10	89 51 50	29 55	" 1 3	0·3751	
816	Chandpur .	[illegible] 2	23 14 0	90 38 0	31 29	" 1 10	0·3731	
817	Madáripur .	" 3	23 10 50	90 12 30	31 21	" 1 10	0·3731	
818	Dolaigunj .	" 4	23 42 10	90 25 30	32 26	" 1 11	0·3708	
819	Sripur . .	" 5	24 12 50	90 29 0	33 16	" 1 19	0·3697	
820	Mymensingh .	" 6	24 46 0	90 23 40	34 27	" 1 29	0·3670	
821	Jagannathganj	" 7	24 41 10	89 45 50	34 18	" 1 2	0·3684	
822	Porabari . .	" 8	24 13 20	89 51 30	33 24	" 1 24	0·3688	
823	Faridpur . .	" 9	23 37 10	89 51 10	33 8	" 1 17	0·3710	
824	Kumarkhali .	" 10	23 51 50	89 14 0	32 33	" 1 17	0·3692	
825	Chuadanga .	[illegible] 8	23 38 40	88 51 40	32 13	" 1 17	0·3700	
826	Krishnagar .	" 9	23 22 40	88 29 10	31 44	" 1 24	0·3704	
827	Plassey . .	" 10	23 46 20	88 17 10	32 5	" 0 53	0·3718	
828	Nawabganj .	" 11	24 35 40	88 16 0	34 8	" 1 39	0·3665	
829	Bulbulchundee .	" 12	24 58 50	88 14 30	35 0	" 1 29	0·3636	
830	Malanchi .	" 13	24 18 40	88 57 50	33 46	" 1 3	0·3696	
831	Santahar .	" 14	24 48 10	88 59 20	34 16	" 1 30	0·3671	
832	Fulchhari .	[illegible] 1	25 11 40	89 37 0	35 12	" 1 26	0·3646	
833	Kaunia . .	" 2	25 47 10	89 25 0	36 28	" 1 35	0·3621	
834	Cooch Behar .	" 3	26 18 30	89 26 20	37 16	" 1 43	0·3608	
835	Jainti . .	" 5	26 41 20	89 36 30	38 23	" 2 15	0·3521	
836	Parbatipur .	[illegible] 3	25 39 10	88 55 10	36 7	" 1 32	0·3631	
837	Panchabibi .	[illegible] 4	25 11 30	89 1 40	35 12	" 1 37	0·3644	
838	Chilahati .	[illegible] 5	26 14 30	88 48 10	37 0	" 1 41	0·3601	
839	Siliguri . .	" 6	26 42 20	88 26 10	37 55	" 1 55	0·3572	
840	Radhikapur .	" 7	25 38 30	88 26 50	36 10	" 1 28	0·3629	
841	Barsoe . .	" 8	25 38 50	87 55 40	36 12	" 1 34	0·3614	
842	Kishanganj .	" 9	26 5 50	87 56 50	36 37	" 1 35	0·3615	
843	Purnea . .	" 4	25 46 30	87 31 10	36 25	" 1 20	0·3621	
844	Madhipura .	[illegible] 6	25 55 40	86 47 30	36 29	" 1 29	0·3611	
845	Banarhat .	[illegible] 6	26 47 30	89 1 20	38 16	" 1 40	0·3572	

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season, 1905-06—contd.

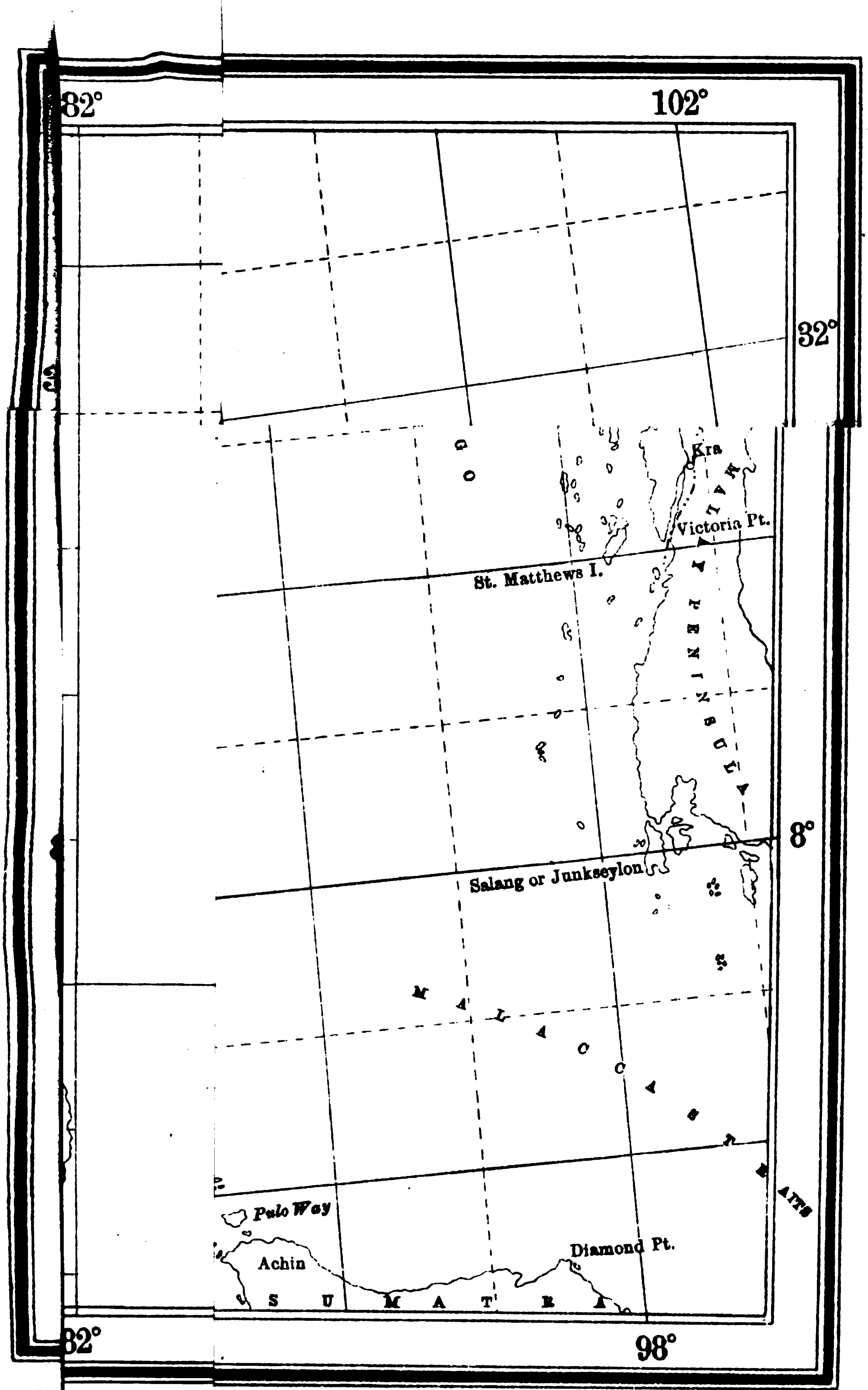
Serial No.	Name of Station.	Survey No.		Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
				° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
846	Dhubri Ghat .	26/90	7	26 1 0	89 59 50	36 31	E 1 21	0·3636	
847	Goálpárá .	„	8	26 11 10	90 37 40	36 47	„ 1 41	0·3617	
848	Kholabanda .	26/91	1	26 10 0	90 58 0	36 57	„ 1 35	0·3615	
849	Palásbári . .	„	2	26 7 40	91 32 40	36 57	„ 1 33	0·3622	
850	Mangaldai or Karupatia Ghat.	„	3	26 28 50	92 8 20	37 34	„ 1 43	0·3618	
851	Tezpur . .	„	4	26 37 50	92 48 20	38 46	„ 1 11	0·3611	
852	Beháli Mukh .	26/94	1	26 46 20	93 21 50	38 11	„ 1 37	0·3598	
853	Kokila Mukh .	„	2	26 51 10	94 8 50	38 22	„ 1 30	0·3603	
854	Názirá . .	„	3	26 54 30	94 43 50	38 30	„ 1 19	0·3601	
855	Sapekhati .	27/96	1	27 6 40	95 9 40	38 53	„ 1 26	0·3599	
856	Márgherita .	„	2	27 17 20	95 41 20	39 5	„ 1 18	0·3594	
857	Táláp . .	„	3	27 40 10	95 33 40	39 53	„ 1 29	0·3577	
858	Oating . .	26/94	4	26 26 10	93 59 30	37 55	„ 1 46	0·3600	
859	Manipur Road (Dimápur).	„	5	25 54 50	93 43 50	36 42	„ 1 13	0·3649	
860	Lumding .	„	6	25 44 50	93 10 40	36 12	„ 1 26	0·3666	
861	Kámpur . .	26/93	5	26 9 40	92 39 30	36 49	„ 1 27	0·3626	
862	Jági Road (Nakholá).	„	6	26 7 20	92 11 30	37 6	„ 1 36	0·3646	
863	Shillong . .	„	7	25 35 0	91 53 40	35 38	„ 1 21	0·3654	
864	Shangpung .	„	8	25 28 50	92 21 0	35 54	„ 1 40	0·3642	
865	Korongma .	„	9	25 26 10	92 43 30	35 54	„ 1 18	0·3660	
866	Háflang . .	25/94	7	25 11 30	93 1 10	35 14	„ 1 33	0·3629	
867	Karimganj .	24/92	1	24 52 0	92 22 10	34 37	„ 1 25	0·3688	
868	Tilágáon . .	„	2	24 26 40	91 57 30	33 49	„ 1 20	0·3697	
869	Sáistáganj .	„	3	24 16 50	91 26 10	33 30	„ 1 15	0·3700	
870	Kamalasagar .	„	4	23 44 40	91 9 10	32 26	„ 1 17	0·3720	
871	Laksam . .	„	5	23 15 40	91 7 20	31 30	„ 1 12	0·3735	
872	Noakhali . .	23/91	1	22 48 20	91 6 30	30 36	„ 1 6	0·3748	
873	Jamtara . .	24/87	7	23 58 40	86 48 50	32 59	„ 1 23	0·3662	
874	Dumka . .	24/88	14	24 15 50	87 14 40	33 17	„ 1 33	0·3364	
875	Godda . .	„	15	24 50 20	87 12 30	34 10	„ 1 8	0·3615	
876	Deoghur . .	24/87	8	24 29 0	86 41 0	33 45	„ 1 25	0·3651	
877	Ganwan . .	„	9	24 37 10	85 55 20	34 1	„ 1 42	0·3645	
878	Bagodar . .	„	10	24 4 50	85 49 30	33 5	„ 1 20	0·3658	
879	Hazaribagh .	„	11	23 59 40	85 22 10	32 38	„ 1 16	0·3682	
880	Chorparan .	„	12	24 22 30	85 15 40	33 33	„ 1 17	0·3645	
881	Emaumgung	24/85	4	24 27 20	84 34 50	33 27	„ 1 14	0·3651	
882	Chatra . .	„	5	24 12 10	84 53 0	32 51	„ 1 26	0·3647	
883	Balumath .	„	6	23 50 10	84 47 40	32 21	„ 1 17	0·3710	

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season, 1905-06—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
884	Lohardaga .	[illegible] 7	23 50 30	84 41 10	31 27	E 1 15	0·3677	
885	Latehar . .	„ 8	23 45 10	84 29 50	32 16	„ 1 21	0·3698	
886(a)	Daltonganj .	„ 3	24 2 10	84 3 40	32 38	„ 1 20	0·3662	Reobserved.
886	Meeral . .	„ 9	24 11 20	83 42 30	32 56	„ 1 20	0·3671	
887	Dúdhi . .	„ 10	24 12 40	83 14 30	33 8	„ 1 31	0·3647	
888	Manchee . .	„ 11	24 39 40	83 25 50	34 10	„ 1 50	0·3617	
889	Sháhganj .	[illegible] 10	24 42 30	82 56 40	34 5	„ 1 20	0·3613	
890	Lalganj . .	[illegible] 11	25 1 20	82 22 10	34 36	„ 1 32	0·3604	
891	Mauganj . .	[illegible] 2	24 40 50	81 50 40	34 11	„ 1 37	0·3598	
892	Sohagi . .	„ 3	24 59 20	81 42 0	34 37	„ 1 21	0·3601	
893	Rewah . .	„ 4	24 33 0	81 17 50	33 50	„ 1 22	0·3611	
894	Rámnagar .	„ 5	24 11 0	81 8 50	33 17	„ 1 26	0·3614	
895	Majhúli . .	„ 6	24 6 50	81 37 0	33 12	„ 1 7	0·3652	
896	Jiawan . .	[illegible] 7	24 20 20	82 16 20	33 29	„ 1 24	0·3683	
897	Saipur . .	„ 8	24 2 30	82 41 30	32 43	„ 1 21	0·3653	
898	Goini . .	„ 9	23 48 0	82 19 20	32 0	„ 1 23	0·3673	
899	Bharatpur .	„ 11	23 44 10	81 46 10	32 21	„ 1 14	0·3638	
900	Ninguani .	„ 12	23 18 50	8[illegible] 0 30	31 16	„ 1 17	0·3651	
901	Baikunthpur .	„ 13	23 16 20	82 33 0	31 7	„ 1 12	0·3674	
902	Mátin . .	[illegible] 12	22 43 50	82 25 0	30 32	„ 1 14	0·3685	
903	Korba . .	„ 13	22 20 30	82 42 30	29 40	„ 0 59	0·3701	
904	Dharamjaygarh	[illegible] 5	22 28 10	83 13 20	29 50	„ 1 6	0·3693	
905	Sikirma .	„ 6	22 26 40	83 56 20	29 45	„ 1 4	0·3682	
906	Jashpur . .	„ 7	22 52 40	84 8 30	30 43	„ 1 7	0·3694	
907	Champa . .	[illegible] 12	23 13 0	83 45 10	31 11	„ 1 19	0·3673	
908	Kalnai . .	[illegible] 8	22 46 30	83 30 20	30 24	„ 1 11	0·3701	
909	Bisrampur .	[illegible] 13	23 6 30	83 12 10	30 59	„ 1 13	0·3659	
910	Kunra . .	[illegible] 13	25 22 30	71 2 40	35 1	„ 1 53	0·3489	
911	Khésar . .	[illegible] 14	25 21 50	70 28 40	34 39	„ 1 37	0·3475	
912	Mithrea . .	„ 15	25 9 40	70 0 0	35 11	„ 1 39	0·3449	
913	Pircah Koláchi .	„ 16	25 1 30	69 26 20	34 32	„ 2 6	0·3471	
914	Talhár .	[illegible] 6	24 53 0	68 49 0	34 4	„ 1 43	0·3477	
915	Mirpur Batoro .	„ 7	24 44 10	68 15 20	33 52	„ 1 37	0·3476	
916	Sháhbandar .	„ 8	24 10 0	67 54 0	32 47	„ 1 33	0·3494	
917	Mirpur Sákro .	„ 9	24 33 10	67 37 0	33 33	„ 1 37	0·3476	
918	Mándir (Cutch) .	[illegible] 8	22 49 30	69 22 0	30 20	„ 1 46	0·3547	
919	Jakhau . .	[illegible] 10	23 13 10	68 43 10	30 53	„ 1 31	0·3534	
920	Banri . .	[illegible] 11	23 44 50	69 29 40	32 25	„ 1 40	0·3502	
921	Trangeri Bet .	„ 12	23 51 10	70 4 20	32 43	„ 0 57	0·3511	

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season, 1905-06—contd.

Serial No.	Name of Station.	Survey No.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C. G. S.	Remarks.
922	Lodhráni . .	24/70 13	23 53 50	70 37 30	32 10	E 1 36	0·3538	
923	Suigám . .	24/72 15	24 9 10	71 21 10	32 42	„ 1 4	0·3562	
924	Kalavád . .	22/70 10	22 12 20	70 22 50	29 37	„ 0 55	0·3577	
925	Salaya . .	„ 9	22 18 10	69 36 20	30 1	„ 1 38	0·3582	
926	Dwárka . .	22/68 1	22 14 40	68 57 10	29 39	„ 1 41	0·3562	
927	Gigásarán .	22/70 11	21 70 0	70 57 10	27 25	„ 0 50	0·3623	
928	Ghoba . .	22/72 11	21 25 40	71 34 20	27 47	„ 0 41	0·3608	
929	Sendwa . .	22/76 14	21 40 50	77 25 20	28 31	„ 0 47	0·3670	
930	Bori . .	22/78 14	22 8 10	77 25 10	28 23	„ 1 9	0·3632	
931	Dhár . .	„ 15	22 21 20	77 51 20	29 22	„ 1 4	0·3666	
932	Jámundonga .	„ 16	22 28 0	78 31 30	29 39	„ 1 0	0·3660	
933	Jangawáni	22/80 12	22 23 30	79 9 20	29 32	„ 1 13	0·3694	
934	Hospet . .	16/76 2	15 16 50	76 23 0	14 31	W 0 4	0·3797	
935	Rassul . .	20/86 6	20 37 20	85 19 10	26 5	E 1 4	0·3780	
936	Hondapa . .	20/82 2	20 56 30	84 42 10	26 42	„ 0 57	0·3762	
937	Charmal . .	22/84 9	21 6 20	84 12 50	27 7	„ 0 53	0·3749	
938	Sonpur . .	20/84 3	20 50 40	83 54 30	26 25	„ 0 46	0·3759	
939	Bisipara . .	„ 4	20 24 50	84 12 30	25 33	„ 0 48	0·3764	
940	Mojjagada .	„ 5	20 1 10	84 31 0	24 50	„ 0 43	0·3779	
941	Dashpala . .	„ 6	20 18 40	84 54 0	25 28	„ 0 49	0·3774	
942	Sihawa . .	20/82 4	20 18 40	81 54 40	25 47	„ 0 54	0·3729	
943	Raigarh . .	„ 5	19 53 20	82 4 20	24 50	„ 0 53	0·3755	
944	Dabgaon . .	„ 6	19 27 0	82 24 40	23 48	„ 0 31	0·3758	
945	Jeypore . .	18/82 4	18 51 30	82 34 40	22 37	„ 0 29	0·3767	
946	Padva . .	„ 5	18 22 20	82 40 40	21 29	„ 0 18	0·3800	
947	Raivalsa . .	18/82 4	18 13 50	83 1 30	21 3	„ 0 41	0·3794	
948	Bobbili . .	„ 5	18 34 30	83 21 10	21 59	„ 0 27	0·3794	
949	Rayagadda .	20/82 7	19 9 50	83 24 40	23 6	„ 0 25	0·3778	
950	Tikarapara .	„ 8	19 37 40	83 29 20	24 2	„ 0 35	0·3770	
951	Dadpur . .	„ 9	19 58 40	83 14 10	24 45	„ 0 29	0·3761	
952	Junagarh .	20/82 7	19 51 50	82 56 10	24 36	„ 0 23	0·3765	
953	Jamgaon or Jaipatna.	„ 8	19 28 10	82 48 20	23 45	„ 0 26	0·3769	
954	Jagdalpur .	„ 9	19 5 40	82 1 40	23 51	„ 0 38	0·3766	
955	Thackawada .	18/82 6	18 44 30	81 48 30	22 30	„ 0 28	0·3767	
956	Govindpili .	„ 7	18 34 50	82 17 0	21 55	„ 0 31	0·3799	
957	Malkangiri .	„ 8	18 21 50	81 53 30	21 33	„ 0 24	0·3802	
958	Pusigudiam .	„ 9	17 53 0	81 31 10	20 16	„ 0 25	0·3804	



No.

irection of Colone… at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún.

Oc

With corrections

Reg. No. 465-S. 06.

L 2

Repeat Stations.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
I	Udaipur . .		24 35 33	73 41 57	33 37	E 1 26	0·3532	
II	Karachi . .		24 49 50	67 2 2	33 58	„ 1 41	0·3464	
III	Quetta .		30 11 52	67 0 20	42 54	„ 3 0	0·3238	
IV	Baháwalpur .		29 23 27	71 40 37	41 56	„ 2 53	0·3324	
V	Ráwalpindi .		33 35 16	73 3 6	48 4	„ 3 43	0·3129	
VI	Bhurtpore .		27 13 27	77 29 28	38 35	„ 2 2	0·3464	
VII	Bangalore .		12 59 35	77 35 58	9 39	W 0 30	0·3814	
VIII	Dhárwár . .		15 27 26	74 59 35	15 10	E 0 3	0·3763	
IX	Porbandar .		21 38 20	69 37 6	28 32	„ 1 16	0·3607	
X	Fyzabad . .		26 47 27	82 7 40	37 47	„ 1 52	0·3534	
XI	Sambalpur .		21 28 3	83 58 24	27 43	„ 0 58	0·3726	
XII	Waltair . .		17 42 57	83 18 41	21 16	„ 0 23	0·3782	
XIII	Darjeeling .		26 59 39	88 16 39	38 14	„ 1 45	0·3567	
XIV	Gaya . .		24 46 30	84 58 54	34 9	„ 1 16	0·3664	
XV	Secunderábad .		17 27 11	78 29 16	20 0	„ 0 23	0·3791	
XVI	Bhusával .		21 2 46	75 47 18	26 47	„ 0 55	0·3680	
XVII	Jubbulpore .		23 8 57	79 56 44	30 51	„ 1 8	0·3643	
XVIII	Tavoy . .		14 4 50	98 12 50	12 17	„ 0 42	0·3947	
XIX	Lashio . .		22 56 47	97 44 30	31 16	„ 0 54	0·3759	
XX	Akyab . .		20 7 53	92 53 18	25 26	„ 0 55	0·3829	
XXI	Silchar or Cachar		24 49 43	92 47 21	34 37	„ 1 22	0·3688	
XXII	Dibrugarh .		27 29 24	94 55 40	39 25	„ 1 27	0·3584	

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 already been 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.

PENDULUM OPERATIONS.

Extracted from the Narrative Report of Major G. P. Lenox Conyngham, R.E., in charge No. 23 Party (Pendulums) for season 1905-06.

The work undertaken consisted of a series of pendulum observations at stations lying, roughly speaking, on a line stretching from Simla to Quetta.

Objects.

1. The objects of the season's work were :—

(*a*) To ascertain whether the marked deficiencies in gravity which had been observed in the outer Himalayan range and the submontane tracts, both on the meridian of Dehra Dún and on that of Darjeeling would again be found in the neighbourhood of Simla.

(*b*) To see whether the pendulums would throw light on the deflections of the plumb-line indicated by the Amritsar—Multan arc of longitude.

On this arc one would have expected to find the plumb-lines at both ends deflected outwards, towards the Himalayas and the Suleiman mountains respectively; but it was found on the contrary that they were attracted inwards.

(*c*) To make a first step towards the examination of the Baluchistan mountains.

(*d*) To make a set of observations at Captain Basevi's station at Mian Mir. This was the last station at which Basevi observed before starting on his journey to Moré, and at it the pendulums were swung on a stand which had been specially constructed for that difficult expedition. This stand, it has been thought, may have been less rigid than the ordinary one.

Choice of stations.

2. During the previous season, 1904-05, it had been found that observations made in a tent were not altogether satisfactory, owing to the unsteadiness of the temperature, it was therefore decided to visit in future only places at which a house of some sort could be obtained. At all the stations of this season, it was found possible to secure good observing rooms.

Temperatures.

3. As an additional safeguard against temperature errors a thermometer with its bulb inserted in a dummy pendulum had been obtained, it being hoped that even though the temperature of the air was varying, this thermometer would indicate the true temperature of the pendulum. The results given by it however were disappointing though for sometime the reason was obscure; it was eventually traced to the fact that there was too close a connection between the dummy pendulum and the masonry pillar, which being generally freshly built and still damp, was colder than the air of the room. The pair of thermometers which had been in use hitherto had however not been discarded and their readings had been regularly recorded; the latter have therefore been used in the reductions.

Measures are being taken to remedy the defect in the dummy pendulum.

Time Observations.

4. An innovation was this year introduced into the method of making the time observations. Hitherto it has been customary to observe one half of the programme of stars in one position of the transit instrument and the other half in

the reverse position, thus cancelling on the whole the effect of any error in the collimation correction, and certain other small errors. This year the plan was adopted of reversing the instrument half way through the observation of each star, thus an equal number of intersections in each position is obtained and the mean time of transit is free from collimation error, error due to inequality of pivots, and error due to imperfect knowledge of the wire intervals. Not only is each observation thus made complete in itself but the labour of the subsequent reduction is much diminished, for the tedious process of reducing to the centre wire is altogether done away with. The final result of a good programme of star transits is probably little if at all more accurate by the new method than by the old, but if clouds or accident interfere with a night's work, there used always to be the danger of being left with an ill-balanced set of observations, whereas by the new system this cannot occur.

5. The success of this method is shewn by the following figures which represent the average probable error of the clock's rate as determined by the observation of one star on two successive nights at the stations named.

Ludhiana	±0s·054	Multan . . .	±0s·044
Mian Mir	±0s·036	Jacobabad . . .	±0s·039
Ferozepore	±0s·061	Sibi	±0s·067
Pathankot	±0s·059	Mach	±0s·047
Montgomery . . .	±0s·032	Quetta	±0s·035
Dera Ghazi Khan . .	±0s·047		

The mean of these is ± 0s·047 and as the average number of stars observed each night was 15, the mean probable error of a final clock rate is ± 0s·012.

Throughout the season the time observations were made by Extra Assistant Superintendent Hanuman Prasad, and the above probable errors reflect credit on his powers as an observer.

Results.

6. The results of the season's work 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 $= \gamma_0$	$g_0'' - \gamma_0$
	° ′ ″	ft.				
Simla . . .	31—6—19	7043	978·842	979·267	979·386	−0·119
Kalká . . .	30—50—8	2202	979·149	979·280	979·364	−0·084
Ludhiana . .	30—52—25	833	979·276	979·325	979·371	−0·046
Pathankot . .	32—16—33	1088	979·239	979·303	979·481	−0·178
Mian Mir . .	31—31—36	708	979·385	979·426	979·420	+0·006
Ferozepur . .	30—55—48	647	979·343	979·380	979·372	+0·008

STATION.	Latitude.	Height above Sea Level.	Observed g.	g Reduced to Sea Level $=g''_0$	Theoretical value at Sea Level $=\gamma_0$	$g''_0-\gamma_0$
	° ′ ″	ft.				
Montgomery . .	30–39–47	557	979·323	979·356	979·351	+0·005
Multan . .	30–11–11	404	979·245	979·269	979·312	−0·043
Dera Ghazi Khan .	30–3–49	397	979·194	979·217	979·303	−0·086
Jacobabad . .	28–16–34	183	979·188	979·199	979·166	+0·033
Sibi . . .	29–32–46	434	979·121	979·146	979·262	−0·116
Mach . . .	29–52–25	3522	978·962	979·173	979·288	−0·115
Quetta . .	30–12–15	5520	978·852	979·176	979·314	−0·138

7. The deficiency in g at Simla is of the same order of magnitude as that found at Mussoorie. For comparison all the hill stations are here tabulated.

Himalayan Stations.

STATION	Height.	$g_0''-\gamma_0$	Thickness of corresponding disc.	Percentage of Height.
Mussoorie Camel's Back	6924	−·109	3100	45
,, Dunseverick . . .	7131	−·115	3270	46
Kurseong	4915	−·130	3700	75
Darjeeling	6966	−·143	4070	60
Sandakphú	11766	−·147	4180	36
Simla	7043	−·119	3380	48

8. The percentages of the compensation of the visible masses at Mussoorie and Simla are very similar, but differ considerably from those at the 3 stations in the Darjeeling region; the actual deficiencies at these 3 stations however are much the same and considerably more than those at Simla and Mussoorie. At Darjeeling and Sandakphú we are within sight of the giants, Kinchinjungá and Everest; by the theory of isostasy there must be greater defects under high ranges than under low ones, and even though the theory does not altogether represent the actual state of things, there is undoubtedly a tendency in that direction. It is therefore natural to suppose that at stations belonging to the same range of hills, using the term range in the sense of an original fold of the earth's crust, we should find deficiencies of similar amount in the underlying strata: but these defects would not bear equal ratios to the heights of the hills, for they would be common to regions of considerable extent, on which there would be higher and lower points, and they would also be almost wholly unaffect-

ed by the alterations in the form of the hills caused by climatic influences. It does not seem wholly unreasonable to entertain the hope that with the pendulum we may be able to trace out the original structural lines of the hills, to classify the ranges in families, and to reconstruct for ourselves their primary outlines before they were distorted and disguised by denudation, erosion and sedimentation.

Submontane Stations.

9. In the next table the stations in the submontane regions are collected.

STATION.	Height.	$g_0'' - \gamma_0$	Thickness of corresponding disc.	Position with reference to hills.
Jalpaiguri	ft. 268	−0·095	2700	25 miles from foot } Siwalik and Himalayan ranges are here not separate.
Siliguri	387	−·135	3840	8 " " " } Siwalik and Himalayan ranges are here not separate.
Dehra Dún	2241	−·121	3440	5 miles from Himalaya on north, 7 from Siwaliks on south.
Kalká	2202	−·084	2370	At foot of Himalayas. Siwaliks 4 miles S. W.
Pathankot	1088	−·178	5060	7 miles from foot of hills. Siwaliks here change direction.

The discrepancies between these defects are large and it is difficult to say whether the amount is to any extent a function of the position of the station with reference to the Himalayan and Siwalik ranges. A more detailed examination of at least two portions of the submontane country is mperative, as until this has been made we shall not be in a position to generalise even in the broadest lines. The region to be examined first should be one where the Himalayan and Siwalik ranges are quite distinct and where the general direction of both is more or less straight and parallel. No more suitable place can be found than the northern portion of the great arc. Observations have already been made at Mussoorie and Dehra Dún, and more should be undertaken at one or more intermediate places, and also in the Siwaliks and the country to the south as far as Kaliana at least.

The very large deficiency at Pathankot indicates that the conditions in this part of the country are abnormal and will require more detailed study.

Deflections at Amritsar and Multan.

10. Turning now to the second of the objects of the season's work which were enumerated at the beginning of this report, we find that the evidence of the pendulums goes far to explain the deflection of the plumb-line at Amritsar and Multan.

The very large deficiency at Pathankot and the considerable one at Dera Ghazi Khan acting in concert with the excess of matter about Mian Mir, Ferozepore and Montgomery, are ample to counteract the attractions of the more distant mountain masses, especially as the latter are shown by the evidence at Simla and Quetta to be less potent than they appear to the eye.

Observations at Mian Mir.

11. At Mian Mir the exact point at which Captain Basevi had observed could not be again occupied, as the house in which his station had been exists no longer. By a stroke of good fortune however a small house only about 100 yards from the site of his station became vacant a few days before the party arrived and the use of it was readily obtained.

The observations showed that the times of vibration of the mean pendulum at Dehra Dún and Mian Mir respectively were:—

Dehra Dún.	*Mian Mir.*	*Difference.*	*Diff. in g.*
·5072511	·5071682	829×10^{-7}	+0·320

In Volume V the vibration numbers at Dehra Dún and Mian Mir are given as—

Dehra Dún.		*Mian Mir.*
86020·86	and	86034·55

difference = 13·69

The connection between the vibration number and *g* is given by the formula—

$$\delta N = \tfrac{1}{2} N \frac{\delta g}{g}, \text{ or } \delta g = \frac{2\,\delta N g}{N}$$

Hence, *g* at Dehra being 979·065,

$$\delta g = \frac{2 \times 13{\cdot}69 \times 979{\cdot}065}{86020{\cdot}86}$$

$$= {\cdot}311$$

This differs from the value now obtained by 0·009 which is not a large quantity. The observation at Mian Mir therefore does not show that the special stand used by Basevi at that place and at Moré, introduced a new source of error.

Captain Basevi's observations led to the conclusion that the value of *g* at Mian Mir was in defect by 0·106 whereas the new result shows an excess of 0·006.

Basevi's value of *g* at Dehra was	978·962
the more recent value is	979·065
Difference	+0·103
Difference between Dehra and Mian Mir old . . .	0·311
" " " " new . . .	0·320
Difference	+0·009
Sum of differences	+0·112

12. It will be noticed that the principal difference between the results of the old and the new Pendulum observations seems to reside in the value of *g* at Dehra Dún. It is imperative that when a suitable opportunity occurs, further observations be made to redetermine the difference in the value of *g* at Kew and Dehra Dún respectively; but the matter is not urgent, for differential operations having Dehra Dún as their base can be perfectly well carried on without an accurate knowledge of the acceleration of gravity at the base. Just as an erroneous longitude of the station of origin is of little or no consequence to a survey until a connection is made with the work of other nations, so in the case of determinations of gravity the absolute value of the acceleration is scarcely required so long as the series is self-contained and rests on one base station.

Value of *g* at Dehra Dún.

13. The large excess of the observed over the computed value of *g* at Jacobabad is a noteworthy and unexpected result. It will be recollected that an excess of similar amount was found in the plains of Bengal during the previous year. It is too early to draw any conclusion or even analogy from this similarity but its existence must be kept in mind.

Observations in Sind.

14. During the year a new chronograph of the same type as a Morse recording instrument was received, but it was not taken into use. The drum chronograph belonging to the longitude equipment, which has been used hitherto, is a first-rate instrument but very heavy and it was thought desirable to obtain a lighter one in case of expeditions in difficult country. In the spring of 1905

New chronograph.

when Sandakphú was visited, the transport of the big chronograph was a source of some trouble, even though there is a good road the whole way. The new chronograph is a copy of one in the possession of the Royal Observatory, Greenwich.

15. As has already been stated a good observing room was obtained at each of the stations of the past season's programme, and no great variations of temperature during any set of observations were met with.

Variations of temperature.

In the following table the average temperatures and hourly changes of temperature inside the pendulum cover are given :—

Stations.	Night.		Day.		Day and Night.	
	Average temperature.	Average hourly change.	Average temperature.	Average hourly change.	Average temperature.	Average hourly change.
Dehra Dún	20·93	—0·02	20·79	+0·10	20·86	+0·04
Simla	11·91	+0·02	10·86	+0·07	11·39	+0·05
Kalka	17·73	+0·12	18·02	+0·15	17·88	+0·14
Ludhiána	16·91	+0·06	16·54	+0·04	16·73	+0·05
Mian Mir	15·18	+0·07	14·91	+0·01	15·05	+0·04
Ferozepore	14·29	+0·04	14·12	+0·05	14·21	+0·05
Pathankot	16·07	+0·06	15·96	+0·11	16·02	+0·08
Montgomery	16·47	—0·03	16·84	+0·06	16·66	+0·02
Dera Ghazi Khan	15·15	+0·04	15·24	—0·01	15·20	+0·02
Multan	17·49	+0·02	17·42	+0·10	17·46	+0·06
Jacobabad	21·56	—0·02	21·72	+0·05	21·64	+0·02
Sibi	22·79	+0·02	22·96	+0·09	22·88	+0·06
Mach	17·33	+0·01	17·23	+0·03	17·28	+0·02
Quetta	16·07	—0·02	16·37	+0·15	16·22	+0·06
Dehra Dún	26·21	—0·11	26·35	+0·11	26·28	±0·00

The hourly changes at all the stations are so similar that no lag corrections have been applied. Kalka is the only station at which there is any noticeable difference. The correction, if applied, would be about 4×10^{7} in the time of vibration, which corresponds to 0·0016 in *g*, a quantity which is not of very great importance.

16. At the beginning of the field season a set of observations was made in the tent as well as in the pendulum room with a view to examining the question of lag with the aid of the dummy pendulum, but the results were incon-

clusive owing to the fact, already alluded to, that the thermometer in the dummy pendulum always indicated too low a temperature.

17. The behaviour of the clock during the season has not been all that could be desired. It has one very marked peculiarity, namely, that the rate always becomes faster from day to day. On the average the increase from day to day is $0^s{\cdot}34$. The maximum increase was $1^s{\cdot}16$ and, out of 29 values of the change which are available, 26 are increases, 2 are decreases and on one occasion the rate did not change at all.

This liability to change does not seem to pass off if the clock be allowed to run for some time before observations are begun, for at Montgomery, owing to cloudy weather, the clock had been going for a week before a single star observation could be obtained, and yet the rates in three successive periods of 24 hours were +0·39, +0·57 and +0·73. It may be that as the weight descends the rate increases, or rather that the rate is faster when the weight is low than when it is high, but it is difficult to establish this, for during a series of pendulum observations it is not desirable to open the clock and wind it up and the opportunity for making a sufficiently long series of observations for the special purpose of investigating this point is not easy to find.

I have not been able to think of any reason for a change in the rate depending upon the position of the weight. A progressive decrease in the temperature of the room might account for it, but an examination of the rates and temperatures does not show any connection between them.

18. The effect of this change of rate on the final results is not likely to amount to an important quantity, for the adopted mean rates probably agree well with the average of the actual rates of the clock at the times during which the pendulums were being observed. And besides this the character of the variation being so constant its influence at each station would be the same and would therefore have no effect on the differences between the base station and the field stations.

19. The probable errors of the final results as deduced from the discordances between the individual values are as given in table A.

TABLE A.

Stations.	No. of sets	Σvv.	Mean Pendulum. Probable error of result of single set.	Mean Pendulum. Probable error of Final value.
Dehra Dún	3	114	±5·09	±2·94
Simla	3	218	7·04	4·06
Ludhiana	4	27	2·02	1·01
Mian Mir	3	17	1·97	1·14
Ferozepore	3	17	1·97	1·14
Pathankot	3	145	5·74	3·32
Montgomery	3	32	2·70	1·56

Stations.	No. of sets.	Σvv.	Mean Pendulum. Probable error of result of single set.	Probable error of Final value.
Dera Ghazi Khan	3	146	5·76	3·33
Multan	3	162	6·07	3·50
Jacobabad	3	3	0·83	0·48
Sibi	2	13	2·43	1·72
Mach	2	41	4·32	3·05
Quetta	3	13	1·72	0·99
Dehra Dún	4	27	2·02	1·01
Sums	42	975	49·68	...

Hence the average probable error of the result of a single set is $\pm 3·55$ or, summing all the residuals,

$$p.\ e.\ \text{of result of single set} = ·6745\sqrt{\frac{975}{(42-14)}} = ·6745 \times 5·90 = \pm 3·98$$

Hence the result of the mean of three sets would have a *p. e.* of $\pm 2·30$.

20. This does not represent the total probable error, for there are several sources of error which do not tend to produce discrepancies between individual results; such are, error in the determination of the flexure correction, errors in the co-efficients of the temperature and pressure corrections, and errors in the corrections applied to the thermometers and the barometer.

21. In table B the differences between the individual pendulums and the mean pendulum at each station and finally the means of these differences are shewn. If the lengths of the pendulums have remained constant these differences should not vary.

TABLE B.

Stations.	Differences from mean Pendulum.				Residuals.			
	137	138	139	140	137	138	139	140
Dehra Dún	−77	−2484	+908	+1652	−2	−4	+4	+3
Simla	−77	−2488	+908	+1657	−2	0	+4	−2
Ludhiana	−73	−2491	+906	+1659	−6	+3	+6	−4
Kalka	−81	−2500	+925	+1656	+2	+12	−13	−1
Mian Mir	−77	−2492	+909	+1660	−2	+4	+3	−5

STATIONS.	Differences from mean Pendulum.				RESIDUALS.			
Ferozepore . .	−75	−2492	+909	+1656	−4	+4	+3	−1
Pathankot . .	−77	−2485	+909	+1652	−2	−3	+3	+3
Montgomery. .	−80	−2487	+913	+1654	+1	−1	−1	+1
Dera Ghazi Khan .	−80	−2487	+912	+1655	+1	−1	0	0
Multan . . .	−79	−2491	+917	+1653	0	+3	−5	+2
Jacobabad . .	−80	−2485	+907	+1660	+1	−3	+5	−5
Sibi . . .	−81	−2488	+915	+1655	+2	0	−3	0
Mach . . .	−82	−2484	+916	+1652	+3	−4	−4	+3
Quetta . .	−80	−2486	+910	+1656	+1	−2	+2	−1
Dehra Dún . .	−83	−2486	+916	+1655	+4	−2	−4	0
Means . .	−79	−2488	+912	+1655				
Sum of squares of residuals					105	254	360	105
Sum of all					824			

22. There is some evidence of slight progressive change in the case of pendulums 137 and 139. The time of vibration of 137 seems to have increased relatively to the mean, and that of 139 to have decreased, that is to say, 137 seems to have become longer and 139 shorter. It is however uncertain whether the changes are real or only apparent, depending on errors of observation. Even if real they are not likely to have exercised any seriously prejudicial result on the deduced values of *g*, for the latter depend on the length of the mean pendulum remaining constant and the two changes under discussion being of opposite sign will have cancelled each other.

If means be formed for the first and second halves of the season's work respectively, omitting Kalka where the results are somewhat discordant, we have—

Pendulum . . .	137	138	139	140
First half . . .	−77	−2488	+909	+1656
Second half . .	−81	−2487	+913	+1655
Change . . .	−4	+1	+4	−1

A change of 4×10^{-7} in the time of vibration of one of these pendulums corresponds to a change in its length of about $0^{mm}\cdot00004$.

23. In table B the residuals, that is the discrepancies between the differences at each station and the means of all are also shewn.

24. It can be shewn that the probable error of the time of vibration of any pendulum at any station is

$$\rho = \cdot6745\sqrt{\frac{\Sigma vv}{3(n-1)}}$$

where Σvv is the sum of all the residuals formed in table B and "n" is the number of stations.

$$\text{Hence } \rho = \cdot6745\sqrt{\frac{824}{3(15-1)}} = \pm2\cdot98$$

25. In table A the observations at Kalka could not be made use of as only one set was made there, if we again omit Kalka the above figures become

$$= \cdot6745\sqrt{\frac{506}{3(14-1)}} = \pm2\cdot43$$

This is the probable error of the final time of vibration of one pendulum at a station, as there were generally 3 sets of observations, the probable error of the result of one set for one pendulum would be $\pm2\cdot43 \times \sqrt{3} = \pm4\cdot21$
and for the mean pendulum $\pm2\cdot10$

26. In the discussion which follows table A this quantity is found $= \pm3\cdot98$. The cause of the difference between the two lies in the fact that the residuals of table A depend upon the variations in the deduced time of vibration of the mean pendulum from day to day. These variations are probably largely due to errors in the adopted clock rate. The residuals of table B depend on the differences between the individual pendulums and the mean pendulum and are not affected by errors in the adopted rate, for the same rate is always used in reducing each of the four pendulums.

27. We may consider that the following are the sources of error affecting the reduced time of vibration :—

1. Errors of observation in coincidence period.
2. Errors of reading thermometers.
3. Errors of reading hygrometer and barometer (very insignificant).
4. Errors of observing arc of vibration (very insignificant).
5. Errors of corrections applied to thermometer readings.
6. Errors due to lag of temperature of pendulums.
7. Errors in determination of clock rate.
8. Errors due to inequalities in the clock's rate.
9. Errors in the determination of the flexure correction.

Errors of class 5 will be nearly constant throughout the observations of one station, for the readings will all be from the same part of the scale, they may vary slightly from station to station but will have no effect on the differences from the mean pendulum.

Errors of class 7 will produce discrepancies between different days but not between different pendulums.

Errors of class 9 will be constant throughout a station, at least if the true flexure remains constant. This is probably the case except where the observations were begun immediately after the erection of the pillar and while the mortar in it was still very wet ; such occasions are rare. The discrepancies between different days or different pendulums throw but little light on this error.

Errors of classes 6 and 8, which are the most important of all, are not purely accidental. Inequalities of clock rate are no doubt partly dependent on imperfections in the mechanism and on ground tremors which must be considered accidental, but they seem to be to a large extent systematic, for they have a distinct daily period. This is known from the fact that though the actual rates at epochs 12 hours apart may differ from each other, yet the mean of these rates will approximate to the mean daily rate. This is taken advantage of in devising the programme of observation and it may be taken that the systematic part of errors of class 8 has been almost wholly eliminated from the mean of a day and a night observation.

Lag of temperature is doubtless governed by law and if the course of the temperature of the air were completely known the temperature of a suspended pendulum might conceivably be deduced with all precision. But the pendulums have to be moved from one place to another, and must therefore be touched from time to time, also when swinging they must be more liable to convection than when at rest. On the whole therefore it seems impossible at present to treat errors due to lag as other than accidental. If the temperature at night were made to fall and that by day to rise at the same rate, or *vice versâ*, a large part of this error would probably be eliminated, but it is difficult to control the temperature with sufficient accuracy and only on one occasion was this cancelment achieved.

Errors of class 6 will therefore be considered accidental.

We thus find that errors of classes 5 and 9 will not leave any mark on the residuals of either table A or table B, that all the others have a share in producing those of table A but that class 7 is not a factor in those of table B.

If we call the total probable error produced by causes 1, 2, 3, 4, 6, 7 and 8 ρ_a and that produced by all the above with the exception of 7, ρ_b and that produced by 7, ρ_7

$$\text{Then } \rho_a^2 = \rho_b^2 + \rho_7^2$$
$$\text{or } (3{\cdot}98)^2 = (2{\cdot}10^2) + \rho_7^2$$
$$\rho = \sqrt{13{\cdot}4} = \pm\, 3{\cdot}66$$

28. The clock rate correction = $58{\cdot}7 \times$ rate in seconds per day $\times 10^{-7}$.

Therefore if the error in the correction = 3·66, the error in the adopted rate = 0·062. The average probable error of the clock rate was shewn near the beginning of this report to be ± 0·012 and the discrepancy between this value and that now deduced is extremely large.

29. The value ± 0·012 is computed from the discrepancies between the results by the different stars. If there were any constant source of error affecting a whole night's work its influence would not be felt in these discrepancies. Such a source of error can only be (*a*) the level correction, (*b*) the retardation of the electric current acting upon the chronograph, (*c*) the pen equation of the latter, (*d*) the personal equation of the observer.

Inequalities in (*b*) are probably very small indeed; (*c*) can be read off with great precision; about (*d*) there is some uncertainty but it is little likely to vary from night to night by a quantity amounting to nearly a tenth of a second. We are then reduced to (*a*). An error in the clock rate is produced by the sum of the errors on two successive nights of observation. Hence if ϵ be the probable error of the dislevelment in seconds of arc on any night we have

$$2\left(\frac{\epsilon}{15}\cos.\zeta\ \sec.\ \delta\right)^2 = (\cdot 062)^2$$

In latitude 30°, sec δ = 1·16

Hence for a Zenith star we have

$$2\left(\frac{\epsilon}{15}\ 1\cdot16\right)^2 = (\cdot062)^2$$

whence $\epsilon = 0''\cdot57$

That is to say if the probable error of the observed dislevelment of the transit axis is $\pm\ 0''\cdot57$ the probable error of the clock rate deduced from transits on successive nights will be $\pm\ 0^s\cdot062$.

$\pm\ 0''\ 57$ is however a large value for the probable error of the determination of the dislevelment, and it seems likely that a considerable portion of the error under discussion is due to variations in the clock's rate other than those which are eliminated by the procedure of observing at epochs separated by 12 hours. Variations of rate are difficult to measure, and though capable of being totally eliminated by swings extending over the 24 hours, the present apparatus and method of observing do not lend themselves to their investigation.

The final probable error of the time of vibration of the mean pendulum, in units of the seventh decimal place, may be estimated thus :—

P.E.	arising from errors 1, 2, 3, 4, 6, 7, 8	$\pm\ 3\cdot98$
P.E.	" " " 5	$\pm\ 0\cdot5$
P.E.	" " " 9	$\pm\ 2\cdot0$

Final probable error $= \pm\ 4\cdot5$

Hence the probable error in the difference between the times of vibration at the Base and at a field station

$$= 4\cdot5\sqrt{2} = \pm\ 6\cdot4$$

and the probable error of the deduced difference in $g = \pm\ 0^{cm}\cdot0025$.

III.

TIDAL AND LEVELLING OPERATIONS.

Extracted from the Narrative Report of Mr. C. F. Erskine, in charge No. 25 Party (Tidal and Levelling), for season 1905-06.

TIDAL OPERATIONS.

Work of the year.

1. During the year tidal registrations were obtained by means of self-registering tide-gauges at 9 observatories. The reduction by harmonic analysis of the observations for 1905 of 9 stations has been completed in the office at Dehra Dun. The publication of tide-tables for 1907 and 1908 is being carried out in England. Data for the tide-tables for 1909 is in course of preparation. The number of ports for which predictions are made is 40.

List of Tidal Stations.

2. The following table gives a complete list of the 42 ports at which observations have been and still are being taken. Of these 8 are now working, 34 have been closed on completion of their registrations. The permanent stations are shown in italics, the others are minor stations at which only a few years' registrations were required:—

	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	"	1898	1902	5	
3	*Aden*	"	1879	Still working.	26	
4	Maskat	"	1893	1898	5	
5	Bushire	"	1892	1901	8	
6	*Karachi*	"	1881	Still working.	25	
7	Hanstal	"	1874	1875	1	Tide-tables not published.
8	Nowanar	"	1874	1875	1	Tide-tables not published.
9	Okha Point	"	1874 re-started. 1904	1875 1906	1 2* (3)	*One year's observation rejected.
10	Porbandar	Personal.	1893	1894	2	
10A	Porbandar	Automatic.	1898	1902	5	With certain interruptions.
11	Port Albert Victor (Kathiawar).	Personal.	1881	1882	1	

	Stations.	Automatic or personal observations.	Date of commencement of observations.	Date of closing of observations.	No. of years of observations.	Remarks.
11A	Port Albert Victor (Kathiawar).	Automatic.	1900	1903	4	
12	Bhavnagar . . .	„	1889	1894	5	
13	*Bombay (Apollo Bandar)*	„	1878	Still working.	28	
14	*Bombay (Prince's Dock)* .	„	1888	„	18	Property of Port Trust.
15	Mormugâo (Goa) . .	„	1884	1889	5	
16	Karwar	„	1878	1883	5	
17	Beypore . . .	„	1878	1884	6	
18	Cochin	„	1886	1892	6	
19	Tuticorin . . .	„	1888	1893	5	
20	Minicoy . . .	„	1891	1896	5	
21	Galle	„	1884	1890	6	
22	Colombo . . .	„	1884	1890	6	
23	Trincomalee . . .	„	1890	1896	6	
24	Pamban Pass . . .	„	1878	1882	4	
25	Negapatam . . .	„	1881	1888	6	Year 1884-85 is excluded.
26	*Madras* . . .	„	1880 re-started. 1895	1890 Still working.	10 11 } 21	
27	Cocanada . . .	„	1886	1891	5	
28	Vizagapatam . . .	„	1879	1885	6	
29	False Point . . .	„	1881	1885	4	
30	Dublat (Saugor Island) .	„	1881	1886	5	
31	Diamond Harbour . .	„	1881	1886	5	
32	*Kidderpore* . . .	„	1881	Still working.	25	
33	Chittagong . . .	„	1886	1891	5	
34	Akyab	„	1887	1892	5	
35	Diamond Island . .	„	1895	1899	5	
36	Bassein (Burma) . .	„	1902	1903	2	
37	Elephant Point . .	„	1880 re-started. 1884	1881 1888	1 5 } 6	

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	Stations.	Automatic or personal observ-ations.	Date of commence-ment of observ-ations.	Date of closing of observations.	No. of years of observ-ations.	Remarks.
38	*Rangoon*	Auto-matic.	1880	Still work-ing.	26	
39	Amherst	„	1880	1886	6	
40	Moulmein	„	1880	1886	6	
41	Mergui	„	1889	1894	5	
42	*Port Blair*	„	1880	Still work-ing.	26	

Observatories closed or opened during the year.

3. Okha Point tidal observatory was closed on 3rd January 1906, after a little over one year's tidal registrations had been obtained. No new tidal observatory was opened during the year.

The Government of India have sanctioned the re-opening of a tidal observatory at Moulmein, and the inclusion of Moulmein as an Indian tidal station.

Mr. Shaw was instructed to visit Moulmein and assist the Port Officer in selecting a suitable site for the Observatory. At an interview he had with the Port Officer on 5th February 1906, he was informed that the Executive Engineer, Moulmein, had already selected a site and submitted plans and estimate to Government. This site is unsuitable on account of lengthy pipe communication between river water and cylinder of gauge, which is objectionable, as from experience we have found that whenever pipe communication is used, frequent breaks in the tidal registrations invariably occur, due to the choking up or breaking of the pipes. Mr. Shaw suggested a more suitable site where no pipe communication was needed, to the Port Officer, and to which he agreed, but the question has not yet been finally settled.

Personal tidal observations.

4. In addition to the automatic registrations made at the stations enumerated above, personal tidal observations to graduated staves were taken daily at the closed tidal stations of Bhavnagar, Chittagong, Akyab and Moulmein, with the object of comparing actual times and heights of high and low water with the predicted times and heights.

Inspection of observatories.

5. All the tidal observatories were inspected during the year.

Working of tidal observatories.

6. The following is a detailed account of the working of the several observatories during the year, commencing with Aden and following the order of the stations round the coast to Burma.

7. *Aden.*—This observatory was inspected by Mr. J. P. Barker in February 1906. There were a few unimportant breaks in the tidal registrations due to the band of the gauge sticking. The auxiliary instruments have worked well throughout the year.

8. *Karachi.*—This observatory was inspected by Mr. C. F. Erskine, Officer in charge of the Tidal Party and Mr. Barker, in January 1906. There were a few short interruptions in the tidal curves due to faulty communication between the sea and cylinder of the gauge. The self-registering aneroid worked well during

the year. On 3rd May 1906 a large new anemograph was set up in the old anemometer house, and, with the exception of two interruptions, has worked well.

9. *Okha Point.*—This observatory was inspected by Mr. Barker in December 1905 and January 1906, and finally closed and dismantled on 3rd January 1906, a little over a year's complete tidal registrations having been obtained. From these registrations a new value of mean sea level has been deduced. The height of mean sea level obtained in 1874 was 9·65 feet above the zero of the gauge; from the recent observations it was found to be 9·60 feet. The difference of 0·05 foot falls well within the difference in the yearly variation of mean sea level obtaining at ports where continuous observations have been carried on through many successive years, and it is so small, that the values obtained by the first observations may be considered identical with those now deduced.

In order to complete the observations required to furnish the means of finally ascertaining whether any change had taken place in the relative levels of land and sea, on the Gulf of Cutch, in the vicinity of Okha, a line of levels was run from the Bench-marks at the tidal station to Gadichi village, a distance of about 11 miles inland, in the course of which 6 old Bench-marks were connected.

The following table shows a comparison of the heights obtained in season 1905-06, with those obtained in season 1874-75. The heights in this table are referred to the zero of the gauge. The zero of the gauge adopted was identical with that fixed upon in 1873:—

Nature of mark.	Distance from Tidal station.	Season.		Difference Old—new.
		1874-75.	1905-06.	
	Miles.			
Zero of Gauge	*Nil*	Origin	Origin	
Mean Sea Level	"	9·65	9·60	+0·05
G. T. S. B. M. A at Tidal Station	"	20·07	20·07	0·00
G. T. S. B. M. B at Tidal Station	"	19·52	19·52	0·00
G. T. S. B. M. C at Tidal Station	"	17·22	17·22	0·00
G. T. S. ° B. M. at Jairam's well at Aramra Village	5	19·77	19·76	+0·01
G. T. S. ° B. M. at Gadichi Hill	10	99·24	99·20	+0·04
Bench-mark embedded at Gadichi Village	11	70·14	70·08	+0·06

Summing up the above statements and figures, it may safely be said that the results of the investigations prove conclusively that no movement of the land relatively to the sea, has taken place in this neighbourhood within the past 32 years.

10. *Bombay* (*Apollo Bandar*).—This observatory was inspected by Mr. Erskine and Mr. Barker in January 1906. There were no interruptions in the tidal registrations during the year.

Bombay (*Prince's Dock*).—This observatory was inspected by Mr. Erskine and Mr. Barker in January 1906. There were five interruptions in July and one in August, in the tidal registrations during the year, due to the driving clock stopping.

12. *Madras.*—This observatory was inspected by Mr. H. G. Shaw in January 1906. There was no break during the year in the registrations of the tide gauge and auxiliary instruments.

13. *Kidderpore.*—This observatory was inspected by Mr. Shaw in January 1906. The registrations by the tide gauge and self-registering aneroid are complete. The self-registering anemometer was frequently out of order.

14. *Rangoon.*—This observatory was inspected by Mr. Shaw in January and February 1906. There was only one short break in the tidal registrations throughout the year, due to the breaking of the copper wire attached to the counterpoise weight of driving clock. The clock of the self-registering aneroid stopped for a few hours on two occasions. The self-registering anemometer was out of order from 10th to 15th May 1906.

15. *Port Blair.*—This observatory was inspected by Mr. Shaw in December 1905. There were, during the year, two unimportant short breaks in the registrations of the tide-gauge and one each in those of the self-registering aneroid and self-registering anemometer, due, in each case, to the stopping of the driving clocks.

Tidal diagrams and daily reports.

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

Tidal constants.

17. The tidal observations for a year at 9 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, 1905.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1905 Observations at Aden; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1905 Observations:—

Short Period Tides.

A_0=5·855 feet.

S_1	H = R =	·087	M_6	R =	·006	Q_1	R =	·129	T_2	R =	·027
	κ = ζ =	166°·47		ζ =	5°·91		ζ =	138°·06		ζ =	189°·61
S_2	H = R =	·604		H =	·006		H =	·155		H =	·027
	κ = ζ =	243°·45		κ =	352°·65		κ =	26°·31		κ =	190°·57
S_4	H = R =	·006	M_8	R =	·002	L_2	R =	·037	$(MS)_4$	R =	·018
	κ = ζ =	273°·75		ζ =	289°·65		ζ =	225°·11		ζ =	70°·51
S_6	H = R =	·006		H =	·002		H =	·043		H =	·017
	κ = ζ =	219°·56		κ =	31°·97		κ =	200°·41		κ =	186°·09
S_8	H = R =	·002	O_1	R =	·546	N_2	R =	·467	$(2SM)_2$	R =	·025
	κ = ζ =	260°·54		ζ =	104°·66		ζ =	150°·46		ζ =	219°·21
				H =	·655		H =	·452		H =	·024
				κ =	37°·14		κ =	221°·82		κ =	103°·63
M_1	R =	·036	K_1	R =	1·173	λ_2	R =	...	$2N_2$	R =	·080
	ζ =	182°·52		ζ =	208°·16		ζ =	...		ζ =	153°·89
	H =	·022		H =	1·305		H =	...		H =	·077
	κ =	336°·20		κ =	33°·82		κ =	...		κ =	181°·03
M_2	R =	1·603	K_2	R =	·131	ν_2	R =	·142	$(M_2N)_4$	R =	·013
	ζ =	110°·54		ζ =	42°·91		ζ =	294°·78		ζ =	36°·68
	H =	1·551		H =	·170		H =	·138		H =	·012
	κ =	226°·1[illegible]		κ =	235°·01		κ =	211°·13		κ =	223°·62
M_3	R =	·025	P_1	R =	·397	μ_2	R =	·083	$(M_2K_1)_3$	R =	·034
	ζ =	43°·99		ζ =	222°·99		ζ =	323°·06		ζ =	78°·32
	H =	·023		H =	·397		H =	·077		H =	·037
	κ =	217°·36		κ =	32°·65		κ =	194°·22		κ =	19°·56

Short Period Tides—contd.

M_4	R =	·005	J_1	R =	·071	R_2	R =	...	$(2M_2K_1)_3$	R =	·007
	ζ =	38°·66		ζ =	207°·97		ζ =	...		ζ =	348°·34
	H =	·004		H =	·083		H =	...		H =	·007
	κ =	269°·82		κ =	75°·30		κ =	...		κ =	33°·84

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide	·018	273·08	·016	317·30
„ Fortnightly „	·034	325·24	·051	35·88
Luni-Solar „ „	·007	175·74	·007	60·16
Solar-Annual „	·326	76·99	·326	357·33
„ Semi-Annual „ . .	·117	289·38	·117	130·07

VALUES OF THE TIDAL CONSTANTS, KARÁCHI, 1905.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1905 Observations at Karáchi; and also the mean values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1905 Observations:—

Short Period Tides.

A_0 = 7·120 feet.

S_1	H = R =	·084	M_6	R =	·042	Q_1	R =	·134	T_2	R =	·028
	κ = ζ =	185°·46		ζ =	206°·36		ζ =	148°·93		ζ =	263°·66
S_2	H = R =	·964		H =	·038		H =	·161		H =	·028
	κ = ζ =	322°·46		κ =	197°·58		κ =	39°·53		κ =	264°·69
S_4	H = R =	·012	M_8	R =	·004	L_2	R =	·078	$(MS)_4$	R =	·048
	κ = ζ =	347°·84		ζ =	89°·31		ζ =	316°·26		ζ =	186°·29
S_6	H = R =	·009		H =	·004		H =	·091		H =	·046
	κ = ζ =	277°·05		κ =	197°·59		κ =	292°·26		κ =	303°·36
S_8	H = R =	·002	O_1	R =	·558	N_2	R =	·675	$(2SM)_2$	R =	·021
	κ = ζ =	199°·29		ζ =	112°·71		ζ =	204°·47		ζ =	216°·43
				H =	·609		H =	·653		H =	·020
				κ =	46°·73		κ =	278°·12		κ =	99°·36
M_1	R =	·050	K_1	R =	1·193	λ_2	R =	...	$2N_2$	R =	·081
	ζ =	185°·93		ζ =	219°·53		ζ =	...		ζ =	206°·02
	H =	·030		H =	1·328		H =	...		H =	·078
	κ =	340°·35		κ =	45°·13		κ =	...		κ =	236°·25
M_2	R =	2·080	K_2	R =	·179	ν_2	R =	·211	$(M_2N)_4$	R =	·030
	ζ =	176°·15		ζ =	123°·04		ζ =	346°·24		ζ =	150°·91
	H =	2·593		H =	·231		H =	·204		H =	·028
	κ =	293°·22		κ =	315°·62		κ =	264°·77		κ =	341°·63
M_3	R =	·052	P_1	R =	·398	μ_2	R =	·087	$(M_2K_1)_3$	R =	·056
	ζ =	141°·01		ζ =	233°·81		ζ =	38°·53		ζ =	127° 06
	H =	·050		H =	·398		H =	081		H =	·060
	κ =	316°·61		κ =	43°·53		κ =	272°·68		κ =	69°·73
M_4	R =	·025	J_1	R =	·007	R_2	R =	...	$(2M_2K_1)_3$	R =	·008
	ζ =	104° 33		ζ =	226°·59		ζ =	...		ζ =	272°·94
	H =	·023		H =	·078		H =	..		H =	·008
	κ =	338°·48		κ =	93°·06		κ =	...		κ =	321°·48

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide	·076	248·68	·068	292·10
„ Fortnightly „	·012	341·66	·018	50·69
Luni-Solar „ „	·003	236·68	·003	119·61
Solar-Annual „	·166	231·11	·166	151·39
„ Semi-Annual „	·216	305·74	·216	146·31

VALUES OF THE TIDAL CONSTANTS, OKHA POINT, 1905.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1905 Observations at Okha Point; and also the ***mean*** values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1905 Observations :—

Short Period Tides.

A_0 = 9·598 feet.

S_1	H = R =	·071	M_6	R =	·010	Q_1	R =	·135	T_2	R =	...
	κ = ζ =	2· 3°·74		ζ =	109°·70		ζ =	291°·65		ζ =	...
S_2	H = R =	1·155		H =	·009		H =	·162		H =	...
	κ = ζ =	14°·10		κ =	180°·24		κ =	53°·01		κ =	...
S_4	H = R =	·011	M_8	R =	·016	L_2	R =	·246	$(MS)_4$	R =	·038
	κ = ζ =	116°·32		ζ =	103°·61		ζ =	341°·32		ζ =	221°·11
S_6	H = R =	·002		H =	·014		H =	287		H =	·037
	κ = ζ =	266°·19		κ =	77°·67		κ =	25°·51		κ =	124°·63
S_8	H = R =	·001	O_1	R =	·584	N_2	R =	·890	$(2SM)_2$	R =	·026
	κ = ζ =	114·44		ζ =	331°·18		ζ =	26°·45		ζ =	146°·75
				H =	·701		H =	·861		H =	·025
				κ =	57°·49		κ =	325°·01		κ =	243°·24
M_1	R =	·066	K_1	R =	1·288	λ_2	R =	...	$2N_2$	R =	·165
	ζ =	169°·81		ζ =	232°·89		ζ =	...		ζ =	291°·07
	H =	·040		H =	1·434		H =	...		H =	·160
	κ =	37°·15		κ =	52°·61		κ =	..		κ =	264°·68
M_2	R =	3·803	K_2	R =	·250	ν_2	R =	·313	$(M_2N)_4$	R =	·072
	ζ =	83°·29		ζ =	190°·41		ζ =	188°·54		ζ =	247°·50
	H =	3·679		H =	·323		H =	·303		H =	·067
	κ =	346°·80		κ =	10°·64		κ =	321°·48		κ =	89°·58
M_3	R =	·032	P_1	R =	·417	μ_2	R =	·157	$(M_2K_1)_3$	R =	·058
	ζ =	333°·52		ζ =	237°·38		ζ =	16°·58		ζ =	335°·86
	H =	·031		H =	·417		H =	·147		H =	·062
	κ =	8°·79		κ =	53°·02		κ =	183°·60		κ =	59°·10
M_4	R =	·126	J_1	R =	·105	R_2	R =	...	$(2M_2K_1)_2$	R =	·031
	ζ =	300°·80		ζ =	303°·89		ζ =	...		ζ =	245°·67
	H =	·118		H =	·123		H =	...		H =	·032
	κ =	107°·83		κ =	86°·04		κ =	...		κ =	232°·97

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·089	302°·25	·080	267°·20
„ Fortnightly „ . . .	·014	167·85	·021	78·74
Luni-Solar „ „ . . .	·082	136·73	·079	233·22
Solar-Annual „ . . .	·121	250·08	·121	164·45
„ Semi-Annual „ . . .	·207	314·38	·207	143·11

VALUES OF THE TIDAL CONSTANTS, BOMBAY (APOLLO BANDAR), 1905.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1905 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 1905 Observations :—

Short Period Tides.

A_0 = 10·066 feet.

S_1	H = R =	·077	M_6	R =	·030	Q_1	R =	·132	T_2	R =	·041
	κ = ζ =	181°·87		ζ =	30°·85		ζ =	153°·51		ζ =	319°·29
S_2	H = R =	1·575		H =	·027		H =	·158		H =	·041
	κ = ζ =	4°·90		κ =	23°·26		κ =	44°·74		κ =	320°·33
S_4	H = R =	·017	M_8	R =	·017	L_2	R =	·081	$(MS)_4$	R =	·103
	κ = ζ =	243°·44		ζ =	353°·94		ζ =	336°·69		ζ =	266°·26
S_6	H = R =	·005		H =	·015		H =	·094		H =	·099
	κ = ζ =	178°·92		κ =	3°·82		κ =	312°·87		κ =	23°·73

Short Period Tides—contd.

S_8	H = R =	·002	O_1	R =	·546	N_2	R =	1·061	$(2SM)_2$	R =	·023
	κ = ζ =	56°·31		ζ =	115°·39		ζ =	241°·44		ζ =	229°·07
				H =	·655		H =	1·026		H =	·022
				κ =	49°·83		κ =	315°·70		κ =	111°·60
M_1	R =	·047	K_1	R =	1·247	λ_2	R =	...	$2N_2$	R =	·155
	ζ =	205°·00		ζ =	219°·50		ζ =	...		ζ =	255°·95
	H =	·029		H =	1·388		H =	...		H =	·150
	κ =	359°·62		κ =	45°·08		κ =	...		κ =	287°·00
M_2	R =	4·131	K_2	R =	·265	ν_2	R =	·294	$(M_2N)_4$	R =	·011
	ζ =	214°·30		ζ =	161°·32		ζ =	19°·32		ζ =	104°·42
	H =	3·997		H =	·342		H =	·284		H =	·011
	κ =	331°·77		κ =	353°·26		κ =	298°·43		κ =	296°·15
M_3	R =	·080	P_1	R =	·399	μ_2	R =	·236	$(M_2K_1)_3$	R =	·079
	ζ =	213°·24		ζ =	235°·87		ζ =	76°·63		ζ =	200°·75
	H =	·076		H =	·399		H =	·221		H =	·085
	κ =	29°·45		κ =	45°·60		κ =	311°·57		κ =	143°·80
M_4	R =	·113	J_1	R =	·078	R_2	R =	...	$(2M_2K_1)_3$	R =	·043
	ζ =	82°·73		ζ =	229°·02		ζ =	...		ζ =	2°·48
	H =	·105		H =	·091		H =	...		H =	·045
	κ =	317°·67		κ =	95°·26		κ =	...		κ =	51°·83

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·071	243°·91	·064	287°·12
„ Fortnightly „	·021	314·06	·031	22·66
Luni-Solar „ „	·017	278·32	·016	160·85
Solar-Annual „	·116	273·43	·116	193·70
„ Semi-Annual „	·162	320·69	·162	161·22

Values of the Tidal Constants, Bombay (Prince's Dock), 1905.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1905 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 1905 Observations :—

Short Period Tides.

A_0=7·981 feet.

S_1	H = R =	·076	M_6	R =	·003	Q_1	R =	·133	T_2	R =	·042
	κ = ζ =	183°·39		ζ =	335°·10		ζ =	152°·27		ζ =	327°·95
S_2	H = R =	1·595		H =	·003		H =	·159		H =	·042
	κ = ζ =	5°·62		κ =	327°·51		κ =	43°·50		κ =	328°·99
S_4	H = R =	·016	M_8	R =	·011	L_2	R =	087	$(MS)_4$	R =	·123
	κ = ζ =	233°·42		ζ =	298°·56		ζ =	327°·42		ζ =	277°·14
S_6	H = R =	·006		H =	·010		H =	·101		H =	·119
	κ = ζ =	222°·14		κ =	48°·44		κ =	303°·60		κ =	34°·61
S_8	H = R =	·001	O_1	R =	·541	N_2	R =	1·064	$(2SM)_2$	R =	·030
	κ = ζ =	92°·55		ζ =	115°·34		ζ =	242°·30		ζ =	230°·49
				H =	·649		H =	1·029		H =	·029
				κ =	49°·78		κ =	316°·56		κ =	113°·02
M_1	R =	·048	K_1	R =	1·239	λ_2	R =	...	$2N_2$	R =	·147
	ζ =	208°·85		ζ =	219°·59		ζ =	...		ζ =	257°·61
	H =	·030		H =	1·379		H =	...		H =	·142
	κ =	3°·47		κ =	45°·17		κ =	...		κ =	288°·66
M_2	R =	4·166	K_2	R =	·260	ν_2	R =	·276	$(M_2N)_4$	R =	·014
	ζ =	214°·52		ζ =	163°·69		ζ =	19°·91		ζ =	156°·97
	H =	4·031		H =	·336		H =	·267		H =	·013
	κ =	331°·99		κ =	355°·63		κ =	299°·03		κ =	348°·71
M_3	R =	·081	P_1	R =	·395	μ_2	R =	·234	$(M_2K_1)_3$	R =	·089
	ζ =	214°·03		ζ =	234°·99		ζ =	78°·26		ζ =	202°·22
	H =	·077		H =	·395		H =	·219		H =	·095
	κ =	30°·24		κ =	44°·72		κ =	313°·20		κ =	145°·28

Short Period Tides—contd.

Tide			Tide			Tide			Tide		
M_4	R =	·115	J_1	R =	·079	R_2	R =	...	$(2M_2K_1)_3$	R =	·046
	ζ =	95°·89		ζ =	230°·03		ζ =	...		ζ =	11°·96
	H =	·108		H =	·093		H =	...		H =	·048
	κ =	330°·83		κ =	96°·27		κ =	...		κ =	61°·32

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide	·076	250·70	·068	293·91
„ Fortnightly „	·028	320·32	·042	28·92
Luni-Solar „ „	·013	286·08	·013	168·61
Solar-Annual „	·019	245·27	·019	165·54
„ Semi-Annual „	·172	330·21	·172	170·75

Values of the Tidal Constants, Madras, 1905.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1905 Observations at Madras; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1905 Observations:—

Short Period Tides.

$A_0 = 2·338$ feet.

Tide			Tide			Tide			Tide		
S_1	H = R =	·021	M_6	R =	·004	Q_1	R =	·003	T_2	R =	·030
	κ = ζ =	90°·28		ζ =	113°·43		ζ =	213°·69		ζ =	164°·69
S_2	H = R =	·445		H =	·003		H =	·004		H =	·030
	κ = ζ =	273°·28		κ =	107°·35		κ =	105°·71		κ =	165°·76
S_4	H = R =	·001	M_8	R =	·002	L_2	R =	·041	$(MS)_4$	R =	·008
	κ = ζ =	228°·01		ζ =	47°·73		ζ =	267°·59		ζ =	130°·76
S_6	H = R =	·001		H =	·002		H =	·048		H =	·008
	κ = ζ =	68°·96		κ =	159°·61		κ =	243°·99		κ =	48°·74
S_8	H = R =	·000	O_1	R =	·075	N_2	R =	·257	$(2SM)_2$	R =	·015
	κ = ζ =	255°·96		ζ =	35°·08		ζ =	161°·99		ζ =	317°·73
				H =	·089		H =	·249		H =	·015
				κ =	330° 04		κ =	237°·03		κ =	199°·75
M_1	R =	·028	K_1	R =	·266	λ_2	R =	...	2 N_2	R =	·035
	ζ =	156°·48		ζ =	152°·57		ζ =	..		ζ =	174°·27
	H =	·017		H =	·296		H =	...		H =	·033
	κ =	311°·35		κ =	338°·13		κ =	...		κ =	206°·37
M_2	R =	1·123	K_2	R =	·087	ν_2	R =	·083	$(M_2N)_4$	R =	·003
	ζ =	125°·38		ζ =	81°·02		ζ =	306°·43		ζ =	38°·05
	H =	1·086		H =	·112		H =	·081		H =	·003
	κ =	243°·35		κ =	272°·93		κ =	226°·28		κ =	231°·05
M_3	R =	·002	P_1	R =	·089	μ_2	R =	·038	$(M_2K_1)_3$	R =	·015
	ζ =	213°·69		ζ =	171°·26		ζ =	330°·03		ζ =	95°·27
	H =	·002		H =	·089		H =	·036		H =	·016
	κ =	30°·65		κ =	341°·01		κ =	205°·97		κ =	38°·80
M_4	R =	·008	J_1	R =	·016	R_2	R =	...	$(2M_2K_1)_3$	R =	·002
	ζ =	331°·65		ζ =	118°·18		ζ =	...		ζ =	295°·46
	H =	·007		H =	·019		H =	...		H =	·003
	κ =	207°·59		κ =	344°·13		κ =	...		κ =	345°·84

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide	·052	228·17	·047	271·10
„ Fortnightly „	·069	325·86	·103	33·91
Luni-Solar „ „	·023	72·87	·022	314·90
Solar-Annual „	·265	253·81	·265	174·06
„ Semi-Annual „	·336	285·93	·336	126·43

VALUES OF THE TIDAL CONSTANTS, KIDDERPORE, 1905.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1905 Observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1905 Observations :—

Short Period Tides.

A_0 = 10·593 feet.

S_1	H = R =	·078	M_6	R =	·200	Q_1	R =	·017	T_2	R =	·070
	κ = ζ =	196°·05		ζ =	326°·95		ζ =	77°·58		ζ =	225°·23
S_2	H = R =	1·573		H =	·181		H =	·021		H =	·070
	κ = ζ =	98°·22		κ =	322°·50		κ =	330°·46		κ =	226°·32
S_4	H = R =	·082	M_8	R =	·096	L_2	R =	·247	$(MS)_4$	R =	·724
	κ = ζ =	102°·29		ζ =	156°·65		ζ =	82°·51		ζ =	314°·71
S_6	H = R =	·007		H =	·084		H =	·287		H =	·701
	κ = ζ =	327°·65		κ =	270°·71		κ =	59°·18		κ =	73°·23
S_8	H = R =	·008	O_1	R =	·194	N_2	R =	·802	$(2SM)_2$	R =	·090
	κ = ζ =	305°·11		ζ =	87°·93		ζ =	326°·47		ζ =	129°·86
				H =	·233		H =	·776		H =	·087
				κ =	23°·45		κ =	42°·34		κ =	11°·35
M_1	R =	·057	K_1	R =	·389	λ_2	R =	...	$2N_2$	R =	·033
	ζ =	223°·23		ζ =	225°·22		ζ =	...		ζ =	265°·02
	H =	·035		H =	·432		H =	...		H =	·032
	κ =	18°·37		κ =	50°·76		κ =	...		κ =	298°·24
M_2	R =	3·931	K_2	R =	·326	ν_2	R =	·358	$(M_2N)_4$	R =	·342
	ζ =	298°·10		ζ =	261°·78		ζ =	94°·02		ζ =	184°·83
	H =	3·804		H =	·421		H =	·346		H =	·320
	κ =	56°·62		κ =	93°·64		κ =	14°·67		κ =	19°·22
M_3	R =	·062	P_1	R =	·157	μ_2	R =	·207	$(M_2K_1)_3$	R =	·077
	ζ =	118°·94		ζ =	229°·16		ζ =	305°·13		ζ =	81°·60
	H =	·059		H =	·157		H =	·194		H =	·083
	κ =	296°·71		κ =	38°·94		κ =	182°·16		κ =	25°·66
M_4	R =	·838	J_1	R =	·026	R_2	R =	...	$(2M_2K_1)_3$	R =	·022
	ζ =	156°·44		ζ =	277°·35		ζ =	...		ζ =	246°·84
	H =	·785		H =	·030		H =	...		H =	·023
	κ =	38°·47		κ =	142°·98		κ =	...		κ =	298°·33

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·372	318°·53	·333	1°·18
„ Fortnightly „	·199	320·48	·296	27·94
Luni-Solar „ „	·994	159·13	·961	40·61
Solar Annual „	2·731	232·27	2·731	152·49
„ Semi-Annual „	1·009	142·91	1·009	343·36

VALUES OF THE TIDAL CONSTANTS, RANGOON, 1905.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1905 Observations at Rangoon; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1905 Observations :—

Short Period Tides.

A_0 = 10·209 feet.

S_1	H = R =	·112	M_6	R =	·263	Q_1	R =	·017	T_2	R =	·082
	κ = ζ =	121°·23		ζ =	88°·19		ζ =	134°·28		ζ =	90°·21
S_2	H = R =	2·145		H =	·238		H =	·020		H =	·082
	κ = ζ =	166°·70		κ =	85°·34		κ =	27°·99		κ =	91°·32
S_4	H = R =	·088	M_8	R =	·104	L_2	R =	·500	$(MS)_4$	R =	·452
	κ = ζ =	254°·72		ζ =	342°·53		ζ =	158°·93		ζ =	84°·42
S_6	H = R =	·011		H =	·092		H =	·582		H =	·437
	κ = ζ =	78°·17		κ =	98°·73		κ =	135°·84		κ =	203°·47

Short Period Tides—contd.

S_8	H = R =	·001	O_1	R =	·230	N_2	R =	1·170	$(2SM)_2$	R =	·156
	κ = ζ =	164°·75		ζ =	89°·10		ζ =	38°·83		ζ =	167°·42
				H =	·275		H =	1·132		H =	·151
				κ =	25°·18		κ =	115°·52		κ =	48°·37
M_1	R =	·038	K_1	R =	·629	λ_2	R =	...	$2N_2$	R =	·149
	ζ =	283°·67		ζ =	207°·66		ζ =	...		ζ =	316°·82
	H =	·023		H =	·700		H =	...		H =	·144
	κ =	79°·08		κ =	33°·18		κ =	...		κ =	351°·15
M_2	R =	6°·072	K_2	R =	·405	ν_2	R =	·497	$(M_2N)_4$	R =	·201
	ζ =	9°·35		ζ =	332°·82		ζ =	183°·36		ζ =	316°·92
	H =	5·874		H =	·523		H =	4·81		H =	·188
	κ =	128°·40		κ =	164°·64		κ =	104°·79		κ =	152°·66
M_3	R =	·058	P_1	R =	·180	μ_2	R =	·498	$(M_2K_1)_3$	R =	·092
	ζ =	160°·05		ζ =	237°·71		ζ =	44°·73		ζ =	109°·57
	H =	·055		H =	·180		H =	·466		H =	·099
	κ =	338°·63		κ =	47°·50		κ =	282°·83		κ =	54°·14
M_4	R =	·476	J_1	R =	·041	R_2	R =	...	$(2M_2K_1)_3$	R =	·099
	ζ =	286°·20		ζ =	254°·42		ζ =	...		ζ =	355°·31
	H =	·446		H =	·048		H =	...		H =	·103
	κ =	164°·30		κ =	119°·76		κ =	...		κ =	47°·89

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide . . .	·159	337·77	·142	20·13
„ Fortnightly „	·133	346·83	·198	53·72
Luni-Solar „ „ . . .	·452	165·85	·437	46·80
Solar-Annual „ . . .	1·497	221·79	1·497	141·99
„ Semi-Annual „ . . .	·249	148·60	·249	349·01

VALUES OF THE TIDAL CONSTANTS, PORT BLAIR, 1905.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1905 Observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epoch (κ) for each particular tide evaluated from the 1905 Observations:—

Short Period Tides.

A_0 = 4·703 feet.

S_1	H = R =	·013	M_6	R =	·001	Q_1	R =	·012	T_2	R =	·022
	κ = ζ =	11°·40		ζ =	289°·98		ζ =	334°·09		ζ =	295°·27
S_2	H = R =	·948		H =	·001		H =	·014		H =	·022
	κ = ζ =	315°·85		κ =	286°·44		κ =	227°·45		κ =	296°·37
S_4	H = R =	·009	M_8	R =	·006	L_2	R =	·093	$(MS)_4$	R =	·027
	κ = ζ =	348°·69		ζ =	315°·00		ζ =	286°·81		ζ =	182°·71
S_6	H = R =	·003		H =	·005		H =	·109		H =	·026
	κ = ζ =	233°·13		κ =	70°·27		κ =	263°·61		κ =	301° 52
S_8	H = R =	·003	O_1	R =	·125	N_2	R =	·423	$(2SM_2)$	R =	·018
	κ = ζ =	139°·19		ζ =	9°·24		ζ =	198°·69		ζ =	257°·75
				H =	·150		H =	·410		H =	·018
				κ =	305°·07		κ =	275°·02		κ =	138°·93
M_1	R =	·025	K_1	R =	·358	λ_2	R =	...	$2N_2$	R =	·049
	ζ =	162°·43		ζ =	143°·52		ζ =	...		ζ =	243°·06
	H =	·015		H =	·398		H =	...		H =	·047
	κ =	317°·72		κ =	329°·05		κ =	...		κ =	276°·91
M_2	R =	2·055	K_2	R =	·177	ν_2	R =	·118	$(M_2N)_4$	R =	·003
	ζ =	162°·49		ζ =	119°·25		ζ =	337°·61		ζ =	197°·10
	H =	1·988		H =	·228		H =	·114		H =	·003
	κ =	281°·30		κ =	311°·09		κ =	258°·70		κ =	32°·25
M_3	R =	·004	P_1	R =	·127	μ_2	R =	·098	$(M_2K_1)_3$	R =	·015
	ζ =	217°·88		ζ =	160°·05		ζ =	64°·05		ζ =	122°·74
	H =	·003		H =	·127		H =	·092		H =	·017
	κ =	36°·10		κ =	329°·84		κ =	301°·68		κ =	67°·08

Short Period Tides—contd.

M_4	R =	·011	J_1	R =	·022	R_2	R =	...	$(2M_2K_1)_2$	R =	·006
	ζ =	280°·97		ζ =	124°·76		ζ =	...		ζ =	189°·31
	H =	·010		H =	·026		H =	...		H =	·007
	κ =	158°·61		κ =	350°·23		κ =	...		κ =	241°·42

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide	·026	325·90	·023	8·38
„ Fortnightly „	·033	321·56	·049	28·70
Luni-Solar „ „	·020	101·11	·019	342·29
Solar-Annual „	·192	229·06	·192	149·28
„ Semi-Annual „	·103	323·41	·103	163·84

Other computations.

18. The actual times and heights of high and low water for 1905 at 13 ports have been compared with the predicted values published in the tide-tables and the results tabulated.

Auxiliary Reports.

19. 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.

Receipt and Issue of tide-tables.

20. The tide-tables for 1906 were received in the Office in time for circulation and were duly distributed.

Datum of tide-tables for 1906.

21. 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 Water Mark" which has not been connected with the Admiralty datum.

Sale of tide-tables.

22. The amount realised on the sale of tide-tables during the financial year ending 30th September 1906 is Rs. 1,156-10-0.

Data supplied to the Tidal Assistant, National Physical Laboratory, Teddington.

23. The following data was supplied to the Tidal Assistant, National Physical Laboratory, Teddington, England :—

(*i*) Values of the tidal constants for the tide-tables for 1908, ready for use in the tide predictor.

(*ii*) Actual values during 1904 of every high and low water measured in duplicate from tidal diagrams at 8 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 1904, the errors being tabulated in such form as to be of aid in improving the predictions.

Errors in Predicted Times and Heights of High and Low Water.

24. The usual tabular statements Nos. 1 to 5 are appended showing the percentage and amount of errors in the predicted times and heights of high and low water for the year 1905 at 13 stations, as determined by comparisons of the predictions given in the tide-tables with actual values measured from the tidal diagrams at 9 stations, and from tide-poles at 4 stations ; the former are made in this office and the latter by 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 1905.

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.	700	36	46	7	9	2
Karachi		Au.	703	22	39	16	20	3
Okha Point		Au.	705	40	46	8	5	1
Bhavnagar		T. P.	359	49	49	1	1	...
Bombay	Apollo Bandar	Au.	704	49	40	6	4	1
	Prince's Dock	Au.	705	36	44	11	6	3
Madras		Au.	705	44	43	6	6	1
Kidderpore		Au.	705	17	30	15	24	14
Chittagong		T. P.	365	22	36	10	12	20
Akyab		T. P.	365	99	1	...	...	...
Rangoon		Au.	705	19	37	15	20	9
Moulmein		T. P.	365	11	75	9	5	...
Port Blair		Au.	705	49	42	4	3	2

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 1905.

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.	695	41	42	9	6	2
Karachi		Au.	704	34	42	11	10	3
Okha Point		Au.	706	29	40	14	15	2
Bhavnagar		T. P.	359	26	66	5	3	...
Bombay	Apollo Bandar	Au.	705	38	44	9	6	3
	Prince's Dock	Au.	706	37	42	11	7	3
Madras		Au.	705	36	49	10	5	...
Kidderpore		Au.	705	26	39	12	15	8
Chittagong		T. P.	365	27	34	8	12	19
Akyab		T. P.	365	99	1	...	..	...
Rangoon		Au.	705	21	38	11	16	14
Moulmein		T. P.	365	10	73	10	6	1
Port Blair		Au.	701	37	42	11	8	2

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 1905.

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.	700	6·7	98	2	...	...
Karachi	Au.	703	9·3	78	20	2	...
Okha Point	Au.	705	12·4	60	29	10	1
Bhavnagar	T. P.	359	31·4	50	32	13	5
Bombay { Apollo Bandar	Au.	704	13·9	66	26	7	1
Bombay { Prince's Dock	Au.	705	13·9	74	22	4	...
Madras	Au.	705	3·5	75	24	1	...
Kidderpore	Au.	705	11·7	39	26	19	16
Chittagong	T. P.	365	13·3	46	19	16	19
Akyab	T. P.	365	8·3	79	19	2	...
Rangoon	Au.	705	16·4	52	27	13	8
Moulmein	T. P.	365	12·7	26	30	19	25
Port Blair	Au.	705	6·6	99	1	...	...

No. 4.

Statement showing the percentage and the amount of the errors in the Predicted Height of Low Water at the various Tidal Stations for the year 1905.

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.	695	6·7	97	3	...	...
Karachi	Au.	704	9·3	68	25	7	...
Okha Point	Au.	706	12·4	68	27	5	...
Bhavnagar	T. P.	359	31·4	73	19	5	3
Bombay { Apollo Bandar	Au.	705	13·9	65	25	7	3
Bombay { Prince's Dock	Au.	706	13·9	63	26	8	3
Madras	Au.	705	3·5	77	22	1	...
Kidderpore	Au.	705	11·7	41	29	15	15
Chittagong	T. P.	365	13·3	52	22	15	11
Akyab	T. P.	365	8·3	68	25	7	...
Rangoon	Au.	705	16·4	21	23	24	32
Moulmein	T. P.	365	12·7	45	24	17	14
Port Blair	Au.	701	6·6	98	2	...	...

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 1905.

Stations.	Automatic or Tide-pole observations.	Mean range at Springs in feet.	Average Errors of Time in Minutes. H. W.	L. W.	of Height in terms of the range. H. W.	L. W.	of Height in inches. H. W.	L. W.
Open Coast.								
Aden	Au.	6·7	10	9	·012	·025	1	2
Karachi	Au.	9·3	13	11	·027	·036	3	4
Okha Point	Au.	12·4	9	11	·027	027	4	4
Bhavnagar	T. P.	31·4	6	8	·013	·011	5	4
Bombay { Apollo Bandar	Au.	13·9	8	9	·024	·024	4	4
Bombay { Prince's Dock	Au.	13·9	10	10	·018	·024	3	4
Madras	Au.	3·5	8	9	·071	·071	3	3
Akyab	T. P.	8·3	3	3	·030	·040	3	4
Port Blair	Au.	6·6	7	9	·013	·013	1	1
General Mean			8	9	·026	·030	...	...
Riverain.								
Kidderpore	Au.	11·7	18	14	·050	·050	7	7
Chittagong	T. P.	13·3	18	18	·044	·038	7	6
Rangoon	Au.	16·4	15	16	·025	·051	5	10
Moulmein	T. P.	12·7	11	11	·059	·046	9	7
General Mean			16	15	·045	·046	...	...

Summary.

The foregoing statement for the year 1905 may be thus summarised :—

Percentage of Time Predictions within 15 minutes of actuals.

		High Water. Per cent.	Low Water. Per cent.
Open Coast Stations.	7 at which predictions were tested by S. R. Tide Gauge	82	79
	2 " " " Tide-pole	99	96
Riverain Stations.	2 " " " S. R. Tide Gauge	52	62
	2 " " " Tide-pole	72	72

Percentage of Height Predictions within 8 inches of actuals.

		High Water. Per cent.	Low Water. Per cent.
Open Coast Stations.	7 at which predictions were tested by S. R. Tide Gauge	96	95
	2 " " " Tide-pole	90	93
Riverain Stations.	2 " " " S. R. Tide Gauge	72	57
	2 " " " Tide-pole	61	72

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

		High Water. Per cent.	Low Water. Per cent.
Open Coast Stations.	7 at which predictions were tested by S. R. Tide Gauge	96	97
	2 " " " Tide-pole	100	99
Riverain Stations.	2 " " " S. R. Tide Gauge	94	92
	2 " " " Tide-pole	87	93

26. The predictions for the riverain stations for the year 1905 were compared with those for the year before with the following results :—

Comparisons of the predictions at Riverain Stations.

At Kidderpore they were found to be better in times of high water and the same in times of low water; in heights they are the same for high water but a little worse for low water. At Chittagong they are about the same in times of high water and better in times of low water; for the heights of both high and low water they are the same. At Rangoon for times of both high and low water they are about the same; in heights they are the same for high water but a little worse for low water. At Moulmein there is a marked improvement in the predictions all round.

At Kidderpore the greatest difference between the actual and predicted heights of low water for 1905 was 2 feet 8 inches on 4th and 5th July, the predictions being higher. At Chittagong it was 2 feet 10 inches on 15th September, the prediction being lower. At Rangoon it was 2 feet 3 inches on 13th and 14th December, the predictions being higher. At Moulmein it was 3 feet 3 inches on 7th September, the prediction being lower.

LEVELLING OPERATIONS.

1. During the past year two Detachments were employed on spirit levelling operations.

2. Before taking the field, Detachments Nos. 1 and 2 were employed in revising the single-line of levels in Mussoorie, executed in May 1905 between Vincent's Hill and Kolukhet.

Owing to the earthquake of the 4th April 1905, the line from Dehra Dun to Mussoorie which was executed in 1904 was revised in May 1905 by double levelling as far as Kolukhet village and owing to the illness of the 1st Leveller, the remaining portion between Kolukhet and Mussoorie, by single-levelling. A difference of 5½ inches was observed on closing work at Vincent's Hill. In order to give the revision work the same weight as the original line, it was decided to revise again the single-levelled portion by double-levelling of precision. The opportunity was also taken of training the new levelling Officers who had just joined the party, the combined detachments being placed under the charge of the Senior Levelling Officer. The work was commenced at Mussoorie on 16th October 1905 and closed at Kolukhet on 27th idem.

The general result of the observations showed that Vincent's Hill had apparently sunk 5 inches instead of 5½ inches.

The results of the levelling operations of May 1904 and October 1905 were tabulated for each leveller's observations and a careful analysis made. The actual amount of subsidence could not be definitely determined and although undoubted sinking was proved, it was evident that the result of the revision levelling in October 1905, *viz.*, a general sinking of Mussoorie of 5 inches, could not be accepted in its entirety.

3. Levelling Detachment No. 1 was employed during the field season in connecting the Standard Bench-marks erected in the United Provinces of Agra and Oudh, in Gwalior, and in the crossing of the Brahmaputra between Dhubri and Fakirganj, thus linking upthe line of levels from Parbatipur to Dhubri with the line from Fakirganj to Gauhati.

Standard Bench-marks were connected at the following towns, 18 in the United Provinces and 1 at Gwalior:—

Saharanpur	One.	Fyzabad	One.
Muzaffarnagar	One.	Allahabad	Two.
Meerut	Two.	Mirzapur	One.
Aligarh	One.	Benares	One.
Bareilly	One.	Ghazipur	One.
Shahjahanpur	One.	Gorakhpur	One.
Lucknow	One.	Muttra	One.
Sitapur	One.	Agra	One.

Gwalior . . One.

4. Levelling Detachment No. 1 left Dehra on 8th November for the field. After all preliminary arrangements had been completed operations were commenced at Saharanpur and the Standard Bench-marks were connected up in the order given above.

After the Standard Bench-mark at Gorakhpur had been connected the detachment left for Dhubri on 16th January 1906 for the purpose of levelling across the Brahmaputra River to connect the Bench-marks at Fakirganj on the left bank of the Brahmaputra with the Bench-marks at Dhubri on the right bank. A careful reconnaissance of the river at Dhubri was made and a suitable channel about 31 chains wide was selected for observations by the recognised tide-pole method.

In all, 3 days' observations were taken of simultaneous readings of the water on the graduated poles and the height above M. S. L. of a referring pile on the left bank of the river was thus deduced. To complete the operations a line of levels was run from this referring pile to the Bench-marks at Fakirganj by double-levelling of precision.

5. River-crossing operations were completed by 2nd February 1906, when the detachment left for Hathras to carry out a short branch line from the embedded Bench-mark there to the Standard Bench-mark at Muttra. The Standard Bench-mark at Agra was then connected with the main line of levels, after which the detachment proceeded to Gwalior for the purpose of levelling from Gwalior to the Standard Bench-mark at Jhansi. Owing to the fact that none of the old block-stone Bench-marks in or about Gwalior connected in seasons 1858—62 could be found, it was necessary to level back to Colonel Sander's monument, Maharajpur, some 30 miles from Gwalior, to obtain an origin from which the branch line should emanate. The connection with the main line had just been completed, when Mr. Corridon was taken seriously ill. Work had then to be stopped after a branch line of single-levelling had been run to Sanichri H. S.

6. The total out-turn of work of levelling Detachment No. 1 amounted to 144 miles, in the course of which the instrument was set up at 1,834 stations. The heights of 19 Standard Bench-marks, 8 old embedded Bench-marks, 40 old inscribed, 6 new embedded, 125 new inscribed Bench-marks were determined, 2 G. T. Survey stations, 16 Railway, 13 P. W. D. and 2 Oudh Irrigation Department Bench-marks were also connected.

7. Next field season Levelling Detachment No. 1 will start the revision of the line of levels between Bombay and Madras *viâ* Gulbarga and Guntakal.

8. The usual tabular statements are appended.

No. 1 Levelling Detachment.

List of Great Trigonometrical Survey Stations connected by Spirit-Levelling Season 1905-06.

Name of Station.	Height in feet above mean Sea-level.		Error of height by Triangulation in feet.	Remarks.
	By Spirit-Levelling.	By Triangulation.		
Begarázpur T. S. The Great Arc Section 24° to 30° or Series A of the North West Quadrilateral.	815·940 ft.	815·44	·5	Reconnected by Spirit levelling in 1905. Spirit-levelled height of Season 1858—62 is identical with present value.
Sanichri H. S. Budhon Meridional Series.	814·227* ft.	825 ft. top of pillar: Height of pillar not known.		* Station in ruins; no mark stone in ground floor; height refers to bed-rock.

No. 1 Levelling Detachment.

Results of Comparison of Staves, Season 1905-06.

Place and date of Comparison.				Staff No. 04.	Staff No. 05.	Staff No. 01.	Staff No. 03.
Saharanpur,	10th	November	1905	−0·0000063	+0·0006091	−0·0044159	−0·0042281
Muzaffarnagar,	17th	„	„	+0·0002615	+0·0012807	−0·0040097	−0·0039911
Meerut,	25th	„	„	−0·0004447	+0·0008899	−0·0050223	−0·0047723
Bareilly,	4th	December	„	−0·0001319	+0·0009495	−0·0042409	−0·0046941
Lucknow,	11th	„	„	−0·0005975	+0·0004865	−0·0050417	−0·0049667
Allahabad,	20th	„	„	−0·0001357	+0·0007393	−0·0044357	−0·0048229
Mirzapur,	29th	„	„	−0·0002379	+0·0010839	−0·0042161	−0·0038911
Benares,	3rd	January	1906	−0·0000287	+0·0010969	−0·0037185	−0·0038121
Gorakhpur,	14th	„	„	−0·0004765	+0·0005171	−0·0043707	−0·0045861
Dhubri,	21st	„	„	−0·0001709	+0·0012355	−0·0039581	−0·0041831
Dhubri	30th	„	„	−0·0003201	+0·0009895	−0·0042259	−0·0038849
Hathras City,	8th	February	„	+0·0010927	+0·0023895	−0·0028855	−0·0025855
Mursan,	15th	„	„	+0·0001017	+0·0011331	−0·0043355	−0·0038041
Muttra	25th	„	„	+0·0008735	+0·0019785	−0·0032433	−0·0033619
Agra Fort,	5th	March	„	+0·0008537	+0·0021697	−0·0029361	−0·0025169
Banmor,	15th	„	„	+0·0005817	+0·0013189	−0·0040785	−0·0033855
Banmor,	6th	April	„	+0·0004163	+0·0012881	−0·0038683	−0·0041465

No. 1 Levelling Detachment.

Tabular Statement of out-turn of work for field season 1905-06.

Section.	Month.	No. of Miles Double Levelling. Main Line. Ms.	Chs.	lks.	Branch Line. Ms.	Chs.	lks.	No. of Miles Single Levelling. Main Line. Ms.	Chs.	lks.	Branch Line. Ms.	Chs.	lks.	Total Levelling. 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.	New Embedded.	New inscribed.	G. T. S.	Railway.	P. W. D.	Irrigation Department.	Remarks.
	November 1905	6	72	78*	10	35	50	...	...	...	...	...	...	17	28	28	...	...	225	2	9	4	...	11	1	...	8	...	Connecting the Standard Bench-marks of the United Provinces of Agra and Oudh and Brahmaputra River crossing operations between Dhubri and Fakirganj.
	December "	11	40	02*	13	12	42	...	...	...	...	...	...	24	52	44	...	...	351	4	19	9	...	35	...	...	2	2	
	January 1906	14	52	†94	2	24	40	...	...	...	...	...	...	16	77	34	116·577	136·111	239	1	11	3	...	22	...	1	...	...	
	February "	1	60	80*	31	77	72	...	...	...	...	...	...	26	58	52	153·454	178·749	426	1	1	1	4	34	...	...	3	...	
	March "	...	...	...	35	31	84	...	...	...	7	41	78	42	73	62	310·845	143·569	507	...	...	2	2	19	1	16	...	...	
	April "	...	...	...	...	5	90	...	...	...	5	51	40	5	57	30	...	...	86	...	...	...	...	4	...	...	...	...	Branch Line Single-levelling to Sanichri H. S.
	Grand Total	34	66	54	96	27	78	...	...	...	13	13	18	144	27	50	580·876	458·429	1,834	8	40	19	6	125	2	17	13	2	

* Check Levelling and Fixing new points.
† Inclusive of 7 Ms. 13 Chs. 20. lks. Check Levelling.

P 4

9. Levelling Detachment No. 2 was first employed on the line from Sukkur to Shikarpur, in order to obtain a connection between the levels executed in 1904-05 and the old levelling of 1858—62 and thus completing the circuit Shikarpur, Kotri, Hyderabad, Rohri, and then in levelling along the N. W. Railway from Lahore to Rawalpindi and in connecting the Standard Bench-marks erected at Lahore and Rawalpindi.

10. This Detachment left Dehra for Sukkur on the 5th November. Work was commenced on 11th idem and closed at Shikarpur on the 2nd December. The Detachment left Shikarpur for Lahore next day.

In the course of check levelling about Lahore, it was found that out of 20 old Bench-marks only 2 were in existence, the others had either been destroyed or could not be found on account of insufficient or faulty descriptions. Care has been taken this season to fix new Bench-marks in the town of Lahore and also in other large towns met with, at important public buildings and other suitable places where they are not likely to be disturbed. Full and concise descriptions of all Bench-marks have been compiled, and, in addition, rough sketches of the sites of all embedded Bench-marks have been prepared and entered in the original field books.

The work on the main line from Lahore Railway Station was started on 14th December 1905 and was closed at Rawalpindi on 20th April 1906. The detachment returned to Dehra on 24th idem. The out-turn of work for the season amounted to 244 miles of double-levelling, in the course of which the instrument was set up at 3,124 stations, and the total rises and falls on the main line amounted to 4,584 feet. The heights of 2 Standard, 30 new Embedded and 205 new Inscribed Bench-marks were determined: 9 old Bench-marks, 3 G. T. Survey stations, 28 Railway and 2 Irrigation Bench-marks were connected. In addition, 2 Principal and 3 Secondary G. T. Survey stations were inspected and reported on during the field season.

11. During the coming field season Detachment No. 2 will work in the United Provinces, Central India and the Punjab, for the purpose of connecting Standard Bench-marks at 10 Cantonment stations, and in completing the line of levels in the Punjab, partially executed last season.

12. The usual tabular statements are herewith appended.

No. 2 Levelling Detachment.

List of Great Trigonometrical Survey Stations connected by Spirit-levelling in Season 1905-06.

Name of Station.	Height in feet above mean Sea-level.		Error of height by triangulation in feet.	Remarks.
	Spirit-levelling.	Triangulation.		
Koár H. S. of Jogi-Tila Meridional Series.	1360·452	1367·4	+ 6·948	Height of upper mark-stone.
Jaoli H. S. of North-West Himalaya Series.	1915·246	1918·4	+3·154	Height of upper mark-stone.
Mankiala *Tope* (Dome) Intersected Point of North-West Himalaya Series.	1954·771	1959·0	+4·229	Height of centre of summit.

LEVELLING DETACHMENT NO. 2.

Table showing the Railway and Irrigation Bench-marks connected in Season 1905-06.

Description of Bench-marks.	Railway or Irrigation Height feet.	Survey Spirit levelled Height feet.	Difference feet.	REMARKS.
Railway.				
Rail at Alexandra Bridge	764·76	764·480	+0·280	In addition to these bench-marks 14 more railway bench-marks were connected, but the railway Engineers were unable to supply their heights, hence they have not been shown in this list.
↑ on S. E. Wall of Culvert near T. P. No. $\frac{915}{7}$	956·53	956·241	+0·289	
↑ on W. parapet of Culvert near T. P. No. $\frac{931}{17}$	912·50	910·749	+1·751	
↑ on S. do. Bridge do. $\frac{934}{9}$	934·85	932·811	+2·039	
↑ on S. do. Culvert do. $\frac{941}{2}$	1019·29	1017·789	+1·501	
↑ on S. do. do. do. $\frac{941}{7}$	1031·16	1029·531	+1·629	
Rail at Bhaikhan Bridge	1448·30	1449·342	—1·042	
□ ↑ on stone embedded near T. P. No. . $\frac{977}{11}$	1715·61	1714·343	+1·267	
□ ↑ on stone do. do. $\frac{980}{10}$	1724·73	1723·480	+1·250	
□ ↑ on stone do. do. $\frac{983}{5}$	1821·17	1820·015	+1·155	
Rail at Ling Bridge	1586·40	1586·935	—0·535	
Rail at Bridge near T. P. No. . . . $\frac{992}{22}$	1514·30	1515·095	—0·795	
Rail at Kurrang Bridge	1548·30	1548·722	—0·422	
Rail at Leh Bridge	1648·04	1649·733	—0·693	
Irrigation.				
↑ on parapet of well near Milestone "99 from Lahore."	796·30	796·967	—0·667	
↑ on N. parapet of culvert near T. P. No. . $\frac{924}{3}$	757·61	758·298	—0·688	

NO. 2 LEVELLING DETACHMENT.

Results of Comparison of Staves, Season 1905-06.

Place and date of Comparison.	Number of Staff.				REMARKS.
	B1.	B2.	IIII.	4	
Sukkur, 12th November 1905 .	+0·0019578	—0·0012144	—0·0009734*	—0·0005100	* Staff No. 13, which was replaced by No. IIII.
Bagarji, 20th November „ .	+0·0019806	—0·0007701	—0·0005131* +0·0010781	—0·0003065	
Shikarpur, 30th November „ .	+0·0020504	—0·0008423	+0·0009072	-0·0001951	
Badami Bag, 10th December 1905 .	+0·0026430	—0·0004349	+0·0012037	—0·0001480	
Shahdara, 20th „ „ .	+0·0024679	+0·0000636	+0·0020919	+0·0004203	
Kamoke, 30th „ „ .	+0·0033400	+0·0000479	+0·0028605	+0·0006835	
Gujranwala, 10th January 1906 .	+0·0035621	+0·0003033	+0·0032271	+0·0010235	
Wazirabad, 18th „ „ .	+0·0032076	+0·0001982	+0·0022156	+0·0006030	

Result of Comparison of Staves, Season 1905-06—contd.

Place and date of Comparison.		Number of Staff.				Remarks.
		B1.	B2.	IIII.	4	
Lala Musa,	30th January 1906 .	+0·0030238	+0·0001878	+0·0025892	+0·0008247	
Kharian,	10th February 1906.	+0·0038811	+0·0008095	+0·0040346	+0·0011438	
Baddo,	21st „ „ .	+0·0037090	+0·0005679	+0·0037741	+0·0009679	
Dina,	5th March 1906 .	+0·0041591	+0·0011266	+0·0039970	+0·0015973	
Sohawa,	16th „ „ .	+0·0042381	+0·0009848	+0·0038148	+0·0016659	
Gujarkhan,	24th „ „ .	+0·0046713	+0·0014446	+0·0047482	+0·0018872	
Mandra,	4th April 1906 .	+0·0043370	+0·0012067	+0·0042337	+0·0017168	
Sihala,	14th „ „ .	+0·0037485	+0·0006288	+0·0035423	+0·0016540	
Rawalpindi,	20th „ „ .	+0·0030588	−0·0001805	+0·0018365	+0·0006845	

No. 2 Levelling Detachment.

Tabular Statement of Out-turn of Work, Season 1905-06.

Section	Month	No. of Miles of Double Levelling.									Total No. of Feet.		No. of stations at which instrument was set up.	No. of Bench-Marks Connected.								Remarks.
		Main Line.			Branch Line.			Total.						Old.								
		Ms.	Chs.	lks.	Ms.	Chs.	lks.	Ms.	Chs.	lks.	Rise.	Fall.		Embedded.	Inscribed.	Standard.	Embedded.	Inscribed.	G. T. Survey.	Railway.	Irrigation.	
Sukkur to Shikarpur	November 1905	23	66	04	3	76	14	27	62	18	72·228	84·183	365	1	3	...	4	23	...	...	...	
	December „	0	46	82	1	42	72	2	9	54	2·205	2·129	31	...	...	...	1	5	...	...	...	
	Totals	24	32	86	5	38	86	29	71	72	74·433	86·312	396	1	3	...	5	28	...	...	...	
Mean Meer	December 1905	0	22	26	0	4	02	0	26	28	1·442	4·634	5	1	2	1	...	..	...	...	...	
Lahore to Rawalpindi	December 1905	31	9	16	5	21	04*	36	30	20	149·765	125·956	428	1	1	...	6	37	...	...	...	* Includes 2 Ms. 41 Chs. 90 lks. check levelling of old work about Lahore for verification.
	January 1906	52	23	52	1	15	40	53	38	92	379·790	265·637	647	...	...	...	7	43	...	1	...	
	February „	22	66	50	13	48	54	36	35	04	250·187	323·347	505	...	...	...	2	20	1	2	2	
	March „	47	62	36	4	46	28	52	28	64	1,479·919	553·059	672	...	...	...	6	40	..	18	...	
	April „	24	43	20	10	9	10	34	52	30	421·905	466·174	471	...	...	1	4	37	2	7	...	
	Totals	178	44	74	34	60	36	213	25	10	2,681·566	1734·173	2,723	1	1	1	25	177	3	28	2	
	Grand Totals	203	19	86	40	23	24	243	43	10	2757·441	1825·119	3,124	3	6	2	30	205	3	28	2	

13. *Determination of Heights by the Horizontal Bar Method.*—A system of determining the heights of points situated on steep hills by means of cross staves and mason's level has been in force in the Levelling party for many years past. It was resorted to only in connecting some of the G. T. Survey hill stations which were found to be inaccessible by ordinary levelling operations. The system was however considered weak and the heights thus obtained were published to the nearest foot. During the past field season Munshi Syed Zille Hasnain, Sub-Assistant Superintendent, thoroughly revised this system and introduced several improvements in it to place it on a more scientific basis in order that the results obtained with it might compare more favourably with those of levelling of precision. He designed a brass slide carrying a slow motion screw and a light wooden horizontal bar fitted with a pair of wires at each end with which to read the vertical staves. The above designs with a detailed procedure of the system, as improved by Munshi Syed Zille Hasnain, were submitted to the Superintendent, Trigonometrical Surveys, and met with his approval. A pair of brass slides and a horizontal bar were prepared and experimental observations were taken with them in the field. The results obtained were found to agree within very close limits with those of Spirit-levelling of precision.

The above system can be used with advantage in levelling over portions of steep and intricate ground occasionally met with in the course of levelling operations where the ordinary levels cannot be used.

14. A detailed note on the working of this system is herewith appended :—

Instruments required.

2 Levelling staves with ropes and plummets complete.
2 Brass slides.
1 Spirit-level mounted on a metal plate containing a fairly sensitive bubble with graduations cut on it (to be adjusted before use).
1 Horizontal bar (10′ × 1″ × 1½″) made of strong light wood.
1 Measuring tape 50′.

Levelling.

(i) Place the station pegs, as far as possible, at a uniform distance of about 9½ feet. Mount the staves and make them perfectly vertical by means of the plumb lines and guy ropes.

(ii) Fix one of the brass slides on the higher staff just a little above the peg and the other slide on the lower staff approximately on a level with the former. Put the horizontal bar on the slides with the marked end of the bar on the back staff. Place the level in the centre of the bar and by gently raising or lowering one of the slides bring the bubble roughly in the centre of its run: then firmly clamp the slides.

(iii) Adjust the bar on the slides so that the centre of the bar may be equidistant from the two staves : this condition will be satisfied when the two ends of the bar project equally from the two staves as indicated by the number of inch spaces marked at each end of the bar.

(iv) Put the level exactly in the centre of the bar with its marked end towards the mark on the bar.

(v) By means of the slow motion screw of one of the slides bring the bubble exactly in the centre of its run. Then read the two staves where they are intersected by the plane of the two parallel wires fixed at each end of the bar. For this purpose raise or lower your eye until the two wires appear to perfectly coincide with one another: then read the staves. One observer to read the back staff and the other the forward staff simultaneously.

(vi) Lift the horizontal bar from the slides; turn the staves 180° round on the pegs keeping the slides intact; place the bar on the slides with the same end on the same staff.

The other face of the bar will now be touching the staves and any error due to the plane of each pair of the wires being out of the horizontal will thus be eliminated.

(vii) Adjust the bar as in (iii) and place the level turned end for end so that the marked end of the level will now be opposite the mark on the bar. The bubble will be found to be very nearly in the centre of its run. If it is slightly out, bring it into the centre by means of the slow motion screw of one of the slides.

(viii) The observers should now change places and read the two staves as before.

(ix) This will give two values for the station which should not differ by more than 0·005. If they do, repeat the observations and take a double set again in the two positions of the level and the bar as before. If the two repeated values show a closer agreement, reject the first two values; if they differ by about the same amount as the first, accept the mean of all the four values.

(x) The above will complete all the observations at the first station. The back staff should now be removed and mounted on the next forward peg and the whole process gone through in the same manner as detailed above.

(xi) Care should be taken to keep the marked end of the bar always on the *same* staff throughout the operations and every line should consist of an even number of stations. This will cancel the errors due to the planes of the two sets of wires at the two ends of bar not being in the same horizontal plane.

(xii) The observations should be recorded in the regular levelling field book (Form P. 30) exactly in the same manner as in ordinary levelling, each station being numbered consecutively and the two vertical staves being respectively called "back" and "forward" with reference to the direction of the line followed.

(xiii) The height so determined should be corrected for the difference of unit of staves from 10 feet.

NOTE.—It is sufficient to use only one face of the staves throughout the operations.

IV.

Extract from the Narrative Report of Lieutenant R. H. Phillimore, R.E., in charge of No. 11 Party (Southern Shan States).

More than half the area of Kengtung State drains into the Mé-hkong and the remainder into the Salween. The watershed between the two river basins is a lofty range running almost north and south along meridian 99°—30′. The highest peak of this range, within Kengtung State, is Loi Hpalan, which is 7,626 feet. Throughout this trans-Salween country the ground is exceedingly mountainous and broken. The rolling downs, which are so characteristic of the western states, have been left behind, and here one steep mountain range succeeds another. The general tendency of these ranges is north and south and some of the rivers they part, flow north while others flow south, their basins dovetailed together in a most intricate fashion.

With the exception of sheet $93\frac{O}{11}$, the season's work lay to the immediate west of, and included, the Salween Mé-hkong watershed. The country in sheets $93\frac{O}{3,4}$ are drained by the Nam Ping, which flows northwards into the Nam Hka, a tributary of the Salween. Sheets $93\frac{O}{7,8}$, $\frac{P}{1,5}$ are all drained by the Nam Hsim, a large and important river which, flowing south eventually, joins the Salween. The Nam Ping is fordable everywhere in the sheets surveyed, but the Nam Hsim can only be crossed at fords which occur every few miles. This latter river is navigable for dug-outs and rafts for short distances and is used for communication between neighbouring villages. The altitude of the Nam Ping at Mong Ping is 1,446 feet. That of the Nam Hsim, where it leaves sheet $93\frac{P}{1}$, is 1,400 feet. The valley of the Nam Ping is for the most part about half a mile wide and cultivated for rice. The lower slopes of the hills on either side are of confused contour and thickly wooded, and as the valley is seldom quite free from morning mists, the surveyors could not progress very rapidly here. The valley of the Nam Hsim only widens out for a few miles here and there, as at Mong Hpet and Tongta in sheet $93\frac{O}{7}$; throughout its passage through sheets $93\frac{O}{8}$, $\frac{P}{5}$ it flows with tortuous course between rocky banks, the hills rising steep and lofty on either side. This valley is in places thickly wooded and in places the hills are bare and rocky, full of punch-bowls, and very difficult to get about in. The watershed between the Nam Ping and Nam Hsim is crossed by a well-made road at a height of 3,490 feet, and rises at several points to over 6,000 feet. The best known peaks are Loi Si, 6,613 feet, and Loi Hpa-min, 6,640 feet. The higher hills are covered with pine trees, their slopes are gradual and their summits easy of access; in fact, here the surveyors found their lightest work. The summit and western slopes of the Salween Mé-hkong watershed are very thickly wooded, and on this account were not easy to survey.

On the whole the country is well supplied with communications. Mules can cross the two ranges above described, in several places. It is more difficult to move about in sheets $93\frac{P}{1,5}$, for, though there are paths all over the hills, the villagers possess no pack animals and the paths are foot-tracks only.

The country surveyed, with the exception of sheet $93\frac{P}{1}$, was fairly well populated. The Nam-Ping valley is thickly populated by Shans, as also is the upper valley of the Nam Hsim. The hills to the west of the Nam Hsim are mainly populated by Palawng's and Mu-hsö's; the hills to the east by Kaw's and Mu-hsö's. These hill tribes are never found below 4,000 feet; the men are sturdy and capable of a good hard day's work. A Mu-hsö or a Kaw will go out with a surveyor day after day, generally going off to sleep at his village several miles off and turning up punctually again the next morning. A Shan, on the other hand, is a very poor man for work in the hills; a climb of a couple of thousand feet lasts him several days and nothing will induce him to act as guide two days running. His usual conception of the duties of a guide is to loiter well behind the party he honours. An attempt will be made next field season to engage a couple of Kaw's or Mu-hsö's for each surveyor, and to get them to work right through the season on a monthly wage. They would displace two Hazaribagh *khalásis* in each squad.

The preceding remarks have no reference to sheet $93\frac{O}{11}$. This sheet lies on the Mé-hkong side of the great watershed and is remarkable in that it contains the capital city and the only plain of any area in the Kengtung State. Kengtung is a walled city with a perimeter of 4½ miles, and a population, according to the census of 1901, of 6,000 persons. The Sawbwa, who is entitled to a salute of nine guns, has his palace inside the city. The Political Officer lives just outside the city near the village of Kengka. The bazaar, which is held every fifth day in the city, is the finest in the Southern Shan States. To the north of the city lies a wide and densely populated plain, some eighty square miles in area. The Nam Hkün flows northwards past the city, and joins the Nam Lwé, a tributary of the Mé-hkong, about twelve miles to the north. The general level of the plain is 2,600 feet; it is somewhat marshy, and very unhealthy for Europeans during the rains. A military police post has been built some fifteen miles to the south-east of Kengtung, on a wooded range called Loi Mwé; it has an elevation of 5,500 feet.

Almost the first thing one would notice as one crosses the great watershed and looks down on the Kengtung plain is the bare and open character of the surrounding hills which have been almost entirely denuded of forest by the inhabitants of the valley. As the hill features are here well-defined, and the slopes not excessive, it was possible to survey this sheet with contours at fifty feet vertical interval, without greatly diminishing the rate of work. The detail in the plain was, however, very troublesome to survey, especially as the morning haze was always thick. The collection and identification of the names of the four or five hundred villages also took much time. Regarding village names generally, every effort was made to obtain good vernacular lists; these lists were, however, far from perfect, for the local *hpoongyis*, though fairly literate, are not particularly strong in spelling. A few surveyors found it difficult to get their names written up in the immediate vicinity of their villages, and brought in names written in the Burmese character; direct transliteration of such names cannot be relied on. The Assistant Political Officer at Kengtung, Mr. D. M. Gordon, has taken great trouble in transliterating the lists, and it is hoped that the names as they appear on the maps will be quite satisfactory.

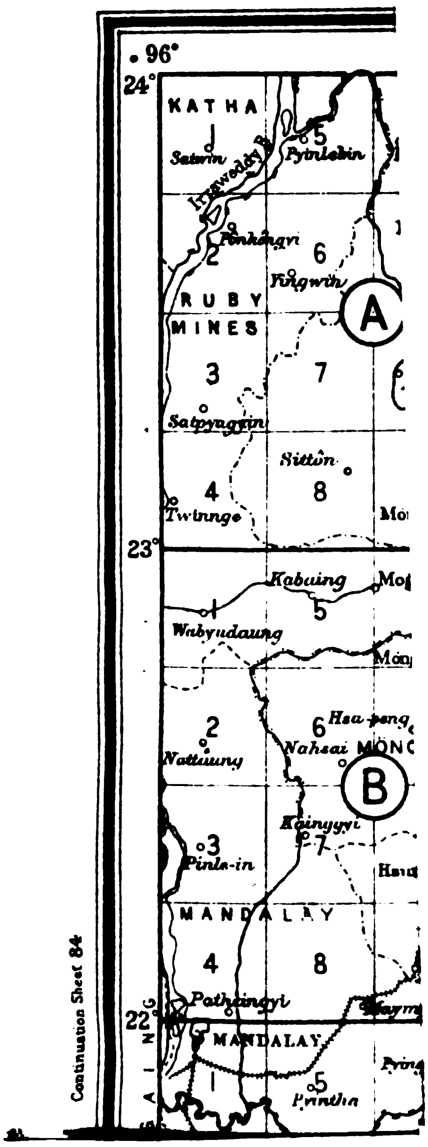
Little reference has yet been made to the mists and haze that interfered with the work of almost every surveyor. During the months of December and January mists hang over every river and stream, morning after morning, clearing off any time between ten o'clock and midday. The mist does not rise above an elevation of about 3,500 feet, but, unless the surveyor has work in the higher hills to carry him on, he has to stay idle for two or three hours every morning. These mists were particularly troublesome in the valley of the Nam Ping and in the lower reaches of the Nam Hsim, and work in the Kengtung plain would have been much interrupted had it been taken up earlier than March. On the whole February is the best month for work; in March the hill fires commence and help to produce the haze that grows thicker every week till the rains break. By the beginning of April this haze was so thick in many parts that work could not be commenced before midday, and sometimes had even to be abandoned for the day. Triangulation was stopped by this haze in the first week of March.

The following description of the country triangulated is given by Mr. Morton.

A high range of hills, a continuation of the Salween Mé-hkong watershed, traverses sheet $93\frac{P}{9}$ running north and south. The highest point of the range that falls in these sheets is Loi Hsamhsum, 7,600 feet above sea-level. The hills are densely clad with jungle and villages are few. The hill tribes are Kaw's and Mu-hsö's. The large Shan village of Möng Hpayak falls in sheet $93\frac{P}{3}$ and from it good mule roads lead to Kengtung, Möng Lin, and Möng Hai. The large stream called the Nam Lin flows in a south-easterly direction into the Mé-hkong. Most of the hill streams flow east into the Nam Lin. The main range of hills divides, in sheet $93\frac{P}{10}$, into two ranges, one running south-east and the other south-west. The spurs falling to the west are covered with pine forest, while the main range is densely clad with chestnut. The Nam Hok flows through sheet $93\frac{P}{14}$ in a southerly direction into the Mé-hsai. The large Shan village Möng Hai is situated near the source of the Nam Hok. There are a number of Mu-hsö villages scattered over the higher ranges, while the lower slopes are thickly populated by Kaw's. The roads from Möng Hai to Kengtung and Möng Hpayak are very good, but that leading to Hawng Luk along the Nam Hok is only practicable for mules from March to May.

In sheets $93\frac{P}{11, 15}$ the main range of hills runs east and west along the south of the sheets, and forms the boundary between Siam and the Shan States. The lower slopes are covered with dense bamboo jungle. The Mé-Hsai is a large hill torrent which flows east through the two sheets, and for a short distance forms the Siamese boundary, before joining the Mé-hkong. It is very difficult to cross this stream owing to its swift current and large boulders. The large Shan village of Möng Tum is situated near the source of the Mé-Hsai and that of Hawng Luk near its junction with the Mé-hkong; the road between them is very bad. From Hawng Luk a good road, well kept up, runs north-east to Möng Lin, and another from Hawng Luk runs south-east to Cheng Sen in Siam. There are very few villages south of the Mé-hsai, though to the north the hills are well populated by Kaw's.

G. I. C. P. O.—No. 105 S. G.—21-3-08.—350.—A. J. N.



96°
24°
KATHA
Pyinlebin
RUBY
MINES
A
Sitton
Twinnge
23°
Kabuing
Wabyudaung
Nahsai
B
Pinle-in
MANDALAY
Patheingyi
22°
MANDALAY
Pyintha
Continuation Sheet 84

EXTRACTS

FROM

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FOR THE SEASON

1905-06.

PREPARED UNDER THE DIRECTION OF

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SURVEYOR GENERAL OF INDIA.

CONTENTS.

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