EXTRACTS

FROM

NARRATIVE REPORTS

OF OFFICERS OF THE

Survey of India

FOR THE SEASON

1907-08

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E.

SURVEYOR GENERAL OF INDIA

CONTENTS

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1910

Price Rs. 1-8 or Two Shillings and Three Pence

Survey of India

EXTRACTS

FROM

NARRATIVE REPORTS

FOR THE SEASON

1907-08

Agents for the Sale of Books published by the Superintendent of Government Printing, India, Calcutta.

IN ENGLAND.

E. A. ARNOLD, 41 and 43, Maddox Street, Bond Street, London, W.

CONSTABLE & Co., 10, Orange Street, Leicester Square, W. C.

GRINDLAY & Co., 54, Parliament Street, London, S. W.

H. S. KING & Co., 65, Cornhill, and 9, Pall Mall, London, E. C.

P. S. KING & SON, 2 and 4, Great Smith Street, Westminster, London, S. W.

KEGAN PAUL, TRENCH, TRÜBNER & Co., 43, Gerrard Street, Soho, London, W.

BERNARD QUARITCH, 11, Grafton Street, New Bond Street, W.

B. H. BLACKWELL, 50 and 51, Broad Street, Oxford.

DEIGHTON, BELL & Co., Cambridge.

T. FISHER UNWIN, 1, Adelphi Terrace, London, W. C.

W. THACKER & Co., 2, Creed Lane, London.

LUZAC & Co., 46, Great Russell Street, London, W. C.

ON THE CONTINENT.

R. FRIEDLÄNDER & SOHN, 11, Carlstrasse, Berlin, N. W.

OTTO HARRASSOWITZ, Leipzig, Germany.

KARL HIERSEMANN, Leipzig, Germany.

RUDOLF HAUPT, 1, Dorrienstrasse, Leipzig, Germany.

ERNEST LEROUX, 28. Rué Bonaparte, Paris.

MARTINUS NIJHOFF, The Hague, Holland.

IN INDIA.

THACKER, SPINK & Co., Calcutta and Simla.

NEWMAN & Co., Calcutta.

S. K. LAHIRI & Co., Calcutta.

R. CAMBRAY & Co., Calcutta.

B. BANERJI & Co., Calcutta.

HIGGINBOTHAM & Co., Madras.

V. KALYANARAMA AIYAR & Co., Madras.

G. A. NATESAN & Co., Madras.

THOMPSON & Co., Madras.

MURTHY & Co., Madras.

TEMPLE & Co., Madras.

COMBRIDGE & Co., Madras.

A. R. PILLAI & Co., Trivandrum.

THACKER & Co., LD., Bombay.

A. J. COMBRIDGE & Co., Bombay.

D. B. TARAPOREVALA, SONS & Co., Bombay.

RADHABAI ATMARAM SAGOON, Bombay.

N. B. MATHUR, Superintendent, Nazair Kanun Hind Press, Allahabad.

RAI SAHIB M. GULAB SINGH & SONS, Mufid-i-Am Press, Lahore.

SUPERINTENDENT, AMERICAN BAPTIST MISSION PRESS, Rangoon.

SUNDER PANDURANG, Bombay.

A. M. & J. FERGUSON, Ceylon.

A. CHAND & Co., Lahore, Punjab.

P. R. RAMA IYAR & Co., Madras.

GOPAL NARAYAN & Co., Bombay.

BABU S. C. TALUKDAR, Proprietor, Students and Company, Cooch Behar.

EXTRACTS

FROM

NARRATIVE REPORTS

OF OFFICERS OF THE

Survey of India

FOR THE SEASON

1907-08

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E.
SURVEYOR GENERAL OF INDIA

CONTENTS

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1910

CONTENTS.

I

NO. 26 PARTY (MAGNETIC).

Annual Report. Season 1907-08.

Personnel.

Imperial Officers.

Captain R. H. Thomas, R.E., in charge to 31st March 1908.

Lieutenant H. J. Couchman, R.E., in charge from 1st April 1908.

Lieutenant H. T. Morshead, R.E., from 16th August 1908.

Provincial Officers.

Messrs. E. C. J. Bond, and H. P. D. Morton, Babus R. P. Ray, N. R. Mazumdar and R. B. Mathur.

Subordinate establishment.

2 Observers, 13 Recorders, 1 Computer, 2 Surveyors and 1 Writer.

The personnel of the party is given in the margin.

000. The health of the party was on the whole satisfactory; two *khalásis* however died of cholera on returning from the field, and one recorder suffered from fever in Burma.

THE MAGNETIC SURVEY IN 1907-08.

The present report deals with the work of the Magnetic Survey in 1907-08.

The report is divided into three main heads as follows:—

I. A brief account of the operations in the field and recess quarters, with a table of the preliminary values of the magnetic elements at field and repeat stations in 1907-08, and an index chart showing the positions of all stations of observation up to date.

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

II. The working of the magnetic observatories in 1907-08.

III. Tables of results at the magnetic observatories in 1907.

I.—FIELD OPERATIONS IN 1907-08.

1. Work of the field detachments.
2. Work of the Imperial officers.
3. Work during recess—
   - Diurnal variation correction.
   - Disturbance correction.
   - Isomagnetic charts.
4. Comparison of instruments with the survey standard.
5. Values of the distribution co-efficient P. for the field instruments.
6. Programme for 1908-09.
7. Results included in this report.

1. *Work of the field detachments.*—The field season opened on October 21st 1907, and closed early in May 1908. Four field detachments were employed during the year under report; three of these worked in Burma and the fourth in Berar, Orissa and Assam. One of the Burma detachments, however, was withdrawn from magnetic work for three months in order to carry out some triangulation for the Chin-Lushai-Arakan boundary, while another, owing to the early break of the rains in south Burma, could not complete its programme. For these reasons, and owing to the difficult country met with, the outturn of new stations was only 80, bringing the total number of stations to date to 1,214, with 22 repeat stations.

2. *Work of the Imperial Officers.*—Two imperial officers were available up to the end of March, when the officer in charge proceeded on furlough. The four observatories were inspected and comparative observations carried out at each and also at Alibág. Vertical force magnets of the new pattern were mounted at the Barrackpore and Kodaikánal observatories and satisfactory adjustments made of their temperature co-efficients, the values found being —3·0γ and +5·2γ per +1° F. respectively. In addition to those at the 22 repeat stations, observations were made at 31 old field stations suitably situated between repeat stations, in order to obtain further values of the secular change in the magnetic elements.

Lieutenant H. T. Morshead, R.E., was posted to the party in August 1908 and has now been trained in magnetic observations.

3. *Work during recess.*—During the recess season the computation of the previous season's field work, and the reduction and tabulation of the base station results for 1907 have been completed (*vide* Part III). The whole of the base line values of the horizontal force magnetographs have been re-computed, using the value of $\frac{m}{H}$ obtained from the deflection observations, combined with the mean value of the moment of the magnet (m_o) for the period, to obtain the value of H. Formerly the practice has been to obtain H. by combining the mH and $\frac{m}{H}$ of the vibration and deflection observations. Now the probable error of a vibration observation is considerably larger than that of a deflection observation, owing to the difficulty of the former operation, and it is therefore preferable to use the deflection observation only in computing H. To do this, however, we must know the value of m, and as this is ordinarily fairly constant, we can obtain a sufficiently accurate value by combining a large number of vibrations and deflections. The values of the base lines obtained by this method agree well *inter se*, and the practice will be continued. The same process has been employed in computing H in the field observations, the values of m obtained being carefully scrutinised and divided into groups, where there has been any change.

The comparisons of instruments in H. F. with the survey standard magnetometer, No. 17 at Dehra Dún, from the beginning of the survey have been recomputed by this method, and the results, which are given below, shew that while the field instruments ordinarily remain fairly constant during the working season, changes often occur during the recess. This is fortunate (though somewhat difficult to understand) as a constant instrumental correction can be applied throughout any one field season. The change from year to year can as a rule be explained by postulating a change in log π^2K, but only on the assumption that the change occurs during the recess. The question, however, is of small importance, from the point of view of the reduction of the survey, and need not be considered for the present.

Diurnal variation correction.

The correction of the horizontal force and declination observations for diurnal variation has been commenced, the formula used being the empircial one given in ast year's report, *viz.*:—

$$h_p = h_a + k(h_b - h_a) \text{ where } k = \frac{lat_a - lat_p}{lat_a - lat_b}.$$

Two values of h_p are found by using the three observatories nearest to the station under correction and a mean taken. The agreement between the two values of h_p is extraordinarily good for all except the south of India, as the subjoined table will shew.

Difference between two values of h_p	Number.	REMARKS.
0 γ	96	
1	124	
2	67	
3	33	12 from Kodaikánal.
4	5	3 " "
5	7	all " "
6 to 14	12	all " "

It will thus be seen that when Kodaikánal is one of the base stations used to determine the diurnal variation correction, the probable error of this correction is commonly large, and it is therefore evident that, either the diurnal variation figures of Kodaikánal are abnormal owing to the fact that the observatory is situated on magnetic rock, or the latitude formula does not hold good in low magnetic latitudes.

To determine which of these alternatives is correct, it is intended, during this field season, to take hourly observations of force for 5 or 6 days at some place in the extreme south of India and also probably in Lower Burma. By comparing the results thus obtained with the magnetograph traces at Kodaikánal it is hoped that some light will be thrown on the question.

The disturbance correction.

Investigations into the correction for disturbance have been continued, the method employed being as follows. A number of points in a disturbed trace are selected haphazard and the values of force determined in the usual way. From these values the normal value of the particular moment is deducted and the residual thus represents the amount of the disturbance correction. (The normal value is obtained by interpolation from the hourly mean values of the selected quiet days.) Similar points at the same absolute time at the other observatories are similarly dealt with, and residuals obtained, which are compared *inter se*. The agreement between these residuals is often good, and there is occasionally evidence of a latitude change, but in many cases there seems to be no possible method of connecting the residuals, as the following tables will shew.

TABLE A.

Examples of agreement between residuals or of latitude change:—

Dehra Dún, Lat. 30°3.	Barrackpore, Lat. 22°8.	Toungoo, Lat. 18°9.	Kodaikánal, Lat. 10°2.	
+13	+10	+9	+10	
+1	−1	+3	+1	

TABLE A—*contd.*

Dehra Dún, Lat. 30°3.	Barrackpore, Lat. 22°8.	Toungoo, Lat. 18°9.	Kodaikánal, Lat. 10°2.	
+12	+10	+11	+15	
+12	+13	+19	+12	
+16	+13	+13	+15	
+24	+29	+20	+22	
−33	−32	−32	−38	
−89	−92	−90	−83	
−19	−20	−22	−27	Latitude.
−12	−11	−4	+3	"
−11	−16	−18	−25	"
+5	−2	−4	−11	"
−35	−39	−41	−47	"
+2	−2	−6	−8	"

TABLE B.

Examples of non-agreement between residuals :—

Dehra Dún.	Barrackpore.	Toungoo.	Kodaikánal.
−21	−21	−22	−8
+56	+43	+37	+45
−22	−27	−12	−32
−20	−21	−39	−34
−56	−57	−57	−30
−51	−40	−46	−29
−16	−3	−14	−10

Examples could be multiplied, but the above will shew that ordinarily it is only one observatory that is at fault, and that the disturbance correction at any station can be obtained by computing the correction at three base stations but that occasionally cases will occur where considerable uncertainty will exist. For example, in the 4th line in Table B, where we have two pairs of accordant values, it would be impossible to determine, with any certainty, the amount of correction to be applied to an observation at a station whose latitude was between that of Barrackpore and Toungoo.

The investigation will be continued, mainly in order to ascertain whether such uncertainties occur sufficiently frequently to necessitate a more rigid investigation on the lines suggested by Sir A. Rücker, F.R.S., mentioned in last year's report. This method, however, is somewhat laborious, and it is hoped that it will not be necessary to employ it. It must be remembered that at present only magnetic disturbances of considerable magnitude have been dealt with, and as these are comparatively rare, a few discrepancies are not of much consequence.

The isomagnetic charts.

During the recess, charts have been prepared showing lines of equal horizontal force declination and dip. These are based on uncorrected observations only, though a rough secular change correction has been applied. They can, therefore, only be regarded as preliminary, and their chief use will be to indicate abnormal areas, where detail survey will be necessary.

The charts have been published in the general report for 1907-08, together with a short explanatory note.

4. *Comparison of instruments with the Survey Standard.*—All the field instruments were as usual compared with the standard instruments at Dehra Dún at the beginning and end of the field season and the results of these comparisons and also the re-computed comparisons of previous years are given in the tables below.

Tables of Instrumental Differences from the Survey Standard at Dehra Dún.

TABLE I.

Horizontal Force.

Expressed in absolute units (C. G. S.)

17—Magnetometer No.	1902-03.		1903-04.		1904-05.		1905-06.		1906-07.		1907-08.	
	Beginning.	End.	Beginning.	End.	Beginning.	End.	Beginning.	End.	Beginning.	End.	Beginning.	End.
1	+6	+3(a) −3(c)	+1	+5	0	+6(b) +14(c)						
	Mean.	+5(a) 0(c)		+3		+3(b) +10(c)						
1 (2A)							−5	−4	−2	−14	−18	−27
	Mean.							−5		−8		−23
3	+15	+14	+20	+23	+23	+20	+23	+21	+11	+2	−2	−1
	Mean.	+15		+22		+22		+22		+6		−2
4	+34	+26	+10	+1	+24	+30	−4	−6	−8	−2	−14	−16
	Mean.	+30		+6		+27		−5		−5		−15
5	−13	No comparison.	+2	−3	+13	+17	+29	+23	+21	+6	−9	−8
	Mean.	−13		0		+15		+26		+14		−9
6	−26	−29	−17	−11	−14	−20	−7	−27	−15	−33	−30	−29
	Mean.	−28		−14		−17		−17		−24		−29
10			+8	+13	+13	No comparison.	+35	+26	+18	+23	+27	+2
	Mean.			+11		+13		+31		+20		+15

(a) Up to 12th March 1903.
(b) " 14th February 1905.
(c) Rest of field season

It must, however, be remembered that the horizontal force correction of a magnetometer, expressed in absolute units, will not remain constant with a change in the magnetic field, but varies as the value of horizontal force at the station of observation. The correction is thus of the form F. H., with at least very close approximation. Table I A gives the values of F for the different magnetometers in different years.

TABLE I A.

HORIZONTAL FORCE.

Values of F appearing in the expression F. H.

17— Magnetometer No.	1902-03.	1903-04.	1904-05.	1905-06.	1906-07.	1907-08.
1	+·00015 (a) 0 (c)	+·00009	+·00018 (b) +·00030 (c)			
1_{a}				−·00015	−·00024	−·00069
3	+·00045	+·00066	+·00066	+·00066	+·00018	−·00006
4	+·00090	+·00018	+·00081	−·00015	−·00015	−·00045
5	−·00039	0	+·00045	+·00078	+·00042	−·00027
6	−·00084	−·00042	−·00051	−·00051	−·00072	−·00087
10		+·00033	+·00039	+·00093	+·00060	+·00045

(a) Up to 12th March 1903.
(b) „ 14th February 1905.
(c) Rest of Field Season.

TABLE II.

DECLINATION AND DIP.

Declination.			Dip.		
17— Magnetometer.	Beginning of field season 1907-08.	End of field season 1907-08.	Earth Inductor No. 30— Dip circle No.	Beginning of field season 1907-08.	End of field season 1907-08.
1	+0′·2	—0′·0	135	—2′·7	—1′·5
3	—0·0	—0·1	136	—1·8	+1·3
4	—0·7	—0·6	138	+2·6	+5·5
5	—0·5	—0·4	139	+0·1 (a) —0·1 (b)	+4·6
6	+0·3	+0·1	140	—0·2	+2·9
10	—0·0	+0·1	170	—0·3	+1·6

(a) Up to 17th February needles 4 D and 2 used.
(b) From 7th April „ 4 C „ 2 „

5. *Values of the distribution co-efficient P for the field instruments.*—The table below gives the "near" values of $P_{1\cdot2}$ and P_{2}, for the field instruments.

The same arrangement of the deflection distances as last year has been used and from each complete observation one "near" and one "far" value of $P_{1\cdot2}$ and $P_{2\cdot3}$ are obtained.

The far values, being of less weight, are not used in computing $\frac{m}{H}$ and have not been shown.

TABLE A.

Number of Magnet.	$P_{1\cdot2}$ from 22·5 and 30 cms.					$P_{2\cdot3}$ from 30 and 40 cms.					Values for 1906-07.	
	Mean from all observations.	Adopted mean value.	Total number of observations.	Number of rejected observations.	Number of observations used in finding means.	Mean from all observations.	Adopted mean value.	Total number of observations.	Number of rejected observations.	Number of observations, used in finding means.	$P_{1\cdot2}$	$P_{2\cdot3}$
2 A	7·23	7·26	82	17	65	9·28	9·29	157	46	111	7·32	9·41
3 A	6·20	6·21	38	1	37	7·37	7·36	43	5	38	6·13	7·32
4 A	7·59	7·59	46	*Nil*	46	8·59	8·64	54	8	46	7·60	8·53
5 A	7·21	7·21	46	*Nil*	46	8·16	8·17	95	13	82	7·30	8·12
6 A	7·88	7·88	24	*Nil*	24	8·06	8·14	37	11	26	7·90	8·06
10	5·81	5·82	55	4	51	7·36	7·34	80	20	60	5·77	7·52

The values of p and q appearing in the formula $1-\frac{p}{r^2}-\frac{q}{r^4}$ (as distinct from the expression $1-\frac{P}{r^2}$ commonly used in the computation of $\frac{m}{H}$) are given below, together with the values of $\log\left(1-\frac{p}{r^2}-\frac{q}{r^4}\right)$ and the change in H at Dehra Dún if the 'q' term is taken into account.

TABLE B.

Magnet.	p	q	Log $\left(1-\frac{p}{r^2}-\frac{q}{r^4}\right)$	Change in H at Dehra Dún.
2A	11·96	−1,503	$\bar{1}$·99222	+58γ
3A	8·87	− 851	$\bar{1}$·99379	+33γ
4A	10·02	− 778	$\bar{1}$·99266	+30γ
5A	9·42	− 711	$\bar{1}$·99307	+27γ
6A	8·48	− 193	$\bar{1}$·99300	+ 7γ
10	9·32	−1,126	$\bar{1}$·99386	+43γ

The values in the last column of the table agree closely with those obtained in previous years.

6. *Programme for 1908-09.*—It was intended to complete the preliminary survey during last field season, but owing to the reasons given in para. 1 of

this report this could not be accomplished. During the ensuing field season, therefore, two field detachments will work in Burma, chiefly along the coast, and it is confidently expected that the preliminary survey will be completed.

Two other detachments will be employed on the detail survey and will examine two of the most abnormal districts as yet discovered, *viz.*, S. W. of Indore and near Pokaran in the Rajputana desert.

In the former district the evidence of abnormality is the value of H. F. obtained at stations No. 621 Bistan and No. 622 Khal Ghat (*vide* magnetic chart). These stations are about 35 miles apart and at the former the value of H. F. is ·378 C. G. S. and at the latter ·320 C. G. S. The declination at Bistan is practically normal, *viz.*, 1° 6′ E but at Khal Ghat it is 2° 36′ E. It is hoped that a definite centre of attraction will be located, but the whole district is composed of Deccan trap and many abnormal values are likely to be met with.

In the latter district the abnormality is mainly shown by the declination values at No. 20 Asolai, 0° 15′ E, and No. 413, Hardikot (near Pokaran) 3° 4′ E. The values of H. F., *viz.*, ·341 and ·339 C. G. S. are both approximately normal, but, as the two stations are nearly on the same parallel, an assumed centre of attraction lying between them would not have much effect on this component, while it would cause a maximum divergence in the values of declination at the two stations.

The method of survey will be to take observations every 10 or 12 miles over the area and to continue these outwards until approximately normal values are obtained. Where extreme abnormality is found the observation will be repeated a short distance (half a mile to a mile) away.

It is difficult to estimate the time required for the examination of any district as this, of course, depends on the area involved, but it is expected that both the districts mentioned above will be completed and probably each detachment will be able to survey other small abnormal areas in Central India. The two Burma detachments will also carry out detail survey, on completion of the preliminary survey, *i.e.*, for about the last two months of the field season.

The officer in charge and the second Imperial officer will visit all the base and repeat stations and will also take observations at several old field stations suitably situated.

7. *Results included in this report.*—A table showing the approximate preliminary values (uncorrected) at the field and repeat stations in 1907-08 is appended (see Tables p. 59) together with an index chart showing all stations of observation to date. The tabulations of the results obtained at Dehra Dún, Barrackpore, Toungoo and Kodaikánal observatories are published for 1907.

II. The Magnetic Observatories in 1907-08.

A.—*Dehra Dún Observatory.*

1. General remarks on working.
2. Mean values of H. F. and declination constants.
3. Mean values of base lines.
4. Mean scale value and temperature range.
5. Mean monthly values of magnetic elements and secular change, 1906-07.

1. *General remarks on working.*—The observatory was in charge of Observer Shri Dhar up to July 1908, and up to the end of September Babu R. P. Ray performed the duties of magnetic observer until relieved by the observer from Toungoo.

The magnetographs continued to give good results throughout the year, and in spite of the heavy rains of 1908 there has been no trouble from water in the underground room.

2. *Mean values of Constants.*—The following table gives the monthly mean values of the magnetic collimation, of the distribution coefficients $P_{1\cdot 2}$ and $P_{2\cdot 3}$ and of the moment of the magnet (m_0) for 1907.

The values of P and m actually used in computing H are also shown, these being obtained by careful scrutiny of the individual values.

Mean values of the constants of the Magnetometer No. 17.

Months 1907.	DECLINATION CONSTANT	HORIZONTAL FORCE CONSTANTS.						
	Mean Magnetic Collimation.	MEAN VALUES OF P'S				Mean values of M_0 C. G. S.	Accepted Mean values of M_0 C. G. S.	REMARKS.
		$P_{1\cdot 2}$	$P_{2\cdot 3}$	Accepted value of $P_{1\cdot 2}$	Accepted value of $P_{2\cdot 3}$.			
	′ ″							
January	−8 24	7·40	8·14			914·60	914·60	
February	−8 23	7·61	8·06			914·60	914·60	
March	−8 22	7·45	7·97			914·60	914·60	
April	−8 27	7·55	7·98			914·11	914·33	
May	−8 22	7·49	7·96			913·97	914·33	
June	−8 22	7·53	8·06			913·73	914·33	
July	−8 21	7·34	8·14	7·44 throughout.	8·02 throughout.	913·73 914·40	914·33	(1) to 17th. (2) from 20th.
August	−8 21	7·39	8·13			914·40	914·33	
September	−8 22	7·38	8·04			914·40 914·16	914·33	(1) to 14th. (2) from 16th.
October	−8 28	7·41	7·91			911·67 911·43	911·84	(1) to 16th (2) from 18th.
November	−8 37	7·38	7·82			911·32	911·84	
December	−8 35	7·47	7·87			911·98 911·87	911·84	(1) to 14th. (2) from 18th.

3. *Mean values of base lines.*—The table below shows the mean values of the H. F. and declination base lines actually used. These values are obtained in the same way as the values of P and m and are more probably correct than the actual monthly means. Changes, such as those in July and October 1907, occasionally occur without any apparent reason and with no sign of a sudden slip of the quartz fibre and in these cases it can only be assumed that the change is gradual and uniform. Values of the base lines for the periods marked *a* can, therefore, only be found by interpolation.

The base line values of the V. F. magnetograph have not been shown as there have been frequent changes.

Dehra Dún Observatory.

Months 1907.	Declination. Mean value of Base line.	Declination. Remarks.	Horizontal Force. Mean value of Base line.	Horizontal Force. Remarks.
	° ′			
January	1 41·29	......	·33121	
February	1 41·29	......	·33121	
March	1 41·29	......	·33121	
April	1 41·29	......	·33121 (1) ·33181 (2)	h. m. (1) till 10-5 on 8th. (2) from 10-15 on 8th.
May	1 41·29 (1) 1 41·01 (2)	(1) to 13th (2) from 14th	·33181	
June	1 41·01	......	·33181 (1) ·33032 (2)	(1) till 7 h. on 8th. (2) from 9 h. on 8th.
July	1 41·01	......	·33030 *a* ·33018	to 10th. to 22nd. from 23rd.
August	1 41·01	......	·33016	
September	1 41·01	......	·33015	
October	1 41·01 (1) 1 40·69 (2)	(1) to 16th (2) from 18th	·33013 *a*	to 21st. from 22nd.
November	1 40·69	......	·33004	
December	1 40·69	......	·33004	

Note.—*a* Base line value assumed to be varying uniformly. Values for individual days found by interpolation.

4. *Mean scale value and temperature range.*—The mean scale value of the H. F. magnetograph was 4·05γ for a change of ordinate of 0·04″ up to the 8th of June when, on the torsion head being turned, the value was altered to 4·14. That of the V. F. instrument has frequently changed owing to the necessity of altering the balance of the magnet. The values have ranged from 4·12γ to 4·91γ.

The mean temperature of the year was 26·3° C with maxima of 27·2° C in October, November and December and a minimum of 25·1° C in April. The base lines are referred to a temperature of 25° C.

5. *Mean value of secular change.*—The following table gives the mean monthly values of the magnetic elements with the secular change for 1906-07 deduced therefrom.

Dehra Dún Observatory.

Secular change.

Months.	Horizontal Force ·33000+10—5			Declination E. 2°+			Dip 43°+		
	Values 1906.	Values 1907.	Secular change, 1906-07.	Values 1906.	Values 1907.	Secular change, 1906-07.	Values 1906.	Values 1907.	Secular change, 1906-07.
	C. G. S.	C. G. S.	γ	′	′	′	′	′	′
January . . .	376	336	—40	39·6	39·0	—0·6	29·0	34·1	+5·1
February . . .	371	333	—38	39·5	38·7	—0·8	30·0	35·8	+5·8
March . . .	376	322	—54	39·3	39·2	—0·1	28·9	33·7	+4·8
April . . .	382	335	—47	39·4	38·6	—0·8	28·6	33·9	+5·3
May . . .	365	330	—35	39·3	38·5	—0·8	29·8	35·3	+5·5
June . . .	374	333	—41	39·2	38·0	—1·2	28·8	35·6	+6·8
July . . .	362	322	—40	38·8	38·1	—0·7	30·7	36·4	+5·7
August . . .	363	325	—38	39·1	37·9	—1·2	31·1	36·4	+5·3
September . .	362	323	—39	39·1	37·8	—1·3	33·2	37·1	+4·9
October . . .	352	310	—42	39·0	37·8	—1·2	31·4	38·0	+6·6
November . .	355	309	—46	38·8	37·5	—1·3	33·5	37·9	+4·4
December . .	342	305	—37	38·8	37·5	—1·3	33·7	38·7	+5·0
Means .	365	324	—41	39·2	38·2	—1·0	30·6	36·1	+5·5

Note.—(1) The values of H. F. have been re-computed from the beginning of the survey with the mean m and the $\frac{m}{H}$ obtained from deflections at 22·5 cms. The above secular change of H. F. is found from these values

(2) In 1906 the dip was observed with Dip Circle No. 44 and in 1907 with Inductor No. 30. The difference between the two instruments is 0·8′, the Inductor giving higher values. The values of dip in 1906 have therefore been increased by this amount.

B.—Barrackpore Observatory.

1. General remarks on working.
2. Mean values of H. F. and Declination constants.
3. Mean values of base lines.
4. Mean scale values and temperature range.
5. Mean monthly values of magnetic elements and secular change 1906-07.

1. *General remarks on working.*—The observatory remained in charge of K. N. Mukerji throughout the year. The magnetographs all worked satisfactorily, though the declination instrument gave a small amount of trouble owing to the base line value varying. This was opened up in December 1907 and a new base mirror fixed, since when the value has been fairly steady. In the last few months, also, there have been signs that the H. F. magnet mirror is perishing and this will be replaced during the ensuing field season. The new pattern V. F. magnet was mounted last field season and has worked satisfactorily.

2. *Mean values of constants.*—The following table gives the monthly mean values of the magnetic collimation, the distribution co-efficients $P_{1,2}$ and $P_{2,3}$ and the magnetic moment of the magnet (m_0) for 1907. The values of P and m actually used in the computation of H are also given.

It will be seen that the value of m has but very slightly changed which is satisfactory.

Mean values of the constants of the Magnetometer No. 20.

Months 1907.	DECLINATION CONSTANT. Mean Magnetic Collimation.	HORIZONTAL FORCE CONSTANTS. Mean values of P's. $P_{1\cdot2}$.	$P_{2\cdot3}$.	Accepted value of $P_{1\cdot2}$.	Accepted value of $P_{2\cdot3}$.	Mean values of m_o C. G. S.	Accepted mean values of m_o C. G. S.	REMARKS.
	′ ″							
January	−7 3	6·68	7·84			949·19	949·19	
February	−7 6	6·75	7·68			949·19	949·19	
March	−7 6	6·88	7·75			949·12	949·12	
April	−7 7	6·78	7·91			949·17	949·17	
May	−7 6	6·73	7·82			949·05	949·01	
June	−7 17	6·74	7·95	6·79 throughout.	7·85 throughout.	949·06	949·01	
July	−7 16	6·81	7·91			949·14	949·01	
August	−7 15	6·79	7·82			948·87	949·01	
September . . .	−7 16	6·81	7·84			948·92	949·01	
October . . .	−7 13	6·77	7·82			949·02	949·01	
November . . .	−7 16	6·84	7·90			948·92	949·01	
December . . .	−7 16	6·81	8·07			949·08	949·01	

3. *Mean values of the base lines.*—The table below gives the values of the H. F. and declination base lines. The V. F. base line has constantly changed and is not shown.

Barrackpore Observatory.

Months 1907.	DECLINATION. Mean value of Base line.	DECLINATION. Remarks.	HORIZONTAL FORCE. Mean value of Base line.	HORIZONTAL FORCE. Remarks.
	° ′			
January . . .	0 20·71 (1)	(1) up to 25th	·37032	
	0 21·57 (2)	(2) from 26th		
February . . .	0 19·70 (1)	(1) up to 8th	·37028	
	0 19·10 (2)	(2) from 11th		
March . . .	0 19·60 (1)	(1) up to 11th	·37028	
	0 18·79 (2)	(2) 13th to 20th		
	0 20·46 (3)	(3) from 23rd		

Barrackpore Observatory—contd.

Months 1907.	Declination.		Horizontal Force.	
	Mean value of Base line.	Remarks.	Mean value of Base line.	Remarks.
	° ′			
April	0 20·84 (1)	(1) 1st and 2nd	*a*	to 15th
	0 19·30 (2)	(2) 3rd to 6th		
	0 18·62 (3)	(3) 8th to end	·37038	from 16th
May	0 18·35 (1)	(1) up to 22nd	·37039	to 5th
	0 17·95 (2)	(2) from 24th	·37040	from 6th
June	0 17·95	...	·37042	
July	0 17·96	...	·37042	
August	0 17·87 (1)	(1) to 21st	·37044	
	0 18·13 (2)	(2) from 23rd		
September	0 18·16	...	·37044	to 21st
			a	from 22nd
October	0 18·16	...	·37033	to 26th
			·37031	from 27th
November	—	Base line value varying.	*a*	to 22nd
			·37005	from 23rd
December	0 17·3 (1)	(1) to 5th	*a*	to 6th
			·37000	from 7th
	0 28·66 (2)	(2) 7th to 9th	*a*	from 15th
	0 25·43 (3)	(3) from 10th	·36993	at end

Note.—*a* = Base line value assumed to be varying uniformly. Values for individual days found by interpolation.

4. *Mean scale values and temperature range.*—The mean scale value of the H. F. magnetograph was 4·82γ for a change of ordinate of 0·04″ with limiting values of 4·80 and 4·86. That of the V. F. instrument was 5·71γ for April and May 1907 and 5·77γ up to December 1907 when the new magnet was mounted the limiting values being 5·76 and 5·79.

The mean temperature of the year was 31·9° C with a maximum of 33·0° C in June and a minimum of 30·8° C in January. The base lines are referred to a temperature of 31° C.

5. *Mean monthly values of secular change.*—The following table gives the mean monthly values of the magnetic elements in 1906 and 1907 and the secular change deduced therefrom.

Barrackpore Observatory.

Secular change.

Months.	Horizontal Force. ·37000 + 10—5.			Declination E 1° +			Dip 30° +		
	Values 1906.	Values 1907.	Secular change 1906-07.	Values 1906.	Values 1907.	Secular change 1906-07.	Values 1906.	Values 1907.	Secular change 1906-07
	C. G. S.	C. G. S.	γ	′	′	′	′	′	′
January . . .	246	281	+35	15·5	12·0	—3·5	23·9	27·6	+3·7
February . . .	246	280	+34	15·5	11·0	—4·5	23·0	30·5	+7·5
March . . .	257	281	+24	15·3	11·2	—4·1	24·8	28·0	+3·2
April . . .	266	297	+31	14·9	10·6	—4·3	24·5	28·7	+4·2
May . . .	265	289	+24	14·3	10·3	—4·0	23·1	29·8	+6·7
June . . .	255	290	+35	14·3	9·8	—4·5	24·0	29·8	+5·8
July . . .	260	283	+23	14·2	9·7	—4·5	24·7	30·6	+5·9
August . . .	261	293	+32	13·9	9·4	—4·5	25·6	30·8	+5·2
September . .	260	293	+33	13·8	9·0	—4·8	25·3	31·0	+5·7
October . . .	266	284	+18	13·0	8·6	—4·4	26·5	31·8	+5·3
November . .	65	290	+25	12·7	8·4	—4·3	25·7	31·8	+6·1
December . .	261	290	+29	12·2	7·9	—4·3	26·8	32·1	+5·3
Means .	259	288	+29	14·1	9·8	—4·3	24·8	30·2	+5·4

Note.—(1) The values of H have been re-computed from the beginning of the survey with the mean m and the $\frac{m}{H}$ obtained from deflections at 22·5 cms. The above secular change of H. F. is found from these values.

(2) During 1906 the dips were observed with the Dip circle No. 45 and in 1907 with the Inductor No. 46. The difference of the two instruments is 1′·6, the inductor giving lower values. The values of Dip with the circle are therefore diminished by this amount.

C.—Toungoo Observatory.

1. General remarks on working.
2. Mean values of H. F. and Declination constants.
3. Mean values of base lines.
4. Mean scale values and temperature range.
5. Mean monthly values of magnetic elements and secular chage 1906-07.

1. *General remarks on working.*—The observatory remained in charge of Surveyor K. K. Dutta until May 1908 when he proceeded on 3 months' leave. Recorder Abdul Majid held charge up to the end of the survey year. K. K. Dutta was in bad health during the autumn of 1907 and was only able to observe occasionally, and the values of P and m from August to October are obtained from very few observations. The magnetographs worked well throughout the year.

2. ***Mean values of H. F. and declination constants.***—The following table gives the monthly mean values of the magnetic collimation, the distribution coefficients $P_{\cdot 1-\cdot 1}$ and $P_{\cdot 1-\cdot 8}$ and the magnetic moment of the magnet (m_0) for 1907. The values of P and m actually used in computing H are also shown.

A new magnet No. 5 B was used from September 1907 which explains the changes in the constants. The change in collimation between October and November is due to the magnet having been turned in its sheath.

Mean values of the constants of the Magnetometer No. 19.

Months 1907.	DECLINATION CONSTANT. Mean Magnetic Collimation.	HORIZONTAL FORCE CONSTANTS. Mean values of P's. $P_{1\cdot 2}$.	$P_{2\cdot 3}$.	Accepted value of $P_{1\cdot 2}$.	Accepted value of $P_{2\cdot 3}$.	Mean values of m_0 C. G. S.	Accepted mean values of m_0 C. G. S.	REMARKS.
	′ ″							
January	−16 38	7·30	8·23	7·13	7·89	886·39	886·39	
February	−16 38	7·19	7·81	7·13	7·89	886·41	886·41	
March	−16 39	7·10	7·26	7·13	7·89	886·38	886·38	
April	−16 36	7·25	7·69	7·13	7·89	886·23	886·23	
May	−16 38	7·13	8·51	7·13	7·89	885·91	886·19	
June	−16 38	6·97	7·80	7·13	7·89	885·94	886·15	
July	−16 39	7·00	8·16	7·13	7·89	885·86	886·11	
August	−16 41	7·03	7·81	7·13	7·89	886·08	886·08	
September	−2 37	7·87	8·20	7·71	7·14	952·41	952·35	Magnet No. 5-B used.
October	−2 34	7·74	7·44	7·71	7·14	952·51	952·35	" "
November	−3 26	7·69	7·14	7·71	7·14	951·92	952·35	" "
December	−3 34	7·70	7·14	7·71	7·14	952·37 (1)	952·35 (1)	(1) to 7th.
						948·48 (2)	948·36 (2)	(2) from 8th.

3. *Mean values of base lines.*—The table below shows the values of the declination and H. F. base lines. Those for the V. F. magnetograph are not given as they have frequently changed.

Toungoo Observatory.

Months 1907.	DECLINATION. Mean value of Base line.	Remarks.	HORIZONTAL FORCE. Mean value of Base line.	Remarks.
	° ′			
January	0 9·90		·38161	
February	0 10·02		·38411	
March	0 10·08		·38414	to 15th.
			a	from 16th.
April	0 9·71		*a*	
May	0 10·13		*a*	up to 10th.
			·38401	from 11th.
June	0 9·71		·38401	to 15th.
			a	from 16th.
July	0 9·50		*a*	to 12th.
			·38392	from 13th.
August	0 8·95		·38391	
September	0 8·90		·38391	
October	0 8·90		·38391	
November	0 8·90		·38391	
December	0 9·00		·38391	

NOTE.—*a* = Base line value assumed to be varying uniformly. Values for individual days found by interpolation.

4. *Mean scale values and temperature range.*—The scale value of the H. F. magnetograph appears to have slightly changed during the year. Starting at 5·60γ in January the value fell to 5·48γ when the torsion head was turned at the end of that month (*vide* change in H. F. base line). From September the value rose again to 5·51γ and appears now to be steady. The scale value of the V. F. instrument has also changed during the year being 5·65γ for April and May, 5·39γ from June to August, and 5·49γ for the rest of the year.

The mean temperature of the year was 89·0° F. with maxima of 89·2° F. in February and April and a minimum of 88·8° F. in April which is extremely satisfactory. The base lines are referred to a temperature of 89° F.

5. *Mean values of secular change.*—The following table gives the mean monthly values of the magnetic elements with the secular change deduced therefrom. The values in H. F. for the last 4 months in the year are unusually high but the mean secular change for the year agrees well with the value +41γ found for 1905-06.

Toungoo Observatory.

Secular change.

Months.	Horizontal force. ·38000+10 5.			Declination. E 0°+			Dip. 22°+		
	Values 1906.	Values 1907.	Secular change 1906-07.	Values 1906.	Values 1907.	Secular change 1906-07.	Values 1906.	Values 1907.	Secular change 1906-07.
	C. G. S.	C. G. S.	γ	′	′	′	′	′	′
January . . .	702	718	+16	45·2	41·5	−3·7	59·8	59·4	−0·4
February . .	703	709	+6	45·4	41·0	−4·4	60·9	62·5	+1·6
March . . .	710	732	+22	45·1	40·4	−4·7	59·8	61·1	+1·3
April . . .	715	748	+33	44·4	40·0	−4·4	60·0	61·5	+1·5
May . . .	710	740	+30	44·4	39·4	−5·0	60·2	62·1	+1·9
June . . .	724	752	+28	43·8	39·3	−4·5	60·2	61·2	+1·0
July . . .	730	746	+16	43·5	38·8	−4·7	59·9	61·8	+1·9
August . . .	722	761	+39	43·1	38·9	−4·2	60·5	62·0	+1·5
September . .	720	771	+51	42·7	38·3	−4·4	60·2	61·5	+1·3
October . .	715	782	+67	42·2	38·1	−4·1	60·4	61·2	+0·8
November . .	721	792	+71	41·8	37·9	−3·9	60·2	62·0	+1·8
December . .	709	802	+93	41·6	37·4	−4·2	60·1	61·8	+1·7
Means .	715	754	+39	43·6	39·3	−4·3	60·2	61·5	+1·3

NOTE.—(1) The values of H. F. have been re-computed from the beginning of the survey with the mean m and the $\frac{m}{H}$ obtained from deflections at 22·5 cms. The above secular change of H. F. is found from these values.

NOTE.—(2) Up till the end of January 1907 the dip was observed with the Dip Circle No. 137 and from February with the Inductor No. 44; occasionally the Dip Circle was used after February also. The difference of the two instruments is 1·0′, the inductor giving higher dips. The values of dip with the circle are therefore increased by this amount.

D.—*Kodaikánal Observatory.*

1. General remarks on working.
2. Mean values of H. F. and declination constants.
3. Mean values of base lines.
4. Mean scale value and temperature range.
5. Mean monthly values of magnetic elements and secular change 1906-07.

1. ***General remarks on working.***—The observatory remained in charge of Surveyor Ramaswami Iyengar throughout the year, except for a period of 3 months while he was on leave, during which time Shri Dhar held charge.

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

The H. F. and Declination magnetographs have given good results throughout the year but the V. F. instrument was unsatisfactory even after the mounting of the new magnet. In June 1908, however, the magnet was made more stable by screwing down the small gravity bob and for the remainder of the year the traces have been excellent. The scale value is now necessarily somewhat high, but this cannot be avoided.

2. ***Mean values of constants.***—The following table gives the monthly mean values of the magnetic collimation, the distribution coefficients $P_{1\cdot2}$ and $P_{2\cdot3}$ and the magnetic moment of the magnet (m_0) for 1907. The values of P and m actually used in computing H are also shown.

Mean values of the constants of magnetometer No. 16.

Months 1907.	DECLINATION CONSTANT. Mean Magnetic Collimation.	HORIZONTAL FORCE CONSTANTS. Mean values of P's. $P_{1\cdot2}$.	$P_{2\cdot3}$.	Accepted value of $P_{1\cdot2}$.	Accepted value of $P_{2\cdot3}$.	Mean values of m_0 C. G. S.	Accepted mean values of m_0 C. G. S.	REMARKS.
	′ ″							
January	−2 18	6·72	8·53	6·72	8·53	925·60(1) 925·39(2) 925·19(3) 924·99(4)	925·60 925·39 925·19 924·99	(1) to 19th. (2) 23rd. (3) 26th and 28th. (4) 30th.
February	−2 18	6·73	8·65	6·73	8·65	924·99	924·99	
March	−2 5	6·78	8·75	6·83	8·57	923·41	923·41	
April	−2 23	6·74	8·44	6·83	8·57	923·32	923·32	
May	−2 24	6·72	8·56	6·83	8·57	923·27	933·27	
June	−2 26	6·88	8·57	6·83	8·57	923·43	923·43	
July	−2 23	6·92	8·73	6·83	8·57	923·45	923·50	
August	−2 26	6·92	8·50	6·83	8·57	923·47	923·50	
September	−2 22	6·81	8·52	6·81	8·52	923·44	923·50	
October	−2 22	6·84	8·55	6·84	8·55	923·52	923·50	
November	−2 20	6·84	8·56	6·84	8·56	923·53	923·50	
December	−2 21	7·07	8·46	7·07	8·46	923·11	923·11	

3. ***Mean values of the base lines.***—The following table shows the base line values of the H. F. and declination magnetographs. It will be noticed that the H. F. base line has been practically steady throughout the year, only a slight and fairly regular fall being observed. The base line values of the V. F. magnetograph have not been shown as they have constantly changed.

Kodaikánal Observatory.

Months 1907.	Declination.			Horizontal Force.	
	Mean value of Base Line.		Remarks.	Mean value of Base Line.	Remarks.
	°	′			
January	1	40·01	......	·36977	
February	1	39·73	......	·36975	
March	1	39·75	......	·36971	
April	1	39·65	......	·36975	
May	1	39·83	......	·36972	
June	1 1	39·85 39·43	Up to 12th From 13th	·36970	
July	1 1	39·61 32·38	Up to 24th From 25th	·36968	
August	1	32·38	......	·36964	
September	1	32·69	......	·36963	
October	1	32·48	......	·36965	
November	1	32·57	......	·36964	
December	1	32·59	......	·36964	

4. *Mean scale value and temperature range.*—The mean scale value of the H. F. magnetograph was 6·14γ for a change of ordinate of 0·04″ with limiting values of 6·13 and 6·16. That of the V. F. instrument varied considerably between 3 and 4γ up to the end of September 1907, when the magnet was removed and cleaned and the scale value raised to 6·03γ after which it remained fairly steady till December when the new magnet was mounted.

The mean temperature of the year was 19·1°C with a maximum of 19·3°C in May and minima of 19·0°C in January and December. The base lines are referred to a temperature of 19·0°C.

5. *Mean monthly values of secular change.*—The following table gives the mean monthly values of the magnetic elements in 1906 and 1907 and the secular change deduced therefrom.

Kodaikánal Observatory.

Secular change.

Months.	Horizontal Force ·37000 + 10−5.			Declination W. 0° +			Dip 3° +		
	Values 1906.	Values 1907.	Secular change 1906-07.	Values 1906.	Values 1907.	Secular change 1906-07.	Values 1906.	Values 1907.	Secular change 1906-07.
	C. G. S.	C. G. S.	γ	′	′	′	′	′	′
January	424	426	+2	34·2	38·8	+4·6	17·9	25·8	+7·9
February	426	415	−11	34·5	39·0	+4·5	20·1	27·2	+7·1
March	429	423	−6	34·8	39·2	+4·4	18·5	24·1	+5·6
April	436	439	+3	35·4	39·9	+4·5	20·1	26·7	+6·6

Kodaikánal Observatory—contd.

Months.	Horizontal Force. ·37000 + ι_0^6.			Declination. W 0° +			Dip. 3° +		
	Values 1906.	Values 1907.	Secular change 1906-07.	Values 1906.	Values 1907.	Secular change 1906-07.	Values 1906.	Values 1907.	Secular change 1906-07.
	C. G. S.	C. G. S.	γ	′	′	′	′	′	′
May	420	429	+9	35·9	40·2	+4·3	21·8	26·3	+4·5
June . . .	419	430	+11	36·3	40·5	+4·2	21·5	27·7	+6·2
July . . .	420	423	+3	36·7	40·7	+4·0	22·5	27·9	+5·4
August . . .	422	430	+8	36·7	41·1	+4·4	22·4	28·3	+5·9
September . .	428	438	+10	37·1	41·7	+4·6	22·4	27·4	+5·0
October . . .	421	436	+15	37·4	41·8	+4·4	23·0	27·7	+4·7
November . .	432	437	+5	38·0	42·4	+4·4	25·2	29·4	+4·2
December . . .	427	440	+13	38·2	42·8	+4·6	26·5	29·7	+3·2
Means .	425	431	+6	36·3	40·7	+4·4	21·8	27·4	+5·6

Note—(1) The values of H. F. have been re-computed from the beginning of the survey with the mean m and the $\frac{m}{H}$ obtained from deflections at 22·5 Cms. The above secular change of H. F. is found from these values.

(2) Up till the end of February 1907 the dips were observed with the Dip Circle No. 46 and from March with the Inductor No. 45; occasionally the Dip Circle was used after March also. The difference of the two instruments is 0·7′ the inductor giving higher dips. The values of dips with the circle have therefore been increased by this amount.

Tables of Results.

INDEX TO TABLES.

* For each observatory the following tables are given :—

1. Absolute observations of dip up to end of March 1907, after which time the results from the V. F. magnetographs are available.
2. Hourly means of declination, horizontal force, vertical force and dip (corrected for temperature) from 5 selected quiet days per month.
3. Diurnal inequality of each of the above deduced from 2.

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

Table A.

The Magnetic Elements at the Observatories in 1907.

Observatory.	Latitude.	Longitude.	Declination.	Horizontal Force.	Vertical Force.	Dip.
	° ′ ″	° ′ ″	° ′			° ′
Dehra Dún . .	30 19 19 N	78 3 19 E	2 38·2 E	·33324 C. G. S.	·31736 C. G. S.	43 36·1 N
Barrackpore .	22 46 29 „	88 21 39 „	1 9·8 „	·37288 „	·21967 „	30 30·2 „
Toungoo . .	18 55 45 „	96 26 3 „	0 39·3 „	·38754 „	·16470 „	23 1·5 „
Kodaikánal .	10 13 50 „	77 27 46 „	0 40·7 W	·37431 „	·02261 „	3 27·4 „

D—Dehra Dûn . {Lat. 30° 19′ 15″, Long. 78° 3′ 15″}
K—Kodaikánal . {Lat. 10° 13′ 50″, Long. 77° 27′ 46″}

B.—*Dates of Magnetic Disturbances, 1907.*

B=Barrackpore . {Lat. 22° 46′ 29″, Long. 88° 21′ 39″}
T=Toungoo . {Lat. 18° 55′ 45″, Long. 96° 27′ 3″}

Date. 1907	January. D	January. K	January. B	January. T	February. D	February. K	February. B	February. T	March. D	March. K	March. B	March. T
1	C	C	C	C	S	—	S	—	S	S	S	S
2	C	C	C	C	S	—	S	S	S	S	S	S
3	(C)	(C)	(C)	(C)	C	—	C	(C)	—	S	C	C
4	(C)	(C)	(C)	(C)	(C)	—	(C)	C	S	S	S	S
5	S	S	S	S	(C)	(C)	(C)	(C)	—	C	C	C
6	C	C	C	C	(C)	(C)	(C)	—	S	C	S	C
7	S	C	C	S	M	S	—	M	S	C	C	C
8	S	S	S	S	S	S	—	S	C	C	C	C
9	S	S	S	S	G	G	—	G	(C)	(C)	(C)	(C)
10	S	S	S	S	G	G	—	G	M	M	M	M
11	M	M	M	M	S	S	—	S	S	S	S	S
12	S	S	S	S	S	S	—	S	M	M	M	M
13	S	—	S	C	C	(C)	—	(C)	C	C	C	C
14	C	C	C	C	M	S	M	M	C	C	C	C
15	M	M	M	M	C	C	—	C	(C)	(C)	(C)	(C)
16	S	S	S	S	C	C	—	C	(C)	(C)	(C)	(C)
17	S	(C)	C	C	S	C	C	C	(C)	(C)	(C)	(C)
18	C	—	C	C	C	C	C	C	C	C	C	C
19	(C)	—	(C)	(C)	(C)	(C)	(C)	(C)	C	C	C	C
20	C	—	C	C	C	S	C	C	C	C	C	C
21	(C)	C	(C)	(C)	C	S	C	C	S	S	S	S
22	C	C	C	C	S	S	S	S	M	M	—	M
23	C	C	C	TE	S	S	S	S	C	C	—	C
24	S	C	S	C	S	S	S	S	(C)	(C)	(C)	(C)
25	S	C	S	TE	S	S	S	S	S	S	S	S
26	(C)	(C)	(C)	(C)	C	C	C	C	C	C	C	C
27	S	S	S	TE	(C)	(C)	(C)	(C)	C	C	C	C
28	S	S	S	S	C	—	C	C	C	C	C	C
29	C	(C)	C	C	...	...	...	...	C	C	C	C
30	S	S	S	S	...	...	...	...	C	C	C	C
31	S	S	S	S	...	...	...	...	C	C	C	C
C	15	15	16	16	14	10	12	14	18	21	20	22
S	14	10	13	10	10	1	6	8	8	7	7	6
M	2	2	2	2	2	...	1	2	3	3	2	3
G	...	...	...	...	2	3	...	2	...	...	...	...
VG	...	...	...	...	...	...	...	...	...	...	...	...

Date. 1907	April. D	April. K	April. B	April. T	May. D	May. K	May. B	May. T	June. D	June. K	June. B	June. T
1	C	C	C	C	S	C	C	C	S	C	C	C
2	(C)	(C)	(C)	(C)	C	C	C	C	(C)	(C)	(C)	(C)
3	C	C	C	C	S	C	S	S	(C)	(C)	(C)	(C)
4	C	C	C	C	(C)	(C)	(C)	(C)	S	S	S	S
5	S	C	C	C	C	C	C	C	C	C	C	C
6	S	S	S	S	S	S	C	S	S	S	S	S
7	S	C	C	C	S	C	S	C	S	C	S	C
8		C	C	C	C	C	C	C	C	C	C	C
9	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	S	C	C	C
10	(C)	(C)	(C)	(C)	C	S	C	C	S	S	S	S
11	S	S	C	C	S	S	S	M	S	S	S	S
12	C	C	C	C	S	C	C	C	S	S	S	S
13	S	C	S	S	S	S	S	S	S	C	C	C
14	S	S	S	S	S	S	S	C	S	S	C	S
15	S	C	C	S	S	S	S	S	C	C	C	C
16	S	S	S	S	S	C	S	C	(C)	(C)	(C)	(C)
17	S	S	S	S	(S)	(C)	(C)	(C)	C	C	C	C
18	S	S	S	C	S	S	S	S	S	S	S	S
19	C	C	C	S	M	S	M	M	M	S	M	S
20	C	C	C	C	S	S	C	S	M	S	S	S
21	C	C	C	C	S	C	C	C	C	C	C	C
22	C	C	C	C	C	C	C	(C)	M	M	M	S
23	C	C	C	C	C	C	C	C	S	C	S	C
24	(C)	(C)	(C)	(C)	S	S	—	C	C	C	C	C
25	C	C	C	C	C	C	C	C	S	C	C	C
26	S	C	C	C	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)
27	C	S	C	C	(C)	(C)	(C)	C	S	S	S	C
28	C	C	C	C	S	C	S	S	S	C	C	C
29	S	S	S	S	M	S	M	M	S	C	C	C
30	(C)	(C)	(C)	(C)	C	C	C	S	(C)	(C)	(C)	(C)
31	...	...	...	...	S	S	—	S	...	...	...	...
C	18	22	23	22	12	19	18	19	11	19	18	20
S	12	8	7	8	17	12	9	9	16	10	10	10
M	...	...	...	...	2	...	2	3	3	1	2	...
G	...	...	...	...	...	...	...	...	...	...	...	...
VG	...	...	...	...	...	...	...	...	...	...	...	...

Date. 1907	July. D	July. K	July. B	July. T	August. D	August. K	August. B	August. T	September. D	September. K	September. B	September. T
1	S	C	C	C	S	S	S	S	C	C	C	C
2	S	S	S	S	S	S	S	S	C	C	C	C
3	S	S	S	S	S	S	S	C	(C)	(C)	(C)	(C)
4	S	C	C	C	S	S	S	C	S	C	C	S
5	S	S	S	S	C	S	C	C	S	S	S	S
6	S	S	C	C	(C)	(C)	(C)	(C)	C	C	C	C
7	S	S	S	S	(C)	(C)	(C)	(C)	C	C	C	C
8	S	S	C	C	C	C	C	C	C	C	C	C
9	S	C	C	C	C	C	C	C	(C)	(C)	(C)	(C)
10	M	S	M	M	S	S	S	S	M	M	M	M
11	M	M	M	M	C	C	C	C	M	M	M	M
12	S	C	C	C	(C)	(C)	(C)	(C)	S	S	S	S
13	(C)	(C)	(C)	(C)	C	C	C	C	C	C	C	C
14	(C)	(C)	(C)	(C)	S	C	S	S	(C)	(C)	(C)	(C)
15	C	C	C	C	S	C	C	S	C	C	C	C
16	(C)	(C)	(C)	(C)	S	S	C	S	S	S	S	S
17	(C)	(C)	(C)	(C)	C	C	C	C	M	S	S	S
18	C	C	C	C	C	C	C	C	S	S	S	S
19	C	C	C	C	C	C	C	C	S	S	S	S
20	(C)	(C)	(C)	(C)	S	S	S	S	S	S	C	S
21	C	C	C	C	S	S	S	S	C	C	C	C
22	S	C	C	C	S	S	C	S	C	C	C	C
23	C	C	C	C	S	C	C	S	(C)	(C)	(C)	(C)
24	C	C	C	C	S	S	S	S	(C)	(C)	(C)	(C)
25	S	S	S	S	S	S	C	S	S	C	C	C
26	S	S	C	C	C	C	C	C	S	S	S	S
27	S	S	C	C	(C)	(C)	(C)	(C)	C	C	C	C
28	S	M	S	S	C	C	C	C	C	C	C	C
29	S	S	S	S	(C)	(C)	(C)	(C)	S	S	S	S
30	C	C	—	—	M	...	M	M	S	S	S	S
31	—	C	—	—	S	...	S	S	...	...	...	...
C	12	18	20	20	15	17	20	17	16	18	19	17
S	16	11	7	7	15	14	10	13	11	10	9	11
M	2	2	2	2	1	...	1	1	3	2	2	2
G	...	...	...	...	...	...	...	...	...	...	...	...
VG	...	...	...	...	...	...	...	...	...	...	...	...

Date. 1907	October. D	October. K	October. B	October. T	November. D	November. K	November. B	November. T	December. D	December. K	December. B	December. T	Remarks.
1	S	S	S	S	(C)	(C)	(C)	(C)	C	C	C	C	
2	S	S	S	S	S	S	S	S	C	C	C	C	
3	C	C	C	S	S	S	S	S	(C)	(C)	(C)	(C)	
4	C	C	C	C	S	S	S	S	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	
7	(C)	(C)	(C)	(C)	S	C	C	C	S	S	S	S	
8	C	C	C	C	S	S	S	—	S	—	S	S	
9	S	C	S	S	S	C	S	S	(C)	(C)	(C)	(C)	
10	C	C	C	C	S	S	S	S	C	C	C	C	
11	S	S	C	S	S	S	S	S	S	S	S	S	
12	S	C	C	S	S	S	S	S	S	S	S	S	
13	G	S	M	M	C	C	C	C	S	S	S	S	
14	G	S	M	M	C	C	C	C	C	C	C	C	
15	M	S	M	M	C	C	C	C	C	C	C	C	
16	S	S	S	S	S	S	C	C	C	C	C	C	
17	C	C	C	C	C	C	C	C	(C)	(C)	(C)	(C)	
18	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	C	C	C	C	
19	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	(C)	
20	C	C	C	C	(C)	(C)	(C)	(C)	S	S	S	S	
21	C	C	C	C	G	M	M	M	C	C	C	C	
22	M	S	S	M	M	S	M	M	C	C	C	C	
23	S	S	S	S	C	C	C	C	C	C	C	C	
24	S	S	S	S	C	C	C	C	(C)	(C)	(C)	(C)	
25	S	S	S	S	C	C	C	(C)	C	C	C	C	
26	S	C	C	S	C	C	C	C	C	C	C	C	
27	S	S	S	S	S	S	S	S	S	S	S	S	
28	S	S	S	S	S	S	S	S	S	C	S	S	
29	S	S	S	S	C	C	C	C	C	C	C	C	
30	S	C	S	S	(C)	(C)	(C)	C	S	S	S	C	
31	(C)	(C)	(C)	(C)	...	...	...	...	C	C	C	C	
C	13	17	16	12	16	18	18	18	19	20	19	20	
S	14	14	12	15	12	11	10	9	12	10	11	11	
M	2	...	3	4	1	1	2	2	...	...	...	...	
G	...	...	...	...	1	...	...	...	...	...	...	...	
VG	...	...	...	...	...	...	...	...	...	...	...	...	

NOTE.—The Magnitudes of the Disturbances are taken from the H. F. Magnetograph. C=Calm. M=Moderate. S=Slight. G=Great. VG=Very Great. The traces were lost on days marked —. The selected quiet days are marked ( ).
TE=Temperature Co-efficient experiment in progress.

Observations of Dip Dehra Dún Inductor No. 30 by Schulze.

1	2		3	4		5	6	7	8
Date.	L. M. T.		Circle.	Dip.		Mean.	Monthly mean Dip.	Diff. Circle E.-W.	REMARKS.
1907.	h.	m.		°	′				
January 8	15	18	E	43	34·0				
	15	33	W	43	34·0				
,, 10	13	26	W	43	34·0				
	13	42	E	43	34·1				
,, 11	12	31	E	43	34·4				
	12	44	W	43	34·1				
,, 12	12	39	W	43	34·7				
	12	51	E	43	35·0				
,, 14	10	37	E	43	34·8	Circle East			
	10	48	W	43	34·6	43° 34·2′			
,, 15	11	09	W	43	34·2				
	11	21	E	43	34·1				
,, 17	14	12	E	43	34·1				
	14	24	W	43	34·0				
,, 18	10	29	W	43	33·9				
	10	39	E	43	33·8		43° 34·1′	+0·2′	
,, 19	12	34	E	43	33·9				
	12	46	W	43	33·6				
,, 22	12	25	W	43	35·8				
	12	39	E	43	35·8				
,, 23	13	27	E	43	35·0				
	13	41	W	43	34·8				
,, 26	12	16	W	43	32·8				
	12	31	E	43	33·0	Circle West			
,, 28	11	18	E	43	33·5	43° 34·0′			
	11	31	W	43	33·2				One pair of readings only
,, 30	12	48	W	43	33·5				
	12	59	E	43	33·7				
,, 31	13	20	E	43	33·5				
	13	36	W	43	33·5				
February 2	12	09	W	43	33·5				
	12	19	E	43	33·4				
,, 4	12	36	E	43	33·1				
	12	43	W	43	33·2				
,, 5	14	59	W	43	34·3				
,, 8	14	49	E	43	33·7				
	15	07	W	43	34·6				
,, 9	11	57	W	43	37·1				
	12	10	E	43	37·2				

Observations of Dip Dehra Dún Inductor No. 30 by Schulze.

1		2		3	4		5	6	7	8
Date.		L. M. T.		Circle.	Dip.		Mean.	Monthly mean Dip.	Diff. Circle E.-W.	REMARKS.
1907.		h.	m.		°	′				
February	11	11	24	E	43	38·2	Circle East			
		11	36	W	43	38·2				
„	14	15	21	W	43	40·8	43° 35·8			
		15	36	E	43	40·9				
„	15	10	47	E	43	37·8				
		10	59	W	43	37·5				
„	16	12	32	W	43	37·3				
		12	44	E	43	37·5		43° 35·8′	0·0′	
„	18	12	20	E	43	34·5				
		12	30	W	43	34·7				
„	20	15	11	W	43	37·0	Circle West			
		15	23	E	43	37·0				
„	21	15	09	E	43	36·4	43° 35·8			
		15	21	W	43	36·6				
„	23	12	22	W	43	34·2				
		12	33	E	43	34·0				
„	25	11	48	E	43	34·3				
		11	57	W	43	34·2				
		12	22	E	43	34·2				
		12	33	W	43	34·2				
		13	06	E	43	34·7				
March	1	11	23	E	43	33·9				
		11	33	W	43	33·9				
		12	18	E	43	33·5				
		12	32	W	43	33·5	Circle East			
		12	55	E	43	34·0				
„	4	10	47	E	43	33·2	43° 33·7			
		10	57	W	43	32·8				
„	6	13	03	W	43	32·9		43° 33·7	+0·1′	
		13	12	E	43	33·1				
„	7	15	10	E	43	34·2				
		15	20	W	43	34·6				
„	8	15	18	W	43	33·3	Circle West			
		15	29	E	43	33·7				
„	14	10	48	E	43	34·3	43° 33·6			
		10	58	W	43	34·2				
„	21	14	21	E	43	33·7				
		14	35	W	43	33·9				

Hourly Means of the Declination as determined at Dehra Dún from the selected quiet days in 1907.

Declination E2°+

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
Winter.																										
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January .	38·9	38·9	38·9	38·8	38·7	38·8	38·6	38·7	39·7	40·6	40·4	38·8	37·7	37·9	38·4	39·0	39·3	39·4	39·0	39·0	39·1	39·0	39·0	39·0	39·1	39·0
February .	38·9	38·9	38·9	38·9	38·8	38·6	38·4	38·4	39·5	40·4	40·4	39·3	37·6	36·9	37·0	37·5	38·2	38·6	38·6	38·7	38·8	38·8	39·0	39·0	39·0	38·7
March .	39·1	39·2	39·2	39·0	38·9	38·7	38·9	39·8	41·4	42·5	42·3	40·8	38·7	37·3	36·9	37·6	38·6	38·9	38·7	38·6	38·8	38·9	38·9	39·0	39·1	39·2
October .	37·9	37·9	37·8	37·7	37·8	37·7	38·1	39·2	40·2	40·1	39·4	37·9	36·0	35·4	35·7	37·0	37·7	37·5	37·3	37·4	37·5	37·6	37·8	38·0	38·0	37·8
November .	37·6	37·6	37·6	37·5	37·5	37·5	37·5	37·5	38·0	38·3	38·0	37·1	36·7	36·9	37·3	37·5	37·4	37·3	37·4	37·4	37·3	37·3	37·4	37·5	37·5	37·5
December .	37·6	37·6	37·6	37·5	37·2	37·0	36·8	36·7	37·1	37·9	38·5	38·0	37·5	37·3	37·4	37·2	37·3	37·5	37·6	37·5	37·6	37·5	37·5	37·7	37·7	37·5
Means .	38·3	38·4	38·3	38·2	38·2	38·1	38·1	38·4	39·3	40·0	39·8	38·7	37·4	37·0	37·1	37·6	38·1	38·2	38·1	38·1	38·2	38·2	38·3	38·4	38·4	38·3
Summer.																										
April .	39·0	39·0	39·0	38·9	38·7	38·9	39·7	41·2	42·1	41·4	39·5	37·5	36·4	35·9	36·4	37·3	37·9	38·3	38·3	38·1	38·3	38·3	38·4	38·6	38·6	38·6
May .	39·2	39·1	39·2	39·1	39·2	39·4	40·7	41·4	41·4	40·0	37·8	36·4	35·7	35·6	36·0	37·1	38·0	38·6	38·4	37·9	37·9	38·0	38·4	38·6	38·7	38·5
June .	38·4	38·4	38·5	38·5	38·5	39·1	40·8	41·8	41·6	40·6	38·5	36·4	34·8	34·2	34·6	35·6	36·7	37·5	37·9	37·9	37·6	37·9	37·9	38·0	38·2	38·0
July .	38·4	38·5	38·6	38·6	38·7	39·1	40·4	41·7	41·7	40·9	38·9	37·0	35·6	34·8	34·9	35·5	36·4	37·6	38·1	37·9	37·6	37·8	38·0	38·2	38·4	38·1
A gust .	38·0	38·3	38·6	38·6	38·7	38·9	40·2	41·0	40·7	39·4	37·6	36·0	35·0	34·8	35·4	36·5	37·5	38·1	38·0	37·6	37·5	37·6	37·8	37·8	38·0	37·9
September .	38·1	38·2	38·3	38·2	38·3	38·4	39·4	40·6	41·1	40·2	38·0	36·4	35·0	34·3	34·7	36·0	37·2	37·8	37·7	37·5	37·6	37·6	37·8	37·9	37·9	37·8
Means .	38·5	38·6	38·7	38·8	38·7	39·0	40·2	41·3	41·4	40·4	38·4	36·7	35·4	34·9	35·3	36·3	37·3	38·0	38·1	37·8	37·8	37·9	38·1	38·2	38·3	38·2

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

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

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

Hourly Means of Horizontal Force in C. G. S. Units (corrected for temperature at Dehra Dún from the selected quiet days in 1907.

Hours	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
·33000+													**Winter.**													
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	334	333	332	333	334	334	335	337	340	341	337	338	343	343	**344**	341	343	337	335	332	329	**329**	330	331	333	336
February	330	330	331	329	328	330	333	334	336	337	338	339	343	**344**	340	336	332	329	327	329	328	**327**	328	329	332	333
March	318	317	**316**	317	318	320	321	321	322	327	330	**331**	330	330	330	326	319	320	322	322	322	320	321	321	322	322
October	306	306	308	308	307	308	308	305	302	**298**	303	313	323	**324**	320	315	313	312	310	311	309	309	311	310	310	310
November	306	**304**	305	305	304	304	307	309	312	314	316	312	**325**	321	313	306	306	306	307	307	305	306	307	309	308	309
December	298	299	**298**	298	300	301	303	307	314	320	**321**	319	313	309	306	304	301	301	301	300	**299**	300	301	301	305	305
Means	315	**315**	315	315	315	316	318	319	321	323	324	327	**330**	329	326	321	319	318	317	317	315	315	316	317	318	319
													Summer.													
April	327	324	325	324	326	327	326	**323**	324	335	347	359	**367**	365	356	344	337	329	327	327	326	328	331	332	333	335
May	323	323	324	323	323	325	325	323	**319**	325	337	349	**352**	349	345	338	331	324	323	325	326	327	327	326	327	330
June	331	327	**325**	326	329	329	331	230	327	326	331	338	347	348	**349**	341	336	331	328	327	331	331	335	333	333	333
July	317	318	314	315	**313**	317	318	317	316	316	319	323	332	**334**	334	331	330	327	323	322	321	323	324	322	321	322
August	323	320	319	319	318	318	321	317	**317**	320	326	333	341	**344**	343	337	331	325	321	320	319	320	322	321	322	325
September	319	317	316	317	318	319	319	315	**310**	310	318	327	336	340	**340**	335	328	324	324	323	323	323	322	322	324	323
Means	323	322	321	321	321	323	323	321	**319**	322	330	338	346	**347**	345	338	332	327	324	324	324	325	327	326	327	328

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

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

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

Hourly Means of Vertical Force in C. G. S. Units (corrected for temperature) at Dehra Dún from the selected quiet days in 1907.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
Winter.																										
·31000 C. G. S.+																										
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October	761	761	761	761	761	761	763	**765**	764	758	751	743	**742**	747	753	758	761	760	759	760	762	762	763	762	[763]	758
November	757	757	757	757	757	758	758	757	**759**	755	750	**746**	747	749	751	750	753	755	756	756	756	756	757	757	[756]	755
December	767	768	767	767	767	767	767	766	768	**768**	764	760	**759**	760	759	760	763	767	766	767	767	767	768	767	[768]	765
Means	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Summer.																										
April	714	714	715	715	715	715	718	**719**	713	703	695	**689**	690	693	696	701	703	704	704	704	706	707	708	708	[708]	706
May	729	729	730	730	729	731	**732**	731	726	717	**713**	714	715	717	720	725	727	728	726	727	728	728	728	729	[729]	725
June	741	741	740	740	741	744	**746**	744	738	728	721	717	717	720	724	729	735	738	739	739	739	739	741	739	[740]	735
July	745	745	745	745	744	746	**749**	746	742	737	729	**723**	724	726	729	732	737	739	741	740	741	742	743	743	[743]	739
August	746	746	745	745	746	748	**750**	748	744	736	732	**729**	730	733	735	738	741	744	745	744	745	747	748	748	[748]	742
September	757	757	757	758	758	758	761	**761**	757	748	738	**734**	735	739	743	750	753	754	752	753	755	757	758	760	[761]	752
Means	739	739	739	739	739	740	**743**	742	737	728	721	**718**	719	721	725	729	733	735	735	735	736	737	738	738	[738]	733

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

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

Hourly Means of the Dip as determined at Dehra Dún from the selected quiet days in 1907.

Hours	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17		19	20	21	22	23	Mid.	Means.
Dip 43°+												Winter.														
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October	38·4	38·4	38·3	38·3	38·3	38·3	34·4	38·7	**38·8**	38·6	38·0	37·1	**36·5**	36·7	37·2	37·8	38·0	38·0	38·1	38·1	38·3	38·3	38·2	38·3	38·3	38·0
November	38·2	38·3	38·2	38·2	38·3	**38·3**	38·2	38·0	38·0	37·6	37·3	36·8	**36·6**	37·0	37·5	37·8	38·0	38·1	38·1	38·1	38·2	36·2	38·1	38·0	38·0	37·9
December	**39·1**	39·1	39·1	39·1	39·1	39·0	38·9	38·6	38·3	38·0	37·8	**37·7**	38·0	38·2	38·3	38·4	38·7	39·0	38·9	39·1	39·1	39·1	39·0	39·0	38·8	38·7
Means	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
												Summer.														
April	34·8	34·9	34·9	34·9	34·9	34·8	35·1	**35·3**	34·9	33·8	32·7	31·8	**31·4**	31·7	32·3	33·2	33·6	34·1	34·2	34·2	34·4	34·4	34·2	34·2	34·2	33·9
May	35·3	35·8	35·8	35·9	35·8	35·8	35·9	**35·9**	35·9	35·0	34·2	33·6	**33·5**	33·8	34·2	34·8	35·3	35·7	35·7	35·6	35·6	35·5	35·5	35·7	35·6	35·3
June	36·0	36·2	**36·3**	36·3	36·1	36·3	36·3	36·2	36·1	35·6	34·9	34·4	**33·9**	34·0	34·2	34·7	35·5	35·9	36·1	36·1	35·9	35·9	35·8	35·8	35·9	35·6
July	37·0	36·9	**37·1**	37·1	37·1	37·0	37·1	37·0	36·8	36·6	36·0	35·5	**35·1**	35·1	35·2	35·5	35·9	36·1	36·5	36·5	36·5	36·5	36·5	36·6	36·6	36·4
August	36·7	36·8	36·9	36·9	37·0	37·1	37·0	**37·1**	36·9	36·3	35·8	35·3	**34·9**	34·9	35·1	35·5	36·0	36·5	36·8	36·7	36·9	36·9	35·9	36·9	36·9	36·4
September	37·5	37·6	37·7	37·6	37·6	37·6	37·7	37·9	**38·0**	37·5	36·5	35·8	35·5	**35·4**	35·7	36·3	36·8	37·1	37·0	37·1	37·2	37·3	37·3	37·5	37·4	37·1
Means	36·3	36·4	36·5	36·5	36·4	36·4	36·5	**36·6**	36·4	35·8	35·0	34·4	**34·1**	34·2	34·5	35·0	35·5	35·9	36·1	36·0	36·1	36·1	36·1	36·1	36·1	35·8

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

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

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

Observations of Dip Barrackpore Inductor No. 46 by Schulze.

Date.		L. M. T.		Circle.	Dip.		Mean.	Monthly Mean Dip	Difference Circle, E.—W.	Remarks.
		h.	m.		°	'	° '	° '		
1907. January	14	15	11	E	30	30·0				
,,	14	15	30	W	30	29·5	Circle East			
,,	14	16	06	W	30	28·7	30 27·7			
,,	14	16	29	E	30	29·6				
,,	17	15	34	E	30	28·7				
,,	17	16	07	W	30	28·4				
,,	26	14	06	W	30	25·6		30 27·6	+0·2	
,,	26	14	38	E	30	25·3				
,,	28	13	02	E	30	24·7				
,,	28	13	24	W	30	25·4	Circle West			
,,	29	15	54	E	30	27·7	30 27·5			
,,	29	16	09	W	30	27·3				
February	13	9	58	E	30	30·0				
,,	13	10	12	W	30	28·9	Circle East			
,,	15	16	14	W	30	31·9	30 30·8			
,,	15	16	34	E	30	32·7				
,,	21	13	57	E	30	30·6				
,,	21	14	24	W	30	30·2		30 30·5	+0·5	
,,	26	17	42	E	30	29·9				
,,	26	18	05	W	30	29·5	Circle West			
,,	28	17	59	E	30	30·6	30 30·3			
,,	28	18	24	W	30	30·9				
March	4	15	16	E	30	26·6				
,,	4	15	30	W	30	26·2				
,,	8	16	37	W	30	27·4	Circle East			
,,	8	16	60	E	30	28·4	30 28·2	30 28·0	+0·4	
,,	11	16	36	E	30	30·0				
,,	11	16	50	W	30	29·7				
,,	14	10	01	W	30	27·7	Circle West			
,,	14	10	20	E	30	27·6	30 27·8			
,,	18	15	43	E	30	27·9				Observations from 18th to 28th are taken on the South Pillar.
,,	18	16	05	W	30	28·1	Circle East			
,,	21	16	45	E	30	29·0	30 28·9			
,,	21	17	03	W	30	28·4				
,,	25	15	59	W	30	28·3		30 28·6	+0·6	
,,	25	16	18	E	30	28·6				
,,	26	15	06	E	30	28·8	Circle West			
,,	26	15	32	W	30	28·3	30 28·3			
,,	28	16	03	E	30	30·0				
,,	28	16	26	W	30	28·3				

Hourly Means of the Declination as determined at Barrackpore from the selected quiet days in 1907.

Declination E. 1° +

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

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

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

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

Hourly Means of Horizontal Force in C. G. S. Units (corrected for temperature) at Barrackpore from the selected quiet days in 1907.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
Winter. 37,000 C. G. S.+																										
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January .	275	274	275	274	275	276	277	278	282	288	294	298	300	300	295	292	285	279	276	274	271	269	269	270	274	281
February .	270	271	272	271	271	272	274	276	282	288	296	298	307	307	300	290	284	275	273	272	272	269	268	270	273	280
March .	269	268	268	269	270	271	273	275	281	292	304	311	310	304	297	287	279	276	278	278	274	272	271	273	273	281
October .	274	274	274	275	277	278	278	276	278	283	291	305	312	310	299	289	283	282	282	280	278	276	277	278	278	284
November	280	280	280	281	281	282	282	289	295	301	310	316	316	310	302	294	288	283	283	283	281	279	280	282	284	290
December	279	279	280	280	281	283	285	292	299	308	314	315	310	307	299	290	288	284	284	283	281	279	282	283	287	290
Means .	275	274	275	275	276	277	278	281	286	293	302	307	309	306	299	290	285	280	279	278	276	274	275	276	278	284
Summer.																										
April .	283	281	279	279	281	282	285	287	298	315	331	339	340	337	324	309	296	289	284	282	279	279	281	285	287	297
May .	277	277	277	279	279	279	281	284	289	297	311	315	319	315	306	300	287	280	278	278	280	281	281	280	280	289
June .	280	282	281	279	280	283	284	289	294	300	312	316	320	318	310	299	288	280	277	277	278	278	278	281	280	290
July .	274	274	272	271	271	271	276	279	286	292	300	305	306	304	297	291	285	279	278	275	275	275	276	278	278	283
August .	285	285	284	284	282	282	286	288	289	297	307	312	318	319	313	308	298	289	286	286	285	285	285	285	287	293
September	279	282	281	281	281	283	285	282	279	284	299	315	323	325	320	311	300	292	288	288	287	286	287	287	287	293
Means .	280	280	279	279	279	280	283	285	289	298	310	317	321	320	312	303	292	285	282	281	281	281	281	283	283	291

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	13	14	15	16	17	18	19	20	21	22	23	Mid.
Winter.																									
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	−6	−7	−6	−7	−6	−5	−4	−3	+1	+7	+13	+17	+19	+19	+14	+11	+4	−2	−5	−7	−10	−12	−12	−11	−7
February	−10	−9	−8	−9	−9	−8	−6	−4	+2	+8	+16	+18	+27	+27	+20	+10	+4	−5	−7	−8	−8	−11	−12	−10	−7
March	−12	−13	−13	−12	−11	−10	−8	−6	0	+11	+23	+30	+29	+23	+16	+6	−2	−5	−3	−3	−7	−9	−10	−8	−8
October	−10	−10	−10	−9	−7	−6	−6	−8	−6	−1	+7	+21	+28	+26	+15	+5	−1	−2	−2	−4	−6	−8	−7	−6	−6
November	−10	−10	−10	−9	−9	−8	−8	−1	+5	+11	+20	+26	+26	+20	+12	+4	−2	−7	−7	−7	−9	−11	−10	−8	−6
December	−11	−11	−10	−10	−9	−7	−5	+2	+9	+18	+24	+25	+20	+17	+9	0	−2	−6	−6	−7	−9	−11	−8	−7	−3
Means	−9	−10	−9	−9	−8	−7	−6	−3	+2	+9	+18	+23	+25	+22	+15	+6	+1	−4	−5	−6	−8	−10	−9	−8	−6
Summer.																									
April	−14	−16	−18	−18	−16	−15	−12	−10	+1	+18	+34	+42	+45	+40	+27	+12	−1	−8	−13	−15	−18	−18	−16	−12	−10
May	−12	−12	−12	−10	−10	−10	−8	−5	0	+8	+22	+26	+30	+26	+17	+11	−2	−9	−11	−11	−9	−8	−8	−9	−9
June	−10	−8	−9	−11	−10	−7	−6	−1	+4	+10	+22	+26	+30	+28	+20	+9	−2	−10	−13	−13	−12	−12	−12	−9	−10
July	−9	−9	−11	−12	−12	−12	−7	−4	+3	+9	+17	+22	+23	+21	+14	+8	+2	−4	−5	−8	−8	−8	−7	−5	−5
August	−8	−8	−9	−9	−11	−11	−7	−5	−4	+4	+14	+19	+25	+26	+20	+15	+5	−4	−7	−7	−8	−8	−8	−8	−6
September	−14	−11	−12	−12	−12	−10	−8	−11	−14	−9	+6	+22	+30	+32	+27	+18	+7	−1	−5	−5	−6	−7	−6	−6	−6
Means	−11	−11	−12	−12	−12	−11	−8	−6	−2	+7	+19	+26	+30	+29	+21	+12	+1	−6	−9	−10	−10	−10	−10	−8	−8

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

Hourly Means of Vertical Force in C. G. S. Units (corrected for temperature) at Barrackpore from the selected quiet days in 1907.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
·21,000 C. G. S.+ Winter.																										
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October .	994	994	994	994	994	995	995	**997**	992	985	979	976	**973**	978	982	984	984	984	986	989	990	990	991	991	[991]	988
November .	995	995	995	995	995	995	996	**996**	995	990	987	985	**984**	984	984	986	987	989	991	993	993	994	995	996	[995]	991
December .	998	998	998	999	999	1,000	1,000	1,000	1,000	998	993	989	987	986	**986**	989	994	995	997	998	998	998	998	998	[998]	996
Means .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Summer.																										
April .	958	958	958	957	958	958	**959**	956	947	940	**937**	937	941	943	946	949	950	951	950	951	952	953	953	954	[955]	951
May .	966	966	966	966	966	**967**	967	961	954	**949**	952	952	954	957	960	961	960	961	962	962	964	965	965	965	[965]	961
June .	969	969	969	968	969	969	**970**	965	960	955	951	**947**	949	955	958	960	961	962	962	962	963	965	965	965	[965]	962
July .	974	974	974	974	974	974	**976**	973	968	965	962	**961**	963	963	962	963	966	968	969	971	973	974	974	973	[973]	970
August .	983	983	983	983	983	983	**984**	981	978	977	974	972	**971**	972	973	973	974	974	977	978	980	981	981	981	981]	978
September .	988	988	988	988	988	988	**989**	987	982	976	971	**969**	970	971	975	977	978	979	981	982	984	986	987	988	[988]	982
Means	973	973	973	973	973	973	**974**	971	965	960	958	**956**	958	960	962	964	965	966	967	968	969	971	971	971	[971]	967

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

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

N. B.—When the sign is + the Vertical force is more, and when — less than the mean value.

Hourly Means of the Dip as determined at Barrackpore from the selected quiet days in 1907.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
													Winter.													
Dip. 30° +																										
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October	32·6	32·6	32·6	32·5	32·5	32·5	32·5	32·7	32·3	31·6	30·9	30·1	29·6	30·0	30·8	31·3	31·6	31·6	31·7	32·0	32·2	32·3	32·3	32·3	32·3	31·8
November	32·4	32·4	32·4	32·4	32·4	32·3	32·4	32·1	31·8	31·3	30·7	30·3	30·2	30·5	30·8	31·3	31·6	31·9	32·1	32·2	32·2	32·4	32·4	32·4	32·3	31·8
December	32·7	32·7	32·6	32·7	32·6	32·6	32·6	32·3	32·0	31·5	30·9	30·6	30·7	30·7	31·1	31·6	32·0	32·3	32·4	32·5	32·6	32·7	32·5	32·5	32·3	32·1
Means	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
													Summer.													
April	29·8	29·8	29·9	29·9	29·8	29·8	29·8	29·5	28·4	27·3	26·4	26·1	26·2	26·6	27·3	28·1	28·7	29·0	29·2	29·3	29·5	29·6	29·5	29·4	29·4	28·7
May	30·6	30·6	30·6	30·5	30·5	30·6	30·5	29·9	29·3	28·6	28·1	28·1	28·0	28·4	29·0	29·3	29·7	30·1	30·3	30·3	30·3	30·3	30·3	30·4	30·4	29·8
June	30·6	30·6	30·6	30·6	30·6	30·5	30·6	30·0	29·5	28·9	28·1	27·7	27·7	28·1	28·7	29·3	29·8	30·2	30·3	30·3	30·3	30·5	30·5	30·3	30·4	29·8
July	31·2	31·2	31·3	31·4	31·4	31·4	31·3	31·0	30·3	29·9	29·4	29·1	29·2	29·3	29·5	29·8	30·3	30·6	30·7	31·0	31·1	31·2	31·2	31·0	31·0	30·6
August	31·4	31·4	31·5	31·5	31·5	31·5	31·4	31·2	30·9	30·5	29·9	29·6	29·3	29·3	29·6	29·8	30·3	30·6	30·9	31·0	31·2	31·3	31·3	31·3	31·2	30·8
September	32·0	31·9	31·9	31·9	31·9	31·8	31·8	31·8	31·6	31·0	30·0	29·3	29·0	29·0	29·5	29·9	30·5	30·8	31·2	31·2	31·4	31·6	31·6	31·7	31·7	31·0
Means	30·9	30·9	31·0	31·0	31·0	30·9	30·9	30·6	30·0	29·4	28·7	28·3	28·2	28·5	28·9	29·4	29·9	30·2	30·4	30·5	30·6	30·8	30·7	30·7	30·7	30·1

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

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

N.B.—When the sign is + the Dip is more, and when − less than the mean value.

Observations of Dip Toungoo, Dip Circle No. 137 by Barrow and Inductor No. 44 by Schulze.

Date.		L. M. T. h.	m.	Needle or Circle.	Dip. °	'	Mean.	Monthly Mean Dip.	Diff. needle 1—2 or Circle E.—W.	Remarks.
1907. January	3	12	15	1	22	57·3				$I_{44}—D_{137}$ = + 1'·0. Hence in order to compare the observations of Dip with Circle, with those with Inductor, the former are to be increased by 1'·0.
„	3	12	15	2	22	54·8	Needle No. 1		•	
„	7	13	15	1	22	61·2	22° 59·7			
„	7	13	15	2	22	57·0				
„	10	13	35	1	22	58·8				
„	10	13	35	2	22	58·8			Needle 1—2	
„	11	14	18	1	22	61·3		22° 58·4	+2·5	
„	11	14	18	2	22	57·3				
„	14	12	32	1	22	60·5				
„	14	12	32	2	22	57·4				
„	17	12	54	1	22	59·4				
„	17	12	54	2	22	60·6	Needle No. 2			
„	21	12	33	1	22	59·2	22° 57·2			
„	21	12	33	2	22	54·5				
February	12	16	00	E	22	64·1				
„	12	16	32	W	22	63·6	Circle East			
„	19	16	12	W	22	62·5	23° 2'·6			
„	19	16	42	E	22	63·0				
„	20	13	43	E	22	62·6			Circle E—W	
„	20	13	57	W	22	62·2				
„	21	14	19	W	22	63·5		23° 2'·5	+0·2	
„	21	14	35	E	22	64·0				
„	26	14	58	E	22	60·9				
„	26	15	13	W	22	61·2	Circle West			
„	28	14	46	E	22	61·0	23° 2'·4			
„	28	15	05	W	22	61·2				
March	4	13	23	W	22	58·0				
„	4	13	45	E	22	58·8				
„	9	17	27	W	22	61·0	Circle East			
„	9	16	00	E	22	65·0	23° 1·0			
„	12	16	17	W	22	65·5				
„	14	10	35	E	22	59·3			Circle E—W	
„	14	10	50	W	22	59·0		23° 1·1	—0·2	
„	26	14	20	E	22	60·1				
„	26	14	34	W	22	61·1				
„	28	16	08	W	22	62·0	Circle West			
„	28	16	40	E	22	61·5	23° 1·2			
	29	8	42	E	22	61·4				
	29	8	57	W	22	61·5				

Hourly Means of the Declination as dotermined at Toungoo from the selected quiet days in 1907.

Hours	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
Declination E 0° +												Winter.														
Months	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	41·3	41·1	41·1	41·1	41·0	41·0	40·9	41·0	41·6	42·6	42·7	42·0	41·4	41·2	40·9	41·3	42·1	42·1	41·6	41·5	41·4	41·5	41·3	41·2	41·3	41·5
February	40·9	40·9	40·9	40·9	40·8	40·6	40·3	40·3	41·1	42·2	42·6	42·2	41·5	41·2	41·0	40·7	40·9	40·8	40·7	40·8	40·9	40·9	40·8	40·9	41·0	41·0
March	40·4	40·5	40·5	40·5	40·3	39·9	39·9	40·8	41·7	42·6	42·7	42·0	40·3	39·0	38·7	39·3	39·8	40·1	40·2	40·2	40·4	40·3	40·1	40·2	40·4	40·4
October	38·1	38·2	38·2	38·2	38·2	38·1	38·4	39·2	39·9	39·8	38·9	37·7	36·6	36·3	36·9	37·7	38·3	38·0	37·8	37·9	38·0	37·9	37·9	37·9	38·1	38·1
November	37·8	37·8	37·8	37·8	37·7	37·6	37·6	37·6	38·4	38·9	39·2	38·4	38·1	38·0	38·0	38·0	38·3	37·8	37·6	37·7	37·7	37·5	37·5	37·7	37·7	37·9
December	37·3	37·3	37·3	37·2	37·1	36·9	36·8	36·5	36·9	37·8	38·5	38·3	37·8	37·4	37·5	37·3	37·5	37·7	37·5	37·5	37·4	37·2	37·2	37·3	37·3	37·4
Means	39·3	39·3	39·3	39·3	39·2	39·0	39·0	39·2	39·9	40·7	40·8	40·1	39·3	38·9	38.8	39·1	39·5	39·4	39·2	39·3	39·3	39·2	39·1	39·2	39·3	39·4
												Summer.														
April	40·1	40·1	40·2	40·1	40·0	40·0	40·7	41·8	42·0	41·3	40·2	38·9	38·4	38·2	38·7	39·4	40·2	40·4	40·1	39·9	39·9	39·9	39·9	40·1	40·1	40·0
May	39·5	39·7	39·9	39·8	39·7	40·0	41·4	42·0	41·5	40·2	38·8	37·8	37·3	37·4	37·9	38·9	39·6	39·8	39·8	39·0	38·8	38·8	39·0	39·1	39·5	39·4
June	39·2	39·3	39·4	39·5	39·5	39·7	41·2	42·2	42·1	41·0	39·7	38·3	37·2	37·1	37·4	37·9	38·5	39·0	39·1	39·0	38·9	38·9	39·0	39·2	39·2	39·3
July	38·6	38·8	39·0	39·0	39·0	39·3	40·4	41·5	41·9	40·9	39·8	38·3	37·4	37·0	36·8	37·0	37·7	38·3	38·7	38·5	38·3	38·3	38·4	38·6	38·8	38·8
August	38·7	38·9	39·0	39·3	39·4	39·6	40·6	41·5	41·3	40·2	38·8	37·6	37·0	37·2	37·5	37·9	38·8	39·2	39·0	38·7	38·5	38·5	38·6	38·7	38·8	38·9
September	38·4	38·5	38·6	38·5	38·5	38·5	39·5	40·5	40·6	39·5	38·1	37·0	36·1	35·6	36·1	37·4	38·7	38·9	38·3	38·1	38·2	38·1	38·1	38·3	38·4	38·3
Means	39·1	39·2	39·4	39·4	39·4	39·5	40·6	41·6	41·6	40·5	39·2	38·0	37·2	37·1	37·4	38·1	38·9	39·3	39·2	38·9	38·8	38·8	38·8	39·0	39·1	39·1

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

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.
Winter.																									
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	−0·2	−0·4	−0·4	−0·4	−0·5	−0·5	−0·6	−0·5	+0·1	+1·1	+1·2	+0·5	−0·1	−0·3	−0·6	−0·2	+0·6	+0·6	+0·1	0	−0·1	0	−0·2	−0·3	−0·2
February	−0·1	−0·1	−0·1	−0·1	−0·2	−0·4	−0·7	−0·7	+0·1	+1·2	+1·6	+1·2	+0·5	+0·2	0	−0·3	−0·1	−0·2	−0·3	−0·2	−0·1	−0·1	−0·2	−0·1	0
March	0	+0·1	+0·1	+0·1	−0·1	−0·5	−0·5	+0·4	+1·3	+2·2	+2·3	+1·6	−0·1	−1·4	−1·7	−1·1	−0·6	−0·3	−0·2	−0·2	0	−0·1	−0·3	−0·2	0
October	0	+0·1	+0·1	+0·1	+0·1	0	+0·3	+1·1	+1·8	+1·7	+0·8	−0·4	−1·5	−1·8	−1·2	−0·4	+0·2	−0·1	−0·3	−0·2	−0·1	−0·2	−0·2	−0·2	0
November	−0·1	−0·1	−0·1	−0·1	−0·2	−0·3	−0·3	−0·3	+0·5	+1·0	+1·3	+0·5	+0·2	+0·1	+0·1	+0·1	+0·4	−0·1	−0·3	−0·2	−0·2	−0·4	−0·4	−0·2	−0·2
December	−0·1	−0·1	−0·1	−0·2	−0·3	−0·5	−0·6	−0·9	−0·5	+0·4	+1·1	+0·9	+0·4	0	0·1	−0·1	+0·1	+0·3	+0·1	+0·1	0	−0·2	−0·2	−0·1	−0·1
Means	−0·1	−0·1	−0·1	−0·1	−0·2	−0·4	−0·4	−0·2	+0·5	+1·3	+1·4	+0·7	−0·1	−0·5	−0·6	−0·3	+0·1	0	−0·2	−0·1	−0·1	−0·2	−0·3	−0·2	−0·1
Summer.																									
April	+0·1	+0·1	+0·2	+0·1	0·0	0	+0·7	+1·8	+2·0	+1·3	+0·2	−1·1	−1·6	−1·8	−1·3	−0·6	+0·2	+0·4	+0·1	−0·1	−0·1	−0·1	−0·1	−0·1	+0·1
May	+0·1	+0·3	+0·5	+0·4	+0·3	+0·6	+2·0	+2·6	+2.1	+0·8	−0·6	−1·6	−2·1	−2·0	−1·5	−0·5	+0·2	+0·4	+0·4	−0·4	−0·6	−0·6	−0·4	−0·3	+0·1
June	−0·1	0	+0·1	+0·2	+0·2	+0·4	+1·9	+2·9	+2·8	+1·7	+0·4	−1·0	−2·1	−2·2	−1·9	−1·4	−0·8	−0·3	−0·2	−0·3	−0·4	−0·4	−0·3	−0·1	−0·1
July	−0·2	0	+0·2	+0·2	+0·2	+0·5	+1·6	+2·7	+3·1	+2·1	+1·0	−0·5	−1·4	−1·8	−2·0	−1·8	−1·1	−0·5	−0·1	−0·3	−0·5	−0·5	−0·4	−0·2	0
August	−0·2	0	+0·1	+0·4	+0·5	+0·7	+1·7	+2·6	+2·4	+1·3	−0·1	−1·3	−1·9	−1·7	−1·4	−1·0	−0·1	+0·3	+0·1	−0·2	−0·4	−0·4	−0·3	−0·2	−0·1
September	+0·1	+0·2	+0·3	+0·2	+0·2	+0·2	+1·2	+2·2	+2·3	+1·2	−0·2	−1·3	−2·2	−2·7	−2·2	−0·9	+0·4	+0·6	0	−0·2	−0·1	−0·2	−0·2	0	−0·1
Means	0·0	+0·1	+0·3	+0·3	+0·3	+0·4	+1·5	+2·5	+2·5	+1·4	+0·1	−1·1	−1·9	−2·0	−1·7	−1·0	−0·2	+0·2	+0·1	−0·2	−0·3	−0·3	−0·3	−0·1	0

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

Hourly Means of Horizontal Force in C. G. S. Units (corrected for temperature) at Toungoo from the selected quiet days in 1907.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
·38000 C. G. S.+												Winter.														
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	705	709	709	708	710	711	713	714	718	727	739	746	743	737	732	727	718	714	710	709	708	706	704	705	706	718
February	696	697	698	700	701	702	703	706	711	718	727	736	741	739	727	714	706	702	700	702	701	697	695	696	698	709
March	714	713	713	713	716	717	718	722	733	749	766	778	776	765	753	738	729	724	725	724	723	721	720	720	719	732
October	771	770	769	770	772	772	772	770	776	787	801	815	819	812	797	785	778	779	781	779	777	773	775	777	776	782
November	781	782	781	782	781	783	782	787	795	806	817	826	826	818	809	797	787	782	784	783	781	781	783	786	785	792
December	789	791	792	791	792	793	797	803	810	820	828	832	828	822	811	804	798	795	794	792	793	791	792	793	795	802
Means	743	744	744	744	745	746	748	750	757	768	780	789	789	782	772	761	753	749	749	748	747	745	745	746	747	756
												Summer.														
April	730	732	728	728	729	730	732	738	756	777	792	799	794	786	772	757	745	739	737	733	732	732	731	733	735	748
May	733	732	729	731	733	733	734	736	749	759	765	772	768	760	750	741	734	727	723	721	727	730	731	732	732	740
June	735	739	740	737	737	739	742	746	754	766	777	786	787	785	774	759	747	741	740	740	741	743	743	744	745	752
July	735	735	735	733	733	732	737	742	749	761	768	773	772	767	761	753	745	738	736	739	740	740	740	741	740	746
August	751	752	752	749	749	748	750	754	760	768	779	784	786	786	779	774	764	756	754	756	756	756	755	755	756	761
September	755	758	757	756	757	758	759	755	757	769	787	802	807	805	797	786	774	766	766	766	765	764	764	764	764	771
Means	740	741	740	739	740	740	742	745	754	767	778	786	786	782	772	762	752	745	743	743	744	744	744	745	745	753

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

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.
Winter.																									
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	−13	−9	−9	−10	−8	−7	−5	−4	0	+9	+21	+28	+25	+19	+14	+9	0	−4	−8	−9	−10	−12	−14	−13	−12
February	−13	−12	−11	−9	−8	−7	−6	−3	+2	+9	+18	+27	+32	+30	+18	+5	−3	−7	−9	−7	−8	−12	−14	−13	−11
March	−18	−19	−19	−19	−16	−15	−14	−10	+1	+17	+34	+46	+44	+33	+21	+6	−3	−8	−7	−8	−9	−11	−12	−12	−13
October	−11	−12	−13	−12	−10	−10	−10	−12	−6	+5	+19	+33	+37	+30	+15	+3	−4	−3	−1	−3	−5	−9	−7	−5	−6
November	−11	−10	−11	−10	−11	−9	−10	−5	+3	+14	+25	+34	+34	+26	+17	+5	−5	−10	−8	−9	−11	−11	−9	−6	−7
December	−13	−11	−10	−11	−10	−9	−5	+1	+8	+18	+26	+30	+26	+20	+9	+2	−4	−7	−8	−10	−9	−11	−10	−9	−7
Means	−13	−12	−12	−12	−11	−10	−8	−6	+1	+12	+24	+33	+53	+26	+16	+5	−3	−7	−7	−8	−9	−11	−11	−10	−9
Summer.																									
April	−18	−16	−20	−20	−19	−18	−16	−10	+8	+29	+44	+51	+46	+38	+24	+9	−3	−9	−11	−15	−16	−16	−17	−15	−13
May	−7	−8	−11	−9	−7	−7	−6	−4	+9	+19	+25	+32	+28	+20	+10	+1	−6	−13	−17	−19	−13	−10	−9	−8	−8
June	−17	−13	−12	−15	−15	−13	−10	−6	+2	+14	+25	+34	+35	+33	+22	+7	−5	−11	−12	−12	−11	−9	−9	−8	−7
July	−11	−11	−11	−13	−13	−14	−9	−4	+3	+15	+22	+27	+26	+21	+14	+7	−1	−8	−10	−7	−6	−6	−6	−5	−6
August	−10	−9	−9	−12	−12	−13	−11	−7	−1	+7	+18	+23	+25	+25	+18	+13	+3	−5	−7	−5	−5	−5	−6	−6	−5
September	−16	−13	−14	−15	−14	−13	−12	−16	−14	−2	+16	+31	+36	+34	+26	+15	+3	−5	−5	−5	−6	−7	−7	−7	−7
Means	−13	−12	−13	−14	−13	−13	−11	−8	+1	+14	+25	+33	+33	+29	+19	+9	−2	−8	−10	−10	−9	−9	−9	−8	−8

N. B.—When the sign is + the Horizontal force is more, and when − it is less than the mean.

Hourly Means of Vertical Force in C. G. S. Units (corrected for temperature) at Toungoo from the selected quiet days in 1907.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
·16000 C. G. S. +												Winter.														
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October .	481	481	481	481	481	482	484	485	480	472	465	462	464	472	477	480	480	476	478	481	481	481	482	483	483	478
November .	496	496	496	496	496	497	497	498	499	493	487	483	482	485	490	493	494	492	493	495	495	496	497	498	498	493
December .	496	495	495	495	495	495	495	495	496	495	492	488	487	487	489	491	494	494	494	495	496	497	·98	498	498	494
Means .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
												Summer.														
April .	471	471	471	470	470	471	474	472	463	456	455	456	455	462	467	471	472	469	466	467	468	470	470	471	472	467
May .	476	476	476	475	475	477	480	475	466	459	456	459	461	467	473	477	478	476	473	472	473	474	475	475	476	472
June .	469	469	468	468	469	470	475	471	462	454	451	451	453	459	464	466	468	469	468	466	467	468	469	469	470	465
July .	476	476	475	475	475	475	480	478	471	465	460	457	458	461	463	468	469	470	470	470	471	473	473	474	475	470
August .	483	484	484	485	485	486	490	486	479	471	467	467	466	469	473	479	484	482	480	481	481	483	483	484	485	480
September .	483	484	484	484	484	484	489	487	476	464	457	455	458	465	476	482	483	479	476	478	480	480	481	482	482	477
Means .	476	477	476	476	476	477	481	478	470	462	458	8	459	464	469	474	476	474	472	472	473	475	475	476	477	472

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

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

N.B.—When the sign is + the V. F. is more, and when — it is *less* than the mean.

Hourly Means of the Dip as determined at Toungoo from the selected quiet days in 1907.

Dip. 22°+

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
Winter.																										
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October	61·8	61·8	61·9	61·8	61·7	61·8	62·0	62·1	61·6	60·6	59·6	58·9	59·0	59·8	60·7	61·3	61·5	61·1	61·2	61·5	61·6	61·7	61·7	61·8	61·8	61·2
November	62·6	62·6	62·6	62·6	62·6	62·6	62·7	62·5	62·4	61·6	60·8	60·2	60·1	60·6	61·3	61·9	62·3	62·3	62·3	62·5	62·5	62·6	62·6	62·6	62·6	62·0
December	62·3	62·2	62·2	62·2	62·2	62·1	62·0	61·8	61·7	61·3	60·8	60·4	60·4	60·6	61·1	61·5	61·9	62·0	62·1	62·2	62·2	62·4	62·4	62·4	62·3	61·8
Means	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Summer.																										
April	62·3	62·3	62·4	62·3	62·3	62·3	62·5	62·2	60·9	59·7	59·2	59·0	59·1	59·9	60·7	61·5	61·9	61·9	61·7	61·9	62·1	62·2	62·2	62·3	62·3	61·5
May	62·6	62·7	62·7	62·6	62·6	62·7	62·9	62·5	61·4	60·5	60·1	60·1	60·4	61·1	61·9	62·5	62·7	62·8	62·7	62·7	62·6	62·6	62·6	62·6	62·7	62·1
June	62·1	61·9	61·8	61·9	62·0	62·0	62·3	61·8	60·9	59·9	59·3	59·0	59·2	59·7	60·4	61·1	61·6	61·9	61·8	61·7	61·7	61·7	61·8	61·8	61·8	61·2
July	62·6	62·6	62·5	62·6	62·6	62·6	62·8	62·5	61·7	60·9	60·3	59·9	60·0	60·4	60·8	61·4	61·7	62·0	62·1	62·0	62·0	62·2	62·2	62·2	62·3	61·8
August	62·6	62·6	62·6	62·8	62·8	62·9	63·1	62·7	62·0	61·1	60·5	60·3	60·2	60·4	60·9	61·5	62·2	62·3	62·3	62·3	62·3	62·4	62·5	62·5	62·6	62·0
September	62·5	62·4	62·5	62·5	62·5	62·4	62·8	62·7	61·9	60·6	59·5	58·9	58·9	59·5	60·6	61·4	61·9	61·8	61·6	61·7	61·9	61·9	62·0	62·1	62·1	61·5
Means	62·5	62·4	62·4	62·5	62·5	62·5	62·7	62·4	61·5	60·5	59·8	59·5	59·6	60·2	60·9	61·6	62·0	62·0	62·0	62·1	62·1	62·2	62·2	62·3	62·3	61·7

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

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

N. B.- When the sign is + the Dip is more, and when — less than the mean value.

Observations of Dip Kodaikánal Dip Circle No. 46 by Barrow. Inductor No. 45 by Schulze.

Date.		L. M. T.		Needle.	Dip.	Mean.	Monthly Mean Dip.	Diff. 2−3C.	REMARKS.
1907. Month.		h.	m.		° ′	° ′	° ′		
January	7	13	26	2	3 23·2				I 45 − D46 = +0·7′ Hence to compare the observed dips with circle with those with inductor the former are to be increased by 0·7.′
				3C	3 25·9				
,,	10	13	26	2	3 24·4				
				3C	3 22·0	Needle No. 2.			
,,	11	13	29	2	3 24·4	3 24·9			
				3C	3 27·4				
,,	14	12	26	2	3 27·0				
				3C	3 28·4				
,,	17	13	12	2	3 25·4		3 25·1	−0·5	
				3C	3 25·3				
,,	21	13	23	2	3 25·1				
				3C	3 25·2				
,,	24	13	25	2	3 23·5	Needle No. 3C			
				3C	3 25·2	3 25·4			
,,	28	13	27	2	3 28·0				
				3C	3 25·3				
,,	29	13	28	2	3 24·9				
				3C	3 26·3				
,,	31	13	17	2	3 22·6				
				3C	3 22·6				
February	4	13	28	2	3 26·0				
				3C	3 26·0				
,,	7	13	29	2	3 27·8	Needle No. 2.			
				3C	3 25·5	3 26·1			
,,	8	13	21	2	3 26·0				
				3C	3 30·2				
,,	11	13	22	2	3 22·5				
				3C	3 24·1				
,,	14	13	33	2	3 25·3				
				3C	3 25·1		3 26·5	−0·8	
,,	18	13	31	2	3 24·1				
				3C	3 26·4				
,,	20	14	12	2	3 27·4				
				3C	3 26·4				
		14	35	2	3 25·9	Needle No. 3C			
				3C	3 26·3	3 26·9			
		14	59	2	3 27·1				
				3C	3 26·4				

Observations of Dip Kodaikánal Dip Circle No. 46 by Barrow. Inductor No. 45 by Schulze.

Date.		L. M. T.		Circle or Needle.	Dip.		Mean.	Monthly Mean Dip.	Diff. E. W.	Remarks.
1907. Month.		h.	m.		°	'	° '	° '		
February		15	20	2	3	26·1				
				3C	3	26·7				
„	21	11	6	2	3	28·0				
				3C	3	30·5				
		11	27	2	3	27·4				
				3C	3	29·6				
March	4	15	56	W	3	23·7				
		16	21	E	3	24·6				
„	5	14	5	E	3	23·9	Circle East			
		14	32	W	3	23·9	3 24·3			
„	7	14	25	W	3	22·9				
		14	51	E	3	22·9				
„	11	14	26	E	3	24·1				
		14	50	W	3	23·5		3 24·1	+0·3	
„	14	8	40	W	3	25·5				
		9	4	E	3	25·3				
„	18	9	7	E	3	26·2				
		9	41	W	3	25·3	Circle West			
„	19	14	19	W	3	22·3	3 24·0			
		14	41	E	3	22·8				
„	22	14	6	E	3	24·5				
		14	37	W	3	24·9				
„	25	13	43	W	3	24·2				
		14	3	E	3	24·1				

Hourly Means of the Declination as determined at Kodaikánal from the selected quiet days in 1907.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
Declination W 0° +													Winter.													
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January .	38·7	38·8	38·9	39·0	39·1	39·2	39·5	**39·7**	39·3	38·5	38·3	38·7	38·8	38·5	38·2	**38·0**	38·3	38·5	38·8	38·6	38·5	38·7	38·8	38·9	38·7	38·8
February .	38·9	38·9	39·0	39·0	39·0	39·3	39·6	**39·7**	39·4	38·8	**38·2**	38·5	39·1	38·9	38·7	38·9	38·9	38·9	39·1	39·0	38·9	38·8	38·8	38·9	38·8	39·0
March .	39·3	39·2	39·2	39·5	39·7	**39·8**	39·8	39·3	38·9	38·3	**37·8**	38·1	38·7	39·4	39·5	39·2	39·3	39·3	39·3	39·2	39·3	39·4	39·6	39·6	39·4	39·2
October .	41·8	41·8	41·8	41·9	42·0	42·0	41·6	41·2	41·1	**41·0**	41·7	42·6	**42·7**	42·1	41·8	41·5	41·4	41·8	42·0	42·0	42·0	42·0	42·0	42·0	41·9	41·8
November .	42·3	42·2	42·4	42·4	42·5	42·4	42·6	43·1	42·7	42·6	43·1	**43·2**	42·8	42·3	41·9	**41·8**	41·8	42·1	42·2	42·1	42·2	42·3	42·5	42·4	42·4	42·4
December .	42·7	42·7	42·9	43·0	43·1	43·2	43·6	**44·1**	43·8	43·3	42·9	42·4	42·5	42·5	42·1	**42·0**	42·2	42·4	42·6	42·5	42·6	42·7	42·9	43·0	42·9	42·8
Means .	40·6	40·6	40·7	40·8	40·9	41·0	41·1	**41·2**	40·9	40·4	40·3	40·6	40·8	40·6	40·4	**40·2**	40·3	40·5	40·7	40·6	40·6	40·7	40·8	40·8	40·7	40·7
													Summer.													
April .	39·7	39·7	39·7	39·8	39·8	39·8	39·5	**39·1**	39·2	39·9	40·3	40·9	**41·3**	40·9	40·5	39·9	39·5	39·6	39·7	39·8	39·9	39·9	39·9	39·9	39·8	39·9
May .	40·0	39·8	39·6	39·7	39·8	39·8	39·2	**39·1**	39·6	40·3	41·0	**41·5**	41·4	41·1	40·7	40·3	39·7	39·6	39·9	40·4	40·6	40·6	40·4	40·2	40·1	40·2
June .	40·4	40·4	40·3	40·3	40·3	40·1	39·3	38·6	**38·5**	39·1	40·5	41·4	42·1	**42·5**	42·0	41·4	40·7	40·4	40·5	40·8	41·0	40·9	40·8	40·8	40·6	40·5
July .	40·8	40·6	40·6	40·5	40·5	40·3	39·7	**38·6**	38·7	39·1	40·5	41·5	42·5	**42·5**	42·1	41·4	40·9	40·3	40·3	40·9	41·1	41·1	41·0	40·8	40·7	40·7
August .	41·1	41·0	40·8	40·8	40·8	40·6	39·9	**39·3**	39·8	40·7	41·7	42·4	**42·9**	42·6	41·7	41·2	40·5	40·3	40·8	41·2	41·4	41·5	41·4	41·3	41·1	41·1
September .	41·6	41·5	41·5	41·5	41·6	41·5	40·8	39·8	**39·6**	40·6	41·9	42·9	43·7	**43·7**	42·9	41·9	41·2	41·1	41·6	41·8	42·0	42·0	42·0	41·9	41·8	41·7
Means .	40·6	40·5	40·4	40·4	40·5	40·4	39·7	**39·1**	39·2	40·0	41·0	41·8	**42·3**	42·2	41·7	41·0	40·4	40·2	40·5	40·8	41·0	41·0	40·9	40·8	40·7	40·7

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

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.
Winter.																									
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	+0.1	0	−0.1	−0.2	−0.3	−0.4	−0.7	−0.9	−0.5	+0.3	+0.5	+0.1	0	+0.3	+0.6	+0.8	+0.5	+0.3	0	+0.2	+0.3	+0.1	0	−0.1	+0.1
February	+0.1	+0.1	0	0	0	−0.3	−0.6	−0.7	−0.4	+0.2	+0.8	+0.5	−0.1	+0.1	+0.3	+0.1	+0.1	+0.1	−0.1	0	+0.1	+0.2	+0.2	+0.1	+0.2
March	−0.1	0	0	−0.3	−0.5	−0.6	−0.6	−0.1	+0.3	+0.9	+1.4	+1.1	+0.5	−0.2	−0.3	0	−0.1	−0.1	−0.1	0	−0.1	−0.2	−0.4	−0.4	−0.2
October	0	0	0	−0.1	−0.2	−0.2	+0.2	+0.6	+0.7	+0.8	+0.1	−0.8	−0.9	−0.3	0	+0.3	+0.4	0	−0.2	−0.2	−0.2	−0.2	−0.2	−0.2	−0.1
November	+0.1	+0.2	0	0	−0.1	0	−0.2	−0.7	−0.3	−0.2	−0.7	−0.8	−0.4	+0.1	+0.5	+0.6	+0.6	+0.3	+0.2	+0.3	+0.2	+0.1	−0.1	0	0
December	+0.1	+0.1	−0.1	−0.2	−0.3	−0.4	−0.8	−1.3	−1.0	−0.5	−0.1	+0.4	+0.3	+0.3	+0.7	+0.8	+0.6	+0.4	+0.2	+0.3	+0.2	+0.1	−0.1	−0.2	−0.1
Means	+0.1	+0.1	0	−0.1	−0.2	−0.3	−0.4	−0.5	−0.2	+0.3	+0.4	+0.1	−0.1	+0.1	+0.3	+0.5	+0.4	+0.2	0	+0.1	+0.1	0	−0.1	−0.1	0
Summer.																									
April	+0.2	+0.2	+0.2	+0.1	+0.1	+0.1	+0.4	+0.8	+0.7	0	−0.4	−1.0	−1.4	−1.0	−0.6	0	+0.4	+0.3	+0.2	+0.1	0	0	0	0	+0.1
May	+0.3	+0.4	+0.6	+0.5	+0.4	+0.4	+1.0	+1.1	+0.6	−0.1	−0.8	−1.3	−1.2	−0.9	−0.5	−0.1	+0.5	+0.6	+0.3	−0.2	−0.4	−0.4	−0.2	0	+0.1
June	+0.1	+0.1	+0.2	+0.2	+0.2	+0.4	+1.2	+1.9	+2.0	+1.4	0	−0.9	−1.6	−2.0	−1.5	−0.9	−0.2	+0.1	0	−0.3	−0.5	−0.4	−0.3	−0.3	−0.1
July	−0.1	+0.1	+0.1	+0.2	+0.2	+0.4	+1.0	+2.1	+2.0	+1.6	+0.2	−0.8	−1.8	— ·8	−1.4	−0.7	−0.2	+0.4	+0.4	−0.2	−0.4	−0.4	−0.3	−0.1	0
August	0	+0.1	+0.3	+0.3	+0.3	+0.5	+1.2	+1.8	+1.3	+0.4	−0.6	−1.3	−1.8	−1.5	−0.6	−0.1	+0.6	+0.8	+0.3	−0.1	−0.3	−0.4	−0.3	−0.2	0
September	+0.1	+0.2	+0.2	+0.2	+0.1	+0.2	+0.9	+1.9	+2.1	+1.1	−0.2	−1.2	−2.0	−2.0	−1.2	−0.2	+0.5	+0.6	+0.1	−0.1	−0.3	−0.3	−0.3	−0.2	−0.1
Means	+0.1	+0.2	+0.3	+0.3	+0.2	+0.3	+1.0	+1.6	+1.5	+0.7	−0.3	−1.1	−1.6	−1.5	−1.0	−0.3	+0.3	+0.5	+0.2	−0.1	−0.3	−0.3	−0.2	−0.1	0

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

Hourly Means of Horizontal Force in C. G. S. Units (corrected for temperature) at Kodaikánal from the selected quiet days in 1907.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
·37000 +													Winter.													
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	405	404	404	**403**	403	404	404	413	430	457	483	452	489	472	452	431	419	416	414	409	407	405	404	404	403	426
February	393	393	395	395	394	394	394	386	409	430	460	475	**485**	467	442	424	415	409	406	402	397	394	393	**392**	392	415
March	391	391	391	393	393	393	**390**	396	419	457	494	**514**	511	491	457	431	415	410	411	404	401	399	398	395	395	423
October	**406**	407	409	410	409	409	407	415	444	479	513	**522**	507	475	449	435	432	429	425	420	417	415	414	413	412	436
November	419	419	419	418	417	**416**	418	425	438	459	484	**493**	486	475	456	440	432	431	430	426	424	422	421	420	421	437
December	**420**	420	420	420	422	421	425	416	451	464	475	**484**	482	475	466	454	441	434	429	427	424	424	424	423	427	440
Means	**406**	406	405	407	406	**406**	406	414	432	458	485	**497**	493	476	454	436	426	422	419	415	412	410	409	408	408	430
													Summer.													
April	410	**408**	409	410	411	410	409	424	456	491	523	529	518	490	457	433	427	426	425	419	416	415	415	415	415	439
May	**403**	405	407	407	406	407	413	428	450	476	488	**497**	483	462	442	426	417	415	413	413	410	410	410	409	410	429
June	410	410	**409**	410	411	410	414	419	436	463	486	**490**	484	464	448	431	421	416	414	415	415	415	415	414	414	430
July	407	407	405	404	**403**	405	407	414	427	445	463	472	**474**	463	445	428	414	406	409	413	412	411	412	411	411	423
August	412	411	410	409	**408**	410	414	418	432	453	469	484	**489**	480	460	440	426	416	416	416	414	413	413	413	413	430
September	408	407	407	407	407	408	**406**	409	439	482	514	**529**	524	501	469	442	425	424	424	421	418	415	414	413	413	438
Means	408	408	408	408	**408**	408	411	419	440	468	491	**500**	495	477	454	433	422	417	417	416	414	413	413	413	413	432

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

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.
Winter.																									
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	**−21**	−22	−22	**−23**	−23	−22	−22	−13	+4	+31	+57	**+66**	+63	+46	+26	+5	−7	−10	−12	−17	−19	−21	−22	−22	−23
February	−22	−22	−20	−20	−21	**−21**	−21	−19	−6	+15	+45	+60	**+70**	+52	+27	+9	0	−6	−9	−13	−18	−21	−22	−23	−23
March	−32	−32	−32	−30	−30	**−30**	**−33**	−27	−4	+34	+71	**+91**	+88	+68	+34	+8	−8	−13	−12	−19	−22	−24	−25	−28	−28
October	**−30**	−29	−27	−26	−27	−27	−29	−21	+8	+43	+77	**+85**	+71	+39	+13	−1	−4	−7	−11	−16	−19	−21	−22	−23	−24
November	−18	−18	−18	−19	−20	**−21**	−19	−12	+1	+22	+47	+56	+49	+38	+19	+3	−5	−6	−7	−11	−13	−15	−16	−17	−16
December	**−20**	−20	−20	−20	−18	−19	−15	−4	+11	+24	+35	**+44**	+42	+35	+26	+14	+1	−6	−11	−13	−16	−16	−16	−17	−13
Means	**−24**	−24	−24	−23	−24	−24	−24	−16	+2	+28	+55	**+67**	+63	+46	+24	+6	−4	−8	−11	−15	−18	−20	−21	−22	−22
Summer.																									
April	−29	**−31**	−30	−29	−28	−29	−30	−15	+17	+52	+84	**+90**	+79	+51	+18	−6	−12	−13	−14	−20	−23	−24	−24	−24	−24
May	**−26**	−24	−22	−22	−23	−22	−16	−1	+21	+47	+59	**+68**	+54	+33	+13	−3	−12	−14	−16	−16	−18	−19	−19	−20	−19
June	−20	−20	**−21**	−20	−19	−20	−16	−11	+6	+33	+56	**+60**	+54	+34	+18	+1	−9	−14	−16	−15	−15	−15	−15	−16	−16
July	−16	−16	−18	−19	**−20**	−18	−16	−9	+4	+22	+40	+49	**+51**	+40	+22	+5	−9	−17	−14	−10	−11	−12	−11	−12	−12
August	−18	−19	−20	−21	**−22**	−20	−16	−12	+2	+23	+39	+54	**+59**	+50	+30	+10	−4	−14	−14	−14	−16	−17	−17	−17	−17
September	−30	−31	−31	−31	−31	−30	**−32**	−29	+1	+44	+76	**+91**	+86	+63	+31	+4	−13	−16	−14	−17	−20	−23	−24	−25	−25
Means	−24	−24	−24	−24	**−24**	−24	−21	−13	+8	+36	+59	**+68**	+63	+45	+22	+1	−10	−15	−15	−16	−18	−19	−19	−19	−19

N. B.—When the sign is + the Horizontal force is more, and when − less than the mean value.

Hourly Means of Vertical Force in C. G. S. Units (corrected for temperature) at Kodaikánal from the selected quiet days in 1907.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
·02000 C. G. S.+													Winter.													
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October .	274	275	275	275	274	275	**278**	275	270	260	245	**239**	240	242	249	257	260	264	268	270	271	272	273	275	275	265
November .	289	289	289	289	289	289	289	289	**290**	290	284	282	278	272	**271**	275	276	277	280	282	282	283	284	285	285	283
December .	291	**291**	291	290	289	289	290	289	289	288	287	286	280	**277**	277	281	281	282	284	287	287	287	288	289	289	286
Means .	285	285	285	285	284	284	**286**	284	283	279	272	269	266	**264**	266	271	272	274	277	280	280	281	282	283	283	278
													Summer.													
April .	263	261	261	260	261	263	266	**269**	263	255	248	241	234	**232**	236	245	253	251	251	251	252	254	256	256	257	253
May .	258	258	258	257	257	259	**261**	259	250	242	237	234	**232**	234	239	246	250	249	248	249	249	252	252	252	253	249
June .	266	265	265	265	265	266	270	272	272	267	261	262	257	**256**	256	257	261	262	261	261	263	264	266	265	265	264
July .	268	268	268	268	268	270	272	**272**	272	266	266	265	**260**	264	267	266	264	265	263	260	261	263	264	265	265	266
August .	275	274	274	274	274	276	**280**	276	273	270	266	263	259	**258**	263	267	271	271	270	269	269	270	271	272	273	270
September .	270	270	270	271	271	271	**276**	275	267	257	248	239	257	243	251	260	262	260	259	259	260	263	265	269	274	261
Means .	267	266	266	266	266	268	**271**	271	266	260	254	251	**247**	248	252	257	260	260	259	258	259	261	262	263	265	261

Diurnal Inequality of the Vertical Force at Kodaikánal as deduced from the preceding Table.

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

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

Hourly Means of the Dip as determined at Kodaikánal from the selected quiet days in 1907.

Dip 3°+

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.	Means.
Winter.																										
Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October	28·7	28·8	28·8	28·8	28·7	28·8	**29·1**	28·8	28·2	27·1	25·5	**24·9**	25·1	25·4	26·2	27·0	27·3	27·7	28·1	28·3	28·4	28·5	28·6	28·8	28·8	27·7
November	30·0	30·0	30·0	30·0	30·1	**30·1**	30·0	30·0	30·0	29·9	29·2	29·0	28·7	**28·2**	28·2	28·6	28·8	28·9	29·2	29·4	29·4	29·5	29·6	29·7	29·7	29·4
December	**30·2**	30·2	30·2	30·1	30·0	30·0	30·1	29·9	29·9	29·7	29·5	29·4	28·9	**28·6**	28·7	29·1	29·2	29·3	29·5	29·8	29·8	29·8	29·9	30·0	30·0	29·7
Means	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Summer.																										
April	27·7	27·5	27·5	27·4	27·5	27·7	28·0	**28·2**	27·5	26·5	25·7	25·0	24·5	**24·4**	25·0	25·9	26·7	26·5	26·5	26·6	26·7	26·9	27·0	27·0	27·1	26·1
May	27·3	27·3	27·3	27·2	27·2	27·4	**27·5**	27·2	26·3	25·4	24·9	24·6	**24·5**	24·8	25·3	26·1	26·5	26·4	26·3	26·4	26·4	26·7	26·7	26·7	26·8	26·3
June	28·0	27·9	27·9	27·9	27·9	28·0	28·3	**28·5**	28·4	27·8	27·1	27·2	**26·8**	26·8	26·9	27·0	27·5	27·6	27·5	27·5	27·7	27·8	28·0	27·9	27·9	27·7
July	28·2	28·2	28·2	28·2	28·2	28·4	**28·6**	28·5	28·4	27·8	27·7	27·6	**27·1**	27·5	27·9	27·9	27·8	27·9	27·7	27·4	27·5	27·7	27·8	27·9	27·9	27·9
August	28·8	28·7	28·7	28·7	28·7	28·9	**29·2**	28·9	28·5	28·1	27·7	27·3	26·9	**26·9**	27·4	27·9	28·4	28·4	28·3	28·2	28·2	28·3	28·4	28·5	28·6	28·3
September	28·4	28·4	28·4	28·5	28·5	28·5	**28·9**	28·8	27·9	26·8	25·8	24·9	**24·7**	25·4	26·3	27·3	27·5	27·4	27·3	27·3	27·4	27·7	27·9	28·2	28·7	27·4
Means	28·1	28·0	28·0	28·0	28·0	28·2	**28·4**	28·4	27·8	27·1	26·5	26·1	**25·8**	26·0	26·5	27·0	27·4	27·4	27·3	27·2	27·3	27·5	27·6	27·7	27·8	27·4

Diurnal Inequality of the Dip at Kodaikánal as deduced from the preceding Table.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	13	14	15	16	17	18	19	20	21	22	23	Mid.
Winter.																									
Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October	+1.0	+1.1	+1.1	+1.1	+1.0	+1.1	+1.4	+1.1	+0.5	−0.6	−2.2	−2.8	−2.6	−2.3	−1.5	−0.7	−0.4	0	+0.4	+0.6	+0.7	+0.8	+0.9	+1.1	+1.1
November	+0.6	+0.6	+0.6	+0.6	+0.7	+0.7	+0.6	+0.6	+0.6	+0.5	−0.2	−0.4	−0.7	−1.2	−1.2	−0.8	−0.6	−0.5	−0.2	0	0	+0.1	+0.2	+0.3	+0.3
December	+0.5	+0.5	+0.5	+0.4	+0.3	+0.3	+0.4	+0.2	+0.2	0	−0.2	−0.3	−0.8	−1.1	−1.0	−0.6	−0.5	−0.4	−0.2	+0.1	+0.1	+0.1	+0.2	+0.3	+0.3
Means	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Summer.																									
April	+1.0	+0.8	+0.8	+0.7	+0.8	+1.0	+1.3	+1.5	+0.8	−0.2	−1.0	−1.7	−2.2	−2.3	−1.7	−0.8	0	−0.2	−0.2	−0.1	0	+0.2	+0.3	+0.3	+0.4
May	+1.0	+1.0	+1.0	+0.9	+0.9	+1.1	+1.2	+0.9	0	−0.9	−1.4	−1.7	−1.8	−1.5	−1.0	−0.2	+0.2	+0.1	0	+0.1	+0.1	+0.4	+0.4	+0.4	+0.5
June	+0.3	+0.2	+0.2	+0.2	+0.2	+0.3	+0.6	+0.8	+0.7	+0.1	−0.6	+0.5	−0.9	−0.9	−0.8	−0.7	−0.2	−0.1	−0.2	−0.2	0	+0.1	+0.3	+0.2	+0.2
July	+0.3	+0.3	+0.3	+0.3	+0.3	+0.5	+0.7	+0.6	+0.5	−0.1	−0.2	−0.3	−0.8	−0.4	0	0	−0.1	0	−0.2	−0.5	−0.4	−0.2	−0.1	0	0
August	+0.5	+0.4	+0.4	+0.4	+0.4	+0.6	+0.9	+0.6	+0.2	−0.2	−0.6	−1.0	−1.4	−1.4	−0.9	−0.4	+0.1	+0.1	0	−0.1	−0.1	0	+0.1	+0.2	+0.3
September	+1.0	+1.0	+1.0	+1.1	+1.1	+1.1	+1.5	+1.4	+0.5	−0.6	−1.6	−2.5	−2.7	−2.0	−1.1	−0.1	+0.1	0	−0.1	0	0	+0.3	+0.5	+0.8	+1.3
Means	+0.7	+0.6	+0.6	+0.6	+0.6	+0.8	+1.0	+1.0	+0.4	−0.3	−0.9	−1.3	−1.6	−1.4	−0.9	−0.4	0	0	−0.1	−0.2	−0.1	+0.1	+0.2	+0.3	+0.4

N. B.—When the sign is + the Dip is more, and when — less than the mean value.

TABLE G.

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season, 1907-08.

Serial No.	Name of Station.	Survey No.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C. G. S.	REMARKS.
1135	Mōng Mā	22/98 3	22 45 10	98 16 10	30 52	E 0 52	0·3773	H is derived from mean M throughout.
1136	Mōng Yai	„ 4	22 25 30	98 2 30	30 18	„ 0 53	0·3784	
1137	Mōng Awt	„ 5	22 2 20	98 22 30	29 32	„ 0 51	0·3799	
1138	Hsupwo	„ 6	21 49 50	98 50 20	29	„ 0 49	0·3806	
1139	Mōng Ping	21/100 1	21 21 0	99 1 10	28 10	„ 0 45	0·3823	
1140	Kēng Tung	„ 2	21 17 0	99 37 0	28 2	„ 0 45	0·3820	
1141	Mōng Yāng	„ 3	21 50 40	99 41 30	29 10	„ 0 41	0·3802	
1142	Hsuplamhsuplwe	„ 4	21 23 40	100 14 20	28 16	„ 0 44	0·3822	
1143	Namlang (Pa-liao.)	20/100 1	20 49 50	100 20 50	27 7	„ 0 47	0·3842	
1144	Mōng Hai	„ 2	20 46 10	99 48 10	26 59	„ 0 45	0·3839	
1145	Mōng Hsāt	„ 3	20 31 40	99 15 50	26 27	„ 0 47	0·3845	
1146	Mōng Tung	20/98 1	20 18 0	98 54 10	25 58	„ 0 45	0·3850	
1147	Mōng Htā	„ 2	19 51 10	98 34 0	25 0	„ 0 44	0·3860	
1148	Mōng Pan	„ 3	20 19 10	98 22 10	26 0	„ 0 45	0·3845	
1149	Mōng Nai	„ 4	20 30 20	97 52 0	26 19	„ 0 41	0·3843	
1150	Kēng Tawng	„ 5	20 45 10	98 18 10	26 51	„ 0 45	0·3838	
1151	Mōng Pu	„ 6	20 54 40	98 44 30	27 15	„ 0 48	0·3830	
1152	Wān Kawng	21/98 7	21 23 20	98 22 30	28 13	„ 0 48	0·3820	
1153	Wān Hoko	„ 8	21 0 10	97 57 0	27 22	„ 0 44	0·3829	
1154	Wān Hohwe	„ 9	21 9 0	97 34 40	27 39	„ 0 46	0·3822	
1155	Nawngla-yaw	„ 10	21 38 20	97 44 30	28 38	„ 0 47	0·3810	
1156	Mān Li	„ 11	22 5 50	97 31 30	29 38	„ 0 48	0·3796	
1157	Kyawkku	21/96 17	21 48 20	96 56 10	29 0	„ 0 48	0·3805	
1158	Lawk Sawk	„ 18	21 14 40	96 52 30	27 52	„ 0 45	0·3817	
1159	Taunggyi	20/96 7	20 46 30	97 2 50	26 53	„ 0 49	0·3837	
1160	Kalaw	20/96 10	20 37 40	96 34 10	26 33	„ 0 45	0·3835	
1161	Sillod	20/75 9	20 18 40	75 38 50	25 21	„ 0 11	0·3690	
1162	Deulghát	„ 10	20 32 0	76 7 10	26 10	„ 0 33	0·3647	
1163	Mehkar	„ 11	20 9 10	76 35 10	25 48	„ 0 47	0·3656	
1164	Chikni	20/77 13	20 5 0	77 53 30	25 6	„ 0 51	0·3708	
1165	Boraghat	21/84 13	21 31 40	84 33 30	28 15	„ 0 59	0·3750	
1166	Bonaigarh	„ 14	21 49 0	84 57 30	28 54	„ 0 25	0·3729	
1167	Pál Lahara	21/85 6	21 25 50	85 11 30	27 51	„ 0 31	0·3739	
1168	Tálcher	20/85 7	20 57 10	85 14 30	27	„ 0 58	0·3768	
1169	Kantolo	21/85 7	21 7 20	85 37 40	27 54	„ 0 45	0·373	
1170	Gutgaon	„ 8	21 24 10	85 53 20	27 52	„ 0 52	0·3753	
1171	Keonjhar	„ 9	21 37 40	85 35 30	28 15	„ 0 49	0·3740	

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season, 1907-08.

Serial No.	Name of Station.	Survey No.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C. G. S.	Remarks.
1172	Jaintigarh	[illegible] 10	22 4 10	85 40 40	29 8	E 1 4	0·3727	H is derived from mean M throughout.
1173	Chaibassa	„ 11	22 32 30	85 48 30	30 9	„ 1 10	0·3707	
1174	Rairangpur	„ 12	22 15 20	86 11 0	29 45	„ 0 58	0·3720	
1175	Kasmi	„ 13	21 50 0	86 15 10	28 14	„ 0 18	0·3789	
1176	Baripáda	„ 14	21 55 50	86 43 0	29 5	„ 0 33	0·3737	
1177	Dántan	[illegible] 7	21 56 10	87 16 40	29 10	„ 0 53	0·3726	
1178	Contai	„ 8	21 46 40	87 44 30	28 30	„ 0 44	0·3759	
1179	Bálikuda	[illegible] 8	20 8 30	86 16 10	25 9	„ 0 28	0·3809	
1180	Chandbali	„ 9	20 46 10	86 43 40	26 42	„ 0 19	0·3797	
1181	Amarpur	[illegible] 11	23 32 0	91 39 30	32 7	„ 1 2	0·3727	
1182	Singurajabari	„ 12	24 8 0	91 53 50	33 17	„ 1 7	0·3709	
1183	Silgháta	[illegible] 7	22 12 20	92 8 30	29 38	„ 0 57	0·3767	
1184	Golabari	[illegible] 13	23 5 0	91 58 50	31 17	„ 1 3	0·3743	
1185	Nandgaon	[illegible] 12	27 42 50	77 23 10	39 22	„ 2 8	0·3447	
1186	Palwal	„ 13	28 8 50	77 19 50	40 7	„ 2 13	0·3425	
1187	Tamu	[illegible] 7	24 12 50	94 19 0	33 34	„ 0 58	0·3712	
1188	Lenacot	„ 8	23 54 30	93 47 50	32 50	„ 1 7	0·3724	
1189	Tunzan	„ 9	23 35 30	93 41 30	32 15	„ 1 6	0·3732	
1190	Fort White	„ 10	23 14 50	93 46 30	31 35	„ 1 16	0·3740	
1191	Tao	[illegible] 7	22 45 50	93 11 20	30 43	„ 0 56	0·3759	
1192	Haka	„ 8	22 38 30	93 37 20	30 32	„ 0 59	0·3756	
1193	Kan	„ 9	22 24 40	94 6 20	30 7	„ 0 53	0·3777	
1194	Sihaung	„ 10	22 51 0	94 3 20	31 4	„ 0 50	0·3767	
1195	Moulmein	[illegible] 1	16 29 40	97 37 30	17 45	„ 0 36	0·3926	
1196	Thatôn	„ 2	16 55 10	97 20 20	18 36	„ 0 36	0·3918	
1197	Kyaikto	[illegible] 1	17 18 40	97 1 0	19 26	„ 0 37	0·3923	
1198	Thaungbyin	[illegible] 10	19 55 20	96 31 10	25 4	„ 0 42	0·3851	
1199	Thitkyit	„ 11	19 37 50	96 40 30	24 34	„ 0 40	0·3860	
1200	Pinlaung	„ 12	20 7 50	96 46 50	25 29	„ 0 40	0·3845	
1201	Loi-put	[illegible] 8	20 17 30	97 18 40	25 51	„ 0 45	0·3845	
1202	Mawkmai	„ 9	20 13 10	97 43 30	25 45	„ 0 44	0·3848	
1203	Ta-supteng	„ 10	19 51 20	97 45 10	25 0	„ 0 40	0·3857	
1204	Namon	„ 11	19 21 40	97 30 50	23 58	„ 0 43	0·3872	
1205	Loi-kaw	„ 12	19 40 20	97 13 10	24 36	„ 0 43	0·3863	
1206	Kreuko	„ 13	19 15 10	97 2 30	23 48	„ 0 42	0·3867	
1207	Pazaung	[illegible] 2	18 52 10	97 18 40	22 56	„ 0 47	0·3882	
1208	Salween	„ 3	18 27 0	97 21 40	21 57	„ 0 39	0·3893	
1209	Papun	„ 4	18 3 20	97 27 20	21 16	„ 0 43	0·3886	

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season, 1907-08.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
1210	Maipali	[illegible] 5	17 30 50	97 38 40	20 1	E 0 36	0·3908	H is derived from mean M throughout.
1211	Hlaingbwé	„ 6	17 7 0	97 49 10	19 7	„ 0 40	0·3914	
1212	Mergui	[illegible] 1	12 26 50	98 38 50	8 35	„ 0 32	0·3965	
1213	Palaw	„ 2	12 58 0	98 44 20	9 52	„ 0 31	0·3967	
1214	Shintabi	[illegible] 1	14 29 10	98 10 0	13 17	„ 0 37	0·3955	
	Old Stations re-observed—							
46	Ruk	[illegible] 3	27 48 20	68 38 20	39 21	„ 2 7	0·3351	
92	Kundián	[illegible] 4	32 27 30	71 28 20	47 31	„ 3 26	0·3107	
98	Amritsar	[illegible] 7	31 38 10	74 51 30	45 33	„ 2 55	0·3238	
105	Sachín	[illegible] 9	21 4 40	72 52 40	27 13	„ 0 28	0·3654	
130	Ajmer	[illegible] 3	26 27 30	74 38 30	37 12	„ 1 57	0·3462	
171	Kirkee	[illegible] 2	18 33 30	73 50 0	22 21	„ 0 9	0·3668	
177	Wádi	[illegible] 1	17 3 0	77 0 0	18 44	„ 0 13	0·3758	
186	Arkonam	[illegible] 5	13 5 10	79 40 20	10 4	W 0 27	0·3835	
199	Cannanore	[illegible] 5	11 52 30	75 22 0	7 32	„ 0 27	0·3819	
216	Miraj	[illegible] 1	16 49 10	74 38 10	19 4	„ 0 4	0·3771	
232	Delhi	[illegible] 2	28 40 20	77 14 20	40 57	E 2 2	0·3405	
335	Trichinopoly	[illegible] 2	10 47 30	78 40 40	4 51	W 1 3	0·3812	
355	Bellary	[illegible] 2	15 8 50	76 55 30	14 31	„ 0 23	0·3766	
373	Jálna	[illegible] 4	19 51 50	75 53 0	24 52	E 0 47	0·3704	
376	Nander	[illegible] 1	19 9 30	77 18 10	23 56	„ 0 12	0·3715	
384	Bezwada	[illegible] 1	16 31 0	80 36 50	17 34	W 0 18	0·3814	
481	Allahabad	[illegible] 7	25 27 30	81 49 20	35 25	E 1 26	0·3582	
489	Monghyr	[illegible] 8	25 23 10	86 27 50	35 25	„ 1 21	0·3629	
494	Sainthia	[illegible] 3	23 56 50	87 41 20	32 54	„ 1 8	0·3680	
500	Sini	[illegible] 1	22 47 0	85 56 50	30 21	„ 1 3	0·3730	
522	Bhatni	[illegible] 3	26 23 0	83 55 40	37 12	„ 1 38	0·3560	
545	Bína	[illegible] 4	24 10 50	78 11 0	33 13	„ 1 9	0·3602	
557	Indore	[illegible] 1	22 42 10	75 52 40	30 26	„ 0 57	0·3650	
573	Cawnpore	[illegible] 4	26 27 0	80 21 0	37 21	„ 1 50	0·3534	
579	Sutna	[illegible] 1	24 34 20	80 50 0	34 13	„ 1 27	0·3598	
692	Balasore	[illegible] 4	21 30 30	86 54 40	28 8	„ 0 46	0·3759	
699	Berhampur	[illegible] 1	19 18 10	84 48 40	23 32	„ 0 24	0·3804	
710	Cumbum	[illegible] 6	15 35 50	79 6 40	15 46	„ 0 3	0·3777	
761	Khairi	[illegible] 3	22 55 20	81 52 50	30 39	„ 1 3	0·3665	
765	Raipur	„ 5	21 15 50	81 38 20	27 51	„ 0 43	0·3709	
775	Kamptee	[illegible] 8	21 12 30	79 12 40	27 34	„ 0 51	0·3682	
1026	Rangamati	[illegible] 3	22 38 10	92 11 50	30 23	„ 1 0	0·3760	

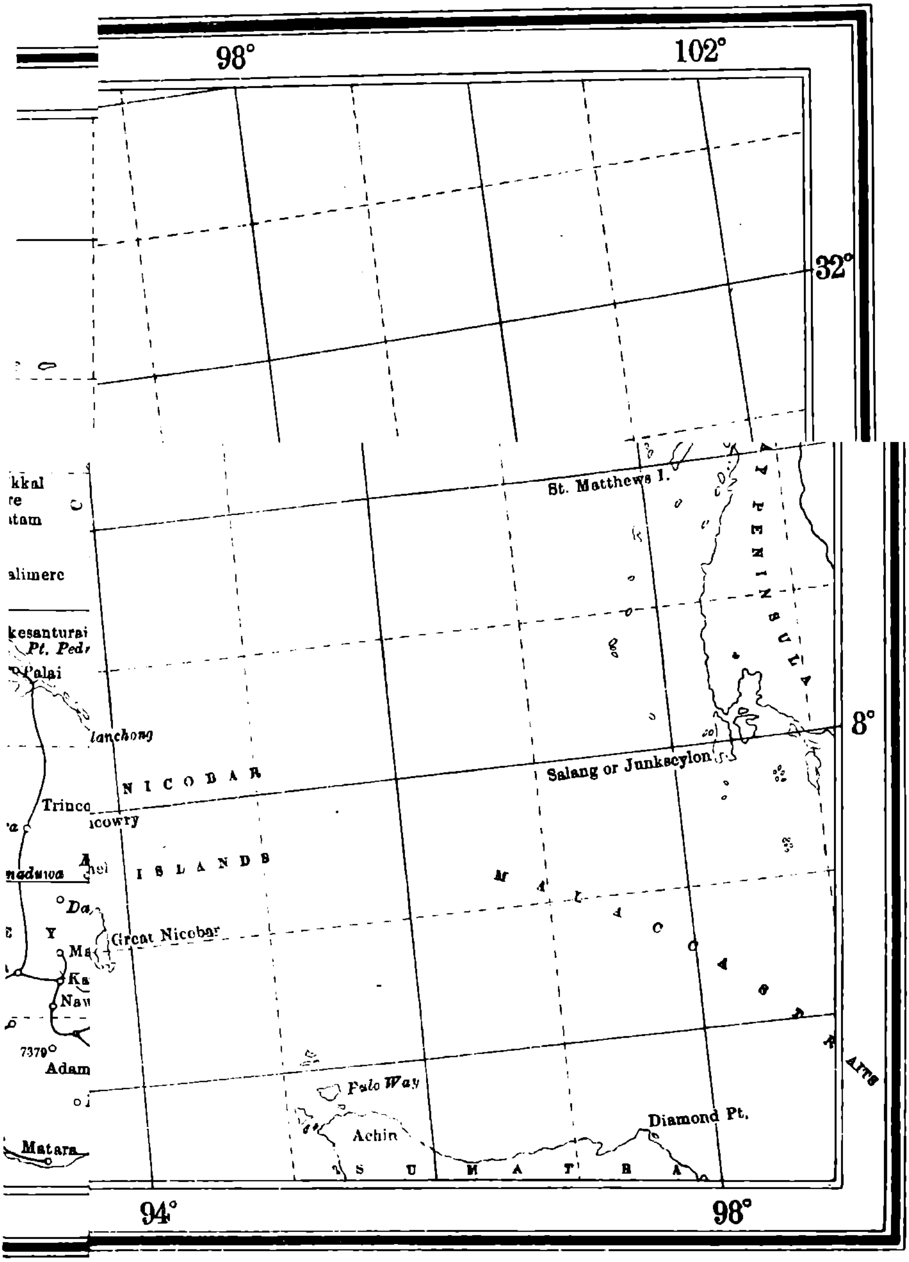
Repeat Stations.

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 49	E 1·24	0·3530	H is derived from mean M throughout.
II	Karáchi . .		24 49 50	67 2 2	34 14	„ 1·40	0·3457	
III	Quetta . .		30 11 52	67 0 20	43 7	„ 2·58	0·3232	
IV	Baháwalpur .		29 23 27	71 40 37	42 9	„ 2·51	0·3318	
V	Ráwalpindi .		33 35 16	73 3 6	48 18	„ 3·42	0·3122	
VI	Bharatpur .		27 13 27	77 29 28	38 42	„ 1·59	0·3458	
VII	Bangalore .		12 59 35	77 35 58	9 48	W 0·37	0·3811	
VIII	Dhárwár .		15 27 26	74 59 35	15 23	„ 0·13	0·3761	
IX	Porbandar .		21 38 20	69 37 6	28 45	E 1·13	0·3600	
X	Fyzabad . .		26 47 27	82 7 40	37 54	„ 1·48	0·3529	
XI	Sambalpur .		21 28 3	83 58 24	27 52	„ 0·49	0·3725	
XII	Waltair . .		17 42 57	83 19 1	21 12	„ 0·15	0·3785	
XIII	Darjeeling .		26 59 49	88 16 39	38 18	„ 1·36	0·3570	
XIV	Gaya . .		24 46 30	84 58 54	34 16	„ 1·9	0·3659	
XV	Secunderabad .		17 27 11	78 29 16	20 11	„ 0·18	0·3792	
XVI	Bhusával . .		21 2 46	75 47 18	26 59	„ 0·50	0·3680	
XVII	Jubbulpore .		23 8 57	79 56 44	31 2	„ 1·3	0·3643	
XVIII	Tavoy . .		14 4 50	98 12 30	12 19	„ 0·31	0·3957	
XIX	Lashio . .		22 56 47	97 44 40	31 16	„ 0·47	0·3762	
XX	Akyab . .		20 7 53	92 53 18	25 29	„ 0·45	0·3838	
XXI	Silchar or Cachar		24 49 43	92 47 21	34 43	„ 1·13	0·3692	
XXII	Dibrugarh .		27 29 24	94 55 40	39 30	„ 1·19	0·3587	

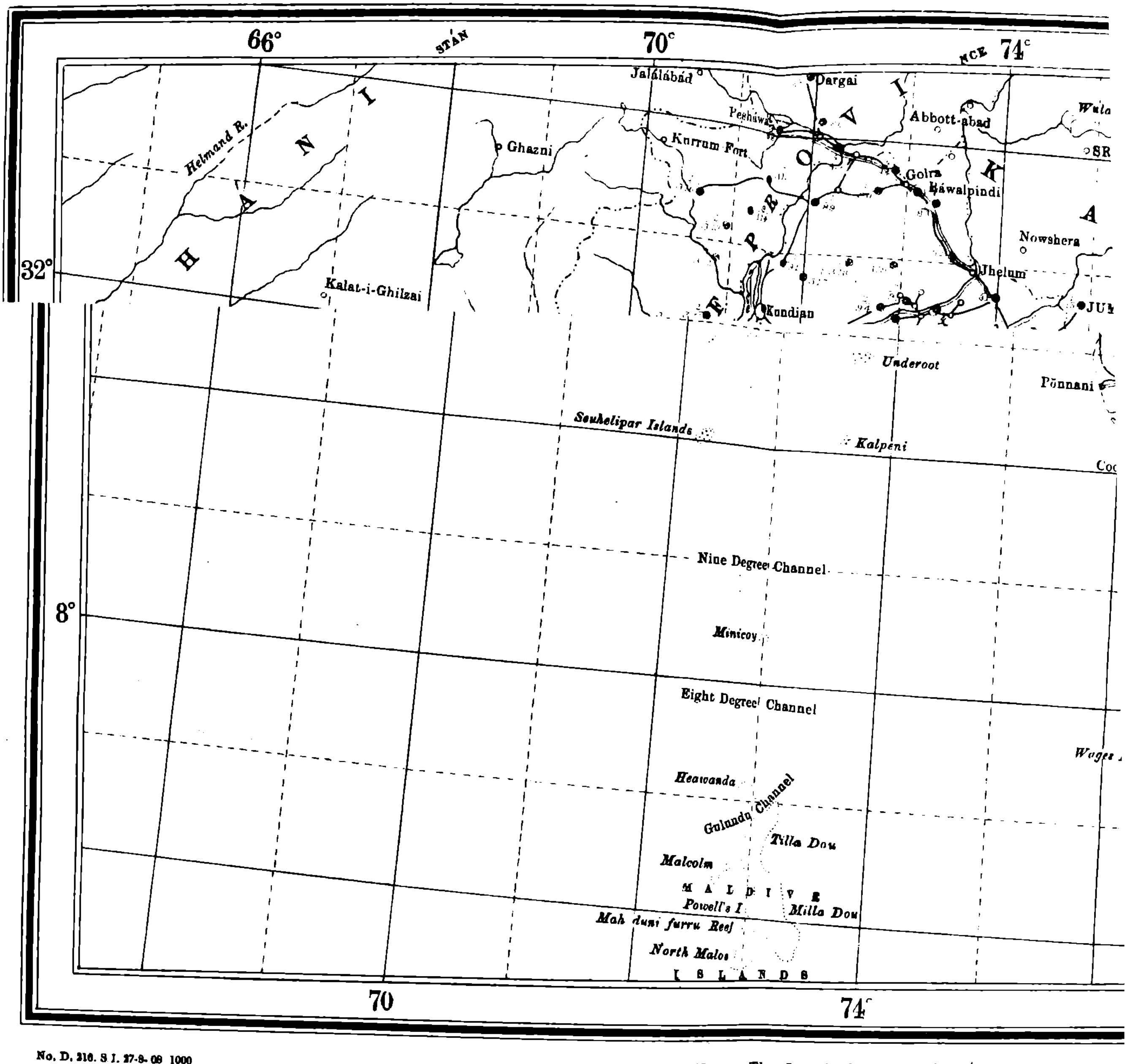
NOTE.—The above values of Dip, Declination, and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered preliminary values only.

The survey numbers refer to the published chart : thus No. $\frac{26}{76}$ 3 denotes No. 3 station, 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.



Pul *Heliozincographed at the Office of the Trigonometrical Branch, Survey of India. Dehra Dún.*



No. D. 316. S I. 27-8-08 1000

Notes—The Longitudes are referrible to the Greenwich Meridian, taking that of the Madras Observatory as 80° 14′ 54″ East.

II.

TIDAL AND LEVELLING OPERATIONS.

Annual Narrative Report of Mr. C. F. Erskine, in charge No. 25 Party (Tidal and Levelling Operations). Season, 1907-08.

Imperial Officer.

Mr. C. F. Erskine.

Provincial Officers.

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

Subordinate Establishment.

1 Surveyor, 23 Computers and Recorders, 2 Native Artificers, 3 Tidal Observatory Clerks.

The *personnel* of the party during the year under report was as shown in the margin.

TIDAL OPERATIONS.

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

The reduction by harmonic analysis of the observations for 1907 of the 8 stations named above has been completed. The tide-tables for 1909 have arrived in India and will be distributed in due course. The work of publication of tide-tables for 1910 is in progress in England. Data for the tide-tables for 1911 and 1912 were despatched to England in July 1908.

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

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

Serial No.	Stations.	Automatic or personal observations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	Suez	Automatic .	1897	1903	7	
2	Perim	Ditto .	1898	1902	5	
3	*Aden*	Ditto .	1879	Still working.	28	
4	Masqāt	Ditto .	1893	1898	5	
5	Būshire	Ditto .	1892	1901	8	

Serial No.	Stations.	Automatic or personal observations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	REMARKS.
6	*Karáchi* . .	Automatic .	1881	Still working.	27	
7	Hanstal . . .	Ditto .	1874	1875	1	Tide-Tables not published.
8	Nowanar . .	Ditto .	1874	1875	1	
9	Okha Point . .	Ditto .	1874 Re-started 1904	1875 1906	1 1 } 2	Year 1904-05 excluded.
10	Porbandar . .	Personal .	1893	1894	2	
10/A	Porbandar . .	Automatic .	1898	1902	5	With certain interruptions
11	Port Albert Victor (Káthiáwár).	Personal .	1881	1882	1	
11/A	Port Albert Victor (Káthiáwár).	Automatic .	1900	1903	4	
12	Bhávnagar . .	Ditto .	1889	1894	5	Tide pole readings taken.
13	*Bombay (Apollo Bandar).*	Ditto .	1878	Still working.	30	
14	*Bombay (Prince's Dock).*	Ditto .	1888	"	20	Property of Port Trust.
15	Mormugao (Goa) .	Ditto .	1884	1889	5	
16	Kárwár . . .	Ditto .	1878	1883	5	
17	Beypore . .	Ditto .	1878	1884	6	
18	Cochin . . .	Ditto .	1886	1892	6	
19	Tuticorin . .	Ditto .	1888	1893	5	
20	Minicoy . . .	Ditto .	1891	1896	5	
21	Galle . . .	Ditto .	1884	1890	6	
22	Colombo . .	Ditto .	1884	1890	6	
23	Trincomalee . .	Ditto .	1890	1896	6	
24	Pámban Pass . .	Ditto .	1878	1882	4	
25	Negapatam . .	Ditto .	1881	1888	6	Year 1884-85 is excluded.
26	*Madras* . . .	Ditto .	1880 Re-started 1895	1890 Still working.	10 13 } 23	
27	Cocanada . .	Ditto .	1886	1891	5	

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

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

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

6. *Aden.*—This observatory was inspected by Mr. C. F. Erskine, officer in charge of the Tidal party, in January 1908. During the past year, there have been a few short interruptions in the tidal registrations, due either to the pencil failing to mark, or to the driving clock stopping. The auxiliary instruments have worked well during the year.

7. *Karáchi.*—This observatory, which had been wrecked in the cyclone of 6th June 1907, was re-started by Mr. H G. Shaw on 12th October 1907, since when the driving clock of the tide-gauge stopped for a few hours on two

occasions, otherwise the tide-gauge has worked well. The small self-registering anemometer has frequently been out of order. No breaks have occurred in the records of the other auxiliary instruments.

8. *Apollo Bandar (Bombay)*.—This observatory was inspected by Mr. Erskine in December 1907. There were two breaks of some hours in the tidal curves, one in October and one in December 1907, when, in each case from some cause unknown, the float-band came off the stud-wheel and fell into the cylinder.

9. *Prince's Dock (Bombay)*.—This observatory was inspected by Mr. Erskine in December 1907, on account of the driving clock of tide-gauge stopping; there were six unimportant interruptions of the registrations of the tide-gauge.

10. *Madras*.—This observatory was inspected by Mr. Erskine in January 1908. There has been no break during the past year in the registrations of the tide-gauge and auxiliary instruments.

11. *Kidderpore*.—This observatory was inspected by Mr. Shaw in January 1908. There were a few short interruptions in the tidal registrations due either to faulty communication between the cylinder and river, or breaking of cord of counterpoise weight of traveller pencil.

12. *Rangoon*.—This observatory was inspected by Mr. Shaw in January 1908. The registrations of the tide-gauge are complete. The self-registering anemometer was out of order from 8th to 10th October 1907. The clock of the self-registering aneroid stopped for a few hours on one occasion.

13. *Port Blair*.—This observatory was inspected by Mr. Shaw in January 1908. During the past year, the interruptions in the tidal curves were few and unimportant; they were due to the driving clock stopping. The self-registering anemometer was frequently out of order. The self-registering aneroid worked well.

14. *Proposed Tidal Observatory at Moulmein*.—The tidal observatory cabin at Moulmein was erected in August 1908. The tide-gauge and other instruments will be installed before the end of the year and registrations will be commenced from 1st January 1909. Moulmein will then become a permanent tidal station.

15. *Tidal diagrams and Daily Reports*.—The Tidal, Aneroid and Anemometer diagrams, and daily reports have been submitted regularly to the office at Dehra Dún.

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

VALUES OF THE TIDAL CONSTANTS, ADEN, 1907.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1907 Observations at Aden; and also the ***mean*** values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1907 Observations:

Short Period Tides.

$A_0 = 5{\cdot}858$ feet.

S_1 $H = R =$	·084	M_6 $R =$	·006	Q_1 $R =$	·163	T_2 $R =$	·082
S_1 $\kappa = \zeta =$	176°·94	M_6 $\zeta =$	139°·03	Q_1 $\zeta =$	126°·31	T_2 $\zeta =$	259°·02
S_2 $H = R =$	·662	M_6 $H =$	·005	Q_1 $H =$	·173	T_2 $H =$	·082
S_2 $\kappa = \zeta =$	243°·21	M_6 $\kappa =$	7°·35	Q_1 $\kappa =$	43°·60	T_2 $\kappa =$	260°·50

Short Period Tides—contd.

S_4	H = R =	·005	M_8	R =	·001	L_2	R =	·056	$(MS)_4$	R =	·005
	κ = ζ =	308°·83		ζ =	108°·44		ζ =	223°·91		ζ =	170°·34
S_6	H = R =	·005		H =	·001		H =	·046		H =	·005
	κ = ζ =	203°·20		κ =	292°·87		κ =	220°·95		κ =	126°·45
S_8	H = R =	·001	O_1	R =	·624	N_2	R =	·432	$(2SM)_2$	R =	·014
	κ = ζ =	33°·69		ζ =	257°·57		ζ =	129°·02		ζ =	67°·35
				H =	·662		H =	·426		H =	·014
				κ =	36°·53		κ =	223°·46		κ =	111°·24
M_1	R =	·039	K_1	R =	1·261	λ_2	R =	...	$2N_2$	R =	·067
	ζ =	161°·78		ζ =	212°·84		ζ =	...		ζ =	330°·18
	H =	·041		H =	1·306		H =	...		H =	·066
	κ =	35°·82		κ =	34°·13		κ =	...		κ =	202°·96
M_2	R =	1·585	K_2	R =	·176	ν_2	R =	·026	$(M_2N)_4$	R =	·016
	ζ =	269°·58		ζ =	55°·86		ζ =	130°·18		ζ =	167°·06
	H =	1·561		H =	·196		H =	·025		H =	·015
	κ =	225°·69		κ =	238°·86		κ =	266°·01		κ =	217°·61
M_3	R =	·022	P_1	R =	·422	μ_2	R =	·057	$(M_2K_1)_3$	R =	·015
	ζ =	93°·69		ζ =	222°·58		ζ =	289°·98		ζ =	101°·54
	H =	·022		H =	·422		H =	·055		H =	·015
	κ =	207°·85		κ =	32°·71		κ =	202°·20		κ =	238°·95
M_4	R =	·007	J_1	R =	·110	R_2	R =	...	$(2M_2K_1)_3$	R =	·013
	ζ =	57°·72		ζ =	350°·70		ζ =	...		ζ =	282°·93
	H =	·007		H =	·115		H =	...		H =	·013
	κ =	329°·94		κ =	29°·51		κ =	...		κ =	13°·85

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·035	192°·78	·033	54°·44
" Fortnightly "	·036	154°·47	·041	12°·66
Luni-Solar " "	·013	69°·21	·013	113°·10
Solar-Annual "	·420	79°·62	·420	359°·48
" Semi-Annual "	·151	266°·78	·151	106°·51

VALUES OF THE TIDAL CONSTANTS, KARÁCHI 1906-07.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1906-07 Observations at Karáchi; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1906-07 Observations:—

Short Period Tides.

$A_0 = 7·328$ feet.

S_1	H = R =	·086	M_6	R =	·045	Q_1	R =	·156	T_2	R =	·112
	κ = ζ =	170°·78		ζ =	145°·61		ζ =	356°·27		ζ =	9°·13
S_2	H = R =	·964		H =	·042		H =	·172		H =	·112
	κ = ζ =	322°·46		κ =	197°·69		κ =	51°·86		κ =	226·52
S_4	H = R =	·015	M_8	R =	·010	L_2	R =	·088	$(MS)_4$	R =	·044
	κ = ζ =	19°·29		ζ =	314°·53		ζ =	344°·68		ζ =	66°·46
S_6	H = R =	·008		H =	·010		H =	·077		H =	·043
	κ = ζ =	291°·52		κ =	263°·97		κ =	293°·67		κ =	323°·83
S_8	H = R =	·000	O_1	R =	·614	N_2	R =	·633	$(2SM)_2$	R =	·018
	κ = ζ =	225°·00		ζ =	111°·18		ζ =	259°·44		ζ =	16°·34
				H =	·678		H =	·619		H =	·018
				κ =	46°·41		κ =	277°·17		κ =	118°·97
M_1	R =	·050	K_1	R =	1·243	λ_2	R =	...	$2N_2$	R =	·080
	ζ =	300°·17		ζ =	79°·32		ζ =	...		ζ =	111°·41
	H =	·044		H =	1·320		H =	...		H =	·078
	κ =	25°·06		κ =	45°·41		κ =	...		κ =	249°·51

Short Period Tides—contd.

Tide	R =	ζ =	H =	κ =
M_2	2·667	35°·18	2·609	292°·54
M_3	·050	107°·46	·048	313°·50
M_4	·027	171°·44	·026	326°·16
K_2	·234	205°·09	·274	317°·94
P_1	·403	21°·19	·403	47°·25
J_1	·101	204°·35	·110	46°·12
ν_2	·078	289°·73	·076	325°·81
μ_2	·083	119°·90	·080	274°·62
R_2	...	...	...	...
$(M_2N)_4$	·023	55°·80	·022	330°·89
$(M_2K_1)_3$	·063	190°·70	·065	54°·15
$(2M_2K_1)_3$	·009	241°·13	·009	69°·77

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·018	152°·57	·017	32°·20
" Fortnightly "	·025	190°·34	·031	37°·25
Luni-Solar " "	·035	96°·78	·034	199°·42
Solar-Annual "	·143	8°·09	·143	72°·04
" Semi-Annual "	·117	57°·80	·117	185°·69

VALUES OF THE TIDAL CONSTANTS, BOMBAY, 1907.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1907 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 1907 Observations:—

Short Period Tides.

A_0=10·188 feet.

Tide	H = R =	κ = ζ =
S_1	·079	189°·43
S_2	1·562	3°·69
S_4	·006	194°·27
S_6	·003	126°·87
S_8	·002	225°·00

Tide	R =	ζ =	H =	κ =
M_1	·041	86°·35	·043	61°·32
M_2	4·049	12°·29	3·987	330°·28
M_3	·065	276°·63	·063	33°·62
M_4	·103	30°·83	·100	306°·83
M_6	·018	152°·34	·017	26°·33
M_8	·009	156°·50	·009	348°·49
O_1	·615	267°·15	·652	48°·07
K_1	1·330	224°·33	1·378	45°·55
K_2	·365	173°·78	·406	356°·63
P_1	·411	233°·89	·411	44°·10
J_1	·100	9°·11	·105	46°·84
Q_1	·156	139°·74	·166	60°·01
L_2	·130	323°·15	·107	321°·06
N_2	·962	219°·35	·948	316°·69
λ_2	...	...	...	...
ν_2	·033	206°·57	·033	345°·15
μ_2	·193	38°·26	·187	314°·25
R_2	...	...	...	...
T_2	·240	9°·80	·240	11°·36
$(MS)_4$	·104	62°·20	·103	20°·20
$(2SM)_2$	·036	69°·31	·035	111°·32
$2N_2$	·084	37°·52	·082	274°·21
$(M_2N)_4$	·021	208°·26	·020	263°·60
$(M_2K_1)_3$	·040	134°·27	·041	273°·49
$(2M_2K_1)_3$	·049	340°·96	·050	75°·74

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·062	42°·76	·059	263°·41
„ Fortnightly „	·031	166°·06	·035	22°·21
Luni-Solar „	·076	101°·53	·075	143°·54
Solar-Annual „ „	·138	67°·06	·138	346°·85
„ Semi-Annual „	·124	8°·36	·124	207°·93

VALUES OF THE TIDAL CONSTANTS, BOMBAY, (PRINCE'S DOCK) 1907.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1907 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 1907 Observations.

Short Period Tides.

$A_0 = 8{\cdot}247$ feet.

S_1	H = R =	·077	M_6	R =	·011	Q_1	R =	·159	T_2	R =	·239
	κ = ζ =	195°·24		ζ =	317°·97		ζ =	140°·47		ζ =	14°·74
S_2	H = R =	1·605		H =	·010		H =	·169		H =	·239
	κ = ζ =	5°·35		κ =	191°·96		κ =	60°·74		κ =	16°·29
S_4	H = R =	·019	M_8	R =	·006	L_2	R =	·132	$(MS)_4$	R =	·126
	κ = ζ =	192°·30		ζ =	282°·01		ζ =	322°·61		ζ =	86°·67
S_6	H = R =	·005		H =	·006		H =	·108		H =	·124
	κ = ζ =	170°·73		κ =	114°·00		κ =	320°·52		κ =	44°·67
S_8	H = R =	·002	O_1	R =	·628	N_2	R =	·995	$(2SM)_2$	R =	·043
	κ = ζ =	55°·62		ζ =	267°·51		ζ =	220°·69		ζ =	64°·95
				H =	·666		H =	·979		H =	·042
				κ =	48°·44		κ =	318°·03		κ =	106°·96
M_1	R =	·045	K_1	R =	1·347	λ_2	R =	...	$2N_2$	R =	·089
	ζ =	88°·46		ζ =	224°·48		ζ =	...		ζ =	37°·09
	H =	·047		H =	1·395		H =	...		H =	·088
	κ =	63°·42		κ =	45°·70		κ =	...		κ =	273°·78
M_2	R =	4·156	K_2	R =	·380	ν_2	R =	·047	$(M_2N)_4$	R =	·015
	ζ =	13°·70		ζ =	176°·43		ζ =	223°·87		ζ =	278°·25
	H =	4·093		H =	·422		H =	·047		H =	·014
	κ =	331°·70		κ =	359°·28		κ =	2°·46		κ =	333°·59
M_3	R =	·069	P_1	R =	·419	μ_2	R =	·208	$(M_2K_1)_3$	R =	·018
	ζ =	274°·59		ζ =	235°·17		ζ =	43°·84		ζ =	121°·30
	H =	·068		H =	·419		H =	·201		H =	·018
	κ =	31°·58		κ =	45°·38		κ =	319°·83		κ =	260°·52
M_4	R =	·103	J_1	R =	·105	R_2	R =	...	$(2M_2K_1)_3$	R =	·061
	ζ =	60°·62		ζ =	8°·17		ζ =	...		ζ =	353°·85
	H =	·100		H =	·109		H =	...		H =	·062
	κ =	336°·62		κ =	45°·89		κ =	...		κ =	88°·62

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·047	58°·17	·045	278°·82
„ Fortnightly „	·040	173°·74	·046	29·89
Luni-Solar „ „	·067	87°·85	·066	129·86
Solar-Annual „	·151	53°·00	·151	332·79
„ Semi-Annual „	·132	3°·11	·132	202·69

VALUES OF THE TIDAL CONSTANTS, MADRAS, 1907.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1907 Observations at Madras ; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1907 Observations.

Short Period Tides.

$A^0 = 2{\cdot}294$ feet.

S_1	H = R =	·025	M_6	R =	·004	Q_1	R =	·007	T_2	R =	·049
	κ = ζ =	88°·87		ζ =	211°·83		ζ =	153°·81		ζ =	265°·80
S_2	H = R =	·459		H =	·004		H =	·007		H =	·049
	κ = ζ =	270°·79		κ =	87°·32		κ =	74°·88		κ =	267°·44

Short Period Tides—contd.

Tide		Value	Tide		Value	Tide		Value	Tide		Value
S_4	H = R =	·001	M_8	R =	·001	L_2	R =	·044	$(MS)_4$	R =	·001
	κ = ζ =	116°·57		ζ =	345°·96		ζ =	249°·77		ζ =	245°·56
S_6	H = R =	·001		H =	·001		H =	·036		H =	·001
	κ = ζ =	353°·66		κ =	179°·96		κ =	247°·91		κ =	204°·05
S_8	H = R =	·002	O_1	R =	·089	N_2	R =	·244	$(2SM)_2$	R =	·017
	κ = ζ =	315°·00		ζ =	188°·56		ζ =	138°·74		ζ =	176°·93
				H =	·094		H =	·240		H =	·017
				κ =	330°·01		κ =	236°·85		κ =	218°·44
M_1	R =	·023	K_1	R =	·290	λ_2	R =	...	$2N_2$	R =	·036
	ζ =	53°·72		ζ =	156°·15		ζ =	...		ζ =	8°·52
	H =	·025		H =	·301		H =	...		H =	·036
	κ =	28°·93		κ =	337°·35		κ =	...		κ =	246°·25
M_2	R =	1·108	K_2	R =	·103	ν_2	R =	·021	$(M_2N)_4$	R =	·004
	ζ =	282°·03		ζ =	84°·41		ζ =	141°·51		ζ =	112°·83
	H =	1·091		H =	·114		H =	·021		H =	·004
	κ =	240°·53		κ =	267°·22		κ =	280°·84		κ =	169°·45
M_3	R =	·005	P_1	R =	·094	μ_2	R =	·023	$(M_2K_1)_3$	R =	·014
	ζ =	267°·40		ζ =	171°·24		ζ =	285°·41		ζ =	99°·81
	H =	·004		H =	·094		H =	·022		H =	·014
	κ =	25°·14		κ =	341°·47		κ =	202°·41		κ =	239°·51
M_4	R =	·008	J_1	R =	·031	R_2	R =	...	$(2M_2K_1)_3$	R =	·002
	ζ =	240°·17		ζ =	268°·49		ζ =	...		ζ =	199°·29
	H =	·008		H =	·032		H =	...		H =	·002
	κ =	157°·16		κ =	305°·93		κ =	...		κ =	295°·09

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	·039	150°·55	·037	10°·94
„ Fortnightly „ . . .	·019	186°·62	·022	42°·22
Luni-Solar „ „ . . .	·016	176°·75	·016	218°·25
Solar-Annual „ . . .	·293	295°·55	·293	215°·32
„ Semi-Annual „ . . .	·231	281°·92	·231	121°·45

Values of the Tidal Constants, Kidderpore, 1907.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1907 Observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1907 Observations.

Short Period Tides.

A_0 = 10·358 feet.

Tide		Value	Tide		Value	Tide		Value	Tide		Value
S_1	H = R =	·089	M_6	R =	·168	Q_1	R =	·023	T_2	R =	·205
	κ = ζ =	203°·95		ζ =	74°·10		ζ =	81°·87		ζ =	129°·87
S_2	H = R =	1·613		H =	·160		H =	·024		H =	·205
	κ = ζ =	96°·67		κ =	311°·23		κ =	3°·79		κ =	131°·47
S_4	H = R =	·108	M_8	R =	·071	L_2	R =	·216	$(MS)_4$	R =	·718
	κ = ζ =	102°·08		ζ =	70°·89		ζ =	68°·20		ζ =	109°·91
S_6	H = R =	·008		H =	·067		H =	·177		H =	·707
	κ = ζ =	19°·60		κ =	267°·07		κ =	66°·60		κ =	68°·96
S_8	H = R =	·007	O_1	R =	·223	N_2	R =	·712	$(2SM)_2$	R =	·073
	κ = ζ =	320°·53		ζ =	244°·71		ζ =	304°·90		ζ =	335°·01
				H =	·236		H =	·701		H =	·071
				κ =	26°·73		κ =	43°·85		κ =	15°·96
M_1	R =	·030	K_1	R =	·414	λ_2	R =	...	$2N_2$	R =	·148
	ζ =	111°·08		ζ =	230°·00		ζ =	...		ζ =	138°·57
	H =	·031		H =	·429		H =	...		H =	·146
	κ =	86°·56		κ =	51°·17		κ =	...		κ =	17°·44
M_2	R =	3·905	K_2	R =	·414	ν_2	R =	·143	$(M_2N)_4$	R =	·298
	ζ =	95°·09		ζ =	263°·26		ζ =	221°·68		ζ =	321°·15
	H =	3·845		H =	·459		H =	·141		H =	·289
	κ =	54°·13		κ =	86°·02		κ =	1°·81		κ =	19°·15

Short Period Tides—contd.

Tide	R	ζ	H	κ
M_3	·035	172°·77	·034	291°·34
M_4	·789	111°·09	·765	20°·18
P_1	·150	231°·04	·150	41°·30
J_1	·032	332°·22	·033	9°·34
μ_2	·301	257°·66	·292	175°·75
R_2	...	...	...	...
$(M_2K_1)_3$	·160	246°·80	·163	27°·02
$(2M_2K_1)_3$	·028	223°·95	·028	320°·86

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·360	151°·11	·342	11°·20
„ Fortnightly „	·224	160°·00	·256	15°·02
Luni-Solar „ „	·931	2°·73	·917	43°·68
Solar-Annual „	2·210	228°·35	2·210	148°·10
„ Semi-Annual „	·853	107°·08	·853	306°·58

VALUES OF THE TIDAL CONSTANTS, RANGOON, 1907.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1907 Observations at Rangoon; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1907 Observations.

Short Period Tides.

A_0 = 10·241 feet.

Tide	R	ζ	H	κ
S_1 (H = R, κ = ζ)	·100	146°·67	·100	146°·67
S_2 (H = R, κ = ζ)	2·147	169°·58	2·147	169°·58
S_4 (H = R, κ = ζ)	·092	264°·30	·092	264°·30
S_6 (H = R, κ = ζ)	·005	22°·71	·005	22°·71
S_8 (H = R, κ = ζ)	·002	106°·70	·002	106°·70
M_1	·078	149°·23	·083	124°·97
M_2	5·998	171°·07	5·906	130°·65
M_3	·023	204°·25	·022	323°·62
M_4	·472	245°·24	·458	164°·40
M_6	·247	208°·31	·236	87°·04
M_8	·078	263°·46	·073	101°·77
O_1	·262	245°·71	·278	28°·28
K_1	·663	214°·49	·686	35°·65
K_2	·597	342°·86	·663	165°·58
P_1	·191	242°·46	·191	52°·73
J_1	·051	16°·49	·053	53°·31
Q_1	·042	124°·03	·044	46°·80
L_2	·413	145°·83	·338	144°·47
N_2	1·041	17°·79	1·025	117°·56
λ_2	...	...	...	...
ν_2	·180	335°·78	·178	116°·68
μ_2	·575	5°·34	·558	284°·49
R_2	...	...	...	...
T_2	·329	157°·91	·329	159°·53
$(MS)_4$	·467	250°·71	·460	210°·28
$(2SM)_2$	·152	3°·33	·149	43°·76
$2N_2$	·305	237°·97	·300	117°·03
$(M_2N)_4$	·187	102°·45	·181	161°·80
$(M_2K_1)_3$	·176	303°·04	·180	83°·77
$(2M_2K_1)_3$	·107	309°·46	·107	47°·46

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·233	150°·52	·221	10°·33
„ Fortnightly „	·114	177°·37	·130	31°·81
Luni-Solar „ „	·435	2°·70	·428	43°·12
Solar-Annual „	1·185	232°·74	1·185	152°·47
„ Semi-Annual „	·154	111°·50	·154	310°·95

Values of the Tidal Constants, Port Blair, 1907.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1907 Observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1907 Observations.

Short Period Tides.

A_0 = 4·833 feet.

S_1 H = R =	·018	M_6 R =	·005	Q_1 R =	·012	T_2 R =	·111
S_1 κ = ζ =	79°·36	M_6 ζ =	132°·09	Q_1 ζ =	332°·56	T_2 ζ =	314°·33
S_2 H = R =	·959	M_6 H =	·005	Q_1 H =	·012	T_2 H =	·111
S_2 κ = ζ =	314°·21	M_6 κ =	10°·12	Q_1 κ =	254°·96	T_2 κ =	315°·94
S_4 H = R =	·005	M_8 R =	·003	L_2 R =	·087	$(MS)_4$ R =	·013
S_4 κ = ζ =	186°·58	M_8 ζ =	280°·31	L_2 ζ =	278°·05	$(MS)_4$ ζ =	210°·80
S_6 H = R =	·002	M_8 H =	·003	L_2 H =	·071	$(MS)_4$ H =	·013
S_6 κ = ζ =	135°·00	M_8 κ =	117°·68	L_2 κ =	276°·59	$(MS)_4$ κ =	170°·15
S_8 H = R =	·001	O_1 R =	·145	N_2 R =	·398	$(2SM)_2$ R =	·024
S_8 κ = ζ =	210°·96	O_1 ζ =	163°·22	N_2 ζ =	175°·40	$(2SM)_2$ ζ =	116°·25
		O_1 H =	·154	N_2 H =	·392	$(2SM)_2$ H =	·024
		O_1 κ =	305°·54	N_2 κ =	274°·81	$(2SM)_2$ κ =	156°·90
M_1 R =	·021	K_1 R =	·390	λ_2 R =	...	$2N_2$ R =	·043
M_1 ζ =	55°·77	K_1 ζ =	145°·69	λ_2 ζ =	...	$2N_2$ ζ =	31°·10
M_1 H =	·022	K_1 H =	·404	λ_2 H =	...	$2N_2$ H =	·042
M_1 κ =	31°·40	K_1 κ =	326°·85	λ_2 κ =	...	$2N_2$ κ =	270°·59
M_2 R =	2·036	K_2 R =	·241	ν_2 R =	·031	$(M_2N)_4$ R =	·001
M_2 ζ =	319°·93	K_2 ζ =	125°·23	ν_2 ζ =	164°·34	$(M_2N)_4$ ζ =	344°·06
M_2 H =	2·005	K_2 H =	·267	ν_2 H =	·031	$(M_2N)_4$ H =	·001
M_2 κ =	279°·27	K_2 κ =	307°·96	ν_2 κ =	304°·90	$(M_2N)_4$ κ =	42°·81
M_3 R =	·005	P_1 R =	·134	μ_2 R =	·083	$(M_2K_1)_3$ R =	·028
M_3 ζ =	258°·93	P_1 ζ =	154°·95	μ_2 ζ =	28°·35	$(M_2K_1)_3$ ζ =	140° 03
M_3 H =	·005	P_1 H =	·134	μ_2 H =	·080	$(M_2K_1)_3$ H =	·029
M_3 κ =	17°·95	P_1 κ =	325°·22	μ_2 κ =	307°·04	$(M_2K_1)_3$ κ =	280°·54
M_4 R =	·014	J_1 R =	·040	R_2 R =	...	$(2M_2K_1)_3$ R =	·007
M_4 ζ =	192°·53	J_1 ζ =	268°·12	R_2 ζ =	...	$(2M_2K_1)_3$ ζ =	118°·07
M_4 H =	·013	J_1 H =	·041	R_2 H =	...	$(2M_2K_1)_3$ H =	·007
M_4 κ =	111°·22	J_1 κ =	305°·06	R_2 κ =	...	$(2M_2K_1)_3$ κ =	215°·60

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·035	164°·76	·033	24°·69
,, Fortnightly ,, ...	·015	181°·32	·017	36°·01
Luni-Solar ,, ,, ...	·013	24°·68	·013	65°·33
Solar-Annual ,, ...	·196	258°·07	·196	177°·80
,, Semi-Annual ,, ...	·054	45°·20	·054	244°·67

17. *Other Computations.*—The actual times and heights of high and low water for 1907 at 12 ports have been compared with the predicted values published in the tide-tables and the results tabulated.

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

19. *Receipt and Issue of tide-tables.*—The tide-tables for 1908 were received in the office in time for circulation and were duly distributed.

20. *Datum of tide-tables.*—The datum for the tide-tables 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.

21. *Sale of tide-tables.*—The amount realised on the sale of tide-tables during the year ending 30th September 1908 is R1,671-11-6.

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

(i) Values of the tidal constants for the tide-tables for 1910, 1911, and 1912 ready for use in the tide predicting machine.

(ii) Actual values during 1906 of every high and low water measured in duplicate from the tidal diagrams at 9 stations, and of tide-pole observations taken during daylight at 4 closed stations, the latter under the supervision of the Port Officers, and supplied by them to this office.

(iii) Comparisons of the above with predicted values for 1908, the errors being tabulated in such form as to be of aid in improving the predictions.

23. *Errors in Predictions.*—The 5 tabular statements which are appended, show the percentage and amount of errors in the predicted times and heights of high and low water for the year 1907 at 12 stations, as determined by comparisons of the predictions given in the tide-tables with actual values measured from the tidal diagrams at 8 stations, and from tide-poles at 4 stations; the former are made in this office, and the latter by the Port Officials.

No. 1.

Statement showing the percentage and the amount of the errors in the Predicted Times of High Water at the various Tidal Stations for the year 1907.

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	Auto.	689	37	44	8	8	3
Karáchi	Auto.	447	47	39	6	6	2
Bhávnagar	T. P.	365	53	46	1	...	...
Bombay { Apollo Bandar	Auto.	704	47	39	6	5	3
Bombay { Prince's Dock	Auto.	696	31	48	12	8	1
Madras	Auto.	705	39	44	11	5	1
Kidderpore	Auto.	705	17	31	12	23	17
Chittagong	T. P.	365	25	36	14	13	12
Akyab	T. P.	337	99	1	...	...	...
Rangoon	Auto.	702	29	38	12	15	6
Moulmein	T. P.	365	6	77	14	3	...
Port Blair	Auto.	703	39	48	7	5	1

No. 2.

Statement showing the percentage and the amount of the errors in the Predicted Times of Low Water at the various Tidal Stations for the year 1907.

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	Auto.	685	33	44	12	9	2
Karáchi	Auto.	446	28	46	11	13	2
Bhávnagar	T. P.	365	56	42	2	...	...
Bombay { Apollo Bandar	Auto.	702	44	45	6	4	1
Bombay { Prince's Dock	Auto.	696	41	47	7	3	2
Madras	Auto.	705	38	47	8	5	2
Kidderpore	Auto.	702	13	22	11	22	32
Chittagong	T. P.	365	27	26	14	15	18
Akyab	T. P.	340	98	1	...	...	1
Rangoon	Auto.	704	25	33	12	18	12
Moulmein	T. P.	365	6	70	18	6	...
Port Blair	Auto.	702	45	40	9	5	1

No. 3.

Statement showing the percentage and the amount of the errors in the Predicted Heights of High Water at the various Tidal Stations for the year 1907.

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	Auto.	689	6·7	97	3	...	...
Karáchi	Auto.	447	9·3	73	25	2	...
Bhávnagar	T. P.	365	31·4	47	35	14	4
Bombay { Apollo Bandar	Auto.	704	13·9	71	25	4	...
Bombay { Prince's Dock	Auto.	696	13·9	70	24	6	...
Madras	Auto.	705	3·5	87	13	...	...
Kidderpore	Auto.	705	11·7	42	31	15	12
Chittagong	T. P.	365	13·3	41	23	12	24
Akyab	T. P.	337	8·3	84	16	...	...
Rangoon	Auto.	702	16·4	51	31	13	5
Moulmein	T. P.	365	12·7	24	25	21	30
Port Blair	Auto.	703	6·6	94	6	...	...

No. 4.

Statement showing the percentage and the amount of the errors in the Predicted Heights of Low Water at the various Tidal Stations for the year 1907.

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		Auto.	685	6·7	98	2	...	...
Karáchi		Auto.	446	9·3	86	14	...	...
Bhávnagar		T. P.	365	31·4	62	33	4	1
Bombay	Apollo Bandar	Auto.	702	13·9	73	22	4	1
	Prince's Dock	Auto.	696	13·9	70	24	5	1
Madras		Auto.	705	3·5	91	9	...	...
Kidderpore		Auto.	702	11·7	35	27	16	22
Chittagong		T. P.	365	13·3	44	31	18	7
Akyab		T. P.	340	8·3	86	13	1	...
Rangoon		Auto.	704	16·4	30	27	20	23
Moulmein		T. P.	365	12·7	37	29	19	15
Port Blair		Auto.	702	6·6	99	1	...	...

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 1907.

Stations.		Automatic or Tide-pole observations.	Mean range at springs in feet.	Average Errors.					
				Of Time in Minutes.		Of Height in terms of the range.		Of Height in inches.	
				H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
Open Coast.									
Aden		Auto.	6·7	10	11	·012	·012	1	1
Karáchi		Auto.	9·3	8	12	·027	·018	3	2
Bhávnagar		T. P.	31·4	6	6	·013	·011	5	4
Bombay	Apollo Bandar	Auto.	13·9	8	8	·018	·018	3	3
	Prince's Dock	Auto.	13·9	10	8	·018	·018	3	3
Madras		Auto.	3·5	9	9	·048	·048	2	2
Akyab		T. P.	8·3	2	2	·030	·020	3	2
Port Blair		Auto.	6·6	9	8	·025	·025	2	2
General Mean				8	8	·024	·021	2·8	2·4
Riverain.									
Kidderpore		Auto.	11·7	18	25	·050	·057	7	8
Chittagong		T. P.	13·3	15	19	·050	·038	8	6
Rangoon		Auto.	16·4	13	15	·025	·041	5	8
Moulmein		T. P.	12·7	12	13	·059	·046	9	7
General Mean				15	18	·046	·046	7·2	7·2

The foregoing statement for the year 1907 may be thus summarised :—

Percentage of time predictions within 15 minutes of accuals.

		High Water Per cent.	Low Water Per cent.
Open Coast Stations.	6 at which predictions were tested by S. R. Tide-gauge .	84	83
	2 " " " Tide-pole . .	100	99
Riverain Stations.	2 " " " S. R. Tide-gauge .	58	47
	2 " " " Tide-pole . .	72	64

Percentage of height predictions within 8 inches of actuals.

		High Water Per cent.	Low Water Per cent.
Open Coast Stations.	6 at which predictions were tested by S. R. Tide-gauge .	98	98
	2 " " " Tide-pole . .	91	97
Riverain Stations.	2 " " " S. R. Tide-gauge .	78	60
	2 " " " Tide-pole . .	57	71

Percentage of height predictions within one-tenth of mean range at Springs.

		High Water Per cent.	Low Water Per cent.
Open Coast Stations.	6 at which predictions were tested by S. R. Tide-gauge .	98	99
	2 " " " Tide-pole . .	100	100
Riverain Stations.	2 " " " S. R. Tide-gauge .	96	90
	2 " " " Tide-pole . .	84	96

24. *Comparisons of the predictions at Riverain Stations.*—The predictions for the riverain stations for the year 1907, were compared with those for the year before with the following results :—

At Kidderpore they are about the same for high water times, but worse for low water times. For the high water heights they are better, but for the low water heights they are worse. At Chittagong they are about the same for high and low water times, they are worse for high water heights, and about the same for low water heights. At Rangoon they are practically the same for both times and heights of high and low water. At Moulmein there is practically no change.

At Kidderpore the greatest difference between the actual and predicted heights of low water for 1907 was 2 feet 7 inches on 19th and 20th September, the actual being lower than the predicted. At Chittagong it was 1 foot 8 inches, on 19th May, the actual being higher. At Rangoon it was 2 feet 9 inches, on 12th July, the actual being lower. At Moulmein it was 2 feet, on 12th July, the actual being lower.

LEVELLING OPERATIONS.

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

The combined strength of the levelling detachments in the field was as detailed below :—

Detachment No. 1.—Two levellers : Mr. E. H. Corridon, 1st leveller; Mr. O. N. Pushong, 2nd leveller; 3 recorders; 30 menials.

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

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

In each instance the 1st leveller had charge of the detachment.

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

26. *Programme for past field season.*—The following programme of work was allotted to the levelling detachments :—

Detachment No. 1—

(i) The revision of the portion of the old line of levels executed in season 1880-81, between Guntakal and Madras.

(ii) The connection of the standard bench-marks, en route, at Cuddapah and Madras.

Detachment No. 2—

(i) To connect the standard bench-marks at Multán, and Dera Ismail Khan with the old line of levels.

(ii) To execute a main line of levels from Ferozepore, along the railway line across Rajputana to Ahmedabad, with the object of breaking the large circuit Karáchi-Ferozepore-Sironj and Bombay, and the connection of a standard bench-mark at Bikaner.

Detachment No. 3—

(i) Revisionary levelling from Kosgi to Guntakal (of the Bombay-Madras line).

(ii) Revisionary levelling from Guntakal to Kárwár.

(iii) Connection of standard bench-marks at Ráichur and Bellary.

This programme was subsequently modified and the portion Guntakal to Bellary omitted, so as to ensure the work being closed at Kárwár by the end of the field season.

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

No. 1 Detachment.—This Detachment left Dehra for Guntakal on 11th October 1907 arriving at its destination on 17th idem. After preliminary arrangements were completed, work was started on 21st October, three bench-marks being cut in Guntakal for connection by No. 3 Detachment, who were revising the length between Kosgi and Guntakal. On 19th January 1908, when the Detachment had reached Kódúru, instructions were received to proceed at once to Madras and commence work from the Madras end of the portion then left to be revised, as there was every likelihood of the tidal observatory at Madras being soon cut off from the northern arm of the harbour owing to the progress of the Madras Harbour Improvement scheme. The Detachment left Kódúru on 23rd January arriving at Madras the same evening. The levelling from the tidal observatory commenced on the 26th January. After levelling from the bed-plate of the self-registering tide-gauge to a bench-mark cut on the wall of the goods-yard at Ráyapúram Station, the connection of the standard bench-mark at the astronomical observatory in College Road was taken up, the opportunity being seized to re-connect as many as possible of the old bench-marks in Madras. Work was then resumed on the main line, Kódúru eventually being reached on 4th April. Next day the Detachment left for Dehra Dún reporting at Head-quarters on 13th April.

No. 2 Detachment.—The Detachment left Dehra Dún for the field on the 12th October 1907. The connection of the standard bench-marks at Multán and Dera Ismail Khan was first taken in hand; on completion of this work the detachment moved to Ferozepore to commence the main line of levels from there to Ahmedabad. Before commencing work on the new line, it was considered necessary to verify the height of the old embedded bench-mark at Ferozepore, from which the line was to emanate. The nearest old bench-mark found in existence was at Kasúr, 16 miles from Ferozepore, and the check levelling was carried out to this point. The levelling on the main line was then started, and was carried along the railway line *viâ* Bhatinda and Bikaner to Nágaur, in Jodhpur territory, where operations were closed for the season, and the detachment returned to recess quarters, reaching Dehra Dún on the 12th of April 1908.

No. 3 Detachment.—This Detachment left Dehra Dún on 12th October 1907 for Ráichur. The connection of the standard bench-mark there was completed on 24th October. The detachment then left for Kosgi, where work was resumed on 25th October, closing at Guntakal on 24th November. Work was again taken up from Bellary on 26th November and finally closed at Kárwár on 21st April 1908. The detachment then returned to recess quarters reaching Dehra Dún on 1st May 1908.

28. *Outturn.*

No. 1 Detachment.—The outturn of work of this detachment amounted to 296 miles, inclusive of check-levelling, in the course of which the instrument was set up at 3,462 stations, the total rises and falls amounting to 5,208 feet. The heights of 2 standard, 22 embedded and 235 inscribed bench-marks were determined, 8 bench-marks of other departments were also connected, and 7 Great Trigonometrical stations in the vicinity of the line of levels visited and reported on.

No. 2 Detachment.—The outturn of work of this detachment amounted to 348·2 miles of levelling, in the course of which the instrument was set up at 3,842 stations, the rises and falls amounting to 4,217 feet, the heights of 3 standard, 33 embedded and 186 inscribed bench-marks were determined: in addition, 15 irrigation bench-marks and 3 G. T. Survey stations were connected. The opportunity was also taken to inspect 7 G. T. Survey stations in addition to those connected by levelling, during the field season.

No. 3 Detachment.—The outturn of work of this detachment amounted to 297 miles of levelling, in the course of which the instrument was set up at 4,700 stations, the total rises and falls being 17,117 feet. The heights of 2 standard, 7 old, and 8 new embedded, 156 old and 90 new inscribed, 1 railway, and 1 irrigation bench-marks were determined. Two principal and 3 secondary Great Trigonometrical Survey stations were inspected and reported on.

Total outturn.—The total outturn of the three detachments was 941 miles of levelling, in the course of which the instrument was set up at 12,094 stations. The bench-marks connected were 8 standard, 70 embedded, 667 inscribed, and 25 belonging to other departments. Three G. T. stations were connected, and 19 were inspected and reported on.

29. *Bombay-Madras Error.*—The old line of levels executed in seasons 1877-81 between Bombay and Madras had a closing error of 2·98 feet, Madras being higher than Bombay. The revised line 1906-08, closed at Madras, with an error + 0·607 foot. The distance levelled over is 806 miles, the error per mile being ·0008 foot, or about $\frac{1}{100}$ of an inch.

Thus about 2·37 feet of error has been eliminated during the operations.

The results of the Revision levelling operations season 1907-08 are shown in the following table :—

Distance from Bombay.	Name of Bench-mark.	Height above M. S. L. at Bombay.		Difference between the 2 values. (ii,—(i).	Published values.
		Seasons 1906-08. (i)	Seasons, 1880-81. (ii)		
472	G. T. S. □ B. M. at Kosgi Railway Station.	1237·921	1239·957	+2·036	1238·10
489	G. T. S. □ B. M. at Ádóni Railway Station.	1361·875	1364·148	+2·273	1362·24
516	G. T. S. □ B. M. at Nancherla Railway Stn.	1552·564	1554·530	+1·966	1552·57
524	G. T. S. □ B. M. at Timmancherla.	1411·433	1413·222	+1·789	1411·24
540	G. T. S. □ B. M. at Gooty.	1199·661	1201·744	+2·083	1199·61
554	G. T. S. □ B. M. at Ráyalcheruvu.	941·088	943·109	+2·021	940·78
587	G. T. S. □ B. M. at Kondápuram.	718·782	720·921	+2·139	718·44
602	G. T. S. □ B. M. at Muddanúru.	617·689	619·900	+2·211	617·37
611	G. T. S. □ B. M. at Yerraguntla.	543·835	545·909	+2·074	543·34
621	G. T. S. □ B. M. at Kamalápuram.	453·322	455·691	+2·369	453·10
636	G. T. S. □ B. M. at Cuddapah.	451·538	453·660	+2·122	451·03
650	G. T. S. □ B. M. at Vontimitta.	423·492	425·622	+2·130	422.96
661	G. T. S. □ B. M. at Nandalúru.	472·493	474·799	+2·306	472·11

Distance from Bombay.	Name of Bench-mark.	Height above M. S. L. at Bombay.		Difference between the 2 values. (ii)−(i)	Published values.
		Seasons 1906-08. (i)	Seasons 1880-81. (ii)		
676	G. T. S. □ at Reddipalle. B. M.	555·940	558·507	+2·567	555·79
688	G. T. S. □ at Kódúru. B. M.	639·443	641·717	+2·274	638·97
705	G. T. S. □ at Mámandúru. B. M.	568·836	571·100	+2·264	568·32
714	G. T. S. □ at Rénigunta. B. M.	365·428	367·744	+2·316	364·95
728	G. T. S. □ at Puttúr. B. M.	491·740	493·933	+2·193	491·12
738	G. T. S. □ at Nagari. B. M.	393·624	395·934	+2·310	393·10
747	G. T. S. □ at Tiruttani. B. M.	281·403	283·639	+2·236	280·79
755	G. T. S. □ at Arkonam. B. M.	293·772	296·013	+2·241	293·15
772	G. T. S. □ at Tiruvallúr. B. M.	152·473	154·778	+2·305	151·99
785	G. T. S. □ at Ávadi. B. M.	80·439	82·806	+2·367	80·01
796	G. T S. □ at Sembiam. B. M.	20·212	22·764	+2·552	19·85
796	G. T. S. □ at Perambúr. B. M.	11·239	13·751	+2·512	10·88
799	Prince of Wales' Memorial Stone.	16·333	18·688	+2·355	15·78
799	M. S. L. at Madras.	0·607	2·976	+2·369	0·00

30. *Bombay-Kárwár Error.*—Owing to the large difference of a foot between the mean sea levels of Bombay and Kárwar, as derived by the old levelling, it was decided to revise the line of levels from Bellary to Kárwár.

The following list of heights exhibits the discrepancies between the old and new levelling on this line:—

Distance from Karwár.	Name of Bench-mark.	Height above M. S. L. at Kárwár.		Difference between the 2 values. (i)—(ii)	Published values.
		Seasons 1907-08. (i)	Seasons 1873-74. (ii)		
0	G. T. S. □ at Kárwár. B. M.	11·772	11·772	0·000	11·76
[illegible]5	⊙ at Rock, Agsúr.	66·948	66·858	+0·090	66·85
47	○ At Guardstone (Arbail) B. M.	180·360	180·301	+0·059	180·29

Distance from Kárwár.	Name of Bench-mark.	Height above M. S. L. at Kárwár.		Difference between the 2 values. (i)—(ii)	Published values.
		Seasons 1907-08. (i)	Seasons 1873-74. (ii)		
60	O G. T. S. B. M. at Guardstone (Yellápur).	1788·851	1788·121	+0·730	1788·11
103	G. T. S. □ B. M. at Hubli.	2060·665	2059·914	+0·751	2059·90
128	G. T. S. B. M. O at Pillar (Annígeri).	2054·323	2053·535	+0·788	2053·52
166	O B. M. at Stone (Hesarúr).	1640·911	1640·025	+0·886	1640·01
198	O B. M. at Embankment (Hospet).	1701·780	1701·975	—0·195	1701·96
240	G. T. S. O B. M. at Drain (Bellary).	1481·776	1481·023	+0·753	1481·01

From above list it will be seen that a very large portion of the error, amounting to 8 inches, has been disclosed on the section Yellápur to Arbail, a distance of 13 miles. The ghats had to be crossed over between these two stations and as may be seen from the above table, the difference in height between Yellápur and Arbail is about 1,608 feet.

The closing error at Kárwár obtained by the old levelling on the lines Bombay, Kedgaon, Hubli and Kárwár was 0·93 foot, Kárwár being higher than Bombay. Introducing the new values on this route, Kárwár mean sea level is now found to be 0·137 foot lower than Bombay mean sea level. The result is obtained thus:—

Bombay mean sea level to Kedgaon (new value) . . .	+1776·678
Kedgaon to Hubli (old value)	+ 262·640
Hubli to Kárwár mean sea level (new value) . . .	—2039·455
Closing Error . .	— 0·137

31. *Difference between Levellers (First—Second).*

Detachment No. 1 :—

Line Guntakal to Madras.

at 50th mile	. . . . =	—0·082 foot.
„ 100th „	. . . . =	—0·075 „
„ 150th „	. . . . =	—0·103 „
„ 200th „	. . . . =	—0·088 „
„ 250th „	. . . . =	—0·070 „
„ 277th „	. . . . =	—0·070 „

Detachment No. 2 :—

Line Ferozepore to Nágaur.

at 50th mile	. . . . =	—0·016 foot.
„ 100th „	. . . . =	—0·072 „
„ 150th „	. . . . =	—0·080 „
„ 200th „	. . . . =	—0·062 „
„ 250th „	. . . . =	—0·059 „
„ 300th „	. . . . =	—0·008 „
„ 325th „	. . . . =	—0·037 „

Detachment No. 3:—

Line Kosgi to Guntakal.

(50 miles) = + 0·052 foot.

Line Bellary to Kárwár.

at 50th mile	= —0·029 foot.
„ 100th „	= —0·171 „
„ 150th „	= —0·069 „
„ 200th „	= —0·146 „
„ 240th „	= —0·079 „

32. *Levels and staves used in the field.*—The levels employed by No. 1 Detachment on the line Guntakal to Madras were Cylindrical Level No. 4 used by Mr. Corridon, and Cylindrical Level No. 1 by Mr. Pushong.

The staves used on this portion were Nos. 01, 03, 04 and 05 of Captain Cowie's pattern.

No. 2 Detachment used American binocular precise levels throughout their levelling from Ferozepore to Nágaur; Munshi Syed Zille Hasnain worked with Level No. 2697, and Mr. Luxa with Level No. 2626. The staves used on this Line were 16 A, 16 B, 20 A and 20 B, which have graduations on only one face. These staves were manufactured at the Mathematical Instrument Office.

No. 3 Detachment used cylindrical levels throughout the season, on the line Kosgi to Guntakal and Bellary to Kárwár. Mr. Talati worked with No. 3, and Babu Sur with No. 2.

The staves employed on these lines were Nos. B 1, B 2, III and 4, of the G. T. pattern.

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

Tables of these comparisons are appended.

No. 1 Levelling Detachment.

Results of comparison of staves—Season 1907-08.

Place and date of comparison.	Number of Staff.				Remarks.
	04	05	01	03	
Guntakal, October 19th, 1907.	—·0000968	+·0015455	—·0038045	—·0047670	Cloudy.
Pátakottacheruvu, „ 27th „ .	—·0006347	+·0004990	—·0046923	—·0054125	Scattered clouds.
Gooty, November 5th „ .	—·0008356	+·0001974	—·0052007	—·0058959	„
Ráyalcheruvu, „ 11th „ .	—·0003542	+·0010272	—·0044228	—·0048635	First Clear day.
Vanganúru, „ 20th „ .	+·0000536	+·0017440	—·0035095	—·0042159	Passing clouds.
Mangapatnam, „ 28th „ .	+·0003720	+·0017095	—·0033514	—·0034655	Clear, after rain.
Yerraguntla, December 9th „	—·0004397	+·0009013	—·0044580	—·0050176	Clear and dry.
Kamalápuram, „ 16th „ .	+·0004346	+·0020154	—·0034439	—·0035016	Cloudy after rain.

Results of comparison of staves—Season 1907-08.

Place and date of comparison.	No. of Staff.				Remarks.
	04	05	01	03	
Cuddapah, December 25th 1907	+·0006750	+·0021875	—·0025920	—·0033747	Light scattered clouds.
Vontimitta, January 3rd 1908	+·0007240	+·0022865	—·0026757	—·0031725	„
Rázampéta, „ 12th „ .	+·0010171	+·0022187	—·0023922	—·0027265	„
Kódúru, „ 21st „ .	+·0005178	+·0020614	—·0030806	—·0035444	Clear.
Ráyapuram, „ 31st „ .	+·0014961	+·0027881	—·0019994	—·0023728	„
Ávadi, February 10th „ .	+·0011256	+·0023349	—·0024433	—·0026808	„
Tiruvélangádu, „ 21st „ .	+·0008142	+·0021610	—·0026640	—·0029297	„
Tiruttani, March 2nd „ .	+·0009255	+·0022114	—·0026777	—·0031309	„
Puttúr, „ 11th „ .	—·0002231	+·0013269	—·0036856	—·0048013	„
Rénigunta, „ 21st „ .	+·0000275	+·0016166	—·0035193	—·0042895	Dry and clear.
Settikunta, „ 30th „ .	+·0002311	—·0014872	—·0032378	—·0038910	Clear after cloudy weather.
Kódúru, April 5th „ .	—·0005064	+·0007122	—·0043192	—·0052099	Dry and clear.

No. 2 Levelling Detachment.

Results of comparison of staves—Season 1907-08.

Place and date of comparison.	Number of Staff.				Remarks.
	20 A.	20 B.	16 A.	16 B.	
Multán, 23rd October 1907 .	—0·0032773	—0·0031338	—0·0039545	—0·0026148	Clear.
Ferozepore, 28th „ „ .	—0·0030595	—0·0028526	—0·0038093	—0·0025354	„
Ferozepore, 8th November „ .	—0·0034625	—0·0032348	—0·0039303	—0·0027542	„
Farídkot, 20th „ „ .	—0·0040431	—0·0039128	—0·0046435	—0·0035712	„
Jaito, 30th „ „ .	—0·0041485	—0·0039034	—0·0046473	—0·0033266	Cloudy.
Sangat, 10th December „ .	—0·0048197	—0·0046022	—0·0051031	—0·0040926	Clear.
Birangkherá, 22nd „ „ .	—0·0048687	—0·0043230	—0·0052031	—0·0041192	Cloudy.
Hanumángarh, 2nd January 1908	—0·0047439	—0·0044470	—0·0051861	—0·0038610	Clear.
Súratgarh, 16th „ „ .	—0·0039041	—0·0037776	—0·0045945	—0·0030850	„
Ráyanwáli, 23rd „ „ .	—0·0040123	—0·0038012	—0·0045909	—0·0030532	Cloudy.
Mahájan, 1st February „ .	—0·0045027	—0·0043586	—0·0051633	—0·0036580	Clear.
Lunkaransar, 17th „ „ .	—0·0050635	—0·0048540	—0·0057475	—0·0043970	„
Jamsar, 26th „ „ .	—0·0053407	—0·0051332	—0·0060665	—0·0043920	„
Bikaner, 9th March „ .	—0·0060433	—0·0055114	—0·0062533	—0·0047432	„
Súrpura, 18th „ „ .	—0·0052555	—0·0052316	—0·0057245	—0·0043612	„
Bhagu, 25th „ „ .	—0·0052639	—0·0050490	—0·0060137	—0·0046584	Light clouds
Nágaur, 6th April „ .	—0·0058287	—0·0058570	—0·0062085	—0·0049868	Cloudy.

No. 3 Levelling Detachment.

Results of comparison of staves—Season 1907-08.

Place and date of comparison.	Number of Staff.				Remarks.
	B 1.	B 2.	IIII.	4	
Ráichur, 24th October 1907 .	+0·0034224	—0·0000933	+0·0015244	+0·0004129	Light clouds.
Kúpgal, 1st November „ .	+0·0036759	—0·0000870	+0·0014200	+0·0002433	Clear.
Ádóni, 9th „ „ .	+0·0036691	—0·0000395	+0·0023763	+0·0006278	„
Aspari, 16th „ „ .	+0·0036107	+0·0000869	+0·0021838	+0·0008071	„
Guntakal, 23rd „ „ .	+0·0036958	+0·0008518	+0·0028341	+0·0010904	„
Kudatini, 1st December „ .	+0·0040005	+0·0006669	+0·0036984	+0·0014640	Cloudy.
Gádiganúru 9th „ „ .	+0·0031318	+0·0003732	+0·0020406	+0·0005163	Clear.
Hospet, 17th „ „ .	+0·0039964	+0·0006120	+0·0031988	+0·0012026	Cloudy.
Belláhunisi, 24th „ „ .	+0·0037853	+0·0004480	+0·0027568	+0·0010258	Clear.
Hampaságaram, 2nd January 1908 .	+0·0036762	+0·0004538	+0·0026085	+0·0006065	„
Hesarúr, 9th „ „ .	+0·0035681	+0·0003391	+0·0026158	+0·0008308	Light clouds.
Mundargi, 16th „ „ .	+0·0035646	+0·0004556	+0·0020733	+0·0003941	„
Dambal, 23rd „ „ .	+0·0035332	+0·0003861	+0·0023506	+0·0008068	Clear.
Gadag, 30th „ „ .	+0·0034159	—0·0001065	+0·0017781	+0·0002859	„
Annígeri, 6th February „ .	+0·0038362	+0·0004816	+0·0022247	+0·0009937	Light clouds.
Sirguppi, 13th „ „ .	+0·0038101	+0·0003829	+0·0012542	+0·0007277	Clear.
Dastikop, 20th „ „ .	+0·0030896	—0·0003833	+0·0005658	+0·0001300	„
Kargod, 27th „ „ .	+0·0034562	+0·0000436	+0·0014601	+0·0002634	Light clouds.
Kirvatti, 5th March „ .	+0·0035616	+0·0001158	+0·0017238	+0·0006524	Clear.
Idgundi, 12th „ „ .	+0·0038747	+0·0004786	+0·0024661	+0·0007707	„
Arbail, 19th „ „ .	+0·0040101	+0·0008831	+0·0033021	+0·0013849	„
Sunksal, 26th „ „ .	+0·0040713	+0·0008193	+0·0037463	+0·0012610	„
Agsúr, 2nd April „ .	+0·0045615	+0·0012044	+0·0040870	+0·0019962	Light clouds.
Hattikeri, 9th „ „ .	+0·0041860	+0·0012555	+0·0040350	+0·0016564	Clear.
Kárwár, 18th „ „ .	+0·0048880	+0·0013469	+0·0048768	+0·0019057	„

34. *Minor Lines of Levelling.*—In addition to the levelling executed during the field season by the three levelling detachments, the following lines of levels were run by officers attached to the G. T. S. office :—

(i) A line of levels from Nojli (Shaw's Station) to ⩚ on stone slab 25 feet north of Myapore canal bungalow, Hardwár. This line was levelled by Lieut. H. T. Morshead, R. E., between January 20th and March 6th, 1908. The level used by him was American binocular precise level No. 2625.

The length of the line was 38 miles, and it was levelled over, both in forward and back directions. The closing error at Hardwár is 0·002 foot between the forward and back levelling.

(ii) A line of levels was run from G. T. S. bench-mark (iron plug) at the Trigonometrical Branch Office, Dehra Dún, to G. T. S. O B. M. cut on Kálsi bridge over the Jumna river, at the 49th mile from Sahàranpur. The line was executed by Lieuts. A. H. Gwyn, I. A., J. A. Field, R. E., and C. M. Thompson, I. A., in March and April. The levels used were Cooke's Cushing's level No. 8446 and American binocular precise level No. 2625.

The length of the line was 31 miles. The closing difference between the results obtained by the two levels at Kálsi was 0·092 foot.

The total outturn of levelling during the past season, including these lines, with those completed by the three levelling detachments is 1,010 miles.

The following is a complete list of standard bench-marks as they stood at close of season 1907-08 :—

Nos.	Completed and connected.	Completed not yet connected.	Completed and to be connected in 1908-09.
1	1 in Calcutta (old).	1 in Sukkur.	1 in Sátára.
2	2 in Bombay (old).	1 in Hyderabad (Sind).	1 in Belgaum.
3	1 in Madras (old).	1 in Karáchi.	1 in Bangalore.
4	1 in Karáchi (old).	1 in Mhow.	1 in Salem.
5	2 in Dehra Dún.	1 in Jacobabad.	1 in Trichinopoly.
6	1 in Sahàranpur.		1 in Negapatam.
7	1 in Muzaffarnagar.		1 in Madura.
8	2 in Meerut.		1 in Tinnevelly.
9	1 in Aligarh.		3 in Secunderabad.
10	1 in Bareilly.		1 in Jodhpur.
11	1 in Shahjahanpur.		1 in Deesa.
12	1 in Lucknow.		1 in Ahmedabad.
13	2 in Sítápur.		1 in Saugor.
14	1 in Fyzabad.		1 in Jubbulpore.
15	2 in Allahabad.		1 in Nágpur.
16	1 in Mirzápur.		1 in Akola.
17	1 in Benares.		1 in Hinganghát.
18	1 in Gházípur.		
19	1 in Gorakhpur.		
20	1 in Muttra.		
21	1 in Agra.		
22	1 in Gwalior.		
23	1 in Lahore.		
24	1 in Ráwalpindi.		
25	1 in Jhánsi.		

The following is a complete list of standard bench-marks as they stood at close of season 1907-08—*continued.*

Nos.	Completed and connected.	
26	1 in Delhi.	
27	1 in Ambála.	
28	1 in Ludhiána.	
29	1 iu Ferozepore.	
30	1 in Jhelum.	
31	1 in Attock.	
32	1 in Peshawar.	
33	1 in Deolali.	
34	1 in Ahmednagar.	
35	1 in Kirkee.	
36	2 in Poona.	
37	1 in Sholápur.	
38	1 in Multán.	
39	1 in Dera Ismail Khan.	
40	1 in Ráichur.	
41	1 in Bellary.	
42	1 in Cuddapah.	
43	1 in Madras (new).	
44	1 in Bikaner.	

Nos.	Under construction.	Proposed for erection.
*1	1 in Calicut.	1 in Rangoon.
2	1 in Roorkee.	1 in Toungoo.
3	1 in Surat.	1 in Mandalay.
*4	1 in Bilaspur.	1 in Shewbo.
*5	1 in Raipur.	1 in Meiktila.
*6	1 in Sambalpur.	1 in Magwe.
7	1 in Godhra.	1 in Wuntho.
8	1 in Dhulia.	1 in Balasore.
*9	1 in Bijápur.	1 in Cuttack.
10	1 in Khanpur.	1 in Berhampur.

* These bench-marks will be connected during the coming field season, 1908-09, if completed in time.

Nos.	Under construction.	Proposed for erection.
11	1 in Baháwalpur.	1 in Vizagapatam.
12	1 in Minchinabad.	1 in Cocanada.
13	1 in Baroda.	1 in Bezwada.
14	1 in Rájkot.	1 in Nellore.
15	1 in Mussooree.	1 in Champáran.
		1 in Muzaffarpur.
		1 in Patna.
		1 in Bhágalpur.
		1 in Nalháti.
		1 in Burdwan.
		1 in Gauháti.
		1 in Dhubri.
		1 in Purnea.
		1 in Dinájpur.
		1 in Mymensingh.
		1 in Dacca.
		1 in Comilla.
		1 in Chittagong.

35. *Standard bench-marks.*—During the past year 32 standard bench-marks were erected and 13 connected, fifteen are under construction, and 28 have been proposed for erection.

36. *Destruction of bench-marks.*—During the past year 265 bench-marks were reported as lost. On the line Bellary to Kárwár no less than 86 out of a total of 223 bench-marks, were reported missing by the levelling officer. On the line Guntakal to Madras, 53 out of 218 were reported by the levelling officer as destroyed.

37. *Recess duties.*—The levelling computations nave been completed. Manuscript pamphlets of heights have been brought up to date.

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

39. *Health of Field Party.*—The health of the men of No. 1 Detachment was very good. The officer in charge No. 2 Detachment reported the health of his party as good, except in the case of a recorder who died of pneumonia early in the field season. The health of the men of No. 3 Detachment was reported as generally bad, owing to malaria.

40. *Programme for Field Season 1908-09.*—The levelling operations to be performed during the coming field season are:—

No. 1 Levelling Detachment will be employed in connecting the standard bench-marks at Sátára, Belgaum, Bijápur, Bangalore, Salem, Calicut, Trichinopoly, Negapatam, Madura, Tinnevelly and 3 in Secunderabad with adjacent lines of levels, and then on the Katni-Secunderabad line of levelling commencing from Secunderabad.

No. 2 Levelling Detachment will be employed in completing the Ferozepore-Ahmedabad line of levels, in running a short line of levels from Pálanpur to Deesa, and in connecting the standard bench-marks at Jodhpur, Deesa and Ahmedadad.

No. 3 Levelling Detachment will be employed on the Katni-Secunderabad line of levelling commencing from Katni and also in connecting the standard bench-marks at Saugor, Jubbulpore, Nágpur, Raipur, Bilaspur, Sambalpur, Akola and Hinganghát with adjacent lines of levels.

NO. 1 LEVELLING DETACHMENT.

Tabular Statement of Outturn of Work—Season 1907-08.

Section.	Month.	No. of Miles of Double Levelling. Main Line. Ms. chs. lks.	Branch Line. Ms. chs. lks.	Total. Ms. chs. lks.	Total No. of Feet. Rise.	Fall.	No. of stations at which Instrument was set up.	No. of Bench-Marks Connected. Old. Standard.	Old. Embedded.	Old. Inscribed.	Standard.	Embedded.	Inscribed.	G. T. Survey.	Irrigation and other department.	Remarks.
Guntakal to Kódúru	October 1907	16 70 14	0 40 6	17 30 20	47·366	258·046	233	...	2	10	...	...	12	...	2	
	November "	54 12 38	3 20 0	57 32 38	170·810	670·535	662	...	2	30	...	...	17	...	1	
	December "	57 52 36	2 62 3	60 34 39	396·150	696·881	684	...	5	34	1	...	15	...	3	
	January 1908	40 10 66	0 26 72	40 37 38	537·021	272·478	463	...	3	20	...	...	11	...	...	
	Total	168 65 54	6 68 81	175 54 35	1,151·347	1,897·940	2,042	...	12	94	1	...	55	...	6	
Madras to Kódúru	January 1908	1 63 46	6 42 90	8 26 36	...	...	119	1	...	9	1	...	2	...	1	
	February "	49 61 98	2 8 6	51 70 04	442·703	175·312	609	...	6	16	...	...	16	...	1	
	March "	52 44 54	0 66 64	53 31 18	957·063	522·495	614	...	4	26	...	...	13	...	...	
	April "	4 11 52	0 0 0	4 11 52*	4·649	56·518	78	...	...	2	...	...	2	...	...	*Exclusive of 2 Ms. 50 chs. 76 lks. Check Levelling.
	Total	108 21 50	9 37 60	117 59 10	1,404·415	754·325	1,420	1	10	53	1	...	33	...	2	
	Grand Total	277 7 4	16 26 41	293 33 45	2,555·762	2,652·265	3,462	1	22	147	2	...	88	...	8	

*Total mileage levelled over inclusive of Check Levelling—296 Ms. 04 chs. 21 lks.

NO. 2 LEVELLING DETACHMENT.

Tabular Statement of outturn of Work—Season 1907-08.

Section.	Month.	NO. OF MILES OF DOUBLE LEVELLING. Main Line. Ms.	chs.	lks.	Branch Line. Ms.	chs.	lks.	Total. Ms.	chs.	lks.	TOTAL NO. OF FEET. Rise.	Fall.	No. of stations at which instrument was set up.	NO. OF BENCH-MARKS CONNECTED. Old. Standard.	Old. Embedded.	Old. Inscribed.	Standard.	Embedded.	Inscribed.	G. T. Survey.	Irrigation.	Remarks.
Connection of standard bench-mark at Dera Ismail Khan.	October 1907	...	...	...	0	14	28	0	14	28	...	...	4	...	1	1	1	...	...	...	...	
Connection of standard bench-mark at Multán.	October 1907	...	...	...	2	9	76	2	9	76	...	...	38	...	1	2	1	...	10	...	...	
Ferozepore to Nágaur	October 1907	...	...	...	6	18	82	6	18	82	...	...	80	1	1	...	...	...	...	...	...	
	November „	43	41	70	12	72	96	56	34	66	191·289	152·209	686	...	...	6	...	5	29	2	...	
	December „	63	16	46	0	21	20	63	37	66	251·428	325·651	752	...	...	...	...	7	35	...	...	
	January 1908	67	61	28	0	62	02	68	43	30	541·335	494·464	734	...	...	...	...	7	37	1	15	
	February „	71	19	50	0	18	10	·71	37	60	505·595	485·600	237	...	...	...	...	6	34	...	...	
	March „	69	68	64	0	1	24	69	69	88	707·392	462·860	714	...	...	...	1	6	35	...	...	
	April „	9	64	46	0	6	44	9	70	90	75·192	23·775	97	...	...	...	...	2	6	...	...	
	TOTAL	325	32	04	20	40	78	345	72	82	2272·231	1944·559	3,800	1	1	6	1	33	176	3	15	
	GRAND TOTAL	325	32	04	22	64	82	348	16	86	2272·231	1944·559	3,842	1	3	9	3	33	186	3	15	

No. 3 Levelling Detachment.

Tabular Statement of outturn of work—Season 1907-08.

Section.	Month.	No. of miles of double levelling. Main Line. Ms.	Main Line. chs.	Main Line. lks.	Branch Line. Ms.	Branch Line. chs.	Branch Line. lks.	Total. Ms.	Total. chs.	Total. lks.	Total No. of feet. Rise.	Total No. of feet. Fall.	No. of stations at which instrument was set up.	No. of bench-marks connected. Old. Embedded.	Old. Inscribed.	Standard.	Embedded.	Inscribed.	Railway.	Irrigation.	Remarks.
Connection of standard bench-mark at Raichur.	October 1907	...	...	...	0	10	86	0	10	86	5·593	22·754	6	...	2	1	...	...	...	...	
Kosgi to Guntakal	October 1907	9	69	12*	0	06	88	9	76	0	163·448	50·344	132	1	6	...	...	2	...	...	
	November 1907	40	22	92	0	78	04	41	20	96	524·450	402·797	524	3	30	...	...	8	...	...	
	Total	50	12	04	1	04	92	51	16	96	687·898	453·141	656	4	36	...	...	10	...	...	
Bellary to Kárwár	November 1907	8	11	44	0	36	74	8	48	18	145·673	72·435	113	...	9	1	...	6	...	...	
	December 1907	51	12	32	2	02	10	53	14	42	1222·052	1133·138	761	1	58	...	...	12	1	...	
	January 1908	48	20	58	0	58	82	48	79	40	1530·777	1091·037	694	...	22	...	...	9	...	...	
	February 1908	56	38	98	1	15	54	57	54	52	1561·357	1870·369	902	1	3	...	4	29	...	1	
	March 1908	48	75	30	0	33	06	49	28	36	1692·460	3424·364	1,099	...	10	...	2	20	...	...	
	April 1908	27	21	20	0	50	02	27	71	22	1084·719	1119·359	559	1	16	...	2	4	...	...	
	Total	240	19	82	5	36	28	245	56	10	7237·038	8710·702	4,128	3	118	1	8	80	1	1	
	GRAND TOTAL	290	31	86	6	52	06	297	3	92	7930·529	9186·597	4,790	7	156	2	8	90	1	1	

* Inclusive of 0—43—68 (Ms. chs. lks.) of check levelling.

No. 2 Levelling Detachment.

List of Great Trigonometrical Survey Stations connected by spirit levelling in season 1907-08.

Name of Station.	Height in feet above Mean Sea Level.		Difference of height by triangulation in feet.	Remarks.
	Spirit levelling.	Triangulation.		
Farídkot Tower Station.				
Sutlej Series . . .	692·498	683·3	−9·198	Height of mark-stone at ground floor.
Alkwála Station.				
Gurhágarh Meridional Series .	715·549	714	−1·549	Height of upper mark-stone.
Súratgarh Station.				
Gurhágarh Meridional Series .	603·016	Not given .	...	Height of ⊙ on roof of northern turret of fort.

Report on the introduetion of the American levels into the Survey of India and upon the changes made in the G. T. Survey system of levelling, by Syed Zille Hasnain, Extra Assistant Superintendent.

The American levels which have been recently introduced are in many respects superior to those hitherto used in the levelling operations of the survey of India. The principal improvements may be described as follows :—

(*I*) *Binocular system* :—An auxiliary telescope is fixed to the main telescope ; this contains two prismatic lenses, on which the image of the bubble is reflected from a mirror mounted obliquely above the bubble tube ; by this means the leveller is able to observe the two ends of the bubble simultaneously with the reading of the staff. Theoretically, in levelling of precision, the bubble should be read at the same instant as the staff. This is impossible with our ordinary levels, for the leveller after reading the staff has to remove his eye from the telescope, and change his position before he can read the bubble.

The mere change in the leveller's position, and in the distribution of the weight of his body, frequently cause a change in the position of the bubble : hence with ordinary levels there can be no certainty that the position of the bubble as indicated by its readings, is absolutely the same as when the staff was read. In this respect the American levels have a great advantage.

(*II*) *Micrometric adjustment* :—The main telescope instead of being fixed to the body of the instrument, as in ordinary levels, is placed in a cylindrical outer case, which latter is permanently fixed to the tribrach : the telescope is supported at the object end by two horizontal screws which hold it to the case ; at the eye end it rests on the hardened tip of a slow motion screw, provided with a micrometer head. This device enables the leveller to move the telescope in a vertical plane and it facilitates the process of levelling : thus after taking a staff and bubble reading, the leveller is able to bring the bubble to precisely the same position again for the second staff, without touching the foot-screws of the instrument. By this means the amount of dislevelment for a pair of staff readings can always be reduced to a minimum, which is not possible in the ordinary instrument. It is obviously wrong for a leveller to touch the foot screws of his level *between* a pair of staff readings, and hence when using an ordinary level, he can not eliminate the dislevelment of the bubble, which so often occurs when the telescope is swung round to the second staff after the reading of the first staff and bubble.

(*III*) *Reservoirs in the level tubes*:—The American levels are provided with reservoir bubble tubes, such as have been employed on astronomical instruments in India. This arrangement enables the bubble to be kept at an uniform length during changes of temperature, and simplifies the determination of the value of one division of the bubble scale and of the correction for dislevelment.

(*IV*) *Triplication of wires*:—The diaphragm carries three horizontal wires instead of the single wire carried in ordinary levels: the upper and lower wires are equidistant from the centre wire. This triplication is a most useful device and the advantages derived from it are fully explained below. A secondary use of the three wires is that it is possible to determine accurately the distance of a staff from the instrument without actual measurement, the interval subtended by the upper and lower wires on a staff at a given distance being known, it is easy to find the distance corresponding to any other interval subtended by the same wires. This becomes particularly useful when levelling is carried across a stream or over broken ground where the chain cannot be used. As explained below American levellers do not chain the distance between their instrument and their staves, but use the wire intervals only for this purpose.

(*V*) *Use of invar*:—Nickel steel and other specially selected materials have been employed with advantage in the construction of the American levels. Different parts of the levels hitherto used in India are affected unequally by temperature and their irregular expansion and contraction produced constant dislevelment.

(*VI*) *Portability*:—The American levels are considerably lighter than the cylindrical levels which have hitherto been used on levelling of precision in India. (It is of course impossible to say whether the American levels will stand the Indian climate as long and as well as our cylindrical levels have done; the latter instruments have been constantly in use for upwards of 50 years, and are as serviceable now as when they were first made.)

2. With all their good points the American levels have I think certain slight disadvantages:—

(*I*) As the American level is largely constructed of nickel steel which is magnetic, it is impossible to attach a magnetic compass to the instrument.

(*II*) The small universal level fixed on the right side of the telescope is not of any practical use.

(*III*) The milled head of the clamping screw attached to the foot screws is perhaps too large, it sometimes comes in contact with the leveller's fingers when levelling the instrument, and thus the foot screws are unconsciously affected. There seems to be no reason why the clamping screw should have such a big head; one half the size would have answered the purpose equally well, and would not then be in the leveller's way.

(*IV*) The fittings of the leather cones at either end of the outer case of the telescope are rather flimsy, and are not suited to the Indian conditions and climate. Owing to constant handling, the fittings of the leather cones, outside the clamping rings frequently become loose, and out of position.

3. To an Indian leveller the following points about the American system of levelling appear to be of interest.

(*a*) Every line of levels is divided into sections of one to two kilometres in length, ($\frac{3}{4}$ to $1\frac{1}{4}$ miles) and each section is levelled over by a single leveller, in both forward and back directions, if the difference between the forward and back results of a section exceeds six millimetres, (or 0·020 foot) the whole section is relevelled, until two values are obtained agreeing to within the above limit

(*b*) The American staves are graduated only on one face, and all three wires are read on both staves.

(*c*) The bubble is put in the centre of the tube for each staff reading.

(*d*) The back staff is read first at stations of odd numbers, and the forward staff at stations of even numbers.

(*e*) The distance from the instrument to the staves is not measured, but laid down approximately equal by eye; the distances to the back and forward staves are made to balance at each pair of stations, as nearly as possible, by setting the instrument beyond or short of the centre point between the staves. For this purpose, a record is kept of the intervals subtended by the extreme wires of the diaphragm, on all the back and forward staves separately; this is constantly summed up as the work progresses, and the sums are not allowed to differ by more than 20 metres (65 feet) at any stage.

(*f*) Folding stands are used and the levels are carried on them throughout the day's work.

(*g*) The collimation error of the instrument is determined daily by special observations in the course of the day's work, and corrections on this account are subsequently applied when computing the results.

4. The six points mentioned in the last paragraph may be compared as follows with our procedure:

(*a*) By levelling each section in both the forward and back directions, the Americans have no doubt a perfect circuit system. In the G. T. Survey levelling, the direction of the operations is reversed on alternate sections, and precaution is taken to balance the total length of back and forward sections at every embedded bench-mark, or say at a distance of about ten miles apart; this practically secures all the advantages of a circuit system, and is a more convenient and a quicker method. The Americans employ a single leveller, who levels each section twice in opposite directions, and the two results of each section must agree to within 0·020 foot. The object of these precautions is (1) to guard against accidental gross error, and (2) to limit the sectional difference between results. As regards (1) the G. T. Survey system is in my opinion preferable to that of the Americans; in the former two levellers are employed, one following the other, with separate instruments, comparing their results station by station, the maximum permissible difference between them for each station being 0·005 foot. Supposing that the American leveller happens to make an error at any station, he cannot discover it before he levels the whole section twice over, and even then he is obliged to relevel the whole section a third and possibly a fourth time to rectify his error, whereas, such a mistake would be discovered by the G. T. Survey levellers almost at once, and could be rectified immediately without any great loss of time or labour. Taking a whole season's work into consideration, the number of whole sections having been levelled more than twice by the American levellers works out to nearly 13 per cent., whereas the number of re-levelments of single stations by the G. T. Survey levellers is found to be less than 3 per cent.

As regards (2) there are no hard and fast rules about the limit of sectional differences between the levellers in the G. T. Survey system, but taking 100 consecutive sections as a test it was found that the average sectional difference was 0·011 of a foot per section of 2·6 miles in length. Only 9 per cent. of the differences exceeded 0·020 foot while 55 per cent. were found to be under 0·010 of a foot. This seems to compare very favourably with the limit of sectional differences, *viz.*, 0·020 of a foot per section of from 1 to 2 kilometres ($\frac{5}{8}$ to $1\frac{1}{4}$ miles), allowed by the American levellers.

(*b*) To guard against errors of reading the staff, the Americans read all the three horizontal wires on each staff, the upper and lower wires being equidistant from the centre wire, the mean of their readings must be equal to that of the centre wire; thus errors of reading are effectively checked.

The G. T. Survey staff is graduated on both faces, the two faces having different zeros on the old pattern staff, and different units on the new staff: both faces are read, and the reading of one face checks the reading of the other face. In this respect the American system is superior to the G. T. Survey system and has the advantages of simplicity and rapidity. By the simple but ingenious device of fixing three horizontal wires in the level, the leveller is enabled, not only to effectively guard against mistakes, but also to completely do away with the so-called bias in reading the staff, for which object the G. T. Survey levellers have had during recent years, to resort to the elaborate and somewhat troublesome device of having different units on the two faces of their staves. If the Indian levels had been provided with three horizontal wires, it would have made the use of the second face of the staff absolutely unnecessary. As a matter of fact the results obtained by the three wire readings on one face, would seem to be more accurate than those deduced from single wire readings on two faces; in the former case the difference of level between two points is obtained from six readings, in the latter case from four readings; thus the weight of the former value is abcut 50 per cent. greater than that of the latter.

It takes appreciably less time to finish all observations at a station, using the three wires on a single face of the staves, than with one wire on both faces; the former method also lessens the labour of the leveller, and it makes the work of the recorder simpler and easier, and it relieves the staff-man of the necessity of presenting the two faces of the staff in succession to the leveller. When using both faces of the staves delays and mistakes are often caused by the staff-man showing the wrong face to the leveller, or by the recorder confounding one face with the other. The use of three wires and a single face does away with this source of error completely.

(*c*) The Americans put the bubble in the middle of the tube for each staff reading, but do not read the bubble. The G. T. Survey levellers not only make the instrument level, but also read the two ends of the bubble for each staff reading. Thus they are able to determine the true amount of any dislevelment which may have occurred between the readings of the two staves; and the necessary corrections for dislevelment can be applied to the approximate differences of level deduced from the staff readings. For this purpose the mean value of one division of the bubble scale of all levels used in the main lines of the G. T. Survey levelling is carefully determined every year before taking the field and suitable tables of correction for dislevelment are prepared for easy use in the field.

The bubbles mounted on all instruments used for precise levelling are sensitive, and take some time to come to rest; they do not readily come to any required position, and they frequently move through a fraction of a division after they have apparently been put to a certain reading. Two American levels have been in use during the past season with No. 2 Levelling detachment, and their bubbles have behaved in much the same manner as described above. Now if the bubble is brought to the middle of its tube, but shifts slightly just as the leveller reads the staff, the Americans have to bring the bubble back to the centre, and re-read the staff; by doing so they spend extra time over the observations; and if they ignore the slight deviation of the bubble from the centre, they introduce a small error due to dislevelment into their work. In a similar case the G. T. Survey levellers would read the two ends of the bubble, and apply the necessary correction for dislevelment. It has been found by actual practice with American levels, that it takes less time to bring the bubble approximately to the centre, and to read its two ends, than to try and bring it exactly to the centre for each staff reading. The G. T. Survey method is therefore quicker than the American method.

(*d*) The American and G. T. Survey systems are similar in the matter of reading the back staff first at odd-numbered stations, and the forward staff first at even-numbered stations, in order to cancel errors due to rising and falling refraction.

(*e*) The advantages of putting the staves at equal distances from the instrument are obviously great; all errors due to curvature and refraction, or imperfect adjustment of the instrument in collimation, are thereby wholly cancelled; the corrections for dislevelment are easily worked out and applied direct to the difference of the readings of the two staves; in addition we are able to read the two staves with the telescope at the same focus. The Americans do not chain their distances, but they are compelled instead to take the following steps :—

(1) To re-focus the telescope for each staff.

(2) To spend time in balancing the distance at each pair of stations, and in keeping a systematic record of the wire intervals throughout the work.

(3) To apply corrections for curvature and refraction in the computations of their work, and last but not least, to determine the collimation error of their instruments every day, and subsequently apply corrections for the same in their computations.

Presumably the chief reason why the Americans do not chain the distances, is owing to labour in that country being expensive. In India it only costs a levelling party about Rupees 15 a month to employ men to measure the distances in advance of them, and the advantages gained thereby more than counterbalance the small expenditure.

(*f*) The Americans use folding stands, and the levels are carried on them throughout the day's work; in the G. T. Survey the custom is to use the universal rigid stand. The stand man goes ahead of the leveller to the station of observation, and approximately levels the stand by means of a mason's level; this greatly helps the leveller in adjusting the instrument, besides which the rigid stand is far more stable than the folding stand. It is a standing rule in the G. T. Survey that the instrument must always be replaced in its box, on the completion of observations at each station. The box containing the level is carried in a cradle by two men from station to station, and the levels are thus as little exposed to atmospheric changes, accidents, etc., as possible. It is mainly due to these precautions that the standard levels of the Survey of India have remained in such good condition for so many years.

(*g*) The G. T. Survey levels are adjusted for collimation periodically in the field; there is no necessity for determining the collimation correction daily, as all errors due to this cause are wholly cancelled by putting the staves at equal distances from the instrument.

Report of the Committee appointed to examine the American Precise Binocular Level.

The questions raised in Syed Zille Hasnain's report involved radical changes in the system of levelling in vogue in the Survey of India, and in March 1907 Colonel Burrard, the Superintendent of Trigonometrical Surveys, appointed a Committee consisting of Major G. P. Lenox-Conyngham, R.E., President, and Captains H. M. Cowie, R.E., and C. M. Browne, D.S. O., R.E., members, to consider the whole subject of precise levelling. The Committee assembled at Mussooree in August 1907, and after a thorough investigation of all the questions at issue, summarised their conclusions as follows :—

1. The American levels are on the whole superior to our old levels.

2. Three readings taken on one face only of each staff are better than one reading on each of the two faces. By the system of three wire readings, the error of estimation can be sensibly reduced, and the speed of working be increased.

3. It is preferable to record the level readings and to apply corrections for dislevelment, rather than to attempt to keep the bubble in the centre of its scale.

4. The distances from the instrument to the staves should always be made equal by ***chain measurement***, and not be balanced by the tacheometric method used by the Americans. With equal distances it is not necessary to apply corrections for collimation, curvature or refraction.

5. It is not essential that the instrument be in the same straight line as the staves.

6. As nickel steel, which is magnetic, is largely used in the construction of the American level, it is impossible to combine the latter with a magnetic compass.

7. The small circular level fitted to the American level is not sensitive, and though useful as an indicator, is not to be relied on for adjusting the instrument.

8. The leather cones of the American levels should have more margin to spare outside their clamping rings.

9. The level may be allowed to be carried on the stand at the discretion of the observer.

10. The G. T. Survey limits of error appear to be much the same as those of the United States Coast and Geodetic Survey, and there is no reason to alter them.

11. The telescopes of the American levels are inferior to those of the cylindrical levels.

12. On all other points, the committee agreed generally with the remarks made by Munshi Syed Zille Hasnain in his report.

In conformity with the above recommendations, the following changes have now been introduced into the G. T. Survey levelling system by order of the Superintendent of Trigonometrical Surveys.

(*a*) The American levels are to be used in future on all first class levelling operations, and are to supersede the old levels.

(*b*) Three readings are to be taken to one face of each staff, in place of one reading to each of the two faces.

(*c*) The bubble is to be read from the observing position by means of the prisms and mirror, and only one reading of the two ends of the bubble are to be taken for each staff reading.

(*d*) The instrument may be erected to one side of the line joining the two staves, when it is found advantageous to do so.

(*e*) All other precautions hitherto followed in the G. T. Survey system are to be continued.

III.

NARRATIVE REPORT.

Extract from the Narrative Report of Captain H. M. Cowie, R.E., in charge No. 22 Party, (Astronomical) for season 1907-08.

ooo. On conclusion of the comparisons between the Indian Standard Bar A and the Bars IB and IS, carried out during November, December and January at Dehra Dún by this party in co-operation with No. 23 Party, normal latitude operations were commenced in the country to the south and to the east of Deesa. By the end of the field season six Great Trigonometrical stations had been visited, four of them being in that portion of the Abu meridional series between Sonáda, a few miles north-east of Ahmedabad, and Chaniána, some miles east of Deesa. The other two stations are at the junction of the Karáchi longitudinal and the Singi meridional series.

ooo. No changes were made this season, in respect to the method of observation and as regards the instruments used, the only modification was the substitution of a 4 volt glow lamp in place of an oil lamp for the illumination of the field of the telescope and the use of a similar lamp for lighting up the levels. Both lamps were run off the same battery of four, N. size, Obach cells. The lamp connections and bracket were designed by me and made in the Dehra workshop. The adjustment of the glow lamp for the illumination of the field requires a little more care than is necessary in the case of an oil lamp, but when once adjusted, there is no doubt as to which is the pleasanter system to work with. Apart from the advantages gained by the removal of a hot oil lamp from the observatory, the comfort of the observer is much increased in that his attention is not frequently distracted by flickering and that the electric lamp requires little or no attention. Four N. size Obach cells will work satisfactorily for the whole season if used economically. With instruments properly adjusted, it will be found to be unnecessary to switch on the current more than half a minute before the transit of the star or to keep it running for more than a minute at a time.

On an average, the programme at each station embraced 52 observations to 50 stars, combined to form 27 pairs. The stars selected for observation were all taken from Newcomb's Catalogue of fundamental stars.

At the last two stations visited, Kárdo and Dhámanva, Mr. J. deG. Hunter, M.A., joined the party for instructional purposes. He already had some experience in taking observations of precision and his visit was for the purpose of acquiring a knowledge of the methods of observation and computation. Further on will be found a table giving the respective results obtained by Mr. Hunter and myself.

ooo. In Volume XVIII of the Professional volumes of the Survey of India, we find India divided into tracts or regions according to the nature and magnitude of the plumb-line deflections. The G. T. stations visited lie in or close to the northern portion of region No. 7. Chart No. I is an orographical

OROGRAPHICAL CHART OF REGION No. 7.

CHART I

•-8·8 Latitude Station of Season 1907-08

•-5·8 Latitude Station of a previous Season

The Negative sign applies to Northerly Deflections

The Positive sign to Southerly Deflections

Heights are given in feet, Depths in fathoms.

Scale 1 Inch = 128 Miles

chart of this region, showing in large figures the position of the stations visited in 1908 and in small figures those at which the plumb-line deflections had been determined in previous years. Against each point is noted the deflection of the plumb-line found there.

Turning to this chart, we see that at the commencement of the 1908 latitude operations, the following facts were known about deflections in the neighbourhood of Deesa. The average deflection for Region No. 7 is $-4.7''$. At Deesa, itself, a deflection of $-8.20''$ has been found; at Chaniána, about 23 miles east of Deesa, there is $-11.25''$. About 31 miles to the north-west of Deesa, at Khankharia, the plumb-line is deflected by $+1.98''$. In the distance of 31 miles the value of the deflection has changed by $10.18''$. At Oria on Mount Abu, about 39 miles north of Chaniána, the deflection is $-3.33''$, giving a change of $7.92''$ in the interval. Sixty-eight miles to the south of Chaniána, at Sonáda, the deflection is found to be $-4.28''$ and at Aramlia, about 154 miles east of Chaniána, the plumb-line is deflected by $-4.61''$. Still further to the south and to the east of the Deesa-Chaniána locality, we find deflections of $4.7''$, $5.5''$, $3.1''$, $4.6''$, $3.2''$, $4.4''$, $3.4''$, to the north, that is to say normal regional deflections. Thus when the 1908 work was commenced, it was known that the Deesa-Chaniána locality exhibited large deflections to the north, and that this deflection to the north decreased rapidly as we went northwards and westwards. To the south and east we had no data nearer than Sonáda and Aramlia at distances of 70 and 150 miles respectively, and these two places had been found to be normal. Was the change of deflection between the normal at Sonáda and Aramlia and the abnormal at Chaniána a slow one or was it abrupt, as had been shown to be the case to the north of Deesa? Did Sonáda and Aramlia mark the limits of the normal area or did this extend closer to Chaniána? Was the Chaniána deflection approximately the maximum in this locality or would a still greater deflection be met with a little further to the south? Would relatively large deflections be found to occur at stations situated on the main mass of the Aravalli Hills? It was hoped that some light might be thrown on these questions by the latitude operations of 1908.

000. The principal results of the season's observations are collected in the following table.

TABLE.

Station.	Longitude.	Height above M. S. L.	Astronomical Latitude.	Seconds of Geodetic Latitude.	Deflection.
	° ′	Feet.	° ′ ″	″	″
Moráli	73 0	466	23 25 17·47	23·18	−5·71
Dhámanva	72 33	397	23 32 2·66	8·40	−5·74
Kaináth	73 1	1,385	23 51 14·99	23·79	−8·80
Kárdo	72 46	807	23 57 2·17	10·02	−7·85
Lakarwás	73 52	2,574	24 31 41·05	47·99	−6·94
Tiki	73 53	2,369	24 55 34·52	38·24	−3·72

These results show that to the south of Chaniána, the latitude of which is 24° 6′ 37″, and where the deflection is −11·25″, we again find an abrupt change in the value of the plumb-line deflection. At Kárdo, about 16 miles south-east of Chaniána, the deflection has changed by + 3·4″ or on an average by one second in 4·7 miles. Between Kárdo and Dhámanva, 31 miles further south the deflection changes by only +2·1″ or by one second in 15 miles; 32 miles still further to the south than Dhámanva, the change is +1·3″ which gives a rate of one second in 24·6 miles.

The results of the observations of former years show that to the north of Chaniána between that station and Oria, 39 miles distant, the deflection changes by one second in 4·9 miles. Between Chaniána and Deesa, 23 miles to the west-north-west, the rate of change is one second in 7·5 miles. Between Deesa and Khankharia, 31 miles still further to the north-west, the change is one second in 3 miles. This rapid change of the value of the deflection round Chaniána tends to show that the disturbing influence to which the relatively high value at this station is due, originates in a purely local cause, situated either upon the surface or shallow-seated below it. The pronounced change between Kárdo and Chaniána, for instance, indicates that the distance separating these two stations is, in magnitude, a decidedly significant fraction of the distance of either of these stations from the seat of the disturbing influence. The distance between the two stations is only some 16 miles. Besides this, we have the fact that on all sides of Chaniána, the change of deflection is of the same sign. In every direction the northerly deflection is found to decrease. Considering the deflections at the three stations of Chaniána (−11·25″) Kárdo (−7·75″) and Kaináth (−8·80″) we see that at Kárdo, the station nearer to Chaniána, where the deflection is large, the deflection is less than at Kaináth, further away. One of the three values is anomalous. While the sign of the change of value between Chaniána and Kárdo is positive, that between Kárdo and Kaináth is negative, though in moving from station to station, the changes of position have continued in the same direction. Moving south from Kaináth and Kárdo, the sign of the change is again positive. As we proceed southwards from Oria, in the north, through Chaniána, Kárdo, Kaináth to Dhámanva, the sign of the changes are, in order negative, positive, negative and positive. To produce this condition of affairs, more than one distinct influence would seem to be in operation. Now, the whole area under consideration is of small extent. It is only about 100 miles from Oria to Sonáda. We find thus, that there are more masses than one, causing deflections of the plumb-line; that these masses are strictly local and situated either on the surface or shallow-seated below it. As the whole area is not large, each mass cannot cover any large extent and consequently, to produce the decided changes of value in the locality, it would appear that these masses must be of a density considerably above the average of the surface and the crust of the earth. As to whether these masses are on the surface or below it, it is impossible to say until the computation of the theoretical deflections has been performed. Until we can allow for the effects of visible surface masses we shall not be in a position to argue the existence of invisible sub-surface masses of great density.

During the season, I determined the densities of various rock specimens collected in the neighbourhood of the stations. The values found are tabulated below:—

Densities of rock specimens.

Station.	From whence obtained.	Density.	Station.	From whence obtained.	Density.
Tiki	North-west	2·63	Moráli	East	3·03
,,	,,	2·90	,,	Station	2·56
,,	,,	3·04	,,	South	2·36
,,	South	2·84	,,	West	2·75
,,	East	2·66	,,	North	2·33
,,	,,	2·67	Kárdo	,,	2·59
Lakarwás	West	2·62	,,	East	2·59
,,	Station	2·65	,,	West	2·59
,,	North	2·62	Kaináth	East	2·42
,,	South	2·88	,,	North	2·63
,,	,,	3·56	,,	West	2·55
,,	,,	3·63	,,	South	2·49
,,	East	2·67			

The only figures, which are specially remarkable, in the list are the quantities for the two specimens from the south of the station of Lakarwás, 3·56 and 3·63.

As regards the two stations of Tiki and Lakarwás, situated in the Aravalli hills, we see that at Tiki the deflection is only —3·73″, while at Lakarwás it is —6·94″. For this change we see at once some explanation in the orography of the locality. The two stations are at nearly the same altitude above sea level, about 2,000 feet, but while a great portion, of the hill masses that rise about 2,000 feet, lie to the north of Lakarwás Tiki, is so placed that the greater proportion of these masses lies to the south. Consequently the effects of that portion of the Aravalli hills, rising in this locality to above 2,000 feet, tend to be opposite sign at the two stations.

The results obtained at Dhámanva and Moráli are very slightly greater than values found at places within the normal area and seem to indicate that these places only just come within the sphere of influence of the disturbing causes in the Chaniána locality.

As regards the possible existence of a deflection still greater than that at Chaniána, we see that to the south, south-east and north-west the probability of the occurrence of a deflection materially greater is small. Deesa on the one side and Kárdo on the other, neither station further away than 20 miles, exhibit considerably smaller values. Between Chaniána and Oria or Lakarwás, however, there are larger intervals and it is possible that a larger deflection might be found.

000. The following table gives further particulars regarding the observations at the different stations.

TABLE.

Station.	No. of stars.	No. of observations.	Seconds of Latitude.	p. e.	p. e. of unit weight.	E.W—W.E.	Apparent error of micrometer value per Rev.	Observer.
			"	"	"	"	"	
Moráli . .	52	55	17·47	±0·055	±0·274	—0·33	—0·0059	H. M. C.
Dhámanva	41	42	2·65	±0·041	±0·171	+0·57	+0·0042	"
" .	42	39	2·68	±0·068	±0·283	+0·18	+0·0008	J. deG. H.
Kaináth . .	57	58	14·99	±0·043	±0·216	+0·03	—0·0017	H. M. C.
Kárdo . .	37	45	2·27	±0·062	±0·255	+0·07	+0·0042	"
" . . .	35	42	2·01	±0·081	±0·326	—0·20	+0·0072	J. deG. H.
Lakarwás .	51	49	41·05	±0·076	±0·360	+0·04	+0·0016	H. M. C.
Tiki . .	57	60	34·52	±0·062	±0·312	—0·15	+0·0023	"
Means .	49	52	...	...	±0·265	+0·04	+0·0008	H. M. C.
	39	41	...	...	±0·305	—0·01	+0·0040	J. deG. H.

The micrometer value used in the computations was 69·210″ ±0·003 determined from observations to 49 star couples.

000. If, considering any two stations on any meridian, we take the difference, "deflection at southern station—deflection at northern station", a negative sign characterising this difference will show that the plumb-lines at the two stations are relatively inclined to one another; a positive sign will show that they are inclined away from one another, (a negative deflection being a deflection relatively to the north).

Now when the plumb-lines at the two stations are inclined away from one another, we conclude that the level surface between the two is of a somewhat greater radius of curvature than the surface of our spheroid. When the plumb-lines are inclined towards one another, the radius of curvature of the level surface must be somewhat smaller than that of the spheroid.

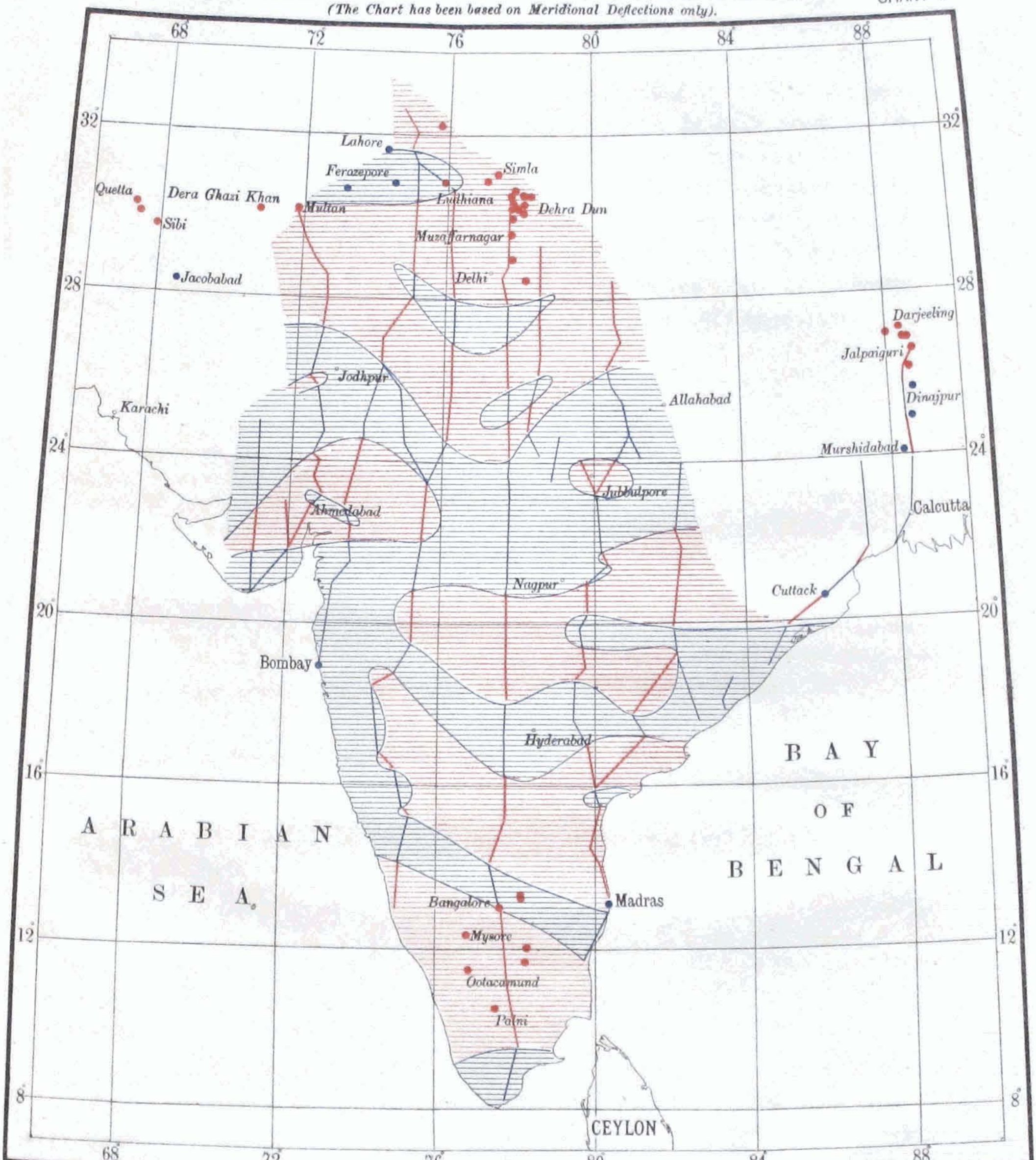
Where the radius of curvature is small, we have, relatively to the spheroid something of the nature of a protuberance where we may expect to find gravity slightly in excess. Where the radius of curvature is great, we may expect to find gravity in defect.

On the accompanying chart No. II, I have joined by a thick blue line latitude stations at which the plumb-lines are found to be deflected towards one another and by a thick red line, those at which they are deflected away from each other. Upon these cross sectional lines, I have blocked out approximately the area in which the plumb-lines are inclined towards and away from each other. In the blue area we may expect to find gravity rather in excess and in the red, slightly in defect. This, however, is to be considered as merely a rough approximation, for it assumes that each observed deflection is a local maximum and also, that between every two stations, the change of deflection is gradual and regular,

CHART II

CHART TO ILLUSTRATE AREAS IN WHICH GRAVITY IS IN EXCESS AND DEFECT

(The Chart has been based on Meridional Deflections only).



Area in which it is suggested that gravity is in defect

Area in which it is suggested that gravity is in excess

Pendulum Station at which gravity has been found to be in defect

Pendulum Station at which gravity has been found to be in excess

Scale 1 Inch = 256 Miles

The data at present available does not allow of the chart being extended to the west beyond Long. 72° and to the east beyond Long. 81°. In the area included between the meridians of 82° and 86° and the parallels of 20° and 24° there is no triangulation which will provide data enabling us to draw out the defining lines of the blue and red regions in this part of India.

Also shown on the chart are the stations at which the half seconds pendulum has been swung. By a blue dot are represented those places at which gravity has been found to be in excess and by a red dot, such places as are characterized by deficiency of gravity. The actually observed values of gravity at these places will indicate to what degree the representation of the areas, over which this force is in excess and defect, as deduced from latitude observations, may be considered correct. As far as the gravity work goes at present, the suggestions based on plumb-line determinations are fairly well corroborated by the pendulum results. A glance at the chart, however, shows that, at present, the pendulum stations are few and distributed more or less round the margin of the area covered by the latitude stations. Over the central portion of this area there are, as yet, no gravity determinations by the half seconds pendulum.

IV.

NARRATIVE REPORT.

Extract from the Narrative Report of Captain H. M. Cowie, R.E., in charge No. 23 Party (Pendulums) for Season, 1907-08.

---

000. During the early part of 1908, a series of pendulum observations was carried out by Major Lenox-Conyngham, R.E., with the object of ascertaining whether, in montane and submontane regions in the southern portion of the Indian peninsula, the force of gravity varied from normal in like manner and degree as in Northern India. The scene of these operations was the trigon lying south of the latitude of Madras.

In consequence of the employment of the party during November, December, and part of January in carrying out comparisons between the standard 10 feet Bar, A, and the reference Bars I_B and I_S, the time available for the pendulum observations was shorter than usual.

The pendulums, nevertheless, where swung at eight stations, exclusive of the base station, Dehra Dún.

000. These stations were:—

Dehra Dún	for standardizing the pendulums.
Bangalore	situated on the Mysore plateau.
Mysore	situated on the Mysore plateau.
Kolar, Edgar Shaft, under-ground station . . .	situated on the Mysore plateau.
" " " surface station	situated on the Mysore plateau.
Salem	at the foot of the Shevaroy Hills.
Yercaud	on the Shevaroy Hills.
Ootacamund	on the Nilgiri Hills.
Kodaikánal	on the Palni Hills.

000. On the whole, satisfactory rooms were available for the observations and it was possible to ensure a fairly steady temperature during each set of swings, though at Yercaud, Kodaikánal and Dehra, in April, the hourly change of day temperatures, was, as will be seen, rather large. No corrections for lag have been applied in deducing the times of vibration. Corrections for lag, based on the mean hourly changes of temperature at Bangalore, Kodaikánal and Dehra in April, would at each place amount to about 3×10^{-7} seconds. In the table below are shown the average night and day temperatures and the hourly changes.

TABLE I.

Station.	Night.		Day.		Mean.	
	Average temp.	Hourly change.	Average temp.	Hourly change.	Average temp.	Hourly change.
	°	°	°	°	°	°
Dehra Dún, 1908 January . . .	16·35	+0·09	16·18	+0·08	16·27	+0·08
Bangalore	24·41	+0·13	24·35	+0·11	24·38	+0·12
Mysore	25·86	—0·04	24·93	+0·11	25·40	+0·04

TABLE I—*contd.*

Station.	Night.		Day.		Mean.	
	Average temp.	Hourly change.	Average temp.	Hourly change.	Average temp.	Hourly change.
	°	°	°	°	°	°
Edgar Shaft, underground	30·06	+0·06	29·94	+0·06	30·00	+0·06
Edgar Shaft, surface	24·16	−0·03	23·72	+0·06	23·94	+0·02
Salem	28·29	+0·03	27·58	+0·10	27·94	+0·07
Yercaud	20·02	−0·05	19·69	+0·22	19·86	+0·09
Ootacamund	15·10	+0·06	15·27	+0·09	15·19	+0·08
Kodaikánal	14·76	−0·03	15·04	+0·23	14·90	+0·10
Dehra Dún, 1908 April	27·33	+0·02	27·06	+0·20	27·19	+0·11

000. The next table gives the amounts of the flexure correction observed and adopted at the various stations. As a rule, two determinations of this correction were made at the commencement and again at the end of the coincidence observations.

TABLE II.

Station.	Date 1908.	Observed Flexure correction.	Adopted Flexure correction.
Dehra Dún	January 1st	57·0	
	" 1st	56·5	January 1st to 4th.
	" 4th	53·9	
	" 4th	55·3	56.
	" 13th	53·6	January 4th to 13th.
	" 13th	53·8	54.
Bangalore	February 2nd	51·7	
	" 2nd	52·2	
	" 5th	56·1	
	" 5th	55·4	54.
Mysore	February 6th	58·0	
	" 6th	57·5	
	" 9th	56·4	
	" 9th	55·5	57.

TABLE II.

Station.	Date 1908.	Observed Flexure correction.	Adopted Flexture correction.
Edgar Shaft, underground . .	February 17th .	54·2	
	„ 17th .	55·9	
	„ 20th .	50·9	
	„ 20th .	50·9	53
Edgar Shaft, surface . . .	February 21st .	49·4	
	„ 21st .	49·4	
	„ 24th .	47·2	
	„ 24th .	48·5	
	„ 26th .	48·2	49.
Salem	March 1st .	57·1	
	„ 1st .	55·6	
	„ 3rd .	56·4	
	„ 3rd .	56·4	56.
Yercaud	March 6th .	55·4	
	„ 6th .	55·7	
	„ 9th .	54·0	
	„ 9th .	55·5	55.
Ootacamund	March 15th .	56·4 }	Rejected.
	„ 15th .	56·7 }	
	„ 15th .	60·3	
	„ 15th .	58·7	
	„ 18th .	57·5	
	„ 18th .	57·9	59.
Kodaikánal	March 22nd .	89·9	
	„ 22nd .	90·4	
	„ 25th .	82·7	
	„ 25th .	80·8	86.

TABLE II—*continued.*

Station.	Date 1908.	Observed Flexture correction.	Adopted Flexture correction.
Dehra Dún	April 17th	45·5	
	„ 17th	44·5	
	„ 23rd	44·9	
	„ 23rd	43·4	45·

At Kodaikánal, as the floor of the observing room was not in very good condition, the marble slab, carrying the pendulum support, was cemented to an "isolated" concrete pillar specially built for the purpose, the large value of the correction at this station is most probably due to the nature of this pillar. At Ootacamund, after two sets of observations had been made, it was found that the agate plane on which rest the knife edges of the pendulum, deviated more than was desirable from the horizontal. The results of these two sets were accordingly rejected. The agate plane was adjusted and fresh sets of observations made. It is remarkable that the adjustment of the agate plane, effected by tightening the screws clamping the stand to the marble slab, had the result of sensibly increasing the flexure correction.

ooo. Throughout the season, the time observations were taken by Babu Hanuman Prasad, Extra Assistant Superintendent. The methods of observing differed in no respect from those of the previous year. This season, however, the new bent Transit instrument, which had arrived in India in the autumn of 1907, was taken into use, replacing the portable Transit belonging to the longitude equipment.

The main details of the new instrument are as follows :—

Effective aperture of objective, 2½ inches ; focal length, about 20 inches. It has a micrometer eye-piece capable of being turned through 90° and eye-pieces giving powers of about 30, 50 and 70, respectively. It is provided with a level, mounted Talcott-wise and is adapted for the taking of Talcott Latitude observations.

The results of the observations were thoroughly satisfactory. The abstract which follows gives for each station the average *p.e.*, of a value of the clock rate determined from star transits on two successive nights.—

	s		s
Dehra Dún, January	±0·021	Salem	±0·010
Bangalore	0·013	Yercaud	0·009
Mysore	0·011	Ootacamund	0·015
Edgar Shaft, underground	0·019	Kodaikánal	...
Edgar Shaft, surface	0·018	Dehra Dún, April	0·014

The mean of these values is ± 0·014. The average number of stars observed each night being 15, the avarage *p.e.*, of a clock rate determined by observations of one star on two successive nights is ± 0·054.

oco. In the table below are given the times of vibration of each pendulum in January and April, 1908, at Dehra Dún.

TABLE III.

Times of vibration at Dehra Dûn.

Date.	Pendulum. 137	138	139	140	Mean.
	s	s	s		s
Jan. 1—2	0·5072575	0·5075013	0·5071596	0·5070862	0·5072512
2—3	2564	5007	1594	0860	2506
4—5	2556	5017	1601	0869	2511
7—12	2570	5005	1593	0870	2509
Means . .	0·5072566	0·5075011	0·5071596	0·5070865	0·5072510
April 17—18	0·5072573	0·5075008	0·5071596	0·5070876	0·5072513
20—21	2576	4999	1596	0878	2512
21—22	2573	5005	1593	0874	2511
Means . .	0·5072574	0·5075004	0·5071595	0·5070876	0·5072512
General Means for Season .	0·5072570	0·5075008	0·5071595	0·5070871	0·5072511
Difference (Apr. —Jan.) . .	+8	—7	—1	+11	+2

The agreement between the April and January value is satisfactory.

000. In order to indicate to what degree the several pendulums have maintained an invariable character during the season and how far we are justified in adopting the general means of the abstract above as representative of each pendulum during the period January to April, the differences between individual pendulums and the mean pendulum have been computed for each set at each station. These differences are given in the following table in the columns under the headings of the pendulum numbers. Further, the mean difference for the season is deduced for each pendulum, and using these mean differences we derive the residuals, v, v.

TABLE IV.

Difference between individual Pendulums and mean Pendulum.

Station.	Date.	137	V	138	V	139	V	140	V
Dehra Dún . .	Jan. 1—2	—63	—3	—2501	—4	+916	—1	+1650	—9
	2—3	—58	+2	—2501	—4	+912	+3	+1646	—5
	4—5	—45	+15	—2506	—9	+910	+5	+1642	—1
	7—12	—61	—1	—2496	+1	+916	—1	+1639	+2
Bangalore . .	Feb. 2—3	—50	+10	—2504	—7	+915	0	+1640	+1
	3—4	—68	—8	—2500	—3	+920	—5	+1649	—8
Mysore . . .	Feb. 7—8	—56	+4	—2505	—8	+925	—10	+1638	+3
	8—9	—65	—5	—2488	+9	+911	+4	+1643	—2
Edgar Shaft, underground . . .	Feb. 17—18	—62	—2	—2496	+1	+913	+2	+1644	—3
	18—19	—56	+4	—2498	—1	+909	+6	+1644	—3
	19—20	—61	—1	—2496	+1	+912	+3	+1646	—5
Edgar Shaft, surface .	Feb. 21—22	—61	—1	—2501	—4	+923	—8	+1641	+0
	22—23	—60	0	—2498	—1	+914	+1	+1644	—3
	23—25	—60	0	—2497	0	+915	0	+1641	0
Salem . . .	Mar. 1—2	—58	+2	—2498	—1	+916	—1	+1639	+2
	2—3	—63	—3	—2491	+6	+912	+3	+1642	—1
Yercaud . . .	Mar. 6—7	—57	+3	—2495	+2	+913	+2	+1641	0
	7—8	—65	—5	—2497	0	+919	—4	+1641	0
Ootacamund . .	Mar. 15—16	—58	+2	—2493	+4	+914	+1	+1638	+3
	16—17	—60	0	—2494	+3	+913	+2	+1640	+1
Kodaikánal . .	Mar. 22—25	—62	—2	—2487	+10	+915	0	+1635	+6
Dehra Dún . .	Ap. {17—18, 22—23}	—60	0	—2495	+2	+917	—2	+1637	+4
	20—21	—64	—4	—2487	+10	+916	—1	+1634	+7
	21—22	—62	—2	—2494	+3	+918	—3	+1637	+4
Means . .	...	—60	...	—2497	...	+915	...	+1641	...

The nature and magnitude of these residuals show that no appreciable change has taken place in any of the pendulums, and that, therefore, the general means of Table III are correctly representative of the season.

000. In Table V, are given for each station the mean observed time of vibration and the value of g deduced therefrom.

TABLE V.

Station.	Time of vibration.	Difference from Dehra.	Observed value of g. in Dynes.
	s		
Dehra Dún	0·5072511	...	979.063
Bangalore	5200	2689	978,025
Mysore	5147	2636	978.045
Edgar Shaft, underground	4921	2410	978.133
Edgar Shaft, surface	5069	2558	978.076
Salem	4965	2454	978.116
Yercaud	5503	2992	977.908
Ootacamund	5951	3440	977·735
Kodaikánal	6189	3678	977.643

000. In Table IV are given the residuals v. formed by comparison of the mean difference with the individual differences between each pendulum and the mean pendulum. Squaring and summing these residuals, we get—

$$\rho=0.6745\sqrt{\frac{[VV]}{3(n-1)}}$$

where ρ is the p. e. of one complete determination of the time of vibration of any pendulum, and n is the number of sets of observations. Since there are four pendulums, the p. e. of one complete determination of the time of vibration of the mean pendulum is—

$$\rho_o=\frac{\rho}{2}$$

From Table IV we get the following sums of squares of residuals—

Pendulum No.	137	138	139	140
Σvv	537	516	340	337
Whence [vv]	1730			
and (n—1) being 22				

$$\rho=0\cdot6745\sqrt{\frac{1730}{3\times22}}$$
$$=\pm\ 3\cdot45$$

and $\rho_o=\pm1\cdot73$

the unit being the seventh decimal place of a second.

If we consider the differences that exist between the mean time of vibration for each complete set of observations and the general mean for each station we get another series of residual from which we can again compute a value of the p. e. of one complete determination of the time of vibration of the mean pendulum. In this case the p. e. $\mu_o=0\cdot6745\sqrt{\frac{[v'v']}{(m-n)}}$

where m is the total number of sets and n is the number of stations.

The residuals v́ are shown in table VI.

TABLE VI.

Station.	Date.	S.	v.	Σ v v.
Dehra Dún . . .	January 1—2	s 0·5072512	2	...
	2—3	2506	4	...
	4—5	2511	1	...
	7—12	2509	1	22
Mean .	...	0·5072510	...	...
Bangalore . . .	February 2—3	0·5075200	0	...
	3—4	5201	1	1
Mean .	...	0·5075200	...	...
Mysore	February 7—8	0·5075151	4	...
	8—9	5144	3	25
Mean .	...	0·5075147	...	...
Edgar Shaft, underground .	February 17—18	0·5074923	2	...
	18—19	4922	1	...
	19—20	4918	3	14
Mean .	...	0·5074921	...	...
Edgar Shaft, surface . .	February 21—22	0·5075066	3	...
	22—23	5070	1	...
	23—25	5072	3	19
Mean .	...	0·5075069	...	...
Salem	March 1—2	0·5074964	1	...
	2—3	4965	0	1
Mean .	...	0·5074965	...	...
Yercaud . . .	March 6—7	0·5075503	0	...
" . . .	7—8	5503	0	0

TABLE VI—*continued.*

Station.	Date.	s	v'	$\Sigma v v$
Mean	......	0·5075503	...	...
Ootacamund . . .	March 15—16	0·5075954	3	...
" . .	16—17	5948	3	18
Mean	......	0·5075951	...	...
Kodaikánal . . .	March 22—25	0·5076189	...	...
Dehra Dún . . .	April 17—18 }	0·5072513	1	...
" . . .	22—23 }			
" . . .	20—21	2512	0	
" . . .	21—22	2511	1	2
Mean . . .	......	0·5072512	$[v' v']$	=102

$$[v'v'] = 102 \text{ and } (m\text{-}n) = 14.$$

Which gives

$$\mu_0 = \pm 1·82.$$

Now in computing ρ_0 we have, taking each set separately, considered the differences between the individual pendulums and the mean pendulum of the set. Consequently causes which produce effects constant during each set but varying from set to set would give rise to errors, of which this investigation could take no count.

On the other hand, μ_0, being deduced from the differences between the time of vibration of the mean pendulum of each set and the general mean for the station, would be affected by errors of this nature, such as might be caused by variations of clock rate and lag in temperature on the part of the pendulums. The close agreement between μ_0 and ρ_0, however, shows that the errors due to such causes, were for the season as a whole, extremely small.

000. The final results of the season's observations are given in the next two tables. The orographical corrections for the reduction to sea level were found to be significant in every case except Mysore and Bangalore. For all stations but Kodaikánal these corrections are based on a detailed examination of the surface masses within 35 miles of the observatory. In the case of Kodaikánal, the investigation was not possible beyond 1 mile from the station on account of the want of suitable maps.

The value of gravity adopted for Dehra Dún is 979·063.

TABLE VII.

Station.	Latitude.	Height above M. S. L.	Observed value of gravity $=g$.	Corrections: for height.	for mass.	Orographical.	Value of gravity at Sea level. $=g_0''$
	° ′ ″	Feet.	Dynes.				Dynes.
Bangalore	13 0 41	3118	978·025	+0·290	−0·109	±0·000	978·206
Mysore	12 18 52	2501	978·045	+0·233	−0·087	±0·000	978·191
Edgar Shaft, underground.	12 55 46	328	978·133	+0·031	−0·011	+0·085	978·238
Edgar Shaft, surface	12 55 47	2945	978·076	+0·274	−0·103	±0·000	978·247
Salem	11 40 5	948	978·116	+0·088	−0·033	+0·001	978·172
Yercaud	11 46 56	4493	977·908	+0·481	−0·157	+0·011	978·180
Ootacamund	11 24 37	7395	977·735	+0·689	−0·258	+0·005	978·171
Kodaikánal	10 13 50	7665	977·643	+0·714	−0·268	+0·003	978·092

Table VIII gives a comparison between the value g_0'' and the theoretical value γ_0 for the latitude for the station of observation.

TABLE VIII.

Station.	g_0''	γ_0	γ
	Dynes.	Dynes.	Dynes.
Bangalore	978·206	978·263	—0·057
Mysore	978·191	978·236	—0·045
Edgar Shaft, underground	978·238	978·260	—0·022
Edgar Shaft, surface	978·247	978·260	—0·013
Salem	978·172	978·212	—0·040
Yercaud	978·180	978·217	—0·037
Ootacamund	978·171	978·203	—0·032
Kodaikánal	978·092	978·164	—0·072

000. At all the stations visited the force of gravity has been, thus, found to be in defect. The deficiency varies in amount from 0·013 at the Edgar shaft, surface station, to 0·072 at Kodaikánal. It is at once noticeable that these deficiencies, found in Southern India, are considerably smaller than the values determined at stations similarly situated, as regards height above M.S.L. in North Indian and sub-Himalayan regions. First, however, considering the South Indian results by themselves, we see that the deficiency in amount is not a function of the height above sea level. Three stations are situated on the Mysore plateau at not very different heights. At two of these, Mysore and Bangalore, the deficiency is nearly the same in amount, but at the third, the Edgar shaft, surface station, it is considerably less than at the two former. The difference of height between Yercaud and Salem is 3,500 feet, the distance

between the two places being about 9 miles, and yet the value of $g_0''-\gamma_0$ changes by only 0·003, being slightly greater at the lower station. The defects at Yercaud and Ootacamund are almost the same though the difference in height between the two stations is 2,900 feet. At Kodaikánal the value of the defect is more than twice that at Ootacamund though the former station is only 270 feet above the latter.

In Table IX are compared the results of the operations in Southern India with those previously determined in the Northern and the sub-Himalayan regions.

TABLE IX.

Station.	Situation.	Height.	$g_0''-\gamma_0$	Thickness of corresponding disc.	Percentage of height.
		Feet.	Dynes.	Feet.	%.
Ootacamund . . .	Hills, South India . .	7395	—0·032	910	12
Kodaikánal . . .	" " " . .	7665	—0·072	2050	27
Simla	Himalayas . . .	7043	—0·119	3380	48
Darjeeling . . .	" . . .	6966	—0·143	4070	60
Mussooree (Camel's Back).	" . . .	6924	—0·110	3100	45
Mussooree (Dunseverick)	" . . .	7129	—0·115	3270	46
Yercaud . . .	Hills, South India . .	4493	—0·037	1050	23
Kurseong . . .	Himalayas . . .	4913	—0·130	3700	75
Quetta	Hills, Baluchistan . .	5520	—0·139	3920	71
Mach	" " . .	3522	—0·117	3270	93
Bangalore . . .	Plateau, South India .	3118	—0·057	1620	52
Edgar shaft, surface .	" " " .	2945	—0·013	370	13
Mysore	" " " .	2501	—0·045	1280	51
Rájpur	Submontane, North India	3321	—0·124	3550	107
Asárori . . .	" " "	2467	—0·112	3180	129
Kálka	" " "	2202	—0·085	2370	107
Dehra Dún . . .	" " "	2239	—0·126	3440	154
Salem	Submontane plains, South India.	948	—0·040	1140	120
Hardwár . . .	Submontane plains, North India.	949	—0·114	3270	344
Roorkee	" " "	867	—0·107	3040	350
Ludhiána	" " "	835	—0·048	1310	157
Nojli . . .	" " "	879	—0·095	2730	311

In this table are also given the thicknesses of a disc of matter of density 2·8, which would be capable of producing an attraction equal to the quantity $g_0'' - \gamma_0$ and the percentage of the height of the station represented by this thickness. It is very noticeable how much greater the quantities $g_0'' - \gamma_0$ and the percentages of height are for places in the Himalayan region than for the South Indian stations of like height. It is seen too, that the percentage of height gradually becomes greater as the height of the station gets less. This is perhaps due to the fact that the quantity $g_0'' - \gamma_0$ maintains a fairly uniform value over a region of considerable area bordering the mountain mass, while, as we move away from the same mass, the height of the station gets less. That the deficiency in the force gravity will not be a function of the height of the station above sea level, is what the theory of isostacy teaches us to expect. We shall expect to find the effects caused by the sinking of a mountain mass into the subjacent media not localized but distributed over a certain area round the mass and the actual value of the deficiency of gravity at places at the foot of a mountain of about the same order of magnitude as that at the top. When considering the amount of deficiency or otherwise of gravity at a station, it is not sufficient to refer to the height of only the station itself, that is, of one particular point. We should take into account the average height of a more or less extensive region in which that station is situated. We thus find some explanation of why it is that the values of $g_0'' - \gamma_0$ at the South India stations are so much less than at places at similar heights, above the sea, in the Himalayan region. The former stations are situated on approximately the summits of the mountain mass and their heights are greater than the average for the elevated region, while the Himalayan stations are, after all, but points on the outer slopes of the main mountain mass, the average height of which is considerably greater than that of the station. With the relatively large value of $g_0'' - \gamma_0$ at the Himalayan points must be kept in mind the great height of the general level of the tracts lying immediately to the north. The amounts of the deficiency of gravity at Simla, Mussooree and Darjeeling are probably more appropriate to a general altitude of 14,000 or 15,000 than to a height of 7,000.

The difference between the northern and southern stations, generally speaking in this :—the latter are placed approximately on the summits of isolated hill masses, while the former are really half way down the outer scarps of an extensive highly elevated tract.

000. At Bangalore, the observations were made at the S. W. end of the Base Line, where Basevi swung the Invariable pendulums in September, 1868. This is the eighth of the old pendulum station that has been revisited. In Volume V, of the Professional Volumes, are given the vibration numbers, N, for the Invariable pendulums swung at these eight places. If we take Dehra Dún as the Base station, and take out the difference, dN, between the values of N at Dehra and at each of the other stations and convert dN into terms of g, in dynes, by means of the relation,

$$dg = \frac{2\,dN\,g}{N}$$

using for g, 978·962, Basevi's value for Dehra, and for N the quantity 86020·86 we get the following:—

TABLE X.

Basevi's Values of dg compared with those recently determined.

Station.	N	dN	Corresponding dg in Dynes.	Recently observed value of dg.	Difference in values of dg.
Madras	85989·03	−31·83	−0·724	−0·784	−0·060
Colába	86005·19	−15·67	−0·357	−0·432	−0·075
Kaliána	86027·25	+6·39	+0·145	+0·091	−0·054
Nojli	86027·62	+6·76	+0·154	+0·080	−0·074
Dehra	86020·86	...	...	...	...
Mussooree	86011·59	−9·27	−0·211	−0·270	−0·059
Mián Mír	86034·55	+13·69	+0·312	+0·320	+0·008
Bangalore	85978·49	−42·37	−0·964	−1·038	−0·074

It is noticeable that whereas the difference in the last column of the table is generally negative and on an average about 0·06, in amount, in the case of Mián Mír where a special stand was used, it is positive in sign and considerably smaller in value. This special stand was of a lighter construction than that usually used and was designed specially for the expedition to the high lying station at Moré. It must be noted that this stand was not employed at the Base station.

The recently determined value of g at Dehra Dún is 979·063, which differs by +0·101 from Basevi's value, 978·962. Combining this difference with those of the last column of the Table above, we get the quantities below.

TABLE XI.

Station.	Difference from Table X.	Difference in Base value.	Difference in value of g.
Madras	−0·060	...	+0·041
Colába	−0·075	...	+0·026
Kaliána	−0·054	...	+0·047
Nojli	−0·074	...	+0·027
Dehra	...	+0·101	+0·101
Mussooree	−0·059	...	+0·042
Mián Mír	+0·008	...	+0·109
Bangalore	−0·074	...	+0·027

It is evident that the greater part of the difference between the new and old values of g, is due to the discrepancy between the value adopted for the Base station. The importance of the adopted Base value is obvious, and it need scarcely be remarked that advantage should be taken of every opportunity that offers a means of collecting independent evidence of the degree of reliance that may be placed in this value. The recent value has already been supported by an independently determined connection with Europe. In 1905, Dr. Hecker connected Jalpaiguri with Potsdam. His observations gave as result

$$g \text{ at Jalpaiguri} = 978{\cdot}924.$$

The result of Major Lenox-Conyngham's observations, made at the same time was

$$g \text{ at Jalpaiguri} = 978{\cdot}922.$$

Both values are referable to $g = 981{\cdot}274$ at Potsdam, Dr. Hecker's result directly, and Major Lenox-Conyngham's indirectly, through Dehra Dún and Kew.

The close agreement of the two values shows that it is improbable that any large errors exist in the quantities adopted for Dehra and Kew.

S. G. P. I.—2 S. G.—17-9-09.

V.

THE SHAN STATES SURVEY OF INDIA.

Extract from the Narrative Report of Captain R. H. Phillimore, R.E., in charge No. 11 Party (Shan States) season, 1907-08.

Work this season lay in the extreme south-eastern corner of Kēng Tung State, being carried on along that portion of the Siam frontier that runs eastwards from Loi Tūm (longitude 99° 30′) to its junction with the French frontier, in sheet 102 $\frac{D}{3}$ and down the Mekong river from latitude 21° 15′ to this same junction. The Mekong river is the boundary between French and British territory for 130 miles. On the French side of the river is the "Province du Haut Mè Hkong", under a commissioner whose head-quarters are at Bān Hwè-sai, about 40 miles down the Mekong from the point where it leaves British territory. This province forms part of a large administrative area, Laos, whose head-quarters are at Luang Prabang. Beyond this Laos territory lie Tong King, Anam, Cochin-China and Cambodia. The "Province du Haut Mè Hkong" covers approximately the Shan States of Kēng Hkawng, and Möng Hsing, whose population is mainly Lū, the same race that inhabits the eastern plains of Kēng Tung State. Before the Franco-British treaty of 1896, which declared the Mekong the dividing line between French and British territory, Möng Hsing was a tributary state to Kēng Tung, and the Kēng Tung Sawbwa collected revenue from several other districts on the left bank of the Mekong and also in a few parts of Kēng Sen which is now Siamese territory. However, during the last century these border districts had been continually changing rulers, the Shans, Siamese and Chinese being constantly at warfare.

In the hilly country of sheet 102 $\frac{D}{1}$, is a circle, whose headman, or Hpaya, is a Mū-hsö by race; his circle includes several villages of other tribes, besides a few Lū villages. In the country to the south the population is mixed, there being a preponderance of western Shans. These immigrated into the country some 20 or 30 years back, when the western states were much disturbed by civil war. They found this corner of Kēng Tung State very thinly populated, being on the Siamese frontier and open to attacks from marauding bands. Some districts such as Möng Kwan in sheet 93 $\frac{P}{11}$ and Möng Hpōngnoi in 102 $\frac{D}{3}$, are regular western Shan colonies, where Tai only is written and no Hkön found at all.

At Hawnglük in sheet 93 $\frac{P}{15}$, Möng Hai, Ho-pūng and Möng Kō in 93 $\frac{P}{14}$ are found, besides Hkōn from Kēng Tung, western Shans, Lū, Lem from the Chinese border, and Youn from Siam. These all belong to Shan stock and intermarry freely, though keeping up distinctions in dialect, dress, ornaments, etc.

Of the hill tribes those most frequently met with were Kaw, Mu-hsō, and Tai-loi; the latter being more numerous in sheets 102 $\frac{C}{4, 8.}$ These Tai-loi with the En, a somewhat similar race, are Budhists, unlike the other hill tribes, and build large permanent villages with masonry ***kyaungs*** and ***wâts***. The hillsides round these villages become practically denuded of all forest trees; patches are cleared and cultivated for two or three seasons and then left fallow for five years or so, whilst other patches are worked. Great care is taken that the fallows should not take fire, for the thick growth that springs up is supposed to benefit the soil more if left unfired until just before re-cultivation. The other hill tribes, who are of a nomadic disposition, constantly shift their villages and move on to fresh fields, never returning to a field once it has been deserted. These tribes, Kaw, Mu-hsö, etc., are reckless of the extent to which they fire the hills. The growth that springs up on the deserted fields is exceedingly difficult to get about in; and if a surveyor has much of such ground in his work his outturn suffers considerably. Very often a surveyor is able to fire the jungle two or three days in advance; he is then able to do in one day an area that might otherwise have taken him two or three. One surveyor who tried this near an En village found that the whole village turned out to extinguish the flames, and save the fallows from burning.

Two tribes were met with in sheet 102 $\frac{C}{12}$ who have no other settlements within British territory, *Yao* and *Miao*; they are of Chinese stock, build their houses on the ground in regular Chinese fashion, and talk Chinese in preference to Shan. Both tribes seem much superior to the other hill tribes; they appear better fed and are certainly more cleanly.

It is an extraordinary feature of this country that all these different tribes live side by side, keeping quite distinct from each other in race and language and yet never falling out. There seem to be so many matters over which it would appear only human to quarrel, water-supply, the burning of jungle, thefts or two villages wishing to clear the same bit of ground for a village site or a field; but nothing of this sort is heard of; the amazement at this expressed by an Afridi sepoy, attached as surveyor to the party, is hardly surprising.

There is never the slightest difficulty in getting help from villagers of any tribe, if they are approached in the right manner through their headmen. The only occasion on which a surveyor was refused help occurred at a Yao village in the north of sheet 102 $\frac{C}{12}$. A few villages here belonged to the Möng Lwè circle, the capital of which is away to the north, outside this season's work. The headman of Möng Lwè had not been warned of the survey going on, as it was not known that any of his villages would fall into the area. The Yao could not read the Hkön letter of authority which the surveyor shewed them, and they refused coolies, guides and permission to camp in their villages. The officer in charge was inspecting the surveyor shortly afterwards, and wrote off to the Möng Lwè headman. A Hkön official came up the hill the following week and the Yao headman disappeared into the jungle; he left all his household property at home, however, which was a mistake, for his pigs and fowls were all swooped up and carried off to Möng Lwè. The surveyor was most politely treated by all the hill men after that.

The officer in charge, the camp officers and the triangulators were accompanied by Hkön clerks from the Sawbwa's court in Kēng Tung. The man with the officer in charge was particularly useful; being influential he contributed much to the courtesy shewn to all members of the party by the various headmen. One case was reported in which an officer's interpreter had requisitioned guides from a village and not paid them; he had further "fined" the headman ten rupees for producing one guide too few. The Assistant

Superintendent, Kēng Tung, handed the case over to the Officer in charge, who after investigation discharged the interpreter from the party, making him refund the ten rupees. This interpreter had been known to be rather a bad lot, and it is hoped that there is not very much of this sort of extortion going on; the Shans would be quick enough to report it if there were.

The most interesting feature of the country under survey was the Mekong river, which formed the eastern limits of work. The Shan name is Nam Hkawng or Mè Hkawng, the latter name having been accepted for popular use in the distorted English form Mekong. To a traveller in the country, the correct pronunciation is a matter of importance; the Shan name for the Salween river is Nam Hkong with the "o" sound long as in "toe"; confusion between the two rivers might be disastrous. The Mekong is full of rapids and the highest point to which steamers have ever been brought is Tāng Aw, latitude 20° 40′, where in 1893 the French built a small fort on the left bank. There is now a regular steamer service up to Bān Hwè-sai some sixty miles below Tāng Aw. The Laos bring large country boats as far as Tāng Aw, where goods are landed and shipped, being conveyed to and from Kēng Tung *viâ* Möng Len and Möng Hpayāk. Except for about 30 miles below Kēng Lap in sheets $102 \frac{D}{5, 9}$ and for about 10 miles in sheet $102 \frac{D}{3}$ the course of the river is through a defile. In these open lengths the river bed widens to nearly a thousand yards, but elsewhere it is seldom as wide as five hundred yards. The river is in flood from about August to October, and it must then be a very fine sight. During the dry season the water falls about 30 or 40 feet, and its width contracts to less than three hundred yards; at rapids it is as narrow as fifty yards, whilst only in the reaches at Pa-liao and above Hsōp Hōk is its full width maintained during the dry season.

The defile of the Mekong is not so striking as that of the Salween in the same latitude; the hills that immediately enclose it not running up so steep, or to such great heights: but it is a very fine river, and is distinctly impressive at low water, swirling down between walls of rock that stand up 30 feet or so above water level. There are several villages along both banks of the river and ferries at frequent intervals. Boats, both dug-outs and rafts, are used for communication up and down the river between village and village. During the dry season, mule and bullock caravans find an excellent route along the bed of the river, this forming quite a highway between Kēng Lap and Hsōp Yawng, where the caravans turn up towards Möng Yawng. During the rains this route cannot be used at all, and caravans use a road over the hills from Möng Yawng to Pa-liao and so on to Kēng Lap.

The French have toll posts at most of the ferries, but no toll is collected on the British side.

The height of the river bed above mean sea level is 1,505 feet at Kēng Kum, latitude 21° 6′ and 1,199 feet at Hsōp Hōk, latitude 20° 20′, where it leaves British territory.

The chief tributaries on the right bank of the Mekong falling under this year's survey are the Nam Yawng, Nam Len and the Nam Hōk. The Nam Yawng drains sheets $102 \frac{C}{4, 8}$, with the large plain of Möng Yawng. In its course down the defile through the riverain range of hills, the Nam Yawng is unfordable even in the dry season. The only ferry is just at its mouth, worked by the villagers of Wān Hsōp Yawng.

The Nam Len drains the southern slopes of the Loi Mwè range, and following south-east drains sheets 93 $\frac{P}{13}$ with the Möng Hpayāk plain, and 102 $\frac{D}{2}$ with the Möng Len plain. In the gorge between Möng Hpayāk and Möng Len the course is rapid and strewn with rocks, and the river can only be crossed by a ferry at Möng Pāng. Through the Möng Len plain the Nam Len widens out to 200 yards and is fordable at many points during the dry season.

The Nam Hōk drains sheet 93 $\frac{P}{14}$, and passes through the plain of Möng Hai, flowing south into the flat country which lies along the Siamese frontier; close to Hawnglük, it is joined on its right bank by the Nam Hsai, a regular mountain torrent which drains sheets 93 $\frac{P}{11,15}$. From Hawnglük eastwards to the Mekong the Nam Hōk forms the boundary between Kēng Tung and Siam with a course devious to an extraordinary degree. In this length it cannot be crossed by ford, nor are there any ferries working.

The ground falling in sheets 102 $\frac{C}{4,8,12}$ and $\frac{D}{5}$ was all good sketching ground, with hills running to about 6,000 feet, bold featured and covered mostly with open pine forest. In the neighbourhood of Langhsāt in sheet 102 $\frac{C}{4}$, the ground is of limestone formation, very much broken. The hills abound in caverns and punchbowls, and several streams disappear into the ground altogether, some coming up again two or three miles off. A good deal of saltpetre is collected in some of the caves and near Möng Ngam in sheet 102 $\frac{D}{1}$ the villagers manufacture and export gun-powder on a small scale.

The Möng Yawng plain is about 32 square miles in area, with a general height of 1,800 feet above the sea. It is covered with rice cultivation and is thickly populated. The city is not very imposing nor is the bazaar of any great size or importance. The district is however a wealthy one, and in days gone by was independent of Kēng Tung; the Myoza is now a man of considerable position in the State. There is a pagoda of some renown on a low hill to the south-west of the plain six miles from the city, by name the Htātntong Sawmyaung. Its construction is of very early date, and it is similar in design to the famous Angcor ruins in Cambodia. It is held in great veneration throughout Kēng Tung and is said to be built over seven hairs of the Buddha, and to have been visited by the great King Asoka.

Möng Len, falling in sheet 102 $\frac{D}{2}$, is a great trade centre. Caravans from Kēng Tung branch off from here in three directions; eastwards to Kēng Lap ferry and so to Möng Hsing; southwards to Tāng Aw on the Mekong where boats are taken; and westwards to Hawnglük *en route* for Chengmai in Siam. The greater volume of trade seems to flow in the Siamese direction. Much merchandise comes straight through from China to Siam in unbroken bulk; lead, tea, salt, etc., coming down through Kēng Tung, Möng Hpayāk, Möng Len and Hawnglük. Many of the caravans wander round on their return journey buying up opium and cotton from hill villages.

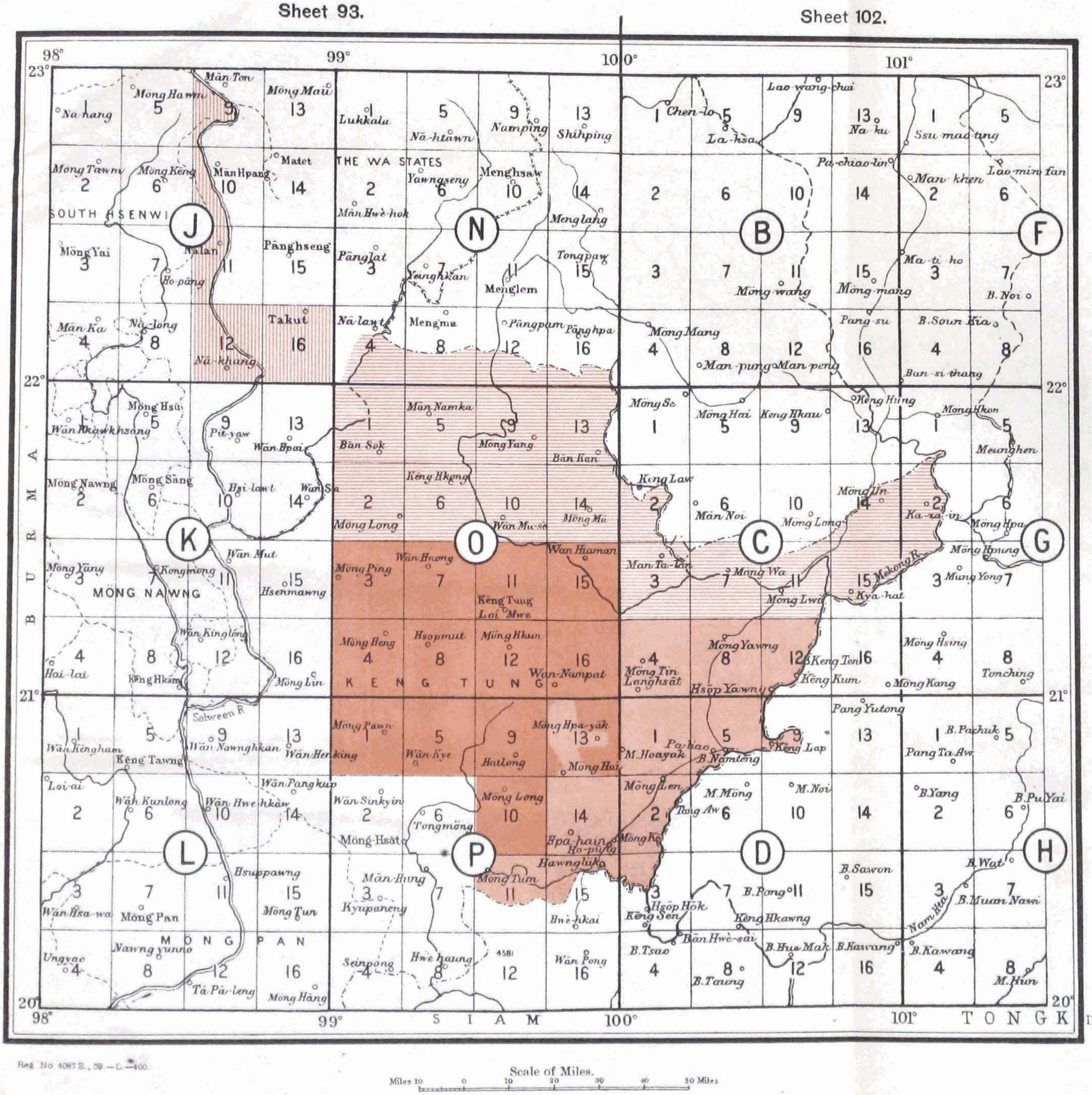
The main roads through these southern sheets are excellent; that is, taken by the standard of other roads in the State. The country in these sheets 102 $\frac{D}{2,3}$, and 93 $\frac{P}{15}$ is low lying and uninteresting; the hills are rather difficult for surveying, being not particularly steep, and covered with thick jungle mostly bamboo. Along the Nam Hōk is a fair extent of level grass land, and a certain amount of teak. This is the only teak found in the Mekong drainage within British territory worth speaking of; it is not at present of any great size nor in any quantity; a sale is now being arranged with a Frenchman who will float the logs down the Mekong.

The country triangulated along the Chinese frontier is of a very different nature to most of that under detail survey this season. It is a mass of steep hills, with ranges running to over 8,000 feet, and intersected by two great rivers, the Nam Lam and the Nam Lwè; these unite in sheet 102 $\frac{C}{7}$ and flow into the Mekong; the height of their junction above sea level is about 1,700 feet. Both these rivers flow through narrow defiles, which hardly open out anywhere to give room for rice cultivation. The whole country is very steep and intricate, so that it is difficult to get over the ground; however, the jungle is not heavy and the very steepness of the hills makes them easy to sketch.

INDEX MAP

to illustrate progress of modern surveys in the

SHAN STATES.



REFERENCES.

Surveyed in previous years..............

Do......in year under report..............

Triangulated in previous years..............

Do.........during year under report..............

Surveyor General's Office,

No. 13, Wood Street,

Calcutta, 16th Mar: 1910.

The Hon'ble Colonel F. B. Longe, R.E., Surveyor General of India, has the honour to present Librarian Smithsonian Institute

with a copy of the Extracts from Narrative Reports of the Survey of India during 1907-08, and requests the favour of an acknowledgment of the receipt of the same.