EXTRACTS
FROM
NARRATIVE REPORTS
OF OFFICERS OF THE
Survey of India
FOR THE SEASON
1903-04.

PREPARED UNDER THE DIRECTION OF
COLONEL F. B. LONGE, R.E.,
SURVEYOR GENERAL OF INDIA.

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CONTENTS.

I

THE MAGNETIC SURVEY OF INDIA.

Extracted from the Narrative Report of Major H. A. D. Fraser, R.E., in charge No. 26 Party (Magnetic) for season 1903-04.

Outturn of field work.

1. The following table shows the outturn of work by the field detachments during the season under review:—

Statement showing the outturn by Field Detachments in the season 1903-04.

	1	2	3	4	5	6	7	8	9
Observer.	Date of commencement of field work.	Date of finishing field work.	Total days of field work.	New stations visited.	Old stations re-visited.	Duplicate stations occupied.	Total stations.	Average outturn per week.	REMARKS.
Mr. P. Morton	8th November 1903.	5th May 1904 .	180	40	...	...	40	1·56	Chiefly in difficult country in south-west India.
„ R. P. Ray	4th November 1903.	23rd January 1904.	136	59	...	...	59	3·04	Railways.
„	9th March 1904	2nd May 1904 .							
„ A. M. Talati	3rd November 1903.	26th April 1904	177	69	...	2	71	2·81	Railways.
„ E. A. Meyer	5th November 1903.	10th February 1904.	98	33	1	...	34	2·43	Railways and roads.
„ K. K. Datta	5th November 1903.	25th April 1904	174	32	21	...	53	2·13	Chiefly in the desert.
TOTAL .	......	......	765	233	22	2	257	2·35	

NOTE.—Columns 1 and 2 do not include the time spent on journeys before commencing and after finishing field work. At all stations complete observations of dip declination and intensity were made. The duplicate stations entered in column 6 are railway junctions visited by two observers.

During the two previous seasons 367 stations were visited so that the total number now amounts to 600. It is hoped that the remaining 500 stations* required to complete the fundamental survey of India and Burma will be completed in three seasons with an establishment of four field detachments. A great part of the remaining work lies in very difficult country and progress will be distinctly slower than in the last two years.

Accuracy of the work.

2. In all observations of declination and intensity the accuracy of the work, as gauged by the agreement of the computed values of constants, was very

---

* The average interval between stations in the fundamental survey is 35 to 40 miles except in the most inaccessible tracts.

satisfactory. The dip circles in use are the best obtainable: they give results which compare favourably with those obtained by similar instruments in other countries, and are treated in the field with the same care as chronometers, being invariably carried by hand when on the march. As usual, however, some of them gave trouble in the field, and it is certain that the accuracy attainable by these instruments under field conditions compares unfavourably with measurements of declination as made with the survey magnetometers.

Account of field work.

3. The first detachment, under Mr. Morton, commenced work at Mahábaleshwar on the 8th November 1903, and thence traversed the difficult country along the West Coast as far south as Cape Comorin. Owing to difficulties in the matter of transport this party was unable to finish its programme, but completed work at 40 new stations and returned to Dehra Dún on the 16th May 1904. Whilst working in the extreme south of India, the observer crossed the magnetic equator and visited several stations at which the needle was found to dip towards the south pole.

The second detachment under R. P. Ray commenced work at Lucknow on the 4th November 1903 and completed work at 59 new stations along the net-work of railway lines between that place and Calcutta. In addition the observer held charge of the magnetic observatory at Barrackpore from the 25th January to the 3rd March 1904 during the illness of the regular observer. Whilst at Calcutta observations were taken in the Botanical Gardens near the site occupied by Hermann Schlagintweit in March 1856. This work had to be done between midnight and 3 A.M. in order to avoid disturbances caused by the running of the electric trams.

The detachment under Mr. Talati worked along railway lines to the west of Lucknow observing at 69 new stations, besides two places also visited by R. P. Ray, making a total of 71 stations in all. In addition to the routine work at each station, a considerable number of extra deflections were taken, using a special suspended magnet of a different length from that ordinarily used. The results so obtained are interesting and will be dealt with later.

The fourth detachment under Mr. Meyer was employed in the south of India chiefly along railway lines, but owing to the illness of the observer at the Kodaikánal Observatory, Mr. Meyer had to be withdrawn from the field on the 11th February, after completing 33 new stations and repeating a declination observation at one old station.

The fifth and last detachment under K. K. Dutta, commenced by re-visiting a number of the first season's stations and subsequently filled in gaps in the Jaisalmer State and in the country between Quetta and the Indus river.

At the commencement and close of the season each observer made a set of comparative observations at Dehra Dún.

Work done by Imperial officers.

4. Lieutenant R. H. Thomas, R.E., was fully trained in taking magnetic observations and the adjustment of magnetographs. He, together with the officer in charge, took observations at eight new repeat stations and nine old ones, besides taking comparative observations at four observatories and inspecting the field detachments whilst at work.

Values of P and of p and q in the distribution co-efficient.

5. The following table shows the value of the distribution constant P during the past year:—

TABLE A.

Numbers of magnet.	P from 22·5 and 30 cms.					P from 30 and 40 cms.					Remarks.
	Mean from all observations.	Adopted mean value.	Total number of observations.	Number of rejected observations.	Number of observations used in finding mean.	Mean from all observations.	Adopted mean value.	Total number of observations.	Number of rejected observations.	Number of observations used in finding mean.	
1 A	7·55	7·53	171	6	165	7·83	7·88	162	28	134	
3 A	6·65	6·66	44	1	43	7·75	7·76	47	8	39	From 23rd October 1903 to 19th January 1904.
3 A	6·04	6·05	52	3	49	7·11	7·12	55	11	44	From 21st January 1904 to 19th May 1904.
4 A	7·51	7·51	81	1	80	8·84	8·86	91	18	73	
5 A	7·21	7·19	51	2	49	7·88	8·03	46	9	37	From 23rd October 1903 to 10th February 1904.
5 A	7·47	7·47	9	...	9	8·33	8·33	9	...	9	From 20th April 1904 to 2nd May 1904 at Dehra.
6 A	7·88	7·89	58	1	57	8·04	8·10	64	9	55	
10	5·77	5·76	97	2	95	7·23	7·15	106	16	90	As used with suspended magnet of ordinary pattern.
10	−4·60	−4·60	34	2	32	−2·81	−2·69	34	5	29	As used with special suspended magnet No. 10K.
16	6·91	6·88	102	8	94	8·52	8·55	105	22	83	1903.
17	7·45	7·45	137	5	132	8·07	8·10	141	24	117	1903.
20	6·84	6·80	42	2	40	7·61	7·57	44	8	36	From August to December 1903.

NOTE.—The moment of magnet 3A dropped suddenly about the 20th January 1904, and the values of P changed at the same time. The cause of the change is unknown.

Magnet 5A was not in use after 10th February 1904 till the second comparison was made at Dehra Dûn in April. The values of P were then found to have changed, though there was no apparent change in the moment.

In all the magnetometers used in this survey the ratio $\frac{\text{short}}{\text{long}}$ magnet $= \frac{1}{1·46}$, the dimensions of the long or deflecting magnet being length 3·65 inches, external diameter 0·4 inch and internal diameter 0·3 inch. Instrument No. 10 is *also* provided with a special short magnet No. 10 K. in which the ratio $\frac{\text{short}}{\text{long}}$ magnet $= \frac{1}{1·23}$, the dimensions of the long magnet being as stated above.

The method used in rejecting extreme values of P is explained on page 40 of "Extracts from Narrative Reports, etc., season 1902-03."

Using the formulæ—

$$P_{1·2} - P_{2·3} = q\left(\frac{1}{r_1^2} - \frac{1}{r_3^2}\right) \text{ and}$$

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

which are explained on pages 40 and 41 of the volume of "Extracts" above alluded to, the following table was compiled :—

TABLE B.

Table showing the values of $P_{1·2}$ and $P_{2·3}$ and of p and q for different magnets.

Magnet.	$P_{1·2}$	$P_{2·3}$	p.	q.	REMARKS.
1A . .	7·53	7·88	8·33	—259	
3A . .	6·66	7·76	9·17	—814	From 23rd October 1903 to 19th January 1904.
3A . .	6·05	7·12	8·50	—792	From 21st January 1904 to 19th May 1904.
4A . .	7·51	8·86	10·59	—999	
5A . .	7·19	8·03	9·08	—622	From 23rd October 1903 to 10th February 1904.
5A . .	7·47	8·33	9·43	—636	From 20th April 1904 to 2nd May 1904.
6A . .	7·89	8·10	8·37	—155	
10 . .	5·76	7·15	8·94	—1,029	Using the ordinary pattern suspended magnet.
10 . .	—4·60	—2·69	—0.24	—1,413	Using suspended magnet No. 10 K.
16 . .	6·88	8·55	10·69	—1,236	
17 . .	7·45	8·10	8·93	—481	
20 . .	6·80	7·57	8·56	—570	

The next table shows the correction which would have to be applied to the computed values of log $\frac{m}{H}$ if the above values of p and q were used in the computation instead of the value of $P_{1·2}$ only. Thus the correction tabulated = Log. $\left(1-\frac{p}{r^2}-\frac{q}{r^4}\right)$ — Log. $\left(1-\frac{P}{r^2}\right)$.

TABLE C.

Instrument.	1	2	3	REMARKS.
	Log. $\left(1-\frac{p}{r^2}-\frac{q}{r^4}\right)$ r = 22·5 cms.	Log. $\left(1-\frac{P}{r^2}\right)$ r = 22·5 cms.	Correction $10^{-5}\times$	
1	1·99324	1·99349	—25	
3	1·99346	1·99425	—79	From 23rd October 1903 to 19th January 1904.
3	1·99401	1·99478	—77	From 21st January 1904 to 19th May 1904.
4	1·99254	1·99351	—97	
5	1·99321	1·99379	—58	From 23rd October 1903 to 10th February 1904.
5	1·99293	1·99354	—61	From 20th April 1904 to 2nd May 1904.
6	1·99303	1·99318	—15	
10	1·99403	1·99503	—100	Using the ordinary pattern suspended magnet.
10	0·00259	0·00393	—134	Using suspended magnet No. 10 K.
16	1·99286	1·99405	—119	
17	1·99310	1·99356	—46	
20	1.99357	1·99412	—55	

Taking the values of H at Dehra Dún equal to 0·334 C.G.S., the following table shows the charges in its absolute value which would result from taking account of the q term :—

TABLE D.

The change in the values of H (due to taking q term into account) at Dehra Dún in 1903-04.

H at Dehra Dún = ·334 C.G.S.

Instrument.	Change in H. at Dehra Dún due to taking q term into account.	REMARKS.
1	$+10\gamma$	
3	$+30\gamma$	From 23rd October 1903 to 19th January 1904.
3	$+30\gamma$	From 21st January 1904 to 19th May 1904.
4	$+37\gamma$	
5	$+22\gamma$	From 23rd October 1903 to 10th February 1904.
5	$+23\gamma$	From 20th April 1904 to 2nd May 1904.
6	$+6\gamma$	
10	$+38\gamma$	
10k	$+52\gamma$	
16	$+46\gamma$	Kodaikánal base station instrument.
17	$+18\gamma$	Dehra Dún „ „ „
20	$+21\gamma$	Barrackpore „ „ „

It will be noticed in table B that the values of P obtained from the two suspended magnets used with magnet No. 10 in the deflection observations differ very widely and that in both cases the value of q is large. It is therefore, interesting to see whether the absolute results obtained with this instrument are brought into accord by taking account of the q term.

During the season observations were taken at 31 stations using both suspended magnets: if we denote the deflection observations taken with the ordinary and special suspended magnets respectively by the figures D_o and D_k, then the order of observation at each station is represented by D_o—V—D_k where V stands for a vibration observation with magnet No. 10. In every case the complete set of observations was taken as rapidly as possible. By using the values of P_r's given in table A and combining V with D_o and D_k, two values of the moment of magnet No. 10 are obtained at each station, which are exhibited in the following table:—

TABLE E.

Values of the moment (m_0) of magnet No. 10.

DATE.	1	2	Difference	
	m_0 From D_0—V.	m_0 From V—D_k.	1 — 2.	
20th November 1903.	863·02	863·34	—0·32	
22nd „	3·10	3·54	·44	

TABLE E.—*continued.*

Values of the moment (m_0) *of magnet No. 10*—continued.

DATE.	1 m_0. From D_0—V.	2 m_0. From V—D_k.	Difference 1 — 2.
24th November 1903	3·24	3·48	·24
26th " .	3·38	3·65	·27
29th .	2·96	3·28	·32
19th December 1903 .	2·96	3·18	·22
21st " .	3·28	3·38	·10
27th " .	2·92	3·10	·18
30th " .	3·06	3·59	·53
3rd January 1904 .	3·16	3·55	·39
5th " .	3·10	3·44	·34
7th " .	3·20	3·50	·30
7th " .	2·96	3·26	·30
11th " .	2·78	3·06	·28
14th " .	3·00	3·18	·18
15th " .	2·84	3·22	·38
23rd " .	2·86	3·16	·30
25th " .	3·04	3·52	·48
28th " .	2·90	3·14	·24
2nd February 1904 .	2·92	3·28	·36
4th " .	2·74	3·04	·30
6th " .	2·92	3·16	·24
11th " .	3·02	3·22	·20
2nd April 1904 .	2·80	2·88	·08
5th " .	2·60	2·94	·34
7th " .	3·10	3·40	[illegible]
10th " .	2·40	2·52	·12
12th " .	2·78	3·14	·36
18th " .	2·70	3·04	·34
20th " .	2·94	3·20	·26
23rd " .	2·40	2·70	·30
26th " .	2·84	3·06	·22
Means .	862·93	863·22	—0·29

We see therefore that the values of m_0 differ considerably owing to the defective method of reduction used. If the method were correct we should expect to find the two mean values of m_0 practically identical.

If now, instead of P_{r^2}, we use the values of p and q given in table B, two new values of m_0 will be found. Table C shows that in the case of D_0 and D_k respectively the quantities −0·00100 and −0·00134 must be added to the previously computed values of Log $\frac{m}{H}$ in order to take the q term into account. To find the corresponding new mean values of m_0 it is only necessary to add one-half of these quantities to the Logs of the mean values of m_0 in columns 1 and 2 of table E, and take out the corresponding natural numbers. These new values are found to be (1) 861·94 and (2) 861·89. The difference between them, *viz.*, (1)—(2) is now +0·05, as against − 0·29 derived from table E. The agreement is satisfactory and seems to justify the following conclusions:—

(1) The method adopted for deriving the values of p and q is reliable.

(2) In the expression $\left(1+\frac{p}{r^2}+\frac{q}{r^4}+\cdots\cdots\right)$ for the distribution co-efficient, terms involving higher powers of r than r^4 are negligible for magnets of the pattern used in this survey.

Average pole distance of magnets.

6. Referring again to table B, we find that the mean value of p for all the ordinary magnets is 9·17. If we denote the lengths of the long and short magnets by L and λ and the pole distances by $2L_{\prime}$ and $2\lambda_{\prime}$, the expression for $p=2L_{\prime}^2-3\lambda_{\prime}^2$. Then assuming that $\frac{2L_{\prime}}{L}=\frac{2\lambda_{\prime}}{\lambda}$ (which is likely to be approximately true as the two magnets are of a similar type) and substituting 9·17 for p and 1·46 for $\frac{L_{\prime}}{\lambda_{\prime}}=\frac{L}{\lambda}$ in the equation $p=2L_{\prime}^2-3\lambda_{\prime}^2$, we find that $\frac{2\lambda_{\prime}}{\lambda}=0{\cdot}85$.

This value agrees closely with that found by Dr. Chree, F.R.S., when he examined the same survey instruments at the Kew Observatory, *vide* Phil. Mag. S. 6, Vol. 8 of August 1904.

Comparison of instruments and houses in declination.

7. A set of simultaneous observations was made in the two absolute houses, using magnetometer No. 17 (the standard) and No. 1. In what follows N.H. stands for north house and S. H. for south house, whereas in the last annual report the letters N. H. stood for new house, *i.e.*, for the existing south house. Using the method explained in the last report the following table exhibits the results of the comparison :—

TABLE F.

Simultaneous declination observations.

DATE.	No. 17 in S. H. or $\frac{\text{S. H.}}{17}$.	No. 1 in N. H. or $\frac{\text{N. H.}}{1}$.	X or $\frac{\text{S. H.}}{17}-\frac{\text{N. H.}}{1}$.	Observer.
	° ′ ″	° ′ ″	″	
5th November 1903 .	2 41 28	2 40 50	+38	H. A. D. F. and S. D.
" " .	41 14	40 40	39	
" " .	41 06	40 27	39	
" " .	40 52	40 16	36	
" " .	40 55	40 09	46	
6th " .	2 40 37	2 39 37	60	
" " .	40 31	39 34	57	
" " .	40 18	39 28	50	
" " .	40 22	39 16	66	
" " .	40 11	39 16	55	
			Mean X= +48	

DATE.	No. 1 in S. H. or $\frac{S.\ H.}{1}$.	No. 17 in N. H. or $\frac{N.\ H.}{17}$.	X_1 or $\frac{S.\ H.}{1} - \frac{N.\ H.}{17}$.	Observer.
	° ′ ″	° ′ ″	″	
5th November 1903 .	2 41 25	2 40 52	+33	H. A. D. F. and S. D.
" " .	41 26	40 46	+40	
" " .	41 25	40 52	+33	
" " .	41 32	41 01	+31	
" " .	41 36	40 53	+43	
6th " .	2 42 34	2 41 56	+38	
" " .	42 45	42 14	+31	
" " .	42 58	42 35	+23	
" " .	43 00	42 28	+32	
" " .	43 09	42 41	+28	
			Mean $X_1 = +33$	

Hence i or No. 17—No. 1 = ½ $(X - X_1) = +8''$ or $+0'{\cdot}13$ and s or S. H. — N. H. = ½ $(X + X_1) = +41''$ or +0·68.

Earlier in the year a number of observations were made with the same instrument in both houses on the same day and a comparison between sites was obtained through the magnetograph curves.

The results were as follows:—

DATE.	S. H. — N. H.
28th March 1903	+0′·30
24th " "	·38
24th " "	.28
27th " "	·28
31st " "	·26
7th April "	1·70
14th " "	·84
14th " "	1·24
14th " "	1·10
17th " "	·58
21st " "	·72
Mean	+0′.70

The result agrees well with that obtained in November and the value for the difference in site S. H.—N. H. has been accepted as +0′·68 for all comparisons made during the year. In the followings tables of comparisons all observations taken in the N. H. have been corrected by the addition of this quantity:—

TABLE G.

Comparison of Magnetometers in declination: End of Field Season, 1902-03 and beginning of Field Season 1903-04.

Date.	No. of Instrument.	Site N. or S. H.	S. (Instruments under comparison.)	D. D₁. (Dehra Dún Standard No. 17.)	D. D.—S. β.	D.D.—β. (D₁.)	S.—D₁.	Observer's initials.
			° ′	° ′	′	° ′	′	
13th March 1903. .		S. H.	2 41·05	2 41·88	+0·83	2 42·22	—1·17	H. F.
		„	40·42	41·15	0·73	41·49	—1·07	„
14th „ . .		„	40·23	41·05	0·82	41·39	—1·16	„
8th May 1903 . .	1	N.H.	2 45·91	2 44·61	—1·31	44·95	+0·96	A. M. T.
		„	45·60	44·40	1·20	44·74	+0·86	„
		„	44·41	43·68	0·73	44·02	+0·39	„
13th „ . .	1A	„	45·31	43·78	1·53	44·12	1·19	„
					β=—0·34		± 0·97	
26th December 1903. .		N. H.	2 41·36	2 41·34	—0·02	2 41·50	—0·14	R. H. T.
		„	41·30	41·24	0·06	41·40	—0·10	„
29th „ . .		„	41·78	41·55	0·23	41·71	+0·07	„
		„	41·80	41·55	0·25	41·71	+0·09	„
		„	41·75	41·55	0·20	41·71	+0·04	„
		„	41·75	41·55	0·20	41·71	+0·04	„
					β=—0·16		±0·08	
29th May 1903 . .	3	S. H.	2 41·85	2 41·47	—0·38	2 41·36	+0·49	R. P. R.
		„	41·97	41·88	0·09	41·77	0·20	„
30th „ . .	3A	„	39·18	38·89	0·29	38·78	0·40	„
		„	39·72	39·61	0·11	39·50	0·22	„
		„	40·45	40·33	0·12	40·22	0·23	„
		„	41·03	40·85	0·18	40·74	0·29	„
		„	41·32	40·95	0·37	40·84	0·48	„
31st „ . .		„	40·50	39·82	0·68	39·71	0·79	„
		„	40·92	40·44	0·48	40·33	0·59	„
1st June „ . .		„	37·63	39·51	+1·88	39·40	—1·77	„
		„	37·68	39·71	2·03	39·60	1·92	„
					β=+0·11		±0·67	
22nd October 1903. .		S. H.	2 41·58	2 42·34	+0·76	2 42·40	—0·82	R. P. R.
		„	41·20	41·92	0·72	41·98	0·78	„
24th „ . .		N.H.	43·01	42·72	—0·29	42·78	+0·23	„
		„	43·38	43·13	0·25	43·19	0·19	„
27t „ . .		S. H.	41·80	41·48	0·32	41·54	0·26	„
		„	41·57	41·27	0·30	41·33	0·24	„
28th „ . .		N.H.	41·45	41·07	0·38	41·13	0·32	„
		„	41·08	40·66	0·42	40·72	0·36	-
					β=—0·06		±0·40	

TABLE G—*contd.*

Comparison of Magnetometers in declination: End of Field Season, 1902-03 and beginning of Field Season, 1903-04.—contd.

Date.	No. of Instrument.	Site N. or S. H.	S. (Instrument under comparison.)	D. D1. (Dehra Dún Standard No. 17.)	D. D—S: β	D. D.—β (D1.)	S.—D1.	Observer's initials.
			° ′	° ′	′	° ′	′	
27th April 1903	4	N.H.	2 39·41	2 38·40	−1·01	2 39·05	+0·36	K. K. D.
		,,	40·31	39·33	0·98	39·98	0·33	,,
28th ,,		,,	39·03	38·40	0·63	39·05	−0·02	,,
29th ,,		,,	40·41	40·36	0·05	41·01	+0·40	,,
		,,	41·48	41·18	0·30	41·83	−0·35	,,
30th ,,	4A	,,	45·98	45·20	0·78	45·85	+0·13	,,
		,,	45·68	44·89	0·79	45·54	0·14	,,
					β=−0·65		±0·25	
23rd October 1903		N.H.	2 37·78	2 37·33	−0·45	2 38·29	−0·51	K. K. D.
		,,	41·98	41·30	0·68	42·26	0·28	,,
		,,	42·01	40·92	1·09	41·88	+0·13	,,
26th ,,		S. H.	42·88	41·79	1·09	42·75	0·13	,,
		,,	42·88	41·58	1·30	42·54	0·34	,,
		,,	43·30	42·20	1·10	43·16	0·14	,,
28th ,,		N.H.	43·45	42·41	1·04	43·37	0·08	,,
		,,	43·81	42·82	0·99	43·78	0·03	,,
29th ,,		S. H.	43·18	42·20	0·98	43·16	0·02	,,
		,,	43·47	42·61	0·86	43·57	−0·10	,,
					β=−0·96		±0·18	,,
5th September 1903	5	S. H.	2 40·30	2 40·52	+0·22	2 40·90	−0·60	E. A. M.
		,,	39·05	38·25	−0·85	38·63	+0·45	,,
		,,	39·48	38·46	0·02	38·84	0·64	,,
6th ,,		,,	40·15	39·70	0·45	40·08	0·07	,,
		,,	40·22	39·80	0·42	40·18	0·04	,,
24th October 1903		N.H.	42·75	41·89	0·86	42·27	0·48	,,
		,,	41·76	41·07	0·69	41·45	0·31	,,
		,,	41·31	40·86	0·45	41·24	0·07	,,
		,,	41·18	40·45	0·73	40·83	0·35	
27th ,,		,,	40·45	39·90	0·55	40·28	0·17	,,
		,,	40·43	40·12	0·32	40·50	−0·07	,,
28th ,,		S. H.	41·05	41·07	+0·02	41·45	0·40	,,
		,,	40·90	40·66	−0·24	41·04	0·14	,,
					β=−0·38		±0·11	

TABLE G—*concld.*

Comparison of Magnetometers in declination: End of Field Season, 1902-03 and beginning of Field Season, 1903-04—concld.

Date.	No. of Instrument.	Site N. or S. H.	S. (Instrument under comparison.)	D. D1. (Dehra Dún Standard No. 17.)	D. D—S. (β.)	D.D.—β (D1.)	S.—D1.	Observer's initials.
			° ′	° ′	′	° ′	′	
2nd May 1903 . .	6	N.H.	2 41·40	2 41·80	+0·40	2 41·06	+0·34	P. M.
		„	40·35	41·18	0·83	40·44	—0·09	„
		„	39·88	40·87	0·99	40·13	0·25	„
					β=+0·74		±0·23	
22nd October 1903 .		N.H.	2 42·83	42·54	—0·29	2 42·23	+0·60	P. M.
		„	43·25	42·85	0·40	42·54	0·71	„
24th „ .		S. H.	40·52	42·72	+2·20	42·41	—1·89	„
		„	40·92	43·13	2·21	42·82	1·90	„
26th „ .		„	43·68	43·44	—0·24	43·13	+0·53	„
		„	43·20	42·92	0·28	42·61	0·59	„
27th „ .		N.H.	41·80	41·48	0·32	41·17	0·63	„
28th „ .		S. H	42·47	42·41	0·06	42·10	0·47	„
		„	42·83	42·82	0·01	42·51	0·32	„
					β=+0·31		±0·85	
23rd October 1903 .	10	N.H.	2 42·65	2 41·98	—0·67	2 42·15	+0·50	A. M. T.
		„	43·11	42·43	0·58	42·60	0·41	„
24th „ . .		S. H.	41·53	41·89	+0·46	42·06	—0·56	„
		„	40·65	41·07	0·42	41·24	0·59	„
		„	40·45	40·86	0·41	41·03	0·58	„
		„	39·90	40·45	0·55	40·62	0·72	„
26th „ . .		N.H.	42·21	41·79	—0·42	41·96	+0·25	„
		„	42·03	41·58	0·45	41·75	0·28	„
		„	42·73	42·20	0·53	42·37	0·36	„
29th „ . .		„	42·73	42·20	0·53	42·37	0·36	„
		„	43·10	42·61	0·49	42·78	0·32	„
					β=—0·17		±0·45	

TABLE H.

Abstract of Results of comparison of Magnetometers in Declination.

17—	End of field season 1902-03.	Beginning of field season 1903-04.
1	−0·34	−0·02*
3	+0·11	−0·06
4	−0·65	−0·96
5	No comparison	−0·38
6	+0·74	+0·31
10	No comparison	−0·17

* This value is the mean of the quantities +0'·13 and —0'·16 which are independently arrived at in the previous tables.

9. The next table exhibits the results of the only comparison made between the north and south houses.

Comparison of houses in H. F.

TABLE J.

SOUTH HOUSE.			NORTH HOUSE.			
1	2	3	4	5		
DATE.	H. F. deduced from vibrations.	Corresponding values of base line.	H. F. deduced from vibrations.	Corresponding values of base line.	S. H.— N. H. *i. e.* (3)—(5).	REMARKS.
	C. G. S.	C. G. S.	C. G. S.	C. G. S.	γ	
26th March 1903 .	0·33482	0·33205	·33466	·033201	+4	Vibrations taken by chronograph with magnet 17.
	78	201	59	196	+5	Mean m_o=916·33.
	80	203	60	198	+5	
	79	203	58	197	+6	
	76	201	62	202	—1	
27th " " .	63	200	68	210	—10	
	70	207	54	197	+10	
	66	203	56	199	+4	
	62	199	57	201	—2	
	58	196	48	193	+3	
	59	206	56	201	+5	
	60	206	57	201	+5	
	48	194	60	205	—11	
	60	206	53	198	+8	
	48	194	58	203	—9	
				Mean S. H.—N.H.=	+1γ	

The difference between houses is therefore negligible.

10. At the end of field season 1902-03, each observer, on returning from the field, took a set of force observations in one of the two absolute houses, whilst

Comparison of instruments in H. F.

at the beginning of the following field season, observations were taken between fixed hours by all the observers in tents pitched close to the absolute houses. The time available for comparisons was limited and many days would have been lost had observations been restricted to the north and south houses. Consequently four tents were pitched at safe distances, but close to the north and south houses, and each observer worked in these and in the north house in rotation, whilst extra observations were taken every day in the south house with the standard instrument. As there is no difference in intensity between the two houses and as the tents were only far enough away to avoid interference between the magnets, it is reasonable to assume that the site differences were *nil.* The base line of the magnetograph was derived from the special observations taken during the period of the comparison with the standard instrument. The results obtained are exhibited below:—

TABLE K.

Comparisons of Instruments in Horizontal Force.

DATE.	No. of Inst.	S. (Inst. under comparison).	D. D. No. 17.	D. D.—S. $=\beta$	D. D.—β = D₁.	S.—D₁.	OBSERVER.
12th March 1903 .	I	·33469	·33464	—5	·33472	—3	H. F.
		468	463	5	471	—3	„
		471	464	7	472	—1	„
		472	466	6	474	—2	„
13th „ .	...	463	458	5	466	—3	„
		463	456	7	464	—1	„
		463	455	8	463	0	„
		468	456	12	464	+4	„
14th „ .	...	460	448	12	456	+4	„
		457	446	11	454	+3	„
		458	445	13	453	+5	„
				β=—8γ		±3γ	
9th May 1903 .	...	·33443	·33429	—14	·33434	+9	A. M. T.
		427	424	3	429	—2	„
		426	424	2	429	—3	„
		442	428	14	433	+9	„
11th „ .	...	435	436	+1	441	—6	„
		436	437	—1	442	—6	„
		437	438	+1	443	—6	„
		456	442	—14	447	+9	„
12th „ .	...	431	429	2	434	—3	„
		433	428	5	433	0	„
		433	426	7	431	+2	„
		427	425	2	430	—3	„
				β=—5γ		±5γ	

TABLE K—*contd.*

Comparisons of Instruments in Horizontal Force.

DATE.	No. of Inst.	S. (Inst. under comparison).	D. D. No. 17.	D. D.—S. $= \beta$	D. D. $- \beta = D_1$.	S. $- D_1$.	OBSERVER.
2nd November 1903	1	·33331	·33326	−5	·33333	−1	R. H. T.
		324	325	+1	331	−7	,,
3rd ,,	...	366	362	−4	368	−2	,,
		352	351	−1	357	−5	,,
4th ,,	...	380	379	−1	385	−5	,,
		385	380	−5	386	−1	,,
9th ,,	...	400	391	−9	397	+3	H. F.
		401	391	−10	397	+4	,,
		401	390	−11	396	+5	,,
		397	387	−10	393	+4	,,
26th December 1903	...	425	422	−3	428	−3	R. H. T.
		423	420	−3	426	−3	,,
		423	422	−1	428	−5	,,
30th ,,	...	467	456	−11	462	+5	,,
		459	454	−5	460	−1	,,
		452	445	−7	451	+1	,,
		446	438	−8	444	+2	,,
		373	371	−2	377	−4	,,
		377	366	−11	372	+5	,,
				$\beta = -6\gamma$		$\pm 3\gamma$	
29th May 1903	3	·33413	·33433	+20	·33420	−7	R. P. R.
		412	434	22	421	−9	,,
		420	436	16	423	−3	,,
		416	436	20	423	−7	,,
30th ,,	...	422	439	17	426	−4	,,
		423	437	14	424	−1	,,
		420	434	14	421	−1	,,
		416	430	14	417	−1	,,
1st June 1903	...	439	443	4	430	+9	,,
		436	441	5	428	+8	,,
		434	438	4	425	+9	,,
		429	434	5	421	+8	,,
				$\beta = +13\gamma$		$\pm 6\gamma$	
23rd October 1903	3	·33383	·33406	+23	·33386	−3	R. P. R.
		383	399	16	381	+2	,,
		387	403	16	385	+2	,,
		394	408	14	390	+4	,,

TABLE K—*contd.*

Comparisons of Instruments in Horizontal Force.

DATE.	No. of Inst.	S. (Inst. under comparison).	D. D. No. 17.	D. D.—S. $=\beta$	D. D.—β $=D_1$.	S.—D_1.	OBSERVER.
		′	′		′		
24th October 1903 .	3	·33397	·33415	+18	397	0	R. P. R.
		397	415	18	397	0	„
		401	418	17	400	+1	„
		396	415	19	397	—1	„
27th „ .	...	389	405	16	387	+2	„
		382	401	19	383	—1	„
		379	397	18	379	0	„
		369	393	24	375	—6	„
28th „ .	...	402	415	13	397	+5	„
		400	415	15	397	+3	„
		398	413	15	395	+3	„
		393	412	19	394	—1	„
				$\beta=+18\gamma$		$\pm2\gamma$	
28th April 1903 .	4	·33411	·33442	+31	·33417	—6	K. K. D.
		410	438	28	413	—3	„
		406	433	27	408	—2	„
		402	428	26	403	—1	„
29th „ .	...	425	450	25	425	0	„
		419	453	34	428	—9	„
		421	455	34	430	—9	„
		432	457	25	432	0	„
30th „ .	...	422	447	25	422	0	„
		424	447	23	22	+2	„
		423	447	24	422	+1	„
		423	447	24	422	+1	„
1st May 1903 .	...	420	447	27	422	—3	„
		428	447	19	422	+6	„
		430	447	17	422	+8	„
		432	448	16	423	+9	„
				$\beta=+25\gamma$		$\pm4\gamma$	
23rd October 1903 .	...	·33405	·33407	+2	·33399	+6	K. K. D.
		395	400	5	392	+3	„
		396	400	4	392	+4	„
		393	405	12	397	—4	„
24th „ .	...	411	418	7	410	+1	„
		403	415	12	407	—4	„
		412	414	2	406	+6	„
		410	414	4	406	+4	„

TABLE K—*contd.*

Comparisons of Instruments in Horizontal Force.

DATE.	No. of Inst.	S. (Inst. under comparison).	D. D. No. 17.	D. D.—S. $=\beta$	D. D.—β. $=D_1$.	S.—D_1.	OBSERVER.
27th October 1903 .	4	·33386	·33405	+19	·33397	—11	K. K. D.
		400	402	2	394	+6	"
		397	398	1	390	+7	"
		377	393	16	385	—8	"
28th " .	...	412	416	4	408	+4	"
		403	414	11	406	—3	"
		395	413	18	405	—10	"
		399	412	13	404	—5	"
				$\beta=+8\gamma$		$\pm5\gamma$	
23rd October 1903 .	5	·33385	·33406	+21	·33408	—23	E. A. M.
		396	399	3	401	—5	"
		396	400	4	402	—6	"
		396	404	8	406	—10	"
24th " .	...	426	415	—11	417	+9	"
		423	415	8	417	+6	"
		425	418	7	420	+5	"
		433	417	16	419	+14	"
27th " .	...	411	405	6	407	+4	"
		409	402	7	404	+5	"
		405	398	7	400	+5	"
		401	393	8	395	+6	"
28th " .	...	417	415	2	417	0	"
		404	414	+10	416	—12	"
		405	413	8	415	—10	"
		418	412	—6	414	+4	"
				$\beta=-2\gamma$		$\pm8\gamma$	
2nd May 1903 .	6	·33476	·33439	—37	·43470	+6	P. M.
		480	442	38	473	+7	"
		482	444	38	475	+7	"
		486	445	41	476	+10	"
3rd " .	...	462	439	23	470	—8	"
		468	439	29	470	—2	"
		471	440	31	471	0	"
		469	440	29	471	—2	"
4th " .	...	470	446	24	477	—7	"
		473	446	27	477	—4	"
		475	444	31	475	0	"
		471	444	27	475	—4	"
				$\beta=-31\cdot\gamma$		$\pm5\gamma$	

TABLE K—*contd.*

Comparisons of Instruments in Horizontal Force.

DATE.	No. of Inst.	S. (Inst. under comparison).	D. D. (No. 7.)	D.D.—S=β.	D.D. β=D_1.	S.—D_1.	OBSERVER.
23rd October 1903	6	·33429	·33404	—25	·33422	+7	P. M.
		424	400	24	418	+6	„
		431	404	27	422	+9	„
		434	409	25	427	+7	„
24th „	...	425	415	10	433	—8	„
		425	415	10	433	—8	„
		430	419	11	437	—7	„
		425	416	9	434	—9	„
27th „	...	420	406	14	424	—4	„
		416	404	12	422	—6	„
		413	400	13	418	—5	„
		408	395	13	413	—5	„
28th „	...	440	415	25	433	+7	„
		438	415	23	433	+5	„
		438	413	25	431	+7	„
		433	412	21	430	+3	„
				$\beta=-18\gamma$		$\pm 6\gamma$	
23rd October 1903	10	·33390	·33406	+16	·33396	—6	A. M. T.
		376	400	24	390	—14	„
		373	400	27	390	—17	„
		381	404	23	394	—13	„
24th „	...	415	416	1	406	+9	„
		413	416	3	406	+7	„
		415	418	3	408	+7	„
		411	415	4	405	+6	„
27th „	...	398	406	8	396	+2	„
		392	403	11	393	—1	„
		390	400	10	390	0	„
		383	395	12	385	—2	„
28th „	...	426	415	—11	405	+21	„
		409	414	+5	404	+5	„
		407	413	6	403	+4	„
		398	412	14	402	—4	„
30th „	...	417	424	7	414	+3	„
		409	423	14	413	—4	„
		407	421	14	411	—4	„
		409	420	11	410	—1	„
				$\beta=+10\gamma$		$\pm 7\gamma$	

TABLE L.

Abstract of results of comparison of Magnetometers in H. F.

17—	End of field season 1902-03.	Beginning of field season 1903-04.
1	$\begin{cases} -8\gamma \\ -5 \end{cases}$	-6γ
3	+13	+18
4	+25*	+8
5	No comparison	—2
6	—31	—18
10	No comparison	+10

---

* After this comparison was completed a fresh value of Log. II^2K was obtained and used in all subsequent work. Had the old value been kept the figure in the second column of the above table would have been $+22\gamma$ instead of $+8\gamma$ and it is clear therefore that instrument No. 4 has not changed appreciably during the year.

Description of the extra sites used in making comparison.

10. In arriving at the figures above given, the assumption was made that there was no difference between the sites on which the observations were taken. Assuming the difference S. H.—N. H. = $+1\gamma$ to be correct, the whole of the observations taken from 23rd to 30th October were analysed for site errors and the results obtained were as follows :—

Calling the error of site 1 S_1, site 2 S_2, etc.,

S. H.—

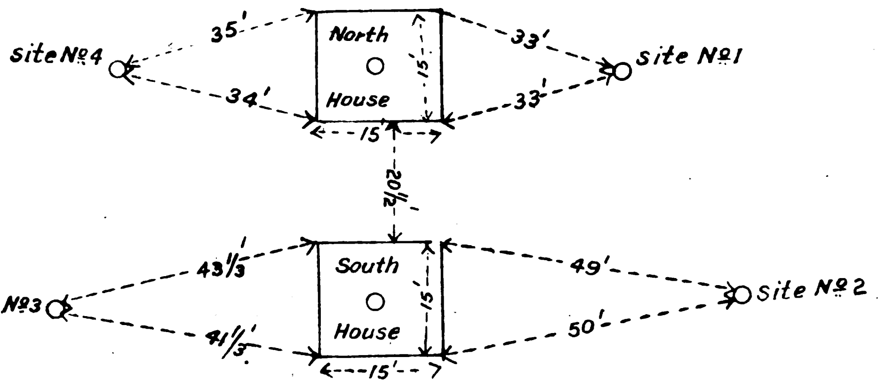
$S_1 = -1\gamma$
$S_2 = +8\gamma$
$S_3 = +10\gamma$
$S_4 = +4\gamma$

and applying these we get :—

17—

$3 = +11\gamma$
$4 = +3\gamma$
$5 = -6\gamma$
$6 = -24\gamma$
$10 = +7\gamma$.

These results are possibly more correct than those given in Table L, but until further data for the site errors are obtainable it is considered advisable to neglect them. The following figure explains the notation used above in describing the sites and represents accurately the relative positions of observation :—



Cause of differences between magnetometers.

11. At the end of paragraph 6 above the conclusion was reached that our method of determining p and q from deflections at three distances is reliable. If then the differences noted in our magnetometers were due solely to errors arising from the neglect of the q term, one would expect these errors to vanish when that term is taken into account.

TABLE M.

Comparisons of Magnetometers in H. F.

Numbers of instruments.	Neglecting q term.	Using q term.
17—1	— 6 γ	+ 2 γ
17—3	+ 18	+ 6
17—4	+ 8	— 11
17—5	— 2	— 7
17—6	— 18	— 6
17—10	+ 10	— 10

NOTE.—The figures in the second column are copied from the second column of Table L: those in the third are obtained by applying the corrections given in Table D. The agreement between instruments is distinctly improved but the differences are even now larger than the probable errors of observation. It is possible that the residual differences may be due to errors in the accepted values of the constants employed in the computations, notably the values of Log π^2 k and of r, the deflection distances.

Comparison of N. and S. houses in dip.

12. During the year six dip circles were compared with the standard No. 44 by simultaneous observations. The results are given below:—

TABLE N.

Simultaneous dip observations.

DATE.	No. 44 in S. H. $=\frac{S.H.}{44}$	No. 135 in N. H. $=\frac{N.H.}{135}$	$\frac{S.H.}{44}-\frac{N.H.}{135}=X.$	REMARKS.
1903.	° ′	° ′	′	
28th May .	43 11·9	43 16·3	—4·4	Needles 1 and 2 with No. 44.
31st „ .	17·5	12·2	—5·3	Needles 2 and 3 No. 135.
31st „ .	15·7	13·2	—4·6	
		Mean X=	—4·8	

TABLE N—*contd.*

Simultaneous dip observations—contd.

DATE.	$\frac{\text{S. H.}}{135}$	$\frac{\text{N. H.}}{44}$	$\frac{\text{S. H.}}{135} - \frac{\text{N. H.}}{44} = X_1$.	REMARKS.
1903	° ′	° ′	′	
29th May	43 14·4	43 12·3	+2·1	
29th "	11·9	14·3	−2·4	
30th "	13·0	11·6	+1·4	
30th "	14·4	15·0	−0·6	
		Mean X_1=	+0·1	
	Hence S. H.—	N. H = —2′·4		
	and $44_{1\cdot2}$ —	$135_{2\cdot1}$ = —2′·5		

DATE.	$\frac{\text{S. H.}}{44}$	$\frac{\text{N. H.}}{137}$	$\frac{\text{S. H.}}{44} - \frac{\text{N. H.}}{137} = X$.	REMARKS.
1903	° ′	° ′	′	
27th April	43 13·2	43 14·2	—1·0	Needles 1 and 2 with No. 44. Needles 1 and 3 with No. 137.
	15·5	13·0	+2·5	
	10·3	13·2	—2·9	
	10·5	10·7	—0·2	
	11·4	12·4	—1·0	
	11·3	10·8	+0·5	
		Mean X=	—0·4	

DATE.	$\frac{\text{S. H.}}{137}$	$\frac{\text{N. H}}{44}$	$\frac{\text{S. H.}}{137} - \frac{\text{N. H.}}{44} = X_1$.	REMARKS.
1903	° ′	° ′	′	
1st May	43 11·8	43 15·0	—3·6	
	9·9	14·1	—4·2	
	8·6	10·5	—1·9	
		Mean X_1 =	—3·2	
	Hence S. H.	—N. H.= —1·8		
	and $44_{1\cdot2}$	—$17_{1\cdot2}$= +1·4		

TABLE N—*contd.*

Simultaneous dip observations—contd.

DATE.	$\frac{\text{S. H.}}{44}$	$\frac{\text{N. H.}}{138}$	$\frac{\text{S. H.}}{44} - \frac{\text{N. H.}}{138} = \text{X.}$	REMARKS.
1903.	° ′	° ′	′	
4th May .	43 12·2	43 17·8	—5·6	Needles 1 and 2 with No. 44.
5th „ .	13·1	16·2	—3·1	Needles 1 and 2 with No. 138.
7th „ .	12·4	15·7	—3·3	
		Mean X =	—4·0	

DATE.	$\frac{\text{S. H.}}{138}$	$\frac{\text{N. H.}}{44}$	$\frac{\text{S. H.}}{138} - \frac{\text{N. H.}}{44} = \text{X.}$	REMARKS.
1903	° ′	° ′	′	
4th May .	43 15·5	43 13·6	+1·9	
5th „ .	16·1	13·5	—2·6	
7th „ .	5·9	12·2	+3·7	
		Mean X_1 =	+2·7	
	Hence S. H.—	N. H. =	—0′·7	
	and $44_{1\cdot2}$—	$138_{1\cdot2}$=	—3′·4	

DATE.	$\frac{\text{S. H.}}{44}$	$\frac{\text{N. H.}}{140}$	$\frac{\text{S. H}}{44} - \frac{\text{N. H.}}{140} = \text{X.}$	REMARKS.
1903.	° ′	° ′		
4th September .	43 14·8	43 16·8	—2·8	Needles 1 and 2 with No. 44.
6th „	13·7	15·7	—2·0	Needles 1 and 2 with No. 140.
7th „ .	15·1	17·0	—1·9	
		Mean X =	—2·0	

DATE.	$\frac{\text{S. H.}}{140}$	$\frac{\text{N. H.}}{44}$	$\frac{\text{S. H.}}{140} - \frac{\text{N. H.}}{44} = X_1.$	REMARKS.
1903	° ′	° ′	′	
4th September .	43 15·1	43 14·9	+0·2	
6th „ .	13·8	15·9	—2·1	
8th „ .	14·6	15·0	—0·4	
		Mean X=	—0·8	
	Hence S. H.	– N. H. =	—1′·4	
	and $44_{1\cdot2}$	—$140_{1\cdot2}$ =	—0·6	

TABLE N—*concld.*

Simultaneous dip observations—concld.

DATE.	$\frac{\text{S. H.}}{44}$	$\frac{\text{N. H.}}{136}$	$\frac{\text{S. H.}}{44} - \frac{\text{N. H.}}{136} = X.$	REMARKS.
1903.	° ′	° ′	′	
8th May .	43 10·9	43 11·8	—0·9	Needles 1 and 2 with No. 44.
9th " .	11·0	13·0	—2·0	Needles 2 and 3 of No. 139 were used in No. 136.
11th " .	10·0	12·6	—2·6	
		Mean X=	—1·8	

DATE.	$\frac{\text{S. H.}}{136}$	$\frac{\text{N. H.}}{44}$	$\frac{\text{S. H}}{130} - \frac{\text{N. H.}}{44} = X_1.$	REMARKS.
1903	° ′	° ′	′	
8th May .	43 11·5	43 12·4	—0·9	
11th " .	12·4	12·5	—0·1	
12th " .	12·9	13·5	—0·6	
	Hence S H.— and $44_{1\cdot2}$—	Mean X_1= N. H. = $136_{2\cdot2}$= 13·9	—0·5 1·2 —0·7	

DATE.	$\frac{\text{S H.}}{44}$	$\frac{\text{N. H.}}{43}$	$\frac{\text{S. H.}}{44} - \frac{\text{N. H.}}{43} = X.$	REMARKS.
1903	° ′	° ′	′	
5th November .	43 20·1	43 20·2	—0·1	Needles 1 and 2 with No. 44.
7th " .	17·5	18·1	—0·6	Needles 2 and 4 with No. 43.
8th " .	19·6	18·9	+0·7	
27th December .	16·9	19·2	—2·3	
		Mean X_1.	—0·6	

DATE.	$\frac{\text{S. H}}{43}$	$\frac{\text{N. H.}}{44}$	$\frac{\text{S. H.}}{43} - \frac{\text{N. H.}}{44} = X_1.$	REMARKS.
1903	° ′	° ′	′	
6th November .	43 17·6	43 19·1	—1·5	
7th "	18·4	19·9	—1·5	
8th " .	16·5	18·1	—1·6	
27th December .	20·8	17·4	+3·4	
	Hence S. H. and $44_{1\cdot2}$—	Mean X_1 = —N. H. = $43_{2\cdot4}$=	—0·3 —0·5 —0·2	

Abstracting the values for the difference in dip between the two houses we get—

$$\text{S. H.}-\text{N. H.} = -\tfrac{1}{6}\{2\cdot4+1\cdot8+0\cdot7+1\cdot4+1\cdot2+0\cdot5\}$$
$$= -1''\cdot3.$$

This value has been accepted and applied to all observations taken in the north house during the year 1903. At the beginning of field season 1903-04, the field dip circles were tested by simultaneous observations taken against No. 44 which was kept in the south house throughout. The other instruments were erected in rotation at the different sites alluded to in paragraph 11. The site errors of sites Nos. 1, 2, 3 and 4 were assumed to be *nil* when computing the results given in the following abstract:—

TABLE O.

$44_{1\cdot2}-$	End of field season 1902-03.	$44_{1\cdot2}-$	Beginning of field season 1903-04.
$43_{2\cdot4}$	No comparison.	$43_{2\cdot4}$	$-0\cdot2$
$135_{2\cdot3}$	$-2\cdot5$	$135_{2\cdot3}$	$+0\cdot1$
$136_{\frac{2\cdot3}{139}}$	$-0\cdot7$	$136_{1\cdot2}$	$-0\cdot9$
$137_{1\cdot3}$	$+1\cdot4$	$137_{1\cdot2}$	$+1\cdot0$
$138_{1\cdot2}$	$-3\cdot4$	$138_{2\cdot3}$	$-0\cdot9$
$140_{1\cdot2}$	No comparison.	$140_{1\cdot2}$	$-0\cdot4$
		$140_{2\cdot3}$	$-0\cdot6$

These comparisons show that the dip circles are in fair agreement at Dehra Dún where the inclination is slightly over 43°. They do not tell us anything about the agreement to be expected in other magnetic latitudes, and it is therefore very questionable whether field results should be corrected for the instrumental differences determined at Dehra Dún only. This question will have to be considered shortly when the reduction of the field observations is taken in hand. Meanwhile the biennial comparisons with the Dehra Dún standard will be continued, as they at all events serve to show whether the field instruments are changing or not.

Moment of Inertia.

13. In the last report a list was published of the accepted values of Log. π^2k for the whole of the survey instruments (except No. 2). It has all along been intended to check as many as possible of these values every year during the recess season. With this idea in view, No. 4 magnetometer was tested with magnet 4 A suspended and the standard inertia bar No. 2, and observations were taken as explained in paragraph 15 of the Annual Report for 1901-02.

The results shown in the table which follows gave a new mean value of Log. π^2k for magnet 4 A of 3·37972, *i.e.*, an increase of 0·00036 over the accepted value, and as the observations seemed to be at least up to the usual standard of accuracy, it was thought that a real change had occurred and the new value was therefore used in all computations from and after the 23rd October 1903. Shortly afterwards new values were computed out for magnets 1 A, 3 A, 5 A, 17 and 19, and in every case considerable changes were noted, though in no instance was any explanation forthcoming which could account for the alteration. As these changes were not in accordance with previous experience it was decided to adhere to the original accepted values in every case except that of magnet 4 A, the new value of which had already been made use of.

The comparisons of instruments in intensity which are published in a previous paragraph clearly indicate the absence of any considerable changes in any of the magnetometers during the recess season of the year 1903, and in the case of magnet 4 A the change actually found is almost wholly accounted for by the adoption of the new value of Log. π^2k. It is therefore reasonably certain that as far as this period is concerned there were no considerable changes in the moments of inertia of the magnets, but it remains to be seen whether the comparisons of instruments at the end of season 1903-04 will support this view. These comparisons have not yet been worked out and further discussion of this point must therefore be deferred for a future report.

TABLE P.

VALUES OF π^2K FOR VARIOUS MAGNETS.

Inertia Bar No. 2.				Inertia Bar No. 17.*	
Magnet Number.					
1 A	3 A	4 A	5 A	17	19
3·370824	3·388037	3·379679	3·379461	3·415454	3·384904
870	8132	735	491	441	4952
710	8146	681	195	398	4919
586	7977	757	206	401	4852
602	937	856	281	437	5074
734	888	676	236	410	
825		674			
791		746			
791		756			
620		855			
575		823			
688		605			
		705			
		793			
		814			
		756			
		788			
		664			
		575			
		561			
		615			
3·370718	3·388020	3·379720	3·379312	3·415424	3·384940

* All results derived from Inertia bar No. 17 require to be corrected by the addition of 0·000239 in order to make them comparable with those obtained from Inertia bar No. 2.

TABLE Q.

Magnet Number.	Inertia bar used.	Published value of Log. π^2K.	New value of Log. π^2K.	Published — New.
1 A	2	3·37046	3·37072	—0·00026
3 A	2	3·38733	3·38802	—0·00069
4 A	2	3·37936	3·37972	—0·00036
5 A	2	3·37894	3·37931	—0·00037
17	17	3·41519	3·41566	+0·00013
19	17	3·38496	3·38518	—0·00022

From the last of these tables it will be seen that the values found during the year 1904 differ very largely from those previously accepted. The two inertia bars used appear to be in perfect condition, whilst no injury has occurred to any of the magnets tested, nor have they been altered in any way. Further tests will be made during the ensuing recess season, but it is not proposed to make any change in the accepted values now used for reduction, and all new values found will be utilized subsequently as may seem best. The following is a list of the accepted values of Log. π^2K for all magnetometers at present in use:—

TABLE R.

Accepted values of Log. π^2K.

Magnet number.	Log. π^2K
1 A	3·37046
3 A	3·38733
4 A	3·37972
5 A	3·37894
6 A	3·39887
10	3·40173
16	3·38717
17	3·41579
19	3·38496
20	3·39954

Distribution of magnetic instruments.

15. During the year under report the instruments were distributed as follows:—

Observatories or field instruments.	Magneto-graphs.		Magnetometers.	Dip circles.	Remarks.
	Horizontal force.	Declination.			
Dehra Dún . .	1	1	17	44	Magnetometers Nos. 1 to 6 and No. 10 are by Messrs. Cooke and Sons.
Kodaikánal . .	2	2	16	46	
Barrackpore . .	3	3	20	45	Magnetometers Nos. 16, 17 and 20 are old Elliott instruments, altered by Messrs. Cooke and Sons.
Captain Fraser . .			1	43	
Lieutenant Thomas .			1	43	
Mr. Morton . .			6	138	Dip circles 135 to 140 are by Dover.
R. P. Ray . .			3	135	Dip circles 44 to 46 are by Barrow, repaired by Dover.
Mr. Talati . .			10	136	
„ Meyer . .			5	140	
K. K. Datta . .			4	137	

Dip circle No. 139 was under repair in England and was not received back till July 1904. The new dip circle was not received, but the H. F. and declination magnetographs for the Burma Observatory arrived in June 1904, as also the first of the four vertical force magnetographs. An earth inductor has been ordered from Schultze and a second instrument of the same kind will shortly be indented for.

General remarks.

16. The results of the field work are exhibited in the table below and the index chart following it shows the situations of the stations occupied up to date.

Owing to the large outturn of field work and the accumulation of records at base stations, special steps were taken during the recess season to strengthen the party and it is satisfactory to note that there are now no arrears of work excepting a few comparisons made at base stations during the last two years. A special staff consisting of one spare observer and two computers has been added to the party in order to deal with observatory tabulations and work connected with the final reduction of the field results. In addition to these duties the spare observer is also available for the relief of the regular observers at base stations when absent on leave or on account of sickness.

Owing to difficulties in obtaining suitable men for the base station observatories, it has been decided to utilize one of the existing field observers in that capacity, so that during the next field season there will be only four detachments at work. However, there is every reason to hope that even with this reduced staff the field work contemplated in the scheme for the fundamental survey will be completed at the end of season 1906-07.

The tabulation of the results obtained at Dehra Dún, Kodaikánal and Barrackpore observatories are published to the end of 1903. Those for the year 1904 are nearly ready and it is intended to bring the next report up to date by publishing results for 1904 and 1905 together.

The mean values of the magnetic elements at the observatories for the year 1903.

Name of observatory.	Latitude.	Longitude.	Mean Dip.	Mean Declination.	Mean Horizontal Force.	Remarks.
	° ′ ″	° ′ ″	° ′	° ′		
Dehra Dún .	30 19 19	78 3 19	43 13·9	E 2 41·6	·33430	
Kodaikánal .	10 13 50	77 27 46	3 5·3	W 0 23·4	·37367	Declination is given for last 5 months only.
Barrackpore .	22 46 29	88 21 39	30 17·7	E 1 25·8	·37198	Last 5 months only.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04.

Serial No.	Name of Station.	Survey No.		Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
				° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
371	Ratagaon (Vijápur).	$\frac{20}{74}$	8	19 56 40	74 45 50	24 55	E 0 50	0·3685	
372	Aurungábád .	$\frac{20}{76}$	3	19 51 30	75 20 20	24 35	" 0 50	0·3695	
373	Jálna . .	"	4	19 51 50	75 53 0	24 35	" 1 5	0·3685	
374	Satona . .	"	5	19 29 30	76 21 30	23 40	" 0 55	0·3710	
375	Parbhani . .	"	6	19 15 20	76 46 50	23 30	" 0 55	0·3715	
376	Nander . .	$\frac{20}{78}$	1	19 9 30	77 18 10	23 30	" 0 20	0·3705	
377	Dharmábád (Bálápur).	$\frac{18}{78}$	1	18 53 10	77 51 30	22 35	" 0 30	0·3730	
378	Upalwai . .	"	2	18 25 10	78 19 20	21 35	" 0 35	0·3740	
379	Masaipet . .	"	3	17 52 40	78 27 30	20 15	" 0 10	0·3750	
380	Alir . .	$\frac{18}{80}$	2	17 38 30	79 2 50	19 50	" 0 30	0·3770	
381	Warangal .	"	1	17 58 40	79 36 50	22 20	" 0 25	0·3755	
382	Mánukota .	"	3	17 36 0	80 0 10	19 25	" 1 10	0·3805	
383	Bona Kalu .	"	4	17 2 0	80 15 50	18 35	" 0 0	0·3775	
384	Bezwada . .	$\frac{16}{80}$	1	16 31 0	80 36 50	17 10	" 0 0	0·3805	
385	Bápatla . .	"	2	15 54 30	80 27 40	16 25	" 0 35	0·3775	
386	Ongole . .	"	3	15 30 20	80 3 20	13 45	" 2 10	0·3855	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
387	Bitragunta .	14/80 7	14 48 40	79 57 20	13 40	W 0 35	0·3805	
388	Arambákkam .	„ 8	13 32 40	80 4 30	10 50	„ 0 20	0·3820	
389	Acharapákkam	12/80 9	12 24 10	79 49 10	6 50	„ 0 55	0·3780	
341	Villupuram .	„ 5	11 56 40	79 29 50	...	E 0 15	...	Declination only re-observed.
390	Eringi . .	„ 10	11 35 50	79 10 20	5 35	W 0 25	0·3775	
391	Atúr . .	12/78 10	11 35 40	78 36 50	6 25	„ 0 25	0·3840	
392	Perambalúr .	„ 12	11 14 10	78 51 50	5 30	„ 0 35	0·3835	
393	Pudukottái .	10/78 4	10 22 50	78 48 50	3 40	„ 0 30	0·3795	
394	Satubara Chattram .	„ 5	10 14 50	79 16 50	2 40	„ 0 35	0·3805	
395	Tiruppattúr .	„ 11	10 7 10	78 36 0	2 55	„ 0 55	0·3805	
396	Nattam . .	„ 10	10 13 40	78 14 0	3 0	„ 0 40	0·3790	
397	Palmanér .	14/78 14	13 12 20	78 44 50	9 45	„ 0 25	0·3805	
398	Madanapalle .	„ 19	13 34 40	78 30 30	10 35	„ 0 15	0·3810	
399	Páragada .	„ 12	14 6 20	77 17 10	12 0	E 0 0	0·3795	
400	Kalyándrug .	„ 11	14 32 50	77 6 40	13 15	W 0 20	0·3765	
401	Hangal . .	14/76 6	14 44 10	76 41 50	13 5	„ 0 5	0·3785	
402	Chalakere .	„ 8	14 19 0	76 39 0	12 20	„ 0 5	0·3795	
403	Hiriyúr . .	„ 10	13 56 30	76 36 40	11 25	„ 0 5	0·3790	
1	Pavdásán .	24/72 3	24 29 20	71 53 50	33 45	E 1 10	0·3520	Re-observed.
2	Sáchor . .	„ 2	24 45 20	71 45 50	33 55	„ 1 40	0·3520	do.
3	Dutwa . .	„ 1	24 52 50	71 28 50	34 0	„ 2 0	0·3495	do.
4(*a*)	Sheria Bheel (*a*)	24/70 1	24 43 50	70 52 50	33 25	„ 1 45	0·3500	do.
5	Tur Loonian .	„ 2	24 39 0	70 31 40	34 5	„ 2 15	0·3505	do.
6(*a*)	Islámkot (*a*) .	„ 3	24 42 10	70 9 50	33 35	„ 1 20	0·3545	do.
7(*a*)	Dipla (*a*) . .	„ 4	24 28 0	69 34 30	33 25	„ 2 0	0·3480	do.
8	Rahím-ki-Bazár	„ 5	24 19 0	69 9 0	32 55	„ 1 50	0·3495	do.
9	Kirria . .	24/68 3	24 20 0	68 46 40	32 45	„ 1 40	0·3500	do.
10(*a*)	Lachpat (*a*) .	„ 4	23 49 20	68 46 20	31 55	„ 1 45	0·3510	do.
11(*a*)	Murr (*a*) . .	„ 5	23 33 20	68 56 40	31 45	„ 2 0	0·3520	do.
12(*a*)	Nakhtrana (*a*) .	24/70 6	23 20 50	69 15 10	31 30	„ 1 35	0·3525	do.
13	Kalyánpur .	„ 8	23 13 40	69 35 40	30 55	„ 1 15	0·3555	do.
14	Bhímasar .	„ 9	23 11 20	70 9 50	30 30	„ 1 5	0·3525	do.
15(*a*)	Lákadiya (*a*) .	„ 7	23 20 30	70 34 40	31 30	„ 1 5	0·3510	do.
16(*a*)	Adesar (*a*) .	„ 10	23 33 30	70 59 10	31 35	„ 1 15	0·3545	do.
17	Váráhi . .	24/72 10	23 47 50	71 26 20	31 55	„ 1 25	0·3545	do.
18	Diodar . .	„ 7	24 6 30	71 46 10	32 25	„ 1 30	0·3550	do.
404	Lohana (Jaswantpura).	„ 14	24 47 20	72 27 10	33 40	„ 1 35	0·3540	
405	Jálor . .	26/72 12	25 21 10	72 36 50	34 40	„ 1 20	0·3500	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04—contd.

Serial No.	Name of Station.	Survey No.		Latitude.			Longitude.			Dip.		Declination.			Horizontal Force.	Remarks.
				°	′	″	°	′	″	°	′		°	′	C. G. S.	
406	Mandaula G. T. S.	26/72	11	25	24	50	71	52	10	35	5	E	2	0	0·3515	
407	Wallar . .	„	9	26	29	10	71	48	40	39	55	„	2	20	0·3470	
408	Mandái, G.T.S.	„	10	26	21	10	71	10	40	36	20	„	1	50	0·3460	
409	Jejrawa . .	26/70	13	26	15	20	70	38	50	36	15	„	2	0	0·3445	
410	Ráviláhu, G.T.S.	„	12	26	52	40	70	2	20	37	25	„	2	10	0·3425	
411	Khubba . .	„	11	26	49	10	70	40	10	37	25	„	2	10	0·3425	
412	Kakrasar . .	26/72	8	26	55	40	71	12	10	37	35	„	2	25	0·3430	
413	Hardikot, G.T.S.	„	7	26	57	30	71	51	00	38	35	„	3	5	0·3390	
414	Satiaya . .	28/72	14	27	25	20	71	39	10	38	15	„	2	40	0·3380	
415	Deega . .	„	15	27	24	20	71	0	0	38	25	„	2	20	0.3400	
416	Kolu, G.T.S. .	28/70	14	27	25	10	70	17	30	38	25	„	2	10	0·3405	
26	Reti . .	„	3	28	5	10	69	51	20	39	25	„	2	40	0·3365	Re-observed.
54(*a*)	Sibi (*a*) . .	30/68	1	29	32	40	67	51	40	41	50	„	2	45	0·3275	do.
417	Lehri . .	„	11	29	10	40	68	12	40	41	15	„	2	20	0·3300	
418	Chirdi Dhabbar	„	12	29	5	20	68	43	10	40	55	„	2	25	0·3310	
419	Derah Bugtí .	30/70	15	29	2	0	69	9	20	40	50	„	2	35	0·3315	
420	Chat . .	„	14	29	20	20	69	24	30	41	25	„	2	40	0·3305	
421	Mat . .	„	13	29	42	20	69	40	0	41	55	„	2	50	0·3290	
422	Rakni . .	„	12	30	2	50	69	55	30	42	25	„	3	0	0·3285	
423	Kingri . .	„	11	30	26	20	69	49	0	43	5	„	3	5	0·3265	
424	Músa-Khel Bazár	„	9	30	52	30	69	48	50	43	45	„	3	10	0·3245	
425	Mekhtar . .	„	10	30	29	0	69	20	20	43	5	„	2	55	0·3260	
426	Fort Sandeman .	32/70	7	31	20	40	69	27	10	44	25	„	3	15	0·3220	
427	Musáfirpur .	30/70	8	30	58	0	69	8	30	43	50	„	3	0	0·3240	
428	Kalu Killa .	30/68	7	30	41	40	68	43	20	43	25	„	2	55	0·3250	
429	Killa Saifulla .	„	6	30	42	50	68	21	10	43	25	„	3	5	0·3240	
430	Hindu Bágh .	„	5	30	49	20	67	44	30	43	40	„	3	0	0·3220	
431	Chinjan . .	„	8	30	34	10	67	55	50	43	0	„	3	0	0·3240	
432	Loralai . .	„	9	30	21	30	68	36	30	42	55	„	2	50	0·3255	
433	Puzza . .	„	10	29	54	0	68	42	40	42	15	„	2	45	0·3275	
434	Ferozepore .	30/74	12	30	57	50	74	36	10	44	30	„	2	30	0·3250	
435	Moga . .	30/76	14	30	49	40	75	10	30	44	0	„	2	55	0·3295	
69	Ladhowál . .	„	1	30	59	0	75	47	20	44	20	„	2	55	0·3290	Re-observed.
436	Mahábaleshwar	18/74	7	17	55	50	73	39	40	20	35	„	0	5	0·3680	
437	Helwák . .	„	8	17	22	20	73	43	10	19	5	„	0	40	0·3715	
438	Ámba . .	18/74	7	16	58	20	73	47	50	19	10	„	0	20	0·3715	
439	Dájeepur .	„	8	16	22	40	73	52	40	17	30	„	0	5	0·3755	
440	Rámghat .	„	9	15	49	40	74	6	20	15	45	„	0	35	0·3660	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04—contd.

Serial No.	Name of Station.	Survey No.		Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
				° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
441	Yellápur . .	14/74	1	14 57 40	74 42 30	13 55	W 0 5	0·3765	
442	Banvási . .	14/76	7	14 32 20	75 1 10	13 5	" 0 5	0·3770	
443	Mauvinhola .	"	9	13 59 10	75 6 20	11 45	" 0 5	0·3775	
444	Koppa . .	"	11	13 31 50	75 19 30	10 35	" 0 25	0·3785	
445	Beltángády .	12/76	8	12 59 10	75 17 0	9 40	" 0 25	0·3780	
446	Sullia . .	"	12	12 34 20	75 23 20	8 40	" 0 15	0·3770	
447	Saklespur .	"	9	12 56 40	75 47 30	9 15	" 0 20	0·3790	
448	Dándigánhálli .	"	10	12 58 20	76 16 50	9 10	" 0 15	0·3785	
449	Yediyur . .	"	11	12 58 40	76 51 20	9 15	" 0 15	0·3795	
450	Singánallúr .	12/78	8	12 8 30	77 13 00	7 50	" 0 15	0·3825	
451	Kávéripur .	"	9	11 54 20	77 45 30	7 45	" 0 25	0·3790	
452	Satyamangalam	"	11	11 30 0	77 14 20	6 15	" 0 25	0·3835	
453	Gundlupet .	12/76	13	11 48 20	76 41 20	6 40	" 0 30	0·3810	
454	Sultan's Battery	"	14	11 39 40	76 15 30	6 25	" 0 30	0·3815	
455	Ootacamund .	"	15	11 24 30	76 42 50	5 45	" 0 30	0·3805	
456	Nilambúr .	"	16	11 16 20	76 13 20	5 25	" 0 30	0·3785	
457	Anamalais .	10/76	3	10 34 50	76 56 0	4 5	" 0 45	0·3805	
458	Dhárápuram .	10/78	8	10 43 30	77 31 20	4 30	" 0 50	0·3840	
459	Periyakulam .	"	9	10 7 40	77 33 20	3 0	" 1 10	0·3835	
460	Top Station (Kanan Devan hills),	"	12	10 6 40	77 13 20	3 50	" 0 10	0·3795	
461	Munnar . .	"	12	10 4 10	77 3 20	3 5	" 0 35	0·3805	
462	Nyamakad Estate (Kanan Devan hills).	"	12	10 8 10	77 3 10	3 0	" 0 40	0·3810	
463	Kuravanath. .	"	13	9 38 50	77 12 30	2 0	" 1 0	0·3815	
464	Kanjarapalli .	10/76	8	9 33 0	76 46 50	1 25	" 1 0	0·3780	
465	Alleppi . .	"	7	9 29 50	76 19 10	0 30	" 1 0	0·3745	
466	Quilon . .	8/76	2	8 53 30	76 36 0	—0 25	E 0 10	0·3780	South end of needle dipping.
467	Punalur . .	10/76	9	9 1 20	76 55 30	0 45	W 1 0	0·3795	
468	Tenkási . .	8/78	6	8 58 0	77 18 30	0 35	" 1 0	0·3805	
469	Virudupatti .	10/78	14	9 35 50	77 57 40	0 45	" 1 10	0·3835	
470	Manapád .	8/78	3	8 22 20	78 4 0	—1 0	" 1 5	0·3800	Do.
471	Nágarkoil .	"	5	8 11 20	77 26 0	—1 25	" 1 5	0·3785	Do.
472	Trivandrum .	"	4	8 28 50	76 55 30	—0 30	" 0 50	0·3800	Do.
473	Cochin . .	10/76	5	9 57 50	76 14 0	2 55	" 0 35	0·3810	
474	Kodhamangalam	"	6	10 3 40	76 37 40	2 40	" 1 0	0·3775	
475	Irinjalakuda .	"	4	10 20 20	76 13 0	4 5	" 0 55	0·3790	
476	Lucknow . .	26/80	2	26 50 0	80 55 20	37 45	E 1 55	0·3510	Visited by two observers.
477	Rae-Bareli .	26/82	3	26 14 0	81 14 40	36 25	" 1 45	0·3550	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
478	Amethi . .	26/82 5	26 9 20	81 48 40	36 30	E 1 55	0·3540	
479	Suriawán .	„ 8	25 28 0	82 25 50	35 15	„ 1 50	0·3585	
480	Chunár . .	„ 10	25 6 10	82 52 30	34 40	„ 1 35	0·3600	
481	Allahabad .	„ 7	25 27 30	81 49 20	35 5	„ 1 40	0·3585	
482	Kunwar . .	„ 6	25 42 0	81 13 10	35 45	„ 1 50	0·3530	
483	Mánikpur .	„ 9	25 3 10	81 5 20	34 30	„ 1 35	0·3590	Visited by two observers.
484	Karmnása .	26/84 11	25 14 30	83 25 20	35 0	„ 1 40	0·3590	
485	Japla . .	24/84 2	24 32 30	84 0 0	34 5	„ 1 10	0·3645	
486	Daltonganj .	„ 3	24 2 0	84 4 30	32 30	„ 1 35	0·3665	
487	Palmerganj .	„ 1	24 51 40	84 19 50	34 35	„ 1 25	0·3605	
488	Nawádah. .	24/86 1	24 52 30	85 32 50	34 10	„ 1 30	0·3645	
489	Monghyr . .	26/86 8	25 23 10	86 27 50	35 10	„ 1 40	0·3620	
490	Bhágalpur .	„ 9	25 14 0	86 57 40	35 5	„ 1 25	0·3625	
491	Sáhibganj .	26/88 2	25 14 50	87 38 20	34 55	„ 1 30	0·3650	
492	Pakaur . .	24/88 1	24 38 50	87 51 40	33 50	„ 1 25	0·3640	
493	Azimganj. .	„ 2	24 14 10	88 15 10	33 15	„ 1 20	0·3685	
494	Sainthia . .	„ 3	23 56 50	87 41 20	32 40	„ 1 15	0·3670	
495	Burdwan . .	„ 5	23 15 0	87 52 40	31 15	„ 1 15	0·3700	
496	Calcutta . .	22/88 3	22 33 40	88 17 30	29 55	„ 1 20	0·3725	
497	Ulubaria . .	„ 4	22 28 20	88 6 20	29 40	„ 1 5	0·3730	
498	Midnapore .	„ 2	22 25 20	87 17 30	29 50	„ 1 10	0·3730	
499	Ghátsila . .	22/86 2	22 35 0	86 28 20	30 10	„ 1 20	0·3705	
500	Sini . .	„ 1	22 47 0	85 56 50	30 5	„ 1 20	0·3725	
501	Purulia . .	24/86 6	23 19 30	86 22 50	31 15	„ 1 30	0·3725	
502	Bankura . .	24/88 6	23 13 30	87 4 10	31 20	„ 1 30	0·3710	
503	Garhbeta. .	22/88 1	22 50 40	87 18 50	31 5	„ 0 55	0·3710	
504	Ránigañj. .	24/88 4	23 35 30	87 7 30	31 40	„ 1 25	0·3700	
505	Kátrásgarh .	24/86 5	23 48 0	86 18 0	32 15	„ 1 25	0·3675	
506	Giridih . .	„ 4	24 10 50	86 19 20	32 50	„ 1 25	0·3660	
507	Baidyanáth .	„ 3	24 30 50	86 38 0	33 35	„ 1 35	0·3655	
508	Gidhaur . .	„ 2	24 52 20	86 18 0	34 15	„ 1 35	0·3640	
509	Barh . .	26/86 7	25 28 20	85 42 50	35 40	„ 1 45	0·3605	
510	Patna . .	„ 5	25 35 30	85 12 20	35 30	„ 1 35	0·3595	
511	Jahánabad .	„ 6	25 13 40	84 59 50	34 55	„ 1 35	0·3615	
512	Buxar . .	26/84 10	25 33 30	83 57 40	35 30	„ 3 35	0·3630	
513	Malipur . .	26/82 4	26 16 10	82 38 50	36 40	„ 1 50	0·3560	
514	Daryábád .	„ 2	26 51 30	81 33 0	37 50	„ 2 0	0·3520	
515	Gonda . .	28/82 4	27 8 30	81 58 20	38 25	„ 2 0	0·3505	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
516	Tulsipur . .	$\frac{27}{82}$ 3	27 31 30	82 24 40	38 55	E 2 10	0·3495	
517	Nánpára . .	„ 2	27 51 40	81 31 10	39 20	„ 2 15	0·3485	
518	Katarnian Ghát	„ 1	28 19 50	81 7 50	40 10	„ 2 20	0·3460	
519	Basti . .	$\frac{26}{82}$ 1	26 49 10	82 46 30	37 50	„ 1 55	0·3535	
520	Gorakhpur .	$\frac{26}{83}$ 1	26 45 0	83 23 20	37 40	„ 1 50	0·3540	
521	Uska-Bazár .	$\frac{27}{83}$ 1	27 11 30	83 6 20	38 35	„ 2 0	0·3510	
522	Bhatni . .	$\frac{26}{83}$ 3	26 23 0	83 55 40	36 55	„ 1 50	0·3555	
523	Mau . .	„ 7	25 56 20	83 34 20	36 20	„ 1 55	0·3550	
524	Azamgarh .	„ 6	26 1 50	83 11 10	36 15	„ 1 50	0·3565	
525	Aunrihar . .	„ 9	25 32 10	83 9 50	35 40	„ 1 45	0·3580	
526	Siwán . .	„ 5	26 12 30	84 20 40	36 40	„ 1 45	0·3565	
527	Chapra . .	„ 8	25 48 10	84 43 20	36 20	„ 0 45	0·3595	
528	Muzaffarpur .	$\frac{26}{85}$ 4	26 6 30	85 22 30	36 35	„ 1 50	0·3590	
529	Pipra . .	$\frac{26}{84}$ 4	26 29 30	84 59 10	37 20	„ 2 15	0·3565	
530	Bettiah . .	„ 2	26 48 50	84 31 30	37 45	„ 2 0	0·3545	
531	Bairagnia. .	$\frac{26}{85}$ 1	26 43 50	85 16 30	38 0	„ 1 55	0·3540	
532	Khanwa Ghát .	$\frac{26}{87}$ 1	26 22 10	87 3 20	37 10	„ 1 30	0·3570	
533	Nirmali . .	$\frac{26}{86}$ 2	26 18 0	86 34 00	36 55	„ 1 55	0·3575	
534	Darbhanga .	„ 3	26 6 0	85 54 20	36 50	„ 1 45	0·3565	
535	Gwalior . .	$\frac{26}{78}$ 3	26 12 50	78 11 0	36 35	„ 2 10	0·3505	
536	Mahona . .	„ 4	25 53 40	77 46 40	35 40	„ 1 45	0·3535	
537	Sipri . .	„ 6	25 26 0	77 39 20	35 15	„ 1 35	0·3520	
538	Bhind . .	„ 2	26 34 10	78 47 50	38 0	„ 1 15	0·3480	
539	Datia . .	„ 5	25 38 40	78 27 30	35 0	„ 1 20	0·3525	
540	Basai . .	„ 7	25 8 40	78 23 30	35 0	„ 1 20	0·3530	
541	Lalitpur . .	$\frac{24}{78}$ 1	24 40 50	78 24 10	33 50	„ 1 30	0·3600	
541(*a*)	Lalitpur (*a*) .	„ 1	24 41 10	78 25 50	34 0	„ 1 30	0·3590	
542	Pachhár . .	„ 2	24 34 50	77 43 40	33 45	„ 1 20	0·3565	
543	Dharnáoda .	„ 3	24 35 50	77 5 50	34 0	„ 1 45	0·3545	
544	Bárán . .	$\frac{25}{76}$ 5	25 5 30	76 30 30	34 45	„ 1 35	0·3530	
545	Bína . .	$\frac{24}{78}$ 4	24 10 50	78 11 0	32 25	„ 1 20	0·3610	
546	Bhílsa . .	„ 6	23 31 10	77 48 50	32 30	„ 2 30	0·3560	
547	Bhopal . .	„ 7	23 15 50	77 24 30	31 25	„ 1 20	0·3605	
548	Hoshangabad .	$\frac{22}{77}$ 1	22 45 10	77 43 0	30 15	„ 1 10	0·3635	
549	Pagdhál . .	„ 4	22 24 50	77 21 10	29 50	„ 1 15	0·3625	
550	Pipláni . .	$\frac{22}{76}$ 3	22 7 10	76 47 30	30 0	„ 1 40	0·3585	
551	Khandwa. .	„ 4	21 49 20	76 21 50	29 10	„ 0 45	0·3665	
552	Burhánpur .	„ 5	21 20 10	76 11 40	27 20	„ 1 5	0·3660	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
553	Sindkheda .	$\frac{21}{74}$ 10	21 14 10	74 44 20	26 50	E 0 55	0·3670	
554	Nandurbár .	„ 9	21 22 30	77 14 40	27 45	„ 1 0	0·3625	
555	Jalgaon . .	$\frac{20}{75}$ 2	21 1 20	75 33 40	26 45	„ 0 50	0·3650	
556	Barwaha . .	$\frac{22}{76}$ 2	22 15 20	76 1 30	29 5	„ 1 5	0·3640	
557	Indore . .	„ 1	22 42 10	75 52 40	30 0	„ 1 10	0·3655	
558	Barnagar . .	$\frac{23}{75}$ 6	23 3 50	75 22 30	31 15	„ 1 25	0·3595	
559	Tarána Road .	„ 4	23 15 40	76 3 50	31 10	„ 1 25	0·3580	
560	Shujáulpur .	„ 5	23 23 0	76 43 40	32 5	„ 1 50	0·3595	
561	Sohágpur .	$\frac{22}{78}$ 3	22 41 30	78 11 20	29 15	„ 1 15	0·3625	
562	Mohpáni . .	„ 2	22 44 40	78 50 20	30 5	„ 1 15	0·3650	
563	Narsinghpur .	$\frac{22}{80}$ 1	22 56 50	79 12 30	30 35	„ 1 30	0·3635	
564	Mirganj . .	$\frac{24}{80}$ 6	23 9 40	79 46 50	31 30	„ 1 20	0·3580	
565	Sleemanábád .	„ 5	23 36 30	80 16 20	31 45	„ 1 10	0·3665	
566	Salaiya . .	„ 4	23 51 10	79 58 20	...	„ 1 30	0·3620	No dip observed.
567	Damoh . .	„ 3	23 50 0	79 26 0	32 30	„ 1 25	0·3600	
568	Saugor . .	$\frac{24}{78}$ 4	23 50 50	78 44 20	32 15	„ 1 50	0·3615	
569	Dholpur . .	$\frac{26}{78}$ 1	26 41 50	77 54 20	37 35	„ 1 50	0·3495	
570	Agra Cant. .	$\frac{28}{78}$ 9	27 10 40	78 0 20	38 10	„ 2 0	0·3470	
571	Shikohabad .	„ 10	27 4 30	78 35 30	38 5	„ 2 10	0·3485	
572	Achalda . .	$\frac{26}{80}$ 3	26 41 50	79 24 50	37 30	„ 2 0	0·3510	
573	Cawnpore .	„ 4	26 27 0	80 21 0	36 55	„ 2 0	0·3535	
574	Kálpi . .	„ 5	26 7 0	79 45 50	36 20	„ 1 50	0·3540	
575	Púnch .	„ 7	25 49 0	79 2 50	35 50	„ 1 40	0·3535	
576	Mau Ránipur .	„ 8	25 15 10	79 9 10	35 0	„ 1 35	0·3555	
577	Mahoba . .	„ 9	25 18 10	79 50 40	35 0	„ 1 50	0·3545	
578	Atarra . .	„ 10	25 17 20	80 34 10	35 5	„ 1 40	0·3565	
579	Sutna . .	$\frac{24}{80}$ 1	24 34 20	80 50 0	33 55	„ 1 40	0·3600	
580	Amdara . .	$\frac{24}{80}$ 2	24 6 10	80 34 40	32 45	„ 1 20	0·3620	
581	Málwa . .	$\frac{26}{80}$ 6	26 0 50	80 40 0	36 10	„ 1 45	0·3535	
582	Araul . .	„ 1	26 55 0	80 1 40	37 55	„ 1 55	0·3510	
583	Farrukhabad .	$\frac{28}{80}$ 11	27 23 10	79 34 40	38 40	„ 2 5	0·3475	
584	Ganj Dundwára	„ 8	27 43 30	78 56 20	39 10	„ 2 15	0·3460	
585	Kherli . .	$\frac{28}{78}$ 8	27 12 10	77 1 30	38 10	„ 2 10	0·3465	
586	Aligarh . .	„ 7	27 53 40	78 4 20	39 20	„ 2 10	0·3450	
587	Dhanári . .	„ 6	28 19 50	78 30 20	40 0	„ 2 10	0·3435	
588	Aonla . .	$\frac{28}{80}$ 6	28 17 50	79 10 10	40 0	„ 2 20	0·3440	
589	Mίránpur Katra	„ 5	28 2 20	79 40 20	39 45	„ 2 10	0·3450	
590	Anjhi . .	„ 9	27 38 20	79 59 20	39 0	„ 2 5	0·3475	
591	Sanoda . .	„ 12	27 7 0	80 25 10	38 10	„ 2 0	0·3495	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season, 1903-04—concld.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
592	Kamalpur . .	$\frac{28}{80}$ 10	27 22 30	80 49 40	38 35	E 2 0	0·3490	
593	Lakhimpur .	" 7	27 56 20	80 46 20	39 30	" 2 10	0·3460	
594	Chandan Chauki	" 3	28 32 20	80 46 40	40 30	" 2 20	0·3450	
595	Khutár . .	" 4	28 12 0	80 15 40	40 0	" 2 10	0·3450	
596	Sháhgarh .	" 2	28 33 30	80 3 10	40 30	" 2 20	0·3435	
597	Richha Road .	" 1	28 43 0	79 29 30	40 45	" 2 20	0·3430	
598	Káthgodám .	$\frac{30}{80}$ 1	29 15 20	79 32 50	41 40	" 2 30	0·3390	
599	Garhmuktesar .	$\frac{28}{78}$ 4	28 46 40	78 4 0	40 55	" 2 30	0·3410	
600	Chola . .	" 5	28 18 30	77 43 40	40 15	" 2 20	0·3420	
601	Moradabad .	" 3	28 50 0	78 45 30	41 0	" 2 25	0·3415	
602	Nagína . .	$\frac{30}{78}$ 10	29 25 50	78 25 00	41 55	" 2 35	0·3380	

Repeat stations.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
I	Udaipur . .		24 35 33	73 41 57	33 25	E 1 30	0·3535	
II	Karáchi . .		24 49 50	67 2 2	33 40	" 1 0	0·3470	
III	Quetta . .		30 11 52	67 0 20	42 45	" 2 55	0·3245	
IV	Baháwalpur .		29 23 27	71 40 37	41 40	" 2 50	0·3330	
V	Ráwalpindi .		33 35 16	73 3 6	47 55	" 3 40	0·3135	
VI	Bharatpur . .		27 13 31	77 29 28	38 20	" 2 05	0·3465	
VII	Bangalore . .		12 59 35	77 35 58	9 25	W 0 25	0·3815	
VIII	Dhárwár . .		15 27 26	74 59 35	15 0	E 0 0	0·3765	
IX	Porbandar .		21 38 20	69 37 6	28 20	" 1 15	0·3610	
X	Fyzabad . .		26 47 27	82 7 40	37 35	" 1 55	0·3535	
XI	Sambalpur .		21 28 3	83 58 26	27 35	" 1 05	0·3720	
XII	Waltair . .		17 42 54	83 19 1	20 55	" 0 30	0·3775	
XIII	Darjeeling .		26 59 49	88 16 39	...	" 1 50	0·3565	No dip observed.
XIV	Gaya . .		24 46 30	84 58 54	34 0	" 1 25	0·3660	
XV	Secunderábád .		17 27 11	78 29 16	19 50	" 0 40	0·3790	
XVI	Bhusával .		21 2 46	75 47 18	26 35	" 1 0	0·3685	
XVII	Jubbulpore .		23 8 57	79 56 44	30 40	" 1 15	0·3650	

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

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

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

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

DEHRA DÚN OBSERVATORY.

General remarks.

1. After all the care and money spent on the prevention of floods in the underground magnetograph room, it is disappointing to have to record a failure of the instruments owing to inundation. The rains of the year 1904 were exceptionally heavy and owing presumably to the breakage of an earthenware pipe underground, a considerable volume of water entered the observatory on the 13th August. During the remainder of this month, except for a few days it was impossible to obtain records as the water interfered with the pendulum of the driving clock. On the 2nd September work was resumed and continued without further interruption.

The following additional measures have since been taken to prevent future floods:—

(1) The earthenware outtake pipe, which is believed to have broken underground, has been blocked altogether where it enters the observatory.

(2) A low watertight wall has been built across the doorway of the inner room, so as to confine flood water entirely to the outer passage.

(3) A heavy brass box has been made, within which the pendulum now swings, so that even if water gains access to the inner room, it will in future be possible to keep the instruments going.

(4) A pump has been purchased for the purpose of keeping the open drainage pit clear of water during periods of heavy rainfall.

It is satisfactory to note that the room was completely dried within two months of the termination of the flood and that the mirrors seem very little the worse for exessive damp. On the 8th November it was found necessary to re-adjust the fixed mirror of the declination magnetograph, but with this exception the instruments were not touched throughout the year.

The tabulated results for the year 1903 are appended. Tables I to III give the actual absolute values obtained throughout the year with the standard instruments used in the south house and in addition the first two tables show, as a test of accuracy, the base line values of the magnetograms deduced from each observation and corrected for temperature in the case of the horizontal force values. Tables V to VIII give the results in declination and horizontal force as tabulated from the curves, whilst table IV gives the disturbances for the year and the selected quiet days utilized in the tabulations.

The declination results.

2. The following table gives the mean magnetic collimation of magnet No. 17 throughout the year, *i. e.*, the difference of the circle readings when the magnet is reserved 180° in its stirrups:—

Magnetic Collimation for each month: Dehra Dún Observatory, Magnet 17.

Months, 1903.	Magnetic collimation.		Months, 1903.	Magnetic collimation.	
	′	″		′	″
January . . .	—9	9	July . . .	—9	5
February . . .	—9	11	August . . .	—9	8
March . . .	—9	13	September . .	—9	11
April . . .	—9	5	October . . .	—9	4
May . . .	—9	6	November . .	—8	27
June . . .	—9	10	December . .	—8	27

The cause of the sudden change which occurred at the end of October is not known, but as there is no simultaneous change in the values of m_0 or P, it was in all probability due to the displacement of one of the magnet cells or their contained glasses and not to a displacement of the magnetic axis.

Although all observations were taken with much care, it is noticeable that the individual values deduced for the base line differ from the monthly mean values, by an amount which is considerably larger than might be expected, as it not unfrequently exceeds 0′·5. Whether these discrepancies indicate actual changes in the base line or, as seems more probable, are due to the observer having failed to remove other magnets to a perfectly safe distance, cannot be said for certain; but this latter explanation seems on the whole the most probable, in view of the fact that a recent determination of the differences between houses in declination is not in accord with the values published in this report.

In the following table the mean monthly declination derived from five selected quiet days is compared for corresponding months in the years 1902 and 1903:—

Mean monthly declination at Dehra Dún.

Months.	1902.	1903.	Annual change.	REMARKS.
	° ′	° ′	′	
March . . .	2 43·9 E	2 42·2 E	−1·7	Data prior to March 1902 are not available.
April . . .	43·8	42·3	1·5	
May . . .	43·6	41·3	2·3	
June . . .	43·0	41·2	1·8	
July . . .	43·1	41·0	2·1	
August . . .	42·3	41·4	0·9	
September . .	42·4	40·0	2·4	
October . . .	42·4	41·0	1·4	
November . .	42·8	41·6	1·2	
December . .	42·6	41·7	0·9	
		Mean	−1·6	

3. In the next table the monthly mean differences between needles 1 and 2 of dip circle No. 44 are tabulated for the years 1902 and 1903.

The dip results.

Months.	Needle 1—Needle 2.	
	1902.	1903.
	′	′
January	—	+0·4
February	—	+1·3
March	−1·3	+0·7
April	−1·4	+0·3
May	+0·3	+0·8
June	−0·3	+1·8
July	−0·3	+1·6
August	−1·0	+0·3
September	−0·4	+1·7
October	+0·1	+0·4
November	−0·4	+1·1
December	−0·2	+1·9

If any useful conclusion can be drawn from these figures it points to the fact that even under observatory conditions needles are erratic in their indications and the values of inclination cannot be trusted nearer than 1′ of arc even in the mean for a month.

If, therefore, it is considered necessary to know the absolute value of the inclination and to study its changes with the same degree of exactitude as in the case of the declination and intensity, it would seem necessary to obtain absolute inclinations from some instrument other than a dip circle. In view of the fact that vertical force magnetographs have been ordered for installation at the four base stations under survey control, it has been decided to purchase an earth inductor at once, an instrument which is reputed to give very constant and accurate results. If experience with this class of instruments proves favourable, one or more additional earth inductors will be obtained. Prior to 1st January 1903 all observations of inclination were taken in the old south house, since demolished, and no comparison in dip was made between that building and the existing south house. Both in declination and force, a well marked difference was found by careful observations between the two sites and there is, therefore, good reason for expecting a difference in dip also, so that it is unfortunate that no comparison was made. Consequently any attempt to arrive at the secular change in dip between 1902 and 1903, by comparing the absolute observations taken in those years would carry very little weight and the figures are therefore omitted.

4. It is satisfactory to report that the observations of intensity during 1903 show a very marked improvement over those made in the previous year.

The force observations.

Table showing the monthly mean values of constants of the survey standard *magnetometer No. 17 during 1903.*

Months.	m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	REMARKS.
January . . .	916·70	7·48	8·10	The values of m_0 are computed from the mean P (at 2·25 and 30 cms.) for the year.
February . . .	916·57	7·38	8·17	
March . . .	916·33	7·47	8·20	
April . . .	916·13	7·35	8·10	
May . . .	915·92	7·32	8·23	
June . . .	915·84	7·30	8·13	
July . . .	915·79	7·40	8·36	
August . . .	916·08	7·45	8·03	
September . .	916·26	7·46	8·09	
October . . .	915·87	7.56	8·04	
November . .	915·63	7·60	8·17	
December . .	915·76	7·52	7·70	

These figures indicate that no abnormal change of any magnitude occurred in the magnets during the year and bear witness to the reliability of the observations. The divergence of individual values from the monthly mean base line values may be inspected in table I, and are considered satisfactory. These monthly mean values of the base line may therefore be accepted with some confidence and are tabulated below for convenience of reference.

MONTHLY MEAN BASE LINE VALUES AND TEMPERTURES AT DEHRA DÛN OBSERVATORY.

H. F. Magnetograph No. 1 by Professor W. Watson, F.R.S., 1903.

1	2	3	4	
Months.	Temperature of H. F. instrument, cent.	Scale value of 0·04 inch.	Base line value C.G.S.	REMARKS.
	°			
January . . .	24·00	4·03 γ	0·33229	The base line values are referred to a temperature of 25°c., the temperature co-efficient used in the reduction being + 1°c. = − 12·6 γ.
February . .	22·78	4·04	230	
March . . .	22·23	4·05	223	
April . . .	22·39	4·05	228	
May . . .	23·35	4·04	223	
June . . .	24·80	4·02	219	
July . . .	26·15	4·02	212	

MONTHLY MEAN BASE LINE VALUES AND TEMPERTURES AT DEHRA DÚN OBSERVATORY—*contd.*

H. F. Magnetograph No. 1 by Professor W. Watson, F.R.S., 1903.

1	2	3	4	
Months.	Temperature of H. F. instrument, cent.	Scale value of 0·04 inch.	Base line value C.G.S.	REMARKS.
August . . .	26·87	4·03	197	Interference noted during August. New base line from 9th September when instrument was fitted with new mirrors.
September . .	26·99	4·05	·33211	
October . . .	26·96	4·05	211	
November . .	26·70	4·03	216	
December . .	25·98	4·05	216	
Mean	24·93	4·04		

The daily deflection readings indicate that something went wrong with the instrument about the 8th August (*vide* last annual report) and the base line value for that month is not therefore comparable with those preceding it. There is perhaps some evidence of fatigue in the system between May and July, but the amount is small and the series is too short to warrant any such definite conclusion. On the whole the instrument seems to have settled down and is now behaving satisfactorily. After 1st July deflections were made at the nearest of the two distances, and after 1st October they were taken on alternate days instead of daily as hitherto.

Table of monthly mean horizontal intensities at Dehra Dún.

Months.	1902.	1903.	Annual change.	REMARKS.
March . . .	0·33469	0·33447	−22 γ	Data prior to March 1902 not available.
April . . .	464	442	22	
May . . .	474	443	31	
June . . .	467	443	24	
July . . .	466	434	32	
August . . .	458	429	25	
September . .	456	424	32	
October . . .	454	413	41	
November . .	460	389	71	
December . .	446	398	48	
		Mean=	−35 γ	

TABLE I.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Dehra Dún Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Jan.	3	K. N. M.	916·68	7·66	8·37	·33452	·33453	·33229	·33229
	3	"	·75	...	...	54		32	
	5	"	·62	7·61	9·16	53		27	
	5	"	·73	...	...	56		32	
	7	"	·62	7·40	7·25	36		34	
	7	"	·58	...	...	34		31	
	10	"	·90	7·53	6·50	76		38	
	10	"	·66	...	...	68		32	
	10	"	·94	7·37	7·76	58		29	
	10	"	·79	...	...	53		29	
	11	"	·71	7·71	7·01	61		32	
	11	"	·87	...	...	67		37	
	11	"	·98	7·63	8·04	63		33	
	11	"	·49	...	...	46		17	
	14	"	·85	7·56	7·67	69		29	
	14	"	·77	...	...	66		31	
	17	S. D.	·77	7·37	8·65	62		37	
	17	"	·41	...	...	49		21	
	17	"	...	...	...	47		28	
	21	K. N. M.	916·75	7·37	9·16	50		27	
	21	"	·66	...	...	46		23	
	22	"	...	7·45	9·30	35		14	
	24	"	917·06	7·43	8·84	50		28	
	24	"	·00	...	...	48		22	
	28	"	916·45	7·09	8·28	56		32	
	28	"	·52	...	...	59		33	
	29	"	...	7·32	8·28	66		40	
	31	"	916·60	7·66	8·37	49		27	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Dehra Dún Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_o.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Jan.	31	K. N. M	916·68	...	...	·33452	·33453	·33236	·33229
	31	„	·24	7·53	7·58	35		22	
	31	„	·41	...	...	41		27	
Feb.	4	K. N. M.	916·54	7·50	8·18	·33448	·33454	·33226	·33230
	4	„	·45	...	...	45		23	
	7	„	·62	7·69	7·86	59		35	
	7	„	·52	...	...	55		25	
	11	„	·66	7·14	9·54	36		39	
	11	„	·68	...	...	37		32	
	12	„	·52	7·37	9·40	49		27	
	12	„	·64	...	...	53		33	
	14	„	·60	7·30	8·14	51		30	
	14	„	·47	...	...	46		27	
	18	„	·62	7·35	8·46	66		32	
	18	„	·64	...	...	66		33	
	18	„	·56	...	...	63		31	
	21	„	·68	7·56	7·48	77		32	
	21	„	·22	...	...	60		24	
	21	„	·37	7·35	8·51	54		22	
	21	„	·58	...	...	62		34	
	25	„	·71	7·30	8·60	34		30	
	25	„	·64	...	...	32		31	
	28	„	·77	7·27	8·14	71		33	
	28	„	·56	...	...	63		30	
Mar.	4	S. D.	916·30	7·53	8·09	·33453	·33448	·33219	·3322
	4	„	·68	...	...	67		27	
	7	„	·49	7·63	7·95	39		21	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Dehra Dún Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_o.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.			C. G. S.	C. G. S	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Mar.	7	S. D.	916·49	...	...	·33439	·33448	·33221	·33223
	11	,,	·66	7·53	8·42	38		26	
	11	,,	·66	...	...	38		26	
	14	,,	915·99	7·40	8·28	30		11	
	14	,,	916·28	...	...	41		22	
	14	,,	·30	...	...	42		21	
	15	,,	...	...	...	56		35	
	15	,,	...	...	...	46		25	
	18	,,	916·45	7·48	8·32	56		31	
	18	,,	·24	...	...	48		21	
	21	,,	·22	7·37	7·76	62		29	
	21	,,	·20	...	...	61		25	
	25	,,	·24	7·37	9·16	54		24	
	25	,,	·22	...	...	53		18	
	28	,,	915·99	7·43	8·60	43		16	
	28	,,	916·24	...	...	52		24	
April	1	S. D.	916·26	7·35	8·00	·33468	·33456	·33229	·33228
	1	,,	·14	...	..	63		31	
	4	,,	·14	7·11	9·81	35		21	
	4	,,	·16	...	...	36		24	
	4	,,	...	7·58	7·11	67		30	
	4	,,	...	·14	8·09	63		27	
	8	,,	916·07	7·30	8·46	14		27	
	8	,,	·30	...	...	23		30	
	11	,,	·33	7·56	7·72	48		29	
	11	,,	·18	...	...	43		24	
	15	,,	·07	8·98	4·95	63		35	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Dehra Dún Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_o.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
April	15	S. D.	916·01	...	...	·33460	·33456	·33230	·33228
	15	„	915·97	7·17	7·62	62		28	
	18	„	916·16	7·53	7·76	76		35	
	18	„	915·99	...	...	70		22	
	22	„	916·01	7·35	8·88	68		31	
	22	„	·16	...	...	73		34	
	29	„	·20	7·45	8·37	73		29	
	29	„	·03	...	...	67		22	
May	2	S. D.	915·97	7·50	8·60	·33458	·33450	·33227	·33223
	2	„	916·05	...	...	61		27	
	9	„	915·90	7·09	7·44	59		28	
	9	„	·82	...	...	56		21	
	9	„	·82	7·30	7·90	55		17	
	13	„	916·07	7·35	8·23	76		31	
	13	„	915·93	...	...	70		25	
	16	„	916·14	6·98	8·70	68		33	
	16	„	·03	...	...	64		26	
	20	„	·01	7·22	7·95	56		30	
	20	„	915·93	...	...	53		23	
	23	„	916·03	7·19	8·70	40		22	
	23	„	915·86	...	...	33		16	
	27	„	·78	7·35	7·20	30		22	
	27	„	·90	...	...	34		24	
	27	„	·88	7·61	7·67	36		22	
	30	„	·71	7·30	8·88	29		15	
	30	„	·74	...	...	30		11	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Dehra Dûn Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_o.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
June	3	S. D.	915·69	7·22	7·95	·33433	·33447	·3323	·33219
	3	,,	·78	...	...	36		19	
	6	,,	·80	7·43	7·76	48		22	
	6	,,	·76	...	...	46		22	
	10	,,	·95	7·19	8·00	50		28	
	10	,,	·99	...	...	52		27	
	13	,,	·93	...	...	75		29	
	13	,,	·61	7·50	8·18	63		17	
	13	,,	·61	...	...	63		21	
	17	,,	·82	7·48	5·89	32		15	
	17	,,	·88	...	...	34		13	
	17	,,	·84	7·22	8·32	36		13	
	20	,,	·74	7·22	8·14	44		16	
	20	,,	·74	..	...	44		14	
	24	,,	·86	7·14	8·79	46		20	
	24	,,	·86	...	...	46		19	
	27	,,	916·01	7·32	7·90	46		18	
	27	,,	915·95	...	...	43		12	
July	1	S. D.	916·18	7·06	8·79	·33446	·33440	·33225	·33212
	1	,,	915·88	...	...	35		21	
	4	,,	·69	7·53	8·20	47		09	
	4	,,	·93	...	...	56		12	
	8	,,	·80	7·45	7·86	53		25	
	8	,,	·63	...	...	46		16	
	11	,,	·59	6·85	9·07	32		18	
	11	,,	·82	...	...	40		18	
	15	,,	·82	7·35	7·01	32		12	
	15	,,	·48	...	...	20		00	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Dehra Dún Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
July	15	S. D.	915·65	...	...	·33426	·33440	·33207	·33212
	16	„	·88	7·27	8·84	31		17	
	18	„	·71	7·24	8·98	56		11	
	18	„	·80	...	...	60		16	
	22	„	·80	7·48	7·58	47		13	
	22	„	·86	...	...	50		10	
	25	„	·80	7·40	8·88	53		02	
	25	„	·74	...	...	50		02	
	29	„	·82	7·50	9·21	09		198	
	29	„	916·01	...	...	16		205	
August	1	S. D.	915·95	7·43	6·78	·33413	·33421	·33201	·33210
	1	„	916·18	...	...	22		07	
	1	„	·20	...	7·62	21		04	
	5	„	·05	7·35	8·18	396		00	
	5	„	·09	...	...	98		194	
	8	„	915·93	7·27	8·04	440		91	·33197
	8	„	·82	...	...	36		86	
	12	„	916·01	7·61	6·27	17		91	
	12	„	...	...	...	28		97	
	12	„	·30	...	7·76	29		85	
	15	„	·07	7·53	8·74	18		96	
	15	„	·05	...	...	17		95	
	19	„	·07	7·61	7·44	22		94	
	19	„	·26	...	...	29		98	
	22	„	·26	7·56	7·34	393		93	
	22	„	...	...	...	87		208	
	26	„	916·20	7·48	8·74	449		03	
	29	„	915·97	7·40	8·28	25		195	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Dekra Dún Observatory.

1	2	3	4	5	6	7	8	9
Date.	Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.		C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
August 29	S. D.	916·26	...	...	·33436	·33421	·33204	·33197
29	,,	·28	...	...	36		04	
Sept. 2	S. D.	916·09	7·43	8·18	·33436	·33429	·33192	·33197
2	,,	·24	...	...	41		99	
5	,,	915·99	7·37	8·65	21		88	
5	,,	916·07	...	...	24		91	
12	,,	·09	7·14	7·62	38		206	·33211
12	,,	·26	...	...	44		11	
12	,,	·28	7·66	8·51	41		06	
12	,,	·41	...	...	46		13	
12	,,	·56	7·30	·879	40		14	
12	,,	·01	...	...	20		05	
13	,,	·54	7·56	7·11	13		10	
13	,,	·39	...	...	08		10	
13	,,	·41	7·50	7·44	07		12	
13	,,	·14	...	...	397		05	
14	,,	·45	7·76	6·83	427		18	
14	,,	·45	...	...	27		15	
14	,,	·35	...	7·95	31		17	
15	,,	·35	7·58	7·48	37		08	
15	,,	·24	...	...	33		02	
16	,,	·43	7·69	7·72	19		11	
16	,,	·47	...	...	20		09	
17	,,	·03	7·45	7·48	44		05	
17	,,	·18	...	...	50		10	
18	,,	·12	7·37	8·37	33		06	
18	,,	·22	...	...	36		04	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Dehra Dún Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Sept.	19	S. D.	916·62	7·61	8·84	·33442	·33429	·33219	·33211
	19	„	·03	...	...	20		196	
	19	„	·26	...	...	29		206	
	23	„	915·99	7·53	7·72	29		12	
	23	„	916·07	...	...	32		16	
	26	„	·26	7·30	7·76	13		19	
	26	„	·28	...	...	13		17	
	30	„	·09	7·45	8·79	29		19	
	30	„	·22	...	...	33		21	
Oct.	3	S. D.	916·26	7·74	8·14	·33414	·33414	·33218	·33211
	3	„	·45	...	...	21		18	
	7	„	·43	7·82	8·56	27		16	
	7	„	·37	...	...	25		13	
	10	„	915·99	7·58	8·37	45		04	
	10	„	916·12	...	...	50		04	
	14	„	·03	7·45	7·67	359		05	
	14	„	·33	...	...	70		14	
	14	„	·45	...	...	74		14	
	17	„	916·22	7·48	7·67	437		13	
	17	„	915·93	...	...	26		03	
	17	„	·99	...	...	29		07	
	21	„	·69	7·53	8·37	36		11	
	21	„	·55	...	...	30		09	
	22	„	·65	7·45	...	28		08	
	22	„	·42	...	...	20		03	
	22	„	·69	...	...	30		13	
	23	„	·82	7·76	8·00	09		14	
	23	„	·63	...	...	-02		14	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Dehra Dún Observatory.

1	2	3	4	5	6	7	8	9
Date.	Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.		C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Dec. 23	S. D.	915·67	7·69	8·09	·33400	·33414	·33213	·33211
23	„	·63	...	...	398		07	
24	„	·95	7·61	8·32	421		19	
24	„	·80	...	...	16		14	
24	„	·69	7·37	8·60	20		14	
24	„	·63	...	...	17		12	
27	„	·90	7·58	8·00	17		22	
27	„	·42	...	...	00		08	
27	„	·57	7·43	7·39	394		05	
27	„	·57	...	...	94		08	
28	„	·76	7·92	6·59	417		14	
28	„	·67	...	...	14		12	
28	„	·69	7·50	7·67	13		12	
28	„	·61	...	...	10		10	
Nov. 1	S. D.	915·50	7·74	8·37	...	·33384	...	·33216
1	„	...	...	...	·33283		·33213	
4	„	·71	7·71	8·32	366		17	
4	„	·52	...	...	59		18	
7	„	·36	7·58	8·74	400		08	
7	„	·59	...	...	09		14	
11	„	·61	7·24	8·42	361		212	
11	„	·46	...	...	56		07	
14	„	·76	7·56	7·67	96		22	
14	„	·65	...	...	93		22	
18	„	·86	7·82	8·28	92		22	
18	„	·78	...	...	89		19	
21	„	·84	7·71	7·48	96		22	

TABLE I—*concld.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Dehra Dún Observatory.

1	2	3	4	5	6	7	8	9
Date.	Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.		C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Nov. 21	S. D.	915·59	...	...	·3387	·33384	·33216	·33216
25	"	·65	7·63	8·04	407		13	
25	"	·65	...	...	07		17	
28	"	·61	7·45	8·98	14		13	
28	"	·44	...	...	08		09	
Dec. 2	S. D.	·57	7·66	7·48	377	·33396	10	·33216
5	"	916·07	7·32	7·62	400		16	
5	"	915·80	...	...	390		10	
9	"	·76	7·53	7·34	410		27	
9	"	·59	...	...	03		23	
11	"	...	...	8·04	06		23	
12	"	·71	7·56	7·76	07		22	
12	"	·44	...	...	397		12	
12	"	·69	...	...	406		21	
16	"	·74	7·43	7·34	392		20	
16	"	·67	...	...	90		20	
19	"	·74	7·63	8·28	415		23	
19	"	·57	...	...	09		17	
23	"	·69	...	...	396		13	
23	"	·71	7·63	7·62	97		14	
23	"	·57	...	...	92		10	
26	"	·67	7·53	7·30	422		10	
26	"	·61	...	...	20		12	
30	"	916·20	7·40	8·18	376		15	
30	"	·14	...	...	374		18	
31	"	·01	...	...	367		11	
31	"	·09	...	...	370		14	

TABLE II.

ABSOLUTE MAGNETIC ORSERVATIONS.

Observations of Declination at Dehra Dún Observatory.

1		2	3	4	5	6	7
Date.		Observer.	Magnetic Collimation.	Observed Declination, East.	Monthly mean observed Declination, East.	Base Line values.	Monthly mean Base Line values.
			′ ″	° ′	° ′	′	
1903.							
January	6	K. N. M.	−9 13	2 42·3	2 42·7	97·3	96·5
	9	„	9 5	2 42·4		97·1	
	13	„	9 8	2 41·8		96·9	
	16	„	9 9	2 43·1		96·5	
	20	„	9 13	2 43·1		96·2	
	23	„	9 13	2 44·0		96·2	
	27	„	9 6	2 42·9		95·9	
	27	„	9 7	2 42·6		95·9	
	30	„	9 16	2 42·8		96·4	
	30	„	9 9	2 42·6		96·4	
	30	„	9 5	2 42·2		96·3	
February	3	K. N. M.	−9 16	2 42·4	2 42·3	96·7	95·9
	3	„	9 11	2 42·5		96·6	
	6	„	9 13	2 43·6		96·5	
	10	„	9 13	2 43·4		95·5	
	11	„	9 1	2 41·2		95·8	
	11	„	16	2 41·4		95·8	
	13	„	9 14	2 42·9		96·2	
	17	„	9 14	2 42·6		95·2	
	20	„	9 16	2 42·9		96·0	
	24	„	9 6	2 40·9		95·6	
	24	„	9 3	2 40·8		95·5	
	27	„	9 11	2 42·5		95·7	
March	3	K. N. M.	−9 9	2 41·3	2 42·4	96·2	95·5
	10	S. D.	9 37	2 41·3		95·2	
	10	„	9 29	2 41·8		95·2	
	13	„	9 14	2 43·7		95·6	

TABLE II—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Dehra Dún Observatory.

1		2	3	4	5	6	7
Date.		Observer.	Magnetic Collimation.	Observed Declination, East.	Monthly mean observed Declination, East.	Base Line values.	Monthly mean Base Line values.
			′ ″	° ′	° ′	′	′
1903.							
March	17	S. D.	−9 18	2 43·8	2 42·4	95·8	95·5
	20	"	9 3	2 40·3		95·9	
	20	"	9 7	2 40·2		95·9	
	24	"	9 9	2 41·0		94·8	
	27	"	9 6	2 44·9		95·8	
	27	"	9 8	2 45·4		95·5	
	31	"	9 1	2 43·1		95·1	
April	3	S. D.	−8 57	2 43·4	2 41·1	95·7	95·2
	3	"	9 13	2 42·4		95·5	
	7	"	9 5	2 42·2		94·9	
	14	"	9 3	2 41·0		94·2	
	17	"	9 1	2 40·5		95·3	
	21	"	8 55	2 41·2		95·3	
	21	"	9 8	2 41·0		95·3	
	28	"	9 13	2 37·3		95·5	
May	1	S. D.	−9 8	2 42·5	2 40·3	95·6	94·9
	5	"	9 9	2 39·8		95·7	
	8	"	9 12	2 39·1		94·3	
	12	"	9 7	2 40·9		95·0	
	15	"	8 57	2 41·6		94·4	
	15	"	9 7	2 41·2		94·3	
	19	"	9 5	2 39·4		94·8	
	22	"	9 5	2 38·9		94·9	
	26	"	9 6	2 40·1		95·7	
	29	"	9 0	2 39·7		95·0	

TABLE II—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Dehra Dûn Observatory.

1	2	3	4	5	6	7
Date.	Observer.	Magnetic Collimation.	Observed Declination, East.	Monthly mean observed Declination, East.	Base Line values.	Monthly mean Base Line values.
1903.		′ ″	° ′	° ′	′	′
June 2	S. D.	−9 13	2 41·4	2 39·4	95·1	95·1
5	”	9 21	2 39·5		94·9	
9	”	9 19	2 39·0		95·1	
12	”	9 2	2 38·6		95·6	
16	”	9 9	2 38·7		95·6	
19	”	9 7	2 39·3		95·3	
23	”	9 4	2 40·0		94·4	
26	”	9 17	2 38·8		95·0	
30	”	9 1	2 39·7		94·7	
July 3	S. D.	−9 13	2 39·9	2 39·4	95·1	94·5
7	”	9 36	2 39·1		95·5	
10	”	8 52	2 37·7		93·7	
10	”	8 52	2 37·1		93·6	
14	”	9 2	2 38·0		95·0	
17	”	53	2 41·1		94·3	
17	”	9 1	2 40·8		94·2	
24	”	9 16	2 39·8		93·9	
24	”	9 3	2 40·0		94·0	
28	”	9 9	2 39·4		95·4	
31	”	9 1	2 40·0		94·4	
August 4	S. D.	−9 16	2 39·1	2 38·7	95·5	95·2
7	”	9 4	2 38·8		95·9	
11	”	9 10	2 37·6		94·9	
14	”	9 4	2 37·7		94·9	
18	”	9 0	2 39·4		95·6	
21	”	9 10	2 38·6		94·9	
25	”	9 10	2 39·7		94·8	

TABLE II—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Dehra Dún Observatory.

1		2	3	4	5	6	7
Date.		Observer.	Magnetic Collimation.	Observed Declination, East.	Monthly mean observed Declination, East.	Base Line values.	Monthly mean Base Line values.
1903.			′ ″	° ′	° ′	′	′
September	1	S. D.	−9 11	2 38·9	2 38·2	94·7	94·6
	4	„	9 3	2 37·8		94·7	
	8	„	9 19	2 37·4		94·4	
	11	„	9 10	2 39·2		95·9	96·3
	15	„	9 10	2 39·4		96·5	
	22	„	9 17	2 37·8		96·1	
	22	„	9 12	2 38·5		97·4	
	25	„	9 6	2 36·6		96·1	
	29	„	9 10	2 38·4		96·1	
October	2	S. D.	−8 57	2 37·8	2 40·	96·2	97·0
	6	„	9 8	2 41·3		97·6	
	9	„	9 2	2 39·6		97·7	
	13	„	8 58	2 40·7		96·0	
	16	„	9 3	2 40·9		96·5	
	20	„	8 58	2 39·9		96·4	
	21	„	9 7	2 39·5		96·6	
	23	„	9 2	2 41·3		97·4	
	23	„	9 9	2 40·9		97·2	
	27	„	9 7	2 40·2		97·4	
	27	„	9 4	2 39·9		97·2	
	27	„	9 6	2 40·1		97·4	
	30	„	9 5	2 41·1		97·3	
November	3	S. D.	−8 29	2 41·3	2 41·6	97·4	97·3
	3	„	8 12	2 42·4		97·5	
	4	„	8 28	2 40·6		97·5	
	4	„	8 25	2 40·8		97·3	
	5	„	8 33	2 40·9		97·1	

TABLE II—*concld.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Dehra Dún Observatory.

1	2	3	4	5	6	7
Date.	Observer.	Magnetic Collimation.	Observed Declination, East.	Monthly mean observed Declination, East.	Base Line values.	Monthly mean Base Line values.
1903.		′	° ′	° ′	′	′
November 5	S. D.	−8 30	2 40·8	2 41·6	96·9	97·3
5	”	8 27	2 40·9		97·0	
5	”	8 25	2 41·0		97·1	
5	”	8 24	2 40·9		96·9	
6	”	8 32	2 41·9		97·0	
6	”	8 30	2 42·2		97·0	
6	”	8 30	2 42·6		97·2	
6	”	8 29	2 42·5		97·1	
6	”	8 30	2 42·7		97·2	
10	”	8 25	2 40·9		97·6	
13	”	8 21	2 40·5		97·6	
17	”	8 28	2 42·5		97·9	
20	”	8 28	2 41·5		97·6	
24	”	8 25	2 42·3		97·6	
27	”	8 27	2 41·8		97·9	
December 1	S. D.	−8 24	2 41·4	2 41·5	97·8	97·6
4	”	8 23	2 42·4		97·6	
8	”	8 30	2 41·1		97·4	
8	”	8 27	2 41·4		97·5	
11	”	8 29	2 40·2		97·4	
15	”	8 24	2 41·4		97·6	
18	”	8 29	2 41·8		97·3	
22	”	8 28	2 42·1		97·6	
25	”	8 30	2 42·0		97·7	
29	”	8 23	2 41·6		97·6	

TABLE III.

ABSOLUTE MAGNETIC OBSERVATIONS: YEAR 1903.

Observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44 and needles Nos. 1 and 2 by Dover.

Date.		Dehra Dún L. M. time of observation (0 to 24 hours.)		Observer.	Needle No.	Observed Dip.		Monthly mean for each needle.	Monthly mean.
1903.		h.	m.			°	′		
January	1	15	55·0	K. N. M.	1	43	10·1	No. 1 43° 11′·2 No. 2 43° 10′·8	43° 11′·0
	1	15	55·0	„	2		10·6		
	5	16	3·0	„	1		9·8		
	5	16	3·0	„	2		11·2		
	8	12	37·0	„	1		9·5		
	8	12	37·0	„	2		9·3		
	12	14	22·0	„	1		11·3		
	12	14	22·0	„	2		11·9		
	12	15	4·0	„	2		12·3		
	13	15	53·0	„	1		12·4		
	15	15	53·0	„	1		12·0		
	15	15	53·0	„	2		9·9		
	16	12	54·0	„	2		9·2		
	19	13	41·0	„	1		12·5		
	19	13	41·0	„	2		8·0		
	19	14	48·0	„	2		13·9		
	22	12	21·0	„	1		11·1		
	22	12	21·0	„	2		12·1		
	26	14	41·0	„	1		11·8		
	26	14	41·0	„	2		11·1		
	29	13	59·0	„	1		11·4		
	29	13	59·0	„	2		10·5		
February	2	13	52·0	K. N. M.	1	43	12·2		43° 12′·0
	2	13	5·20	„	2		11·3		
	5	14	2·0	„	1		13·1		
	5	14	2·0	„	2		9·7		
	5	14	49·0	„	2		12·3		
	9	13	24·0	„	1		12·9		

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS: YEAR 1903.

Observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44 and needles Nos. 1 and 2 by Dover.

Date.		Dehra Dún L. M. time of observation (0 to 24 hours.)		Observer.	Needle No.	Observed Dip.		Monthly mean for each needle.	Monthly mean.
1903.		h.	m.				′		
February	9	13	24·0	K. N. M.	2	43	11·1	No. 1 43° 12′·7 No. 2 43° 11′·4	43° 12′·0
	12	14	54·0	,,	1		14·1		
	12	14	54·0	,,	2		13·1		
	16	12	26·0	,,	1		10·2		
	16	12	26·0	,,	2		8·9		
	16	13	37·0	,,	2		12·6		
	19	12	45·0	,,	1		13·0		
	19	12	45·0	,,	2		11·5		
	23	15	9·0	,,	1		13·5		
	23	15	9·0	,,	2		11·9		
	26	13	51·0	,,	1		12·2		
	26	13	51·0	,,	2		11·5		
March	2	13	0	K. N. M.	1	43	12·2	No. 1 43° 11′·0 No. 2 43° 10′·3	43° 10′·7
	2	13	0	,,	2		10·3		
	5	11	50·0	Shri Dhar	1		10·8		
	5	11	50·0	,,	2		10·6		
	9	11	51·0	,,	1		14·2		
	9	11	51·0	,,	2		13·4		
	12	8	54·0	,,	1		11·1		
	12	8	54·0	,,	2		9·0		
	16	12	8·0	,,	1		11·4		
	16	12	8·0	,,	2		10·8		
	19	11	53·0	,,	1		9·9		
	19	11	53·0	,,	2		8·8		
	20	12	22·0	,,	1		10·3		
	20	12	22·0	,,	2		8·3		
	23	12	8·0	,,	1		10·7		
	23	12	8·0	,,	2		12·0		

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS: YEAR 1903.

Observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44 and needles Nos. 1 and 2 by Dover.

Date.		Dehra Dún L. M. time of observation (0 to 24 hours).		Observer.	Needle No.	Observed Dip.		Monthly mean for each needle.	Monthly mean.
1903.		h.	m.			°	′		
March	26	11	36·0	Shri Dhar	1	43	10·1		43° 10′·7
	26	11	36·0	„	2		9·3		
	30	11	33·0	„	1		9·7		
	30	11	33·0	„	2		10·1		
April	2	11	22·0	„	1	43	10·7	No. 1 43° 12′·4 No. 2 43° 12′·1	43° 12′·3
	2	11	22·0	„	2		11·8		
	6	11	15·0	„	1		13·8		
	6	11	15·0	„	2		13·5		
	9	12	33·0	„	1		14·0		
	9	12	33·0	„	2		14·2		
	13	11	45·0	„	1		8·8		
	13	11	45·0	„	2		11·9		
	13	13	2·0	„	1		11·1		
	13	13	2·0	„	2		10·2		
	16	12	18·0	„	1		12·4		
	16	12	18·0	„	2		10·9		
	20	12	18·0	„	1		14·1		
	20	12	18·0	„	2		14·3		
	23	13	8·0	H. A. D. F.	1		13·0		
	27	12	40·0	Shri Dhar	1		12·9		
	27	12	40·0	„	2		13·4		
	28	14	54·0	„	1		15·1		
	28	14	54·0	„	2		15·9		
	29	13	49·0	„	1		10·1		
	29	13	49·0	„	2		10·5		
	30	14	43·0	„	1		12·9		
	30	14	43·0	„	2		8·1		
	30	15	54·0	„	1		11·9		
	30	15	54·0	„	2		10·8		

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS: YEAR 1903.

Observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44 and needles Nos. 1 and 2 by Dover.

Date.	Dehra Dún L. M. time of observation (0 to 24 hours).	Observer.	Needle No.	Observed Dip.	Monthly mean for each needle.	Monthly mean.
1903.	h. m.			° ′		
May 2	13 56·0	Shri Dhar	1	43 11·7	No. 1 43° 12′·3 No. 2 43° 11′·5	43° 11′·9
2	13 56·0	„	2	10·8		
4	11 45·0	„	1	14·1		
4	11 45·0	„	2	10·2		
5	12 21·0	„	1	13·5		
5	12 21·0	„	2	12·6		
7	12 6·0	„	1	11·9		
7	12 6·0	„	2	12·8		
8	12 36·0	„	1	10·8		
8	12 36·0	„	2	10·9		
9	13 54·0	„	1	12·2		
9	13 54·0	„	2	9·8		
11	11 47·0	„	1	9·4		
11	11 47·0	„	2	10·5		
12	13 13·0	„	1	18·8		
12	13 13·0	„	2	21·2		
14	12 48·0	„	1	11·7		
14	12 48·0	„	2	9·7		
18	12 1·0	„	1	10·1		
18	12 1·0	„	2	10·4		
21	11 44·0	„	2	9·9		
21	11 44·0	„	1	10·7		
25	13 50·0	„	1	11·8		
25	13 50·0	„	2	9·9		
28	15 18·0	„	1	12·9		
28	15 18·0	„	2	11·0		
June 4	14 30·0	„	1	13·7	No. 1 43° 14′·1 No. 2 43° 12′·3	43° 13′·2
4	14 30·0	„	2	11·6		
11	14 23·0	„	1	14·3		

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS: YEAR 1903.

Observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44 and needles Nos. 1 and 2 by Dover.

Date.		Dehra Dún L. M. time of observation (0 to 24 hours.)		Observer.	Needle No.	Observed Dip.		Monthly mean for each needle.	Monthly mean.
1903.		h.	m.			°	′		
June	11	14	23·0	Shri Dhar	2		12·7	No. 1 43° 14′·1	43° 13′·2
	15	14	49·0	„	1		13·5		
	15	14	49·0	„	2		11·9		
	18	12	45·0	„	1		13·6		
	18	12	45·0	„	2		11·7		
	22	14	45·0	„	1		14·0		
	22	14	45·0	„	2		11·6		
	25	15	11·0	„	1		15·9	No. 2 43° 12′·3	
	25	15	11·0	„	2		14·1		
	29	14	1·0	„	1		13·6		
	29	14	1·0	„	2		12·6		
July	2	12	19·0	Shri Dhar	1	43	13·1	No. 1 43° 14′·2	43° 13′·4
	2	12	19·0	„	2		10·8		
	6	11	49·0	„	1		14·8		
	6	11	49·0	„	2		13·7		
	9	15	6·0	„	1		14·9		
	9	15	6·0	„	2		12·4		
	13	14	18·0	„	1		13·6		
	13	14	18·0	„	2		12·8		
	16	12	36·0	„	1		13·4		
	16	12	36·0	„	2		12·7		
	20	14	19·0	„	1		14·1	No. 2 43° 12′·6	
	20	14	19·0	„	2		12·8		
	23	12	40·0	„	1		13·7		
	23	12	40·0	„	2		12·2		
	27	14	5·0	„	1		15·6		
	27	14	5·0	„	2		12·7		
	27	14	14·0	„	1		14·2		

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS: YEAR 1903.

Observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44 and needles Nos. 1 and 2 by Dover.

Date.		Dehra Dún L. M. time of observation (0 to 24 hours).		Observer.	Needle No.	Observed Dip.		Monthly mean for each needle.	Monthly mean.
1903.		h.	m.			°	'		
July	30	13	36·0	Shri Dhar	1	43	14·6	No, 1 43° 14'·2 No. 2 43° 12'·6	43° 13'·4
	30	13	36·0	,,	2		13·0		
August	3	15	8·0	,,	2		15·4		43° 14'·5
	6	13	48·0	,,	1		13·1		
	6	13	48·0	,,	2		13·5	No. 1 43° 14'·6	
	10	14	22·0	,,	1		12·3		
	10	14	22·0	,,	2		15·4		
	11	11	1·0	,,	1		12·9		
	11	11	1·0	,,	2		16·1		
	11	11	1·0	,,	2		12·9		
	13	11	21·0	,,	1		15·6		
	13	11	21·0	,,	2		15·4		
	17	13	50·0	,,	1		15·0		
	17	13	50·0	,,	2		13·6	No. 2 43° 14'·3	
	20	11	1·0	,,	1		15·7		
	20	11	1·0	,,	2		13·8		
	24	13	37·0	,,	1		16·2		
	24	13	37·0	,,	2		13·2		
	24	13	55·0	,,	2		14·2		
	27	11	9·0	,,	1		15·1		
	27	11	9·0	,,	2		14·9		
	31	14	21·0	,,	1		15·7		
	31	14	21·0	,,	2		13·7		
September	3	17	13·0	,,	1		17·5	No. 1 43° 15'·9	43° 15'·0
	3	17	13·0	,,	2		14·1		
	4	14	45·0	,,	1		15·5		
	4	14	45·0	,,	2		14·0		
	6	14	45·0	,,	1		14·9	No. 2 43° 14'·2	
	6	14	45·0	,,	2		12·5		

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS: YEAR 1903.

Observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44 and needles Nos. 1 and 2 by Dover.

Date.		Dehra Dún L. M. time of observation (0 to 24 hours).		Observer.	Needle No.	Observed Dip.	Monthly mean for each needle.	Monthly mean.
1903.		h.	m.			° ′		
September	7	14	57·0	S. D.	1	43 15·7	No. 1 43° 15′·9	43° 15′·0
	7	14	57·0	„	2	14·4		
	10	13	47·0	„	1	15·0		
	10	13	47·0	„	2	13·7		
	14	15	0	„	1	17·8		
	14	15	0	„	2	14·1		
	15	11	20·0	„	1	15·9		
	15	11	20·0	„	2	15·5		
	17	14	40·0	„	1	13·7	No. 2 43° 14′·2	
	17	14	40·0	„	2	15·1		
	21	13	30·0	„	1	16·1		
	21	13	30·0	„	2	13·6		
	24	12	11·0	„	1	15·7		
	24	12	11·0	„	2	15·1		
	28	14	54·0	„	1	16·7		
	28	14	54·0	„	2	14·3		
October	1	10	58·0	„	1	14·2	No. 1 43° 16′·0	43° 15′·8
	1	10	58·0	„	2	13·1		
	5	13	34·0	„	1	14·3		
	5	13	34·0	„	2	15·7		
	8	13	21·0	„	1	15·3		
	8	13	21·0	„	2	17·2		
	12	10	49·0	„	1	16·7		
	12	10	49·0	„	2	17·5		
	15	10	42·0	„	1	15·7	No. 2 43° 15′·6	
	15	10	42·0	„	2	16·1		
	19	13	24·0	„	1	16·5		
	19	13	24·0	„	2	14·6		
	22	11	49·0	„	1	16·0		

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS: YEAR 1903.

Observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44 and needles Nos. 1 and 2 by Dover.

Date.		Dehra Dún L. M. time of observation (0 to 24 hours).	Observer.	Needle No.	Observed Dip.	Monthly mean for each needle.	Monthly mean.
1903.		h. m.			° ′		
October	22	11 49·0	S. D.	2	43 15·4	No. 1 43° 16′·0 No. 2 43° 15′·6	43° 15′·8
	22	13 12·0	”	1	16·6		
	22	13 12·0	”	2	14·6		
	26	12 4·0	”	1	15·8		
	26	12 4·0	”	2	16·3		
	26	13 23·0	”	1	18·3		
	26	13 23·0	”	2	17·6		
	29	12 2·0	”	1	14·6		
	29	12 2·0	”	2	15·5		
	29	13 11·0	”	1	15·9		
	29	13 11·0	”	2	15·3		
November	2	13 44·0	”	1	22·3	No. 1 43° 19′·0 No. 2 43° 17′·9	43° 18′·5
	2	13 44·0	”	2	18·6		
	2	14 41·0	”	1	23·4		
	2	14 41·0	”	2	21·8		
	5	7 55·0	”	1	20·5		
	5	7 55·0	”	2	19·9		
	7	14 40·0	”	1	17·6		
	7	14 40·0	”	2	17·5		
	8	8 1·0	”	1	19·4		
	8	8 1·0	”	2	18·7		
	9	16 38·0	”	1	17·5		
	9	16 38·0	”	2	17·8		
	12	13 36·0	”	1	16·9		
	12	13 36·0	”	2	16·6		
	16	13 28·0	”	1	17·0		
	16	13 28·0	”	2	17·2		
	19	12 28·0	”	1	19·5		
	19	12 28·0	”	2	17·0		

TABLE III—*concld.*

ABSOLUTE MAGNETIC OBSERVATIONS: YEAR 1903.

Observations of Dip at Dehra Dún Observatory taken with Barrow's Dip Circle No. 44 and needles Nos. 1 and 2 by Dover.

Date		Dehra Dún L. M. time of observation (0 to 24 hours).		Observer.	Needle No.	Observed Dip.		Monthly mean for each needle.	Monthly mean.
1903.		h.	m.			°	′		
November	23	12	58·0	S. D.	1	43	17·8	No. 1 43° 19′.0 No. 2 43° 17′·9	43° 18′·5
	23	12	58·0	„	2		17·3		
	26	12	20·0	„	1		18·2		
	26	12	20·0	„	2		16·9		
	30	13	29·0	„	1		18·4		
	30	13	29·0	„	2		1·57		
December	3	13	31·0	„	2		17·1	No. 1 43° 19′·0 No. 2 43° 17′·1	43° 18′·0
	7	12	13·0	„	1		16·7		
	7	12	13·0	„	2		15·0		
	10	15	10·0	„	1		17·1		
	10	15	10·0	„	2		14·7		
	14	13	28·0	„	1		20·4		
	14	13	28·0	„	2		18·5		
	17	13	50·0	„	1		19·5		
	17	13	50·0	„	2		17·3		
	21	13	27·0	„	1		19·9		
	21	13	27·9	„	2		18·3		
	24	12	31·0	„	1		16·3		
	24	12	31·0	„	2		15·2		
	27	11	27·0	„	1		17·9		
	27	11	27·0	„	2		15·9		
	28	13	49·0	„	1		18·5		
	28	13	49·0	„	2		16·3		
	28	12	29·0	N. R. M.	1		18·4		
	28	12	29·0	„	2		15·8		
	31	12	6·0	„	1		22·9		
	31	12	6·0	„	2		21·5		
	31	13	26·0	S. D.	1		21·0		
	31	13	26·0	„	2		19·3		

TABLE IV.

Dates of magnetic disturbances at Dehra Dún in 1903.

Latitude of observatory=30°-19′-29.″
Longitude of „ =78°-5′-42″.

1903.	Months.											
Date.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1	S	C	S	C	C	S	S	C	S	C	V G	S
2	S	(C)	S	(C)	S	M	S	S	S	S	M	S
3	S	C	C	C	(C)	S	C	(C)	(C)	(C)	S	(C)
4	S	C	(C)	S	S	S	(C)	S	...	S	S	M
5	S	S	S	S	M	S	C	S	...	S	S	S
6	C	(C)	S	G	S	C	S	C	S	S	S	S
7	(C)	C	S	S	S	(C)	(C)	(C)	(C)	S	(C)	S
8	C	M	S	...	S	C	C	S	S	S	S	S
9	S	S	S	...	S	S	C	S	...	(C)	S	C
10	S	C	S	...	C	(C)	S	S	...	S	S	(C)
11	S	S	(C)	...	C	S	S	M	S	S	S	C
12	(C)	S	S	C	(C)	C	C	S	M	M	S	C
13	C	S	M	(C)	S	(C)	S	S	S	G	S	M
14	S	C	S	C	S	S	S	S	S	S	(C)	M
15	(C)	S	C	S	S	(C)	(C)	C	C	(C)	C	S
16	S	S	C	(C)	S	S	S	S	(C)	C	(C)	(C)
17	C	S	C	S	M	S	S	(C)	C	S	S	C
18	S	(C)	(C)	S	(C)	S	S	C	C	S	S	C
19	S	C	S	S	C	S	S	(C)	M	C	M	C
20	S	S	C	(C)	(C)	S	C	C	M	(C)	C	S
21	(C)	S	(C)	C	S	S	C	S	S	C	S	S
22	S	S	S	C	S	S	C	M	(C)	S	S	(C)
23	S	C	S	C	S	S	C	S	S	(C)	S	C
24	S	(C)	S	C	S	S	(C)	C	S	S	C	C
25	(C)	S	C	C	S	C	S	C	C	S	(C)	S
26	M	C	C	S	C	C	M	M	(C)	S	S	S
27	M	(C)	(C)	S	(C)	(C)	S	C	S	C	S	C
28	C	C	C	C	C	S	S	C	S	C	S	(C)
29	S	...	S	(C)	C	M	S	(C)	M	S	S	C
30	S	...	S	S	S	M	(C)	S	S	S	C	M
31	S	...	S	...	S	S	S	C	...	V G	...	M
C.	10	15	13	15	12	10	14	15	9	11	8	15
S.	19	12	17	10	17	17	16	13	13	17	19	11
M.	2	1	1	...	2	3	1	3	4	1	2	5
G.	...	...	...	1	...	...	...	...	...	1	...	...
V. G.	...	...	...	...	...	...	...	...	...	1	1	...

TABLE V.

Hourly means of Horizontal Force in C. G. S. Units (corrected for Temperature) at Dehra Dún from the selected quiet days in 1903.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
H. F.													Winter months.												
1903, Months.																									
January . .	·33448	·33448	·33449	·33450	·33450	·33451	·33453	*·33454*	·33453	·33451	·33446	*·33444*	·33450	·33450	·35450	·33446	·33448	·33446	·33448	·33448	33447	·33448	·33448	·33448	·33449
February . .	*44*	45	45	46	46	46	48	51	55	58	60	61	*62*	60	56	53	51	48	48	48	48	46	46	48	51
March . .	42	*40*	41	41	43	42	44	44	47	51	57	*60*	59	57	55	50	47	45	44	42	41	41	43	43	47
October . .	10	08	07	10	09	10	10	09	07	*04*	09	16	24	*28*	22	16	12	12	12	12	13	12	16	15	13
November . .	381	383	382	384	387	387	390	391	395	395	399	403	*408*	404	397	392	386	386	384	382	379	*377*	380	379	389
December . .	394	*391*	394	394	395	396	396	401	403	*407*	406	405	404	403	401	399	396	396	396	394	395	396	397	394	398
Means . .	·33420	*·33419*	·33420	·33421	·33422	·33422	33424	·33425	·33427	·33428	·33430	·33432	*·33435*	·33434	·33430	·33426	·33423	·33422	·33422	·33421	·33421	·33420	·33422	·33421	·33424
H. F.													Summer months.												
April . . .	·33436	*·33435*	·33437	·33436	·33439	·33439	·33440	·33442	·33441	·33445	·33446	·33451	·33453	*·33456*	·33456	·33451	·33444	·33439	·33437	·33437	·33437	·33438	·33438	·33438	·33442
May . . .	39	39	39	38	37	38	39	36	*35*	36	42	52	56	*59*	58	54	50	45	41	39	40	41	43	43	43
June . . .	42	41	41	41	42	43	44	39	*35*	36	42	49	53	*56*	55	51	46	39	38	39	40	41	40	39	43
July . . .	32	32	33	31	31	29	31	31	29	*27*	30	36	44	48	*49*	46	40	32	28	28	28	30	30	32	34
August . .	23	23	23	23	24	25	26	24	*20*	22	27	31	37	*42*	42	40	36	30	28	26	25	27	29	30	29
September . .	22	23	22	24	25	25	23	17	11	*10*	14	21	30	*37*	37	33	28	26	26	25	24	26	27	28	24
Means . .	·33432	·33432	·33433	·33432	·33433	·33433	·33434	·33432	*·33429*	·33429	·33434	·33440	·33416	*·33450*	·33450	·33446	·33441	·33435	·33433	·33432	·33432	·33434	·33435	·33435	*·33436*

TABLE VI.

Diurnal inequality of the Horizontal Force at Dehra Dún as deduced from Table V.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
1903, Months.	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
January	−1	−1	0	+1	+1	+2	+4	+5	+4	+2	−3	−5	+1	+1	+1	−3	−1	−3	−1	−1	−2	−1	−1	−1
February . . .	−7	−6	−6	−5	−5	−5	−3	0	+4	+7	+9	+10	+11	+9	+5	+2	0	−3	−3	−3	−3	−5	−5	−3
March	−5	−7	−6	−6	−4	−5	−3	−3	0	+4	+10	+13	+12	+10	+8	+3	0	−2	−3	−5	−6	−6	−4	−4
October . . .	−3	−5	−6	−3	−4	−3	−3	−4	−6	−9	−4	+3	+11	+15	+9	+3	−1	−1	−1	−1	0	−1	+3	+2
November . . .	−8	−6	−7	−5	−2	−2	+1	+2	+6	+6	+10	+14	+19	+15	+8	+3	−3	−3	−5	−7	−10	−12	−9	−10
December . . .	−4	−7	−4	−4	−3	−2	−2	+3	+5	+9	+8	+7	+6	+5	+3	+1	−2	−2	−2	−4	−3	−2	−1	−4
Means	−4	−5	−4	−3	−2	−2	0	+1	+3	+	+6	+8	+11	+10	+6	+2	−1	−2	−2	−3	−3	−4	−2	−3
Summer.																								
April	−6	−7	−5	−6	−3	−3	−2	0	−1	+3	+4	+9	+11	+14	+14	+9	+2	−3	−5	−5	−5	−4	−4	−4
May	−4	−4	−4	−5	−6	−5	−4	−7	−8	−7	−1	+9	+13	+16	+15	+11	+7	+2	−2	−4	−3	−2	0	0
June	−1	−2	−2	−2	−1	0	+1	−4	−8	−7	−1	+6	+10	+13	+12	+8	+3	−4	−5	−4	−3	−2	−3	−4
July	−2	−2	−1	−3	−3	−5	−3	−3	−5	−7	−4	+2	+10	+14	+15	+12	+6	−2	−6	−6	−6	−4	−4	−2
August	−6	−6	−6	−6	−5	−4	−3	−5	−9	−7	−2	+2	+8	+13	+13	+11	+7	+1	−1	−3	−4	−2	0	+1
September . . .	−2	−1	−2	0	+1	+1	−1	−7	−13	−14	−10	−3	+6	+13	+13	+9	+4	+2	+2	+1	0	+2	+3	+4
Means	−4	−4	−3	−4	−3	−3	−2	−4	−7	−7	−2	+4	+10	+14	+14	+10	+5	−1	−3	−4	−4	−2	−1	−1

NOTE.—When the sign is + the reading is above the mean.

TABLE VII.

Hourly means of the Declination at Dehra Dún as determined from the selected quiet days in 1903.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
Declination East 2°+																									
Winter.																									
1903, Months.																									
January . .	42·6	42·7	42·5	42·3	42·2	42·1	42·2	42·3	43·0	43·8	44·0	42·7	41·9	41·9	42·1	42·1	42·4	42·7	43·0	43·0	43·0	43·0	42·9	42·9	42·6
February . .	42·5	42·6	42·4	42·4	42·3	42·2	42·0	42·2	42·8	43·3	43·2	43·1	42·4	41·9	41·8	41·8	42·1	42·5	42·5	42·6	42·6	42·6	42·5	42·5	42·4
March . .	42·1	42·2	42·1	42·0	41·9	41·9	41·9	42·4	43·4	44·3	44·2	43·1	41·6	40·7	40·5	41·3	42·0	42·3	42·3	42·1	42·1	42·2	42·2	42·3	42·2
October . .	41·2	41·3	41·2	41·0	41·0	41·0	41·1	41·9	42·8	42·8	41·9	40·4	39·0	38·8	39·6	40·7	41·1	41·1	41·0	40·9	40·9	40·9	40·9	41·1	41·0
November . .	41·7	41·6	41·7	41·6	41·2	41·2	41·2	41·5	42·5	42·9	41·9	41·0	40·3	40·4	41·0	41·6	41·9	41·8	41·6	41·8	41·8	41·7	41·9	42·1	41·6
December . .	41·8	42·0	41·9	41·9	41·6	41·6	41·4	41·3	41·4	41·9	42·1	41·7	41·2	41·3	41·5	41·9	41·8	41·7	41·8	41·7	41·7	41·6	41·6	41·8	41·7
Means . .	42·0	42·1	42·0	41·9	41·7	41·7	41·6	41·9	42·6	43·2	42·9	42·0	41·1	40·8	41·1	41·6	41·9	42·0	42·0	42·0	42·0	42·0	42·0	42·1	41·9
Summer.																									
April . .	42·7	42·7	42·8	42·8	42·5	42·4	42·5	43·5	44·4	44·9	43·9	42·0	40·5	39·7	39·9	40·9	41·8	42·4	42·4	42·2	42·1	42·1	42·2	42·3	42·3
May . . .	41·4	41·5	41·6	41·6	41·5	41·7	42·8	43·7	44·0	43·3	42·3	40·7	39·6	39·3	39·5	40·0	40·5	41·0	41·2	40·9	40·7	40·7	40·9	41·0	41·3
June . . .	41·2	41·4	41·6	41·6	41·6	41·9	43·4	44·6	44·6	43·6	42·1	39·9	38·5	37·9	38·0	38·7	39·9	40·9	41·3	41·0	40·9	41·1	41·4	41·5	41·2
July . . .	41·1	41·3	41·3	41·4	41·4	41·6	42·7	43·7	43·7	43·0	41·7	39·7	38·5	38·1	37·8	38·6	39·6	40·7	41·2	41·2	41·1	41·1	41·2	41·3	41·0
August . .	41·4	41·5	41·6	41·7	41·8	42·1	43·4	44·3	44·5	43·6	42·0	40·0	38·9	38·6	39·1	40·0	41·1	41·4	41·4	41·1	41·3	41·0	41·0	41·2	41·4
September . .	40·1	40·2	40·4	40·4	40·5	40·6	41·4	42·6	43·1	42·1	40·1	38·1	36·7	36·6	37·7	39·3	40·4	40·7	40·2	40·0	39·9	39·9	40·0	40·0	40·0
Means . .	41·3	41·4	41·5	41·6	41·6	41·7	42·7	43·7	44·1	43·4	42·0	40·1	38·8	38·4	38·7	39·6	40·6	41·2	41·3	41·1	41·0	41·0	41·1	41·2	41·2

TABLE VIII.

Diurnal inequalities of the Declination at Dehra Dún as deduced from Table VII.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
1903, Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
January	0	+0·1	−0·1	−0·3	−0·4	−0·5	−0·4	−0·3	+0·4	+1·2	+1·4	+0·1	−0·7	−0·7	−0·5	−0·5	−0·2	+0·1	+0·4	+0·4	+0·4	+0·4	+0·3	+0·3
February	+0·1	+0·2	0	0	−0·1	−0·2	−0·4	−0·2	+0·4	+0·9	+0·8	+0·7	0	−0·5	−0·6	−0·6	−0·3	+0·1	+0·1	+0·2	+0·2	+0·2	+0·1	+0·1
March	−0·1	0	−0·1	−0·2	−0·3	−0·3	−0·3	+0·2	+1·2	+2·1	+2·0	+0·9	−0·6	−1·5	−1·7	−0·9	−0·2	+0·1	+0·1	−0·1	−0·1	0	0	+0·1
October	+0·2	+0·3	+0·2	0	0	0	+0·1	+0·9	+1·8	+1·8	+0·9	−0·6	−2·0	−2·2	−1·4	−0·3	+0·1	+0·1	0	−0·1	−0·1	−0·1	−0·1	+0·1
November	+0·1	0	+0·1	0	−0·4	−0·4	−0·4	−0·1	+0·9	+1·3	+0·3	−0·6	−1·3	−1·2	−0·6	0	+0·3	+0·2	0	+0·2	+0·2	+0·1	+0·3	+0·5
December	+0·1	+0·3	+0·2	+0·2	−0·1	−0·1	−0·3	−0·4	−0·3	+0·2	+0·4	0	−0·5	−0·4	−0·2	+0·2	+0·1	0	+0·1	0	0	−0·1	−0·1	+0·1
Means	+0·1	+0·2	+0·1	0	−0·2	−0·2	−0·3	0	+0·7	+1·3	+1·0	+0·1	−0·8	−1·1	−0·8	−0·3	0	+0·1	+0·1	+0·1	+0·1	+0·1	+0·1	+0·2
Summer.																								
April	+0·4	+0·4	+0·5	+0·5	+0·2	+0·1	+0·2	+1·2	+2·1	+2·6	+1·6	−0·3	−1·8	−2·6	−2·4	−1·4	−0·5	+0·1	+0·1	−0·1	−0·2	−0·2	−0·1	0
May	+0·1	+0·2	+0·3	+0·3	+0·2	+0·4	+1·5	+2·4	+2·7	+2·0	+1·0	−0·6	−1·7	−2·0	−1·8	−1·3	−0·8	−0·3	−0·1	−0·4	−0·6	−0·6	−0·4	−0·3
June	0	+0·2	+0·4	+0·4	+0·4	+0·7	+2·2	+3·4	+3·4	+2·4	+0·9	−1·3	−2·7	−3·3	−3·2	−2·5	−1·3	−0·3	+0·1	−0·2	−0·3	−0·1	+0·2	+0·3
July	+0·1	+0·3	+0·3	+0·4	+0·4	+0·6	+1·7	+2·7	+2·7	+2·0	+0·7	−1·3	−2·5	−2·9	−3·2	−2·4	−1·4	−0·3	+0·2	+0·2	+0·1	+0·1	+0·2	+0·3
August	0	+0·1	+0·2	+0·3	+0·4	+0·7	+2·0	+2·9	+3·1	+2·2	+0·6	−1·4	−2·5	−2·8	−2·3	−1·4	−0·3	0	0	−0·3	−0·1	−0·4	−0·4	−0·2
September	+0·1	+0·2	+0·4	+0·4	+0·5	+0·6	+1·4	+2·6	+3·1	+2·1	+0·1	−1·9	−3·3	−3·4	−2·3	−0·7	+0·4	+0·7	+0·2	0	−0·1	−0·1	0	0
Means . . .	+0·1	+0·2	+0·3	+0·4	+0·4	+0·5	+1·5	+2·5	+2·9	+2·2	+0·8	−1·1	−2·4	−2·8	−2·5	−1·6	−0·6	0	+0·1	−0·1	−0·2	−0·2	−0·1	0

NOTE.—When the sign is + the magnet points to the east of mean position and when — to the west.

TABLE IX.

Statement of loss of Magnetograph records in 1903.

DEHRA DÚN OBSERVATORY.

HORIZONTAL FORCE MAGNETOGRAPH.					DECLINATION MAGNETOGRAPH.					Cause of interruption.
PERIOD OF BREAK.				Duration of break.	PERIOD OF BREAK.					
From	On	To	On		From	On	To	On	Duration.	
h. m.	Date	h. m.	Date	h. m.	h. m.	Date	h. m.	Date	h. m.	
19 55	8th April .	10 12	9th April .	14 17	19 55	8th April .	10 12	9th April .	14 17	Clock cord broke.
8 36	10th ,, .	10 40	11th ,, .	26 4	8 36	10th ,, .	10 16	11th ,, .	26 10	,, ,, ,, New cord fitted.
11 0	30th ,, .	12 16	30th ,, .	1 16	11 0	30th ,, .	12 6	30th ,, .	1 16	New cord fitted, glasses cleaned.
...	...	...	...	...	9 51	28th August .	10 4	30th August .	48 13	Not known.
15 22	3rd September	16 16	3rd September	0 54	15 22	3rd September	16 16	3rd September	0 54	Glasses cleaned.
16 36	4th ,, .	14 3	5th ,, .	21 27	...	...	...	...	...	
10 29	9th ,, .	8 27	10th ,, .	21 58	7 25	9th September	8 27	10th September	25 2	New mirrors fitted.
14 15	31st October .	24 0	31st October .	9 45	...	...	...	...	...	Trace went off paper owing to the very great disturbance.
0 20	1st November	3 20	1st November	3 0	...	...	...	...	...	
...	...	...	...	...	9 59	17th November	13 0	17th November	3 1	Lamp failed.
8 5	23rd December	10 7	23rd December	2 2	...	...	...	...	...	Lamp got smoky.
			TOTAL .	100 43				TOTAL .	118 53	

KODAIKÁNAL MAGNETIC OBSERVATORY.

General remarks.

1. During the year 1904, the magnetograph room has never been thoroughly dry. Its condition has certainly been improved by the adoption of the additional precautions detailed in the last annual report, and it is doubtful whether any further improvement can be expected. The trouble arises not only from percolation through the earth slopes and thence through the masonry, but also from actual springs in the foundation rock itself. One small spring was detected during construction and successfully dealt with by means of a drain, but another spring seems to exist under the concrete floor of the inner room. At all times, but particularly after heavy rain, water forces itself up in small quantities through the north-east corner of the floor and thus keeps the room from drying thoroughly. A very free use has been made of blankets and of calcium chloride to keep the room reasonably dry, but the atmosphere remains practically saturated and there has been much trouble with the instruments in consequence. The declination magnetograph has suffered on several occasions from interference produced by delicate fungoidal growths, which could only be removed by opening out the instrument, and it is curious that the H. F. instrument seems to have been entirely free from this trouble.

There were several changes in the staff, as H. N. Gupta, the Observer who replaced Mr. Theodore, had to resign his appointment owing to ill-health. His place was taken first by one of the field observers specially withdrawn for this purpose, and later by the spare observer, till finally a new candidate for the post was enlisted and trained.

Tabulated results are now published from August 1902, when the Observatory was started till the end of 1903. The form of tabulation is the same as for Dehra Dún and Barrackpore.

The declination results.

2. The following table gives the mean magnetic collimation of magnet 16 up to the end of 1903:—

Month.	Magnetic Collimation.	Month.	Magnetic Collimation.
	′ ″		′ ″
August 1902 .	—2 12	May 1903 .	—2 15
September " .	—2 14	June " .	—2 16
October " .	—2 16	July " .	—2 13
November " .	—2 18	August " .	—2 10
December " .	—2 15	September " .	—2 14
January 1903 .	—2 12	October " .	—2 13
February " .	—2 12	November " .	—2 13
March " .	—2 12	December "	—2 14
April " .	—2 10		

The value has evidently remained practically constant. For the first seven months in 1903, the declination trace was so unsatisfactory that no attempt has been made to tabulate the results. During this period the base line values were far from constant and the curves were full of sharp breaks, due presumably to interference caused by the fungoidal growths which have given so much trouble at Kodaikánal. From August onwards the magnet was given a large deflection every day in order to free it completely, and the base line values prove that this measure had the desired effect.

The Dip results.

3. Needles Nos. 1 and 2 were used in Dip Circle No. 46 till the 19th October 1903, when it was found that needle No. 1 suddenly commenced giving results about 10′ too low. No explanation of this sudden change was given by the observer, but it was probably due to an injury to the pivot resulting from a fall. On the 5th November 1903, needle No. 3C., (recently fitted with a new pivot by Dover) was taken into use and has given fairly accordant results ever since.

The following table shows the mean monthly differences between the needles of Circle No. 46:—

Month.	Dip Circle No. 46. Needle 1—Needle 2.	Remarks.
	′	
September 1902 . . .	—1·5	
October „ . .	—1·1	
November „ . . .	—0·8	
December „ . . .	—1·2	
January 1903 . . .	—0·5	
February „ . . .	—0·3	
March „ . . .	—0·5	
April „ . . .	—1·6	
May „ . . .	—0·8	
June „ . . .	—0·3	
July „ . . .	—0·4	
August „ . . .	—0·7	
September „ . . .	—0·8	
October „ . . .	—1·0	Up to 15th October only
	Needle 2—Needle 3C.	
November 1903 . . .	+0·7	
December „ . . .	+0·1	

The accordance of the results is as good as can be expected from this class of instrument.

The force observations.

4. Monthly mean values of constants of Magnetometer No. 16 at Kodaikánal.

Month.	M_0.	P from 22·5 and 30 cms.	P. from 30 and 40 cms.	REMARKS.
September 1902 .	926·47	6·69	8·00	The values of m_0 are computed from the mean P (at 22·5 and 30 cms) for each year.
October „ .	926·41	6·90	8·51	
November „ .	926·47	6·86	8·28	
December „ .	926·41	6·86	8·36	
January 1903 .	926·47	6·94	8·38	
February „ .	926·46	6·77	8·44	
March „ .	926·34	6·80	9·21	Only one set of observations.
April „ .	926·24	6·86	8·30	
May „ .	926·24	6·92	8·74	
June „ .	926·21	6·89	8·60	
July „ .	926·27	6·75	9·01	
August „ .	926·34	6·90	8·45	
September „ .	926·39	6·93	8·24	
October „ .	926·39	6·80	8·49	
November „ .	926·38	6·96	8·39	
December „ .	926·41	7·00	8·75	

The accordance of these figures prove that the observations were carefully taken, and the base line values deduced therefrom may be accepted with confidence.

MEAN MONTHLY BASE LINE VALUES AND TEMPERATURES AT KODAIKÁNAL OBSERVATORY.

H. F. magnetograph No. 2 by Professor W. Watson, F.R.S., 1902 and 1903.

Month.	Temperature of H. F. Instrumental cent.	Scale value of 0·04 inch.	Base Line value C. G. S.	REMARKS.
	°	γ		
August 1902 .	17·13	6·13	0·37068	13th to 15th only.
September „ .	17·20	6·14	62	
October „ .	17·97	6·17	52	

MEAN MONTHLY BASE LINE VALUES AND TEMPERATURE AT KODAIKÁNAL OBSERVATORY—*contd.*

H. F. magnetograph No. 2, by Professor W. Watson, F.R.S., *1902 and 1903*—contd.

Month.	Temperature of H. F. instrumental cent.	Scale value of 0·04 inch.	Base line value C. G. S.	REMARKS.
	°	γ		
November 1902 .	18·42	6·19	41	
December „ .	18·57	6·17	31	
January 1903 .	18·79	6·17	31	Up to 10th January only.
„ „ .	...	...	0·37057	Instrument adjusted values from 28th January only.
February „ .	19·23	6·13	50	
March „ .	19·34	6·16	50	Only two values on 4th March.
April „ .	19·76	6·22	35	
May „ .	19·98	6·17	22	The base line values are referred to a temperature of 19° cent., the temperature co-efficient used in the reduction being + 1°cent.=—12·6γ.
June „ .	19·94	6·14	17	
July „ .	19·90	6·13	22	
August „ .	20·02	6·14	23	
September „ .	20·34	6·14	22	
October „ .	20·40	6·13	23	
November „ .	19·96	6·11	26	
December „ .	19·61	6·11	22	

During 1903 the range of temperature in the inner room was very small and since then it has been still reduced. The true daily range is entirely obscured by variations in the height of the lamps, and is so small that the use of the thermograph which was originally installed has been discontinued, temperatures at intermediate hours being found by direct interpolation between the daily readings.

During the year 1902 the decrease in the base line values shows that the system was gradually giving way and settling down. After the re-adjustment in January 1903, the same thing is noticeable until May, after which the base line values show very little variation.

The new referring mark.

5. During the year 1904 the weather was abnormally fine, and there was very little mist, so that the new mark which is quite close to the Observatory was seldom needed. Its azimuth measured clockwise from true south, is 104° 24′ 34″.

TABLE L.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Kodaikánal Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Value of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line values.
1902.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
August	12	H. F.	929·16	6·83	7·76	·37372	·37398	...	
	12	,,	...	...	...	364		...	
	12	,,	928·95	...	...	364		...	
	13	C. T.	...	6·70	8·18	355		·37063	·37068
	13	,,	...	...	...	362		71	
	14	,,	929·50	6·85	7·11	403		68	
	14	,,	·29	...	...	395		65	
	15	,,	·37	7·22	7·30	430		72	
	15	,,	...	...	...	446		81	
	15	,,	...	...	...	437		62	
	15	,,	...	...	...	446		63	
Sept.	3	,,	926·79	6·12	8·37	389	·37385	76	·37062
	3	,,	·04	...	...	359		71	
	6	,,	·51	7·48	7·67	380		53	
	6	,,	927·06	...	...	402		55	
	10	,,	926·68	6·36	8·00	411		65	
	10	,,	·25	...	...	394		70	
	13	,,	·96	6·85	8·04	384		69	
	13	,,	4·0	...	...	362		60	
	24	,,	·81	6·78	8·28	382		59	
	24	,,	·38	...	...	365		53	
	27	,,	·53	6·57	7·62	399		55	
	27	,,	·32	...	...	390		56	
Oct.	1	,,	927·09	7·53	7·25	383	·37389	57	·37389
	1	,,	...	...	...	353		56	
	2	,,	·04	7·22	9·12	402		50	
	2	,,	926·25	...	...	371		44	
	4	,,	...	6·91	8·60	390		56	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Kodaikánal Observatory.

1	2	3	4	5	6	7	8	9
Date.	Observer.	Value of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizonta Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line values.
1902.		C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Oct. 4	C. T.	...	...	...	·37347	·37389	·37050	·37032
8	„	926·64	6·83	8·56	414		50	
8	„	·15	...	...	394		48	
11	„	·92	6·93	8·28	421		56	
11	„	·32	...	...	396		49	
12	„	...	...	...	432		63	
12	„	...	...	...	421		47	
15	„	926·87	6·54	8·93	409		56	
15	„	·34	...	...	388		56	
18	„	·77	7·37	7·48	407		51	
18	„	·36	...	...	390		50	
19	„	...	...	...	415		53	
19	„	...	...	...	410		60	
22	„	·36	6 62	8·00	403		5	
22	„	·19	...	...	396		54	
25	„	·66	6·78	8·70	391		49	
25	„	·06	...	...	367		41	
29	„	·32	6·67	9·44	356		44	
29	„	·49	...	...	363		51	
30	„	·94	6·46	9·30	357		59	
30	„	·30	...	...	331		48	
5	„	·64	6·83	8·28	379	·37390	45	·37390
5	„	·53	...	...	375		48	
6	„	·74	6·70	8·14	425		50	
6	„	·15	...	...	401		45	
8	„	·66	6·88	7·90	413		47	
8	„	·23	...	...	396		40	
12	„	·68	7·01	7·62	394		42	

TABLE I—*concld.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Kodaikánal Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Value of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line values.
1902.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Nov.	12	C. T.	926·40	...	...	·37383	·37390	·37039	·37041
	13	,,	·64	6·78	8·46	409		51	
	13	,,	·19	...	...	391		38	
	15	,,	·62	6·67	7·62	415		47	
	15	,,	·10	...	...	395		42	
	19	,,	·68	6·88	8·46	402		43	
	19	,,	·30	...	...	387		38	
	22	,,	·47	6·80	9·44	385		38	
	22	,,	·30	...	...	378		37	
	26	,,	·55	7·01	9·02	365		29	
	26	,,	·42	...	...	360		27	
	29	,,	·74	6·72	8·60	385		41	
	29	,,	·36	...	...	370		33	
Dec.	3	,,	·36	7·19	8·46	334	·37391	25	·37031
	3	,,	·53	...	...	340		28	
	6	,,	·34	6·80	8·42	393		37	
	6	,,	·13	...	...	384		36	
	10	,,	·81	7·01	8·28	395		42	
	13	,,	·60	6·96	8·04	400		36	
	13	,,	·49	...	...	396		34	
	17	,,	·45	6·72	8·93	396		29	
	17	,,	·32	...	...	390		29	
	20	,,	·57	6·64	8·70	409		33	
	20	,,	·23	...	...	396		25	
	24	,,	·49	6·93	8·14	388		28	
	24	,,	·34	...	...	382		26	
	27	,,	·47	6·67	7·86	424		37	
	27	,,	·17	...	...	416		31	
	31	,,	·55	6·83	8·42	406		29	
	31	,,	·21	...	...	392		20	

TABLE II.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Kodaikánal Observatory.

1		2	3	4	5	6	7
Date.		Observer.	Magnetic Collimation.	Observed Declination, West.	Monthly mean observed Declination, West.	Base Line values.	Monthly mean Base Line values.
1902. Month.			′ ″	° ′	° ′	′	′
August	15	C. T.	2 7	—15·0	0 15·2	95·7	95·8
	16	,,	2 17	15·0		95·8	
	28	,,	2 13	15·6		95·9	
September	2	,,	2 14	18·2	0 17·7	96·0	96·1
	5	,,	2 11	14·5		95·6	
	9	,,	2 18	18·3		95·9	
	12	,,	2 11	19·0		96·2	
	23	,,	2 19	18·9		96·1	
	26	,,	2 8	17·3		96·6	
	30	,,	2 17	17·9		96·2	
October	3	,,	2 16	18·5	0 18·3	97·3	97·1
	7	,,	2 15	18·5		96 8	
	10	,,	2 12	19·2		97·5	
	14	,,	2 12	18·7		97·1	
	17	,,	2 24	19·2		97·3	
	21	,,	2 8	18·4		97·0	
	24	,,	2 19	17·8		97·1	
	28	,,	2 18	18·6		97·0	
	31	,,	2 28	17·4		96·7	
	31	,,	2 12	17·0		96·9	
November	4	,,	2 20	19·1	0 18·0	97·5	97·4
	7	,,	2 18	18·1		97·9	
	11	,,	2 14	18·0		97·3	
	14	,,	2 13	18·0		97·5	
	18	,,	2 16	17·6		96·9	
	21	,,	2 24	17·1		97·3	
	25	,,	2 18	17·5		97·5	
	28	,,	2 23	18·5		97·7	

TABLE II—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Kodaikánal Observatory.

1		2	3	4	5	6	7
Date.		Observer.	Magnetic Collimation.	Observed Declination, West.	Monthly mean observed Declination, West.	Base Line values.	Monthly mean Base Line values.
1902. Month.			′ ″	° ′	° ′	′	′
December	5	T.	—2 20	17·2	0 18·7	97·3	97·7
	9	"	2 22	18·3		97·5	
	12	"	2 20	19·0		97·3	
	26	"	2 13	19·3		98·0	
	28	"	2 8	19·5		97·8	
	30	"	2 6	18·8		98·3	

TABLE III.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikánal Observatory taken with Barrow's Dip Circle No. 46. Needles Nos. 1 and 2.

Date.		Kodaikánal L. M. time of observation (0 to 24 hrs.)		Observer.	Needle No.	Observed Dip.	Monthly mean for each needle.	Monthly mean.	REMARKS.
1902. Month.		h.	m.			° ′		° ′	
September	1	14	10	C. T.	1	2 59·6	No. 1 2° 59·6′ No. 2 3° 1·1′	3 0·3	
	1	14	16	"	2	3 0·5			
	4	15	3	"	1	2 59·6			
	4	15	3	"	2	3 0·3			
	8	14	10	"	1	2 59·3			
	8	14	10	"	2	3 1·3			
	11	14	1	"	1	2 58·5			
	11	14	1	"	2	3 0·3			
	25	14	17	"	1	2 59·5			
	25	14	17	"	2	3 1·3			
	29	14	24	"	1	3 1·1			
	29	14	24	"	2	3 2·6			

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikánal Observatory taken with Barrow's Dip Circle No. 46. Needles Nos. 1 and 2.

Date.		Kodaikánal L. M. time of observation (0 to 24 hrs.)		Observer.	Needle No.	Observed Dip.		Monthly mean for each needle.	Monthly mean.		Remarks.
1902.		h.	m.			°	′		°	′	
Month.											
October	6	14	11	M.A.S.	1	3	1·0	No. 1 3° 0·7′ No. 2 3° 1·8′	3	1·3	
	6	14	11	,,	2	3	2·5				
	9	14	14	,,	1	3	0·6				
	9	14	14	,,	2	3	1·1				
	13	13	47	,,	1	2	59·1				
	13	13	47	,,	2	3	0·5				
	16	14	16	,,	1	3	1·0				
	16	14	16	,,	2	3	2·1				
	20	13	54	,,	1	3	0·3				
	20	13	54	,,	2	3	1·3				
	23	14	3	,,	1	3	1·3				
	23	14	3	,,	2	3	2·2				
	27	14	13	,,	1	3	1·9				
	27	13	54	,,	2	3	3·1				
November	3	14	8	,,	1	3	0·9	No. 1 3° 1·9′ No. 2 3° 2·7′	3	2·3	
	3	14	8	,,	2	3	1·7				
	10	14	2	,,	1	3	1·8				
	10	14	2	,,	2	3	3·0				
	17	14	24	,,	1	3	2·8				
	17	14	24	,,	2	3	3·6				
	20	14	39	,,	1	3	1·8				
	20	14	39	,,	2	3	2·7				
	24	14	3	,,	1	3	2·2				
	24	14	3	,,	2	3	2·4				
	27	13	52	,,	1	3	2·0				
	27	13	52	,,	2	3	2·5				

TABLE III—*concld.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikánal Observatory taken with Barrow's Dip Circle No. 46. Needles Nos. 1 and 2.

Date.	Kodaikánal L. M. time of observation (0 to 24 hrs.)		Observer.	Needle No.	Observed Dip.		Monthly mean for each needle.	Monthly mean.		REMARKS.
1902.	h.	m.			°	′		°	′	
Month.										
December 1	13	50	M.A.S.	1	3	2·6	No. 1 3° 1·9′ No. 2 3° 31′	3	2·5	
1	13	50	„	2	3	3·7				
8	14	6	„	1	3	2·8				
8	14	6	„	2	3	3·3				
11	13	59	„	1	3	3·8				
11	13	59	„	2	3	5·1				
15	14	2	„	1	3	0·8				
15	14	2	„	2	3	3·0				
18	14	3	„	1	3	1·9				
18	14	3	„	2	3	3·0				
22	14	5	„	1	3	1·7				
22	14	5	„	2	3	3·2				
25	13	49	„	2	3	1·4				
25	13	49	„	1	3	0·7				
29	13	48	„	1	3	1·0				
29	13	48	„	2	3	2·2				

TABLE IV.

Dates of Magnetic Disturbances at Kodaikánal in 1902.

F=10°·13′·50
L=77°·27′·46″.

1902.	Months.				
Dates.	August.	September.	October.	November.	December.
1	...	S	S	C	C
2	...	S	C	C	S
3	...	C	C	C	C
4	...	C	S	(C)	(C)
5	...	(C)	S	C	C
6	...	C	C	C	C
7	...	S	C	S	C
8	...	(C)	C	(C)	(C)
9	...	C	S	C	S
10	...	C	C	C	S
11	...	C	S	C	S
12	...	S	C	C	C
13	...	S	S	S	S
14	(C)	C	(C)	S	C
15	(C)	S	C	S	C
16	M	C	C	C	C
17	S	C	C	(S)	C
18	—	S	S	S	(C)
19	—	S	C	S	C
20	—	S	S	(C)	(C)
21	S	C	S	C	C
22	M	C	C	C	S
23	S	S	(C)	M	S
24	(C)	C	S	S	S
25	C	C	S	S	S
26	S	C	(C)	S	C
27	(C)	C	S	S	C
28	C	C	C	C	C
29	C	S	S	(C)	C
30	C	S	S	C	(C)
31	S	...	S	...	C
Total C.	8	18	16	18	22
Total S.	5	12	15	11	9
Total M.	2	...	...	1	...
Total G.	...	...	...	...	...
Total V.G.	...	...	...	...	...

NOTE.—The magnitude of disturbances is determined from Horizontal Force traces.
C = calm. S = slight. M = moderate. G = great. V. G. = very great.
Days are reckoned from Midnight to Midnight.
The five selected quiet days in each month are distinguished by brackets. The selections are made from the Colába curves by the Director, Colába Observatory. Unclassified days denote that the record was lost.
August 24th was selected by O. C., No. 26 Party (Magnetic).

TABLE V.

Hourly means of Horizontal Force in ç. Gs. units (corrected for temperature) at Kodaikánal from the selected quiet days in 1902.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
													Winter.												
·37000 C. G. S.†	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
October . .	365	366	366	367	366	365	361	361	381	410	431	437	424	408	395	383	376	373	372	369	366	365	366	365	381
November . .	357	358	358	358	357	357	359	369	384	401	414	420	415	402	389	377	370	366	365	364	363	363	362	362	375
December . .	361	363	363	362	362	362	363	369	380	394	401	407	404	398	387	377	367	363	363	363	363	362	363	364	373
													Summer.												
August . .	360	360	360	362	361	362	362	369	384	405	421	425	422	407	391	376	363	362	363	361	359	358	358	360	375
September . .	355	356	358	359	359	358	357	361	383	415	440	454	444	424	401	379	367	364	365	363	362	361	360	359	379
Means . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

TABLE VI.

Diurnal inequalities of Horizontal Force at Kodaikánal as deduced from Table V.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
August	—15	—15	—15	—13	—14	—13	—13	—6	+9	+30	+46	+50	+47	+32	+16	+1	—12	—13	—12	—14	—16	—17	—17	—15
September . . .	—24	—23	—21	—20	—20	—21	—22	—18	+4	+36	+61	+75	+65	+45	+22	0	—12	—15	—14	—16	—17	—18	—19	—20
October . . .	—16	—15	—15	—14	—15	—16	—20	—20	0	+29	+50	+56	+43	+27	+14	+2	—5	—8	—9	—12	—15	—16	—15	—16
November . . .	—18	—17	—17	—17	—18	—18	—16	—6	+9	+26	+39	+45	+40	+27	+14	+2	—5	—9	—10	—11	—12	—12	—13	—13
December . . .	—12	—10	—10	—11	—11	—11	—10	—4	+7	+21	+28	+34	+31	+25	+14	+4	—6	—10	—10	—10	—10	—11	—10	—9

NOTE:—When the sign is + the reading is above the mean.
In August one selected quiet day was lost, as the observatory was started on 12th.

TABLE VII.

Hourly Means of the Declination as determined at Kodaikánal from the selected quiet days in 1902.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
West 0°+													Winter.												
Months, 1902.																									
October . .	18·4	18·4	18·4	18·4	18·5	18·5	18·2	17·7	17·1	17·4	18·3	19·1	19·1	18·8	18·5	18·2	18·0	18·2	18·3	18·4	18·5	18·4	18·5	18·4	18·3
November . .	18·8	18·9	18·9	18·8	18·9	19·0	19·1	19·5	19·1	18·8	19·1	19·0	18·8	18·2	17·9	18·1	18·1	18·2	18·4	18·5	18·6	18·8	18·9	18·8	18·7
December . .	18·7	18·7	18·7	18·9	19·0	19·1	19·2	19·7	19·6	19·4	19·0	18·8	18·6	18·2	17·8	17·9	18·1	18·3	18·5	18·5	18·6	18·6	18·5	18·5	18·7
													Summer.												
August . .	17·3	17·2	17·2	17·1	17·0	16·6	16·1	15·2	15·4	16·3	17·4	18·4	19·1	18·8	18·1	17·5	16·8	16·3	16·8	17·3	17·4	17·4	17·4	17·3	17·1
September . .	17·7	17·7	17·7	17·6	17·7	17·5	16·8	15·5	15·4	16·1	17·3	18·7	19·5	19·5	18·6	17·8	17·2	17·1	17·4	17·5	17·7	17·7	17·7	17·7	17·5

NOTE.—In August means are derived from four selected days only.

TABLE VIII.

Diurnal inequality of the Declination at Kodaikánal as deduced from Table VII.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
Months, 1902.																								
October . . .	+0·1	+0·1	+0·1	+0·1	+0·2	+0·2	—0·1	—0·6	—1·2	—0·9	0·0	+0·8	+0·8	+0·5	+0·2	—0·1	—0·3	—0·1	0·0	+0·1	+0·2	+0·1	+0·2	+0·1
November . . .	+0·1	+0·2	+0·2	+0·1	+0·2	+0·3	+0·4	+0·8	+0·4	+0·1	+0·4	+0·3	+0·1	—0·5	—0·8	—0·6	—0·6	—0·5	—0·3	—0·2	—0·1	+0·1	+0·2	+0·1
December . . .	0·0	0·0	0·0	+0·2	+0·3	+0·4	+0·5	+1·0	+0·9	+0·7	+0·3	+0·1	—0·1	—0·5	—0·9	—0·8	—0·6	—0·4	—0·2	—0·2	—0·1	—0·1	—0·2	—0·2
August	+0·2	+0·1	+0·1	0·0	—0·1	—0·5	—1·0	—1·9	—1·7	—0·8	+0·3	+1·3	+2·0	+1·7	+1·0	+0·4	—0·3	—0·8	—0·3	+0·2	+0·3	+0·3	+0·3	+0·2
September . . .	+0·2	+0·2	+0·2	+0·1	+0·2	0·0	—0·7	—2·0	—2·1	—1·4	—0·2	+1·2	+2·0	+2·0	+1·1	+0·3	—0·3	—0·4	—0·1	—0·0	+0·2	+0·2	+0·2	+0·2

NOTE.—When the sign is + the magnet points to the west of the mean position; when — to the east.

Statement of loss of Magnetograph records for 1902, Kodaikánal Observatory.

HORIZONTAL FORCE MAGNETOGRAPH.									DECLINATION MAGNETOGRAPH.									Cause of Interruption.
PERIOD OF BREAK.						Duration of break.			PERIOD OF BREAK.						Duration of break.			
From		On	To		On				From		On	To		On				
h.	m.	Date.	h.	m.	Date.	h.	m.		h.	m.	Date.	h.	m.	Date.	h.	m.		
22	0	18th August .	10	29	19th August .	12	29		22	0	18th August .	10	29	19th August .	12	29		Clock stopped.
20	0	19th " .	11	22	20th " .	15	22		20	0	19th " .	11	22	20th " .	15	22		" "
10	0	23rd November	12	23	23rd November	2	23		10	0	23rd November	12	13	23rd November	2	23		Not known.
									1	0	24th " .	10	24	24th " .	9	24		Lamps failed.
									13	35	" " .	15	5	" " .	1	30		" "
					TOTAL .	30	14							TOTAL .	41	18		

TABLE I.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Kodaikánal Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed Values of Horizontal Force.	Monthly mean observed values of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Jan.	3	C. T.	926·60	6·83	8·88	·37411	·37397	·37038	·37031
	3	"	·19	...	...	395		28	
	7	"	·68	7·01	7·95	415		38	
	7	"	·17	...	...	395		28	
	10	"	·53	6·98	...	408		29	
	10	"	·45	...	...	404		24	
	17	"	·49	6·98	8·84	383		...	
	17	"	·66	...	...	390		...	
	28	"	·62	6·85	8·09	404		62	·37057
	28	"	·32	...	...	392		59	
	31	"	·60	6·96	8·14	390		55	
	31	"	·30	...	...	378		50	
Feb.	7	"	·66	6·64	8·18	432	·37390	60	·37050
	7	"	·32	...	...	418		57	
	11	"	·57	6·67	8·46	361		54	
	11	"	·34	...	...	352		50	
	14	"	·72	6·88	8·18	419		49	
	14	"	·13	...	...	395		42	
	18	"	·64	6·85	8·70	363		51	
	18	"	·32	...	...	350		47	
	21	"	·55	6·70	8·56	405		52	
	21	"	·21	...	...	391		43	
	25	"	·77	6·88	8·32	364		49	
	25	"	·34	...	...	347		47	
	28	"	·64	6·75	8·55	436		51	
	28	"	·25	...	...	421		50	
March	4	"	·62	6·80	9·21	452	·37441	52	·37043 mean of Feb. and April.
	4	"	·06	...	...	430		47	

TABLE I—*contd.*

ABSOLUTES MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Kodaikánal Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed Values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
April.	4	C. T.	926·34	6·75	8·04	394	·37406	·37040	·37025
	8	,,	·42	7·06	8·14	330		32	
	8	,,	·00	...	...	313		29	
	11	,,	·49	6·83	8·98	379		42	
	11	,,	...	...	...	353		33	
	15	,,	·45	6·83	7·95	413		42	
	15	,,	...	...	...	384		35	
	18	,,	·40	6·85	8·56	417		38	
	18	,,	·00	...	...	401		36	
	22	,,	·36	6·85	8·60	436		36	
	22	,,	925·93	...	...	419		28	
	25	,,	926·06	6·98	...	454		31	
	25	,,	...	...	...	443		28	
	29	,,	·17	6·75	7·86	486		39	
	29	,,	...	...	...	465		31	
May	2	,,	·02	6·85	8·60	423	·37385	35	·37022
	10	,,	·30	6·85	8·37	377		31	
	10	,,	·08	...	...	368		36	
	14	,,	925·96	6·72	8·93	371		07	
	14	,,	...	...	...	365		10	
	16	,,	929·13	6·91	8·14	394		14	
	16	,,	·17	...	...	396		26	
	20	,,	·42	6·85	8·93	430		30	
	20	,,	·23	...	...	422		33	
	23	,,	·51	7·06	8·60	361		30	
	23	,,	·23	...	...	350		22	
	27	,,	·06	6·96	8·98	589		16	
	27	,,	·19	...	...	394		13	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Kodaikánal Observatory.

1	2	3	4	5	6	7	8	9
Date.	Observer.	Value of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed Values of Horizontal Force.	Monthly mean observed values of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line values.
1903.		C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
May. 30	C. T.	·25	6,98	9·02	374		13	
30	„	925·93	...	...	361		14	
June 3	E. A. M.	926·30	6·75	8·37	421	·37393	27	·37017
6	„	·47	6·96	...	365		31	
10	„	·32	6·91	8·32	389		21	
10	„	·08	...	...	379		18	
13	„	·32	6·85	8·60	408		16	
13	„	...	...	...	384		03	
17	„	·10	6·88	8·65	409		06	
17	„	·34	...	...	419		27	
20	„	·36	6·91	8·70	408		17	
20	„	·00	...	...	394		07	
24	„	·00	7·09	8·79	365		11	
24	„	·06	...	...	368		20	
27	„	·17	6·78	8·79	401		14	
27	„	925·98	...	...	393		22	
July 4	C. T.	926·57	6·67	9·35	·37370	·37377	·37027	·37022
4	„	·17	...	...	353		27	
8	„	·13	...	...	383		22	
8	„	·42	...	...	379		21	
8	„	·47	6·67	...	355		25	
8	„	·02	...	...	337		16	
11	„	·45	6·83	8·84	851		26	
11	„	·13	...	...	338		21	
15	„	·38	6·80	9·21	402		20	
15	„	·28	...	...	398		17	
18	„	·25	6·83	8·88	371		19	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Kodaikánal Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed values of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line values.
1903.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
July	18	C. T.	·13	...	...	366	37·377	17	37·022
	23	„	·30	6·64	9·21	395		26	
	23	„	·49	...	...	402		23	
	25	„	·49	6·64	8·98	427		28	
	25	„	·06	...	...	410		22	
	29	„	·23	6·78	8·74	365		22	
	29	„	·38	...	...	371		23	
August	1	„	·30	6·85	8·93	400	37·392	27	·37023
	1	„	·32	...	...	401		27	
	5	„	·38	6·85	8·00	397		28	
	8	„	·30	6·88	...	384		24	
	8	„	·25	...	...	383		27	
	12	„	·45	6·83	7·90	407		27	
	12	„	·23	...	...	398		27	
	13	„	...	...	...	406		26	
	15	„	...	...	...	393		21	
	15	„	...	...	...	413		19	
	15	„	·55	6·93	8·70	365		24	
	15	„	·28	...	...	353		21	
	19	„	·25	7·09	8·09	398		19	
	19	„	·23	...	...	397		15	
	29	„	·32	6·78	8·56	390		22	
	29	„	·17	...	...	384		20	
Sept.	2	„	·25	7·06	..	381	37·392	21	37·322
	2	„	·38	...	...	386		15	
	5	„	·23	7·06	8·04	357		20	
	9	„	·49	7·01	8·51	383		23	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Kodaikánal Observatory.

1	2	3	4	5	6	7	8	9
Date.	Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed values of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.		C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Sept. 9	C. T.	·42	...	...	380	·37392	20	·37022
12	„	·17	...	8·00	414		20	
12	„	·42	...	...	424		16	
16	„	·60	7·06	8·04	394		22	
16	„	·38	...	...	385		17	
19	„	·23	6·88	8·56	435		20	
19	„	·57	...	...	449		21	
23	„	·60	6·78	8·60	361		27	
23	„	·25	...	...	347		29	
26	„	·13	6·78	7·90	412		23	
26	„	·49	...	...	427		21	
30	„	·47	6·80	...	366		24	
30	„	·34	...	...	361		25	
October 1	„	926·21	6·98	7·76	·37403	·37388	·37022	·37023
1	„	·49	...	...	415		22	
3	„	·36	6·83	8·65	404		23	
3	„	·47	...	...	408		15	
7	„	·62	6·67	8·93	400		24	
7	„	·34	...	...	389		24	
10	„	·25	6·91	...	424		24	
10	„	·62	...	...	439		23	
14	„	·38	6·62	8·79	356		30	
17	„	·32	6·57	...	337		21	
17	„	·15	...	...	330		17	
21	„	·64	6·75	8·88	377		30	
21	„	·36	...	...	366		27	
24	„	·51	6·88	...	399		23	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Kodaikánal Observatory.

1		2	3	4	5	6	7	8	9
Date.		Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed values of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line values.
1903.			C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Oct.	24	C. T.	·17	...	...	385	·37388	21	·37023
	28	„	·57	7·11	7·95	390		23	
	28	„	·32	...	...	380		20	
Nov.	4	„	·49	6·91	7·81	314	·37355	30	·37026
	4	„	·45	...	...	312		28	
	7	„	·47	6·96	...	353		25	
	7	„	·15	...	...	340		19	
	11	„	·15	6·88	8·60	360		16	
	11	H.N.G.	·68	7·14	8·18	325		35	
	14	C. T.	·34	6·93	8·32	374		21	
	14	„	·38	...	...	376		25	
	14	H.N.G.	·66	6·93	...	349		34	
	14	„	·42	...	...	340		25	
	14	„	·47	...	9·02	338		24	
	18	C. T.	·34	6·98	...	404		23	
	18	„	·21	...	...	399		26	
	18	„	·38	...	9·12	392		23	
	18	H.N.G.	·74	6·85	8·70	347		39	
	18	„	·60	...	...	340		29	
	21	C. T.	·25	6·91	...	340		21	
	21	„	·28	...	...	341		23	
	21	H.N.G.	·70	...	...	352		36	
	21	„	·40	...	...	340		23	
	25	„	·55	...	...	361		34	
	25	„	·42	...	...	356		35	
	26	„	...	7·09	7·76	365		26	
	28	„	·06	6·98	8·00	377		18	
	28	„	·00	...	...	374		18	

TABLE I—*concld.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Kodaikánal Observatory.

1	2	3	4	5	6	7	8	9
Date.	Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line values.
1903.		C. G. S.	C. G. S.	C. G. S	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Dec. 2	H. N. G.	926·34	...	...	·37320	·37359	·37013	·37022
2	,,	·45	...	...	324		23	
3	,,	...	...	8·46	346		27	
5	,,	·21	7·14	9·02	329		16	
5	,,	·04	...	...	322		14	
9	,,	·34	...	...	346		09	
9	,,	·15	...	...	338		10	
10	,,	...	6·80	8·88	374		14	
12	,,	·55	7·09	9·12	384		19	
12	,,	·47	...	...	381		24	
16	,,	·49	7·06	9·21	351		18	
16	,,	·19	...	...	339		14	
19	,,	·36	...	8·28	367		17	
19	,,	·25	...	...	363		19	
23	,,	·60	6·91	8·18	374		36	
23	,,	·40	...	...	366		32	
26	,,	·72	·719	8·32	418		25	
26	,,	·72	...	...	418		39	
30	,,	·64	6·80	9·30	364		26	
30	,,	·47	...	...	357		36	

TABLE II.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Kodaikánal Observatory.

1	2	3	4	5	6	7
Date.	Observer.	Magnetic Collimation.	Observed Declination, west.	Monthly mean observed Declination west.	Base Line values.	Monthly mean Base Line values.
1903. Month.		′ ″	° ′	° ′	′	′
January 2	C. T.	—2 22	0 18·8	0 19·8		
6	”	2 14	20·2			
9	”	2 7	19·7			
19	”	2 5	20·1			
19	”	2 14	20·0			
19	”	2 17	19·8			
19	”	2 14	19·7			
19	”	2 18	19·4			
19	”	2 14	19·4			
23	”	2 8	20·6			
27	”	2 6	20·9			
30	”	2 5	19·2			
February 3	”	—2 5	0 19·8	0 20·5		
6	”	2 4	20·1			
10	”	2 14	21·1			
13	”	2 8	20·9			
17	”	2 14	20·2			
20	”	2 10	20·7			
24	”	2 23	21·2			
27	”	2 15	19·9			
March 3	”	—2 9	0 20·4	0 20·7		
31	”	2 15	21·0			
April 7	E. A. M.	—1 59	0 21·9	0 20·9		
3	”	2 1	21·9			
10	”	2 19	20·6			
14	”	2 12	21·0			
17	”	2 12	21·3			

TABLE II—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Kodaikánal Observatory.

1		2	3	4	5	6	7
Date.		Observer.	Magnetic Collimation.	Observed Declination, west.	Monthly mean observed Declination, west.	Base Line values.	Monthly mean Base Line values.
1903. Month.			′ ″	° ′	° ′	′	′
April	21	E. A. M.	−2 18	0 20·8	0 20·9		
	24	,,	2 5	20·2			
	28	,,	2 14	19·5			
May	1	,,	−2 12	0 20·0	0 21·3		
	5	,,	2 18	19·1			
	8	,,	2 25	19·9			
	12	,,	2 10	22·8			
	15	,,	2 20	20·0			
	19	,,	2 24	22·6			
	22	,,	2 18	20·5			
	26	,,	2 2	21·2			
	26	,,	2 10	23·5			
	29	,,	2 8	22·9			
June	2	,,	−2 21	0 22·1	0 22·7		
	5	,,	2 6	22·8			
	9	,,	2 20	23·0			
	12	,,	2 24	23·6			
	16	,,	2 14	23·7			
	19	,,	2 18	23·4			
	23	,,	2 21	20·8			
	23	,,	2 12	22·6			
	26	,,	2 22	24·1			
	30	,,	2 6	20·9			
July	3	C. T.	−2 17	0 23·4	0 22·6		
	7	,,	2 7	21·8			
	10	,,	2 11	20·3			
	14	,,	2 11	21·2			

TABLE II—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Kodaikánal Observatory.

1		2	3	4	5	6	7
Date.		Observer.	Magnetic Collimation.	Observed Declination, west.	Monthly mean observed Declination, west.	Base Line values.	Monthly mean Base Line values.
1903. Month.			′ ″	° ′	° ′	′	′
July	17	C. T.	—2 13	0 24·9	0 22·6		
	21	”	2 15	22·9			
	24	”	2 17	22·8			
	28	”	2 12	23·0			
	31	”	2 18	23·3			
August	4	”	—2 7	0 23·6	0 23·5	...	99·7
	7	”	2 11	23·9		100·1	
	11	”	2 4	24·7		100·2	
	14	”	2 8	21·2		99·5	
	18	”	2 14	23·7		99·5	
	21	”	2 12	22·7		99·8	
	25	”	2 15	23·9		99·5	
	28	”	2 9	24·2		99·4	
September	1	”	—2 12	0 23·4	0 23·8	99·4	99·6
	4	”	2 10	23·3		99·5	
	8	”	2 17	24·0		99·5	
	11	”	2 20	23·7		99·4	
	15	”	2 17	22·7		99·8	
	18	”	2 14	24·2		99·8	
	22	”	2 11	24·3		99·5	
	25	”	2 18	24·5		99·6	
	29	”	2 5	23·4		99·6	
October	2	”	—2 11	0 23·3	0 23·6	99·5	99·8
	6	”	2 21	24·0		99·2	
	6	”	2 13	23·9		100·1	
	9	”	2 17	24·6		99·8	
	13	”	2 13	24·1		99·7	

TABLE II—*concld.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Kodaikánal Observatory.

1		2	3		4		5		6	7
Date.		Observer.	Magnetic Collimation.		Observed Declination, west.		Monthly mean observed Declination, west.		Base Line values.	Monthly mean Base Line values.
1903. Month.			′	″	°	′	°	′	′	′
October	16	C. T.	—2	14	0	23·8	0	23·6	100·0	99·8
	20	"	2	14		23·2			99·7	
	23	"	2	9		22·6			99·8	
	27	"	2	11		23·2			99·7	
	30	"	2	10		23·0			99·9	
November	3	"	—2	16	0	23·4	0	23·7	99·6	99·7
	6	"	2	20		23·9			99·6	
	10	"	2	21		25·1			99·3	
	10	H. N. G.	2	5		23·3			99·5	
	13	C. T.	2	23		24·0			100·0	
	13	H. N. G.	2	12		23·9			99·6	
	17	C. T.	2	15		23·3			99·6	
	17	H. N. G.	2	4		23·1			99·7	
	20	C. T.	2	5		23·6			99·8	
	20	H. N. G.	2	4		23·4			99·8	
	24	"	2	13		23·6			100·0	
	27	"	2	12		23·7			99·7	
December	1	"	—2	18	0	22·8	0	23·6	100·0	100·3
	4	"	2	17		22·7			...	
	8	"	2	9		23·4			100·0	
	11	"	2	17		24·5			100·1	
	15	"	2	16		24·1			100·6	
	18	"	2	6		22·6			100·0	
	22	"	2	25		23·4			100·2	
	22	"	2	8		23·7			100·1	
	25	"	2	14		23·8			100·7	
	28	"	2	10		24·7			100·7	
	29	"	2	19		23·9			100·7	

TABLE III.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikánal Observatory taken with Barrow's Dip Circle No. 46 needles Nos. 1, 2 and 3c by Dover.

Date.	Kodaikánal L. M. time of observation (0 to 24 hours).	Observer.	Needle No.	Observed Dip.	Monthly Mean for each needle.	Monthly Mean.	REMARKS.
1903. Month.	h. m.			° ′			
January 1	13 53	C. T.	1	3 2·1	No. 1 3° 3′·2 No. 2 3° 3′·7	3° 3′·4	
1	13 53	"	2	3·2			
5	14 12	"	1	2·5			
5	14 12	"	2	2·5			
8	13 39	"	1	3·6			
8	13 39	"	2	4·7			
12	...	"	1	3·2			
12	...	"	2	2·0			
13	...	"	1	6·9			
13	...	"	2	9·0			
14	...	"	2	4·4			
14	...	"	1	3·3			
26	13 44	"	1	2·0			
26	13 44	"	2	1·1			
29	13 44	"	1	1·8			
29	13 44	"	2	2·4			
February 2	13 48	"	1	3 0·7	No. 1 3° 3′·3 No. 2 3° 3′·6	3° 3′·5	
2	13 48	"	2	1·8			
5	14 4	"	...	...			
5	14 4	"	2	3 3·8			
12	13 40	"	1	3·3			
12	13 40	"	2	3·6			
16	43 46	"	1	3·6			
16	13 46	"	2	3·9			
19	13 35	"	1	5·0			
19	13 35	"	2	4·8			
23	14 7	"	1	5·0			
23	14 7	"	2	4·3			

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikánal Observatory taken with Barrow's Dip Circle No. 46, needles Nos. 1, 2 and 3c by Dover.

Date.		Kodaikánal L. M. time of observation (0 to 24 hours).	Observer.	Needle No.	Observed Dip.	Monthly Mean for each needle.	Monthly Mean.	REMARKS.
1903. Month.		h. m.			° '			
February	26	13 59	C. T.	1	3 2·3			
	26	13 59	,,	2	3·1			
March	2	13 48	,,	1	3 1·9	No. 1 3° 2'·2 No. 2 3° 2'·7	3° 2'·5	
	2	13 48	,,	2	2·3			
	5	14 13	,,	1	2·0			
	5	14 13	,,	2	2·7			
	31	14 32	,,	1	2·8			
	31	14 32	,,	2	3·0			
April	2	13 54	E.A.M.	2	3 2·9	No. 2 3° 4'·3 No. 1 3° 2'·7	3° 3'·5	
	2	13 54	,,	1	1·6			
	6	14 4	,,	2	7·0			
	6	14 4	,,	1	4·6			
	9	13 55·5	,,	2	5·9			
	9	13 55·5	,,	1	3·1			
	12	14 39·0	,,	2	3·2			
	12	14 39·0	,,	1	2·6			
	16	13 40·0	,,	1	2·0			
	16	13 40·0	,,	2	3·5			
	20	13 23	,,	2	3·9			
	20	13 23	,,	1	2·0			
	23	9 20	,,	1	4·2			
	23	9 20	,,	2	3·3			
	27	9 20	,,	1	3·3			
	27	9 20	,,	2	5·2			
	30	11 40	,,	2	3·4			
	30	11 40	,,	1	1·1			
May	4	11 47·5	,,	2	3 2·4			
	4	11 47·5	,,	1	0·9			

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Koddikánal Observatory taken with Barrow's Dip Circle No. 46, needles Nos. 1, 2 and 3c by Dover.

Date.		Kodaikânal L. M. time of observation (0 to 24 hours).		Observer.	Needle No.	Observed Dip.		Monthly Mean for each needle.	Monthly Mean.	REMARKS.
1903. Month.		h.	m.			°	′			
May	7	9	27	E.A.M.	1	3	0·8	No. 2 3° 3′·9 No. 1 3° 3′·1	3° 3′·5	
	7	9	27	„	2		2·3			
	11	13	46	„	1		2·7			
	11	13	46	„	2		3·9			
	14	11	49	„	2		2·9			
	14	11	49	„	1		1·9			
	18	13	48	„	1		3·8			
	18	13	48	„	2		5·4			
	21	13	36·5	„	2		4·6			
	21	13	36·5	„	1		3·6			
	25	13	44·5	„	2		3·3			
	25	13	44·5	„	1		3·8			
	28	14	13	„	2		6·3			
	28	14	13	„	1		7·1			
June	1	12	19	„	2	3	2·6	No. 2 3° 4′·2 No. 1. 3° 3·9′	3° 4′·1	
	1	12	19	„	1		2·5			
	4	13	41	„	2		2·6			
	4	13	41	„	1		2·4			
	8	13	32	„	2		4·9			
	8	13	32	„	1		6·0			
	8	14	58	„	2		5·6			
	8	14	58	„	1		3·0			
	11	12	2	„	1		2·1			
	11	12	2	„	2		4·2			
	15	12	17	„	1		4·4			
	15	12	17	„	2		4·2			
	18	9	24	„	2		2·4			
	18	9	24	„	1		3·7			

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikánal Observatory taken with Barrow's Dip Circle No. 46, needles Nos. 1, 2 and 3c by Dover.

Date.		Kodaikánal L. M. time of observation (o to 24 hrous).		Observer.	Needle No.	Observed Dip.		Monthly Mean for each needle.	Monthly Mean.	Remarks.
1903. Month.		h.	m.			°	′			
June	22	13	38	R.A.M.	2	3	4·9		3° 1·4′	
	22	13	38	„	1	3	5·4			
	25	13	38	„	2	3	5·1			
	25	13	38	„	1	3	4·7			
	29	12	47·5	„	1	3	5·1			
	29	12	47·5	„	2	3	5·6			
July	2	8	57	„	1	3	7·6	No. 1 3° 6·4′ No. 2 3° 6·8′	3° 6·6′	
	2	8	57	„	2	3	7·1			
	6	9	4	C. T.	1	3	5·3			
	6	9	4	„	2	3	6·8			
	9	13	48	„	1	3	5·8			
	9	13	48	„	2	3	6·8			
	13	13	35	„	1	3	4·9			
	13	13	35	„	2	3	5·8			
	17	9	27	„	1	3	6·8			
	17	9	27	„	2	3	6·2			
	20	8	59	„	1	3	7·4			
	20	8	59	„	2	3	6·9			
	23	13	50	„	1	3	6·1			
	23	13	50	„	2	3	6·5			
	27	13	44	„	1	3	7·0			
	27	13	44	„	2	3	7·5			
	30	14	10	„	1	3	6·5			
	30	14	10	„	2	3	7·2			
August	3	13	39	„	2	3	5·1		3° 5·8′	
	3	13	39	„	1	3	4·7			
	6	13	44	„	2	3	9·3			
	6	13	44	„	1	3	8·1			

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikánal Observatory taken with Barrow's Dip Circle No. 46, needles Nos. 1, 2 and 3c by Dover.

Date.		Kodaikánal L. M. time of Observation (0 to 24 hours)		Observer.	Needle No.	Observed Dip.		Monthly Mean for each needle.	Monthly Mean.	REMARKS.
1903. Month.		h.	m.			°	′			
August	10	13	52	C. T.	2	3	5·4	No. 2 3° 6·2′		
	10	13	52	”	1	3	5·0			
	13	13	51	”	2	3	5·3			
	13	13	51	”	1	3	5·3			
	17	13	40	”	2	3	6·0			
	17	13	40	”	1	3	5·1			
	20	13	44	”	2	3	6·6			
	20	13	44	”	1	3	5·5		3° 5·8′	
	24	13	52	”	2	3	5·4	No. 1 3° 5·5′		
	24	13	52	”	1	3	5·0			
	27	13	42	”	2	3	7·3			
	27	13	42	”	1	3	5·9			
	31	13	38	”	2	3	5·2			
	31	13	38	”	1	3	4·8			
September	3	13	30	”	2	3	7·9			
	3	13	30	”	1	3	7·4			
	7	13	56	”	2	3	9·1			
	7	13	56	”	1	3	8·5			
	10	13	42	”	2	3	11·2	No. 2 3° 7·6′		
	10	13	42	”	1	3	9·2			
	14	14	3	”	2	3	5·6			
	14	14	3	”	1	3	4·1		3° 7·2′	
	17	13	24	”	2	3	5·7			
	17	13	24	”	1	3	5·6			
	21	13	41	”	2	3	7·2			
	21	13	41	”	1	3	7·1	No. 1 3° 6·8′		
	24	13	30	”	2	3	6·4			
	24	13	30	”	1	3	5·9			

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikánal Observatory taken with Barrow's Dip Circle No. 46, needles Nos. 1, 2 and 3c by Dover.

Date.		Kodaikánal L. M. time of observation (0 to 24 hours).		Observer.	Needle No.	Observed Dip.		Monthly Mean for each needle.	Monthly Mean.	Remarks.
1903. Month.		h.	m.			°	′			
September	28	14	7	C. T.	2	3	7·4		3° 7·2′	
	28	14	7	„	1	3	6·3			
October	1	13	54	„	2	3	9·1	No. 2 3° 7·2′ No. 1 3° 6·1′	3° 6·9′	
	1	13	54	„	1	3	6·5			
	5	13	44	„	2	3	6·9			
	5	13	44	„	1	3	6·3			
	8	13	42	„	2	3	5·6			
	8	13	42	„	1	3	4·6			
	12	13	45	„	2	3	6·3			
	12	13	45	„	1	3	7·1			
	15	10	46	„	2	3	7·4			
	15	10	46	„	1	3	6·0			
	19	13	49	„	2	3	7·3			
	20	9	3	„	2	3	6·3			
	22	14	43	„	2	3	10·0			
	26	13	26	„	2	3	6·7			
	29	13	30	„	2	3	6·7			
	29	13	55	„	2	3	7·3			
November	2	13	29	„	2	3	9·1		3° 7·9′	
	2	13	29	„	2	3	8·8			
	5	13	39	„	2	3	7·9			
	5	13	39	„	2	3	7·1			
	9	13	58	„	2	3	6·3			
	9	13	58	„		3	5·6			
	9	14	1	H.N.G.	2	3	6·5			
	9	14	1	„	3c	3	6·0			
	12	14	51	C. T.	2	3	7·2			
	12	14	51	„	3c	3	7·7			

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikánal Observatory taken with Barrow's Dip Circle No. 46, needles Nos. 1, 2 and 3c by Dover.

Date.		Kodaikánal L. M. time of observation (0 to 24 hours).		Observer.	Needle No.	Observed Dip.		Monthly Mean for each needle.	Monthly Mean.	REMARKS.
1903. Month.		h.	m.			°	'			
November	12	14	3	H.N.G.	2	3	9·4	No. 2 3° 8·2' No. 3c 3° 7·5'	3° 7·9'	
	12	14	3	"	3c	3	7·5			
	16	14	2	"	2	3	8·9			
	16	14	2	"	3c	3	7·6			
	16	14	49	C. T.	2	3	10·1			
	16	14	49	"	3c	3	8·6			
	19	12	45	"	2	3	7·7			
	19	12	45	"	3c	3	7·2			
	19	13	45	H.N.G.	2	3	7·8			
	19	13	45	"	3c	3	7·7			
	23	9	10	C. T.	2	3	9·6			
	23	9	10	"	3c	3	8·7			
	23	14	9	H.N.G.	2	3	8·9			
	23	14	9	"	3c	3	8·0			
	26	13	46	"	2	3	7·2			
	26	13	46	"	3c	3	7·4			
	30	13	49	"	2	3	8·3			
	30	13	49	"	3c	3	7·7			
December	3	13	47	"	2	3	10·4	No. 2 3° 8·7'	3° 8·6'	
	3	13	47	"	3c	3	11·0			
	7	13	46	"	2	3	7·8			
	7	13	46	"	3c	3	7·9			
	10	13	52	"	2	3	6·2			
	10	13	52	"	3c	3	6·3			
	14	14	1	"	c	3	9·1			
	14	15	26	"	2	3	9·5			
	17	13	51	"	2	3	7·4			
	17	13	51	"	3c	3	6·6			

TABLE III—*concld.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Kodaikánal Observatory taken with Barrow's Dip Circle No. 46, needles Nos. 1, 2 and 3c by Dover.

Date.		Kodaikánal L. M. time of Observation (0 to 24 hours.)		Observer.	Needle No.	Observed Dip.		Monthly Mean for each needle.	Monthly Mean.	Remarks.
1903. Month.		h.	m.			°	′			
December	21	13	55	H.M.G.	2	3	7·7	No. 3c 3° 8·6′	3° 8·6′	
	21	13	55	„	3c	3	8·0			
	24	13	49	„	2	3	9·8			
	24	13	49	„	3c	3	8·8			
	28	13	40	„	2	3	8·9			
	28	13	40	„	3c	3	8·9			
	31	13	30	„	2	3	10·2			
	31	13	30	„	3c	3	10·9			

TABLE IV.

Dates of magnetic disturbances at Kodaikánal Observatory in 1903.

Latitude=10°-13′-50″.
Longitude=77°-27′-46″.

1903.	Months.											
Date.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1 . . .	C	C	S	C	S	S	S	S	S	S	G	S
2 . . .	S	(C)	S	(C)	C	M	S	S	S	...	S	M
3 . . .	S	C	C	...	(C)	S	C	(C)	(C)	(C)	S	(S)
4 . . .	S	C	(C)	S	S	S	(C)	S	S	S	S	M
5 . . .	S	S	S	S	M	S	C	S	S	S	S	S
6 . . .	C	(C)	S	G	M	C	S	S	S	S	S ?	S
7 . . .	(C)	C	S	S	S	(C)	(C)	(C)	(C)	S	(C)	S
8 . . .	C	M	S	S	S	C	C	S	S	S	S	S
9 . . .	S	S	S	M	...	S	C	S	S	(C)	S	C
10 . . .	S	S	C	S	...	(C)	S	S	S	S	S	(C)
11 . . .	S	S	(C)	S	C	S	S	M	S	S	S	C
12 . . .	(C)	S	S	...	(C)	C	C	S	S	M	S	C
13 . . .	...	S	M	(C)	C	(C)	S	S	S	G	C	M
14 . . .	...	C	S	C	S	S	S	S	C	S	(C)	M
15 . . .	...	S	S	S	S	(C)	(C)	S	S	(C)	C	C
16 . . .	(C)	S	C	(C)	C	S	S	C	(C)	C	(C)	(C)
17 . . .	...	S	C	S	M	S	S	(C)	C	S	S	C
18 . . .	S	(C)	(C)	S	(C)	S	S	S	C	S	S	C
19 . . .	C	S	S	S	S	S	S	(C)	M	S	S	C
20 . . .	C	S	S	(C)	(C)	S	S	S	M	(C)	C	S
21 . . .	(C)	S	(C)	S	S	S	S	S	S	C	S	S
22 . . .	C	S	S	C	S	S	C	M	(C)	S	S	(C)
23 . . .	S	C	S	C	S	S	C	S	S	(C)	S	C
24 . . .	S	(C)	S	C	S	S	(C)	S	S	S	C	C
25 . . .	(C)	S	C	C	S	C	S	C	C	S	(C)	C
26 . . .	M	S	C	S	C	C	M	M	(C)	S	C	S
27 . . .	M	(C)	(C)	S	(C)	(C)	S	S	S	S	C	C
28 . . .	C	(C)	C	S	S	S	S	C	S	C	S	(C)
29 . . .	C	...	S	(C)	C	M	S	(C)	M	S	S	C
30 . . .	S	...	S	S	S	M	(C)	S	S	S	S	M
31 . . .	S	...	S	...	S	...	C	C	...	V G	...	M
C. . . .	13	12	12	11	11	10	13	9	9	8	10	17
S. . . .	12	15	18	15	15	17	17	19	18	19	19	8
M . . .	2	1	1	1	3	3	1	3	3	1	...	...
G. . . .	...	...	...	1	...	...	...	...	...	1	1	...
V. G. . . .	...	...	...	...	...	...	...	...	...	1	...	...

NOTE—C=calm. S=slight, M=moderate. G=great. V.G.=very great.
Bracketted days are the quiet days selected by the Director Colába, Observatory.

TABLE V.

Hourly Means of the Horizontal Force in C. G. S. units (corrected for temperature) at Kodaikánal for the selected quiet days in 1903.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Means.
	0.37000+											Winter.													
1903, Months.																									
January	365	365	366	367	367	368	369	373	381	393	403	412	410	405	393	384	377	371	369	369	367	368	368	368	378
February	361	360	362	362	363	362	364	369	382	401	418	429	427	412	392	379	373	370	368	366	365	364	363	363	378
March	360	359	360	360	361	361	360	365	383	414	445	462	457	436	412	388	372	366	367	365	363	362	362	361	383
October	345	345	346	348	348	349	346	350	375	404	423	431	418	397	373	361	357	358	355	352	352	350	351	350	366
November	320	323	322	324	326	325	328	338	359	374	401	401	381	365	348	341	339	340	333	328	324	321	321	320	342
December	338	337	339	340	340	340	341	348	354	369	377	381	381	380	372	361	352	349	346	343	342	343	343	340	352
Means	348	348	349	350	351	351	351	357	372	394	412	419	412	399	382	369	362	359	356	354	352	351	351	350	366
												Summer.													
April	346	346	348	348	350	349	347	351	377	415	448	462	452	421	383	355	343	346	355	355	353	353	351	352	371
May	350	350	350	350	349	348	351	355	376	402	424	436	432	417	393	368	355	350	352	353	352	352	353	353	370
June	348	348	349	350	350	349	354	363	380	401	418	422	409	386	365	350	353	344	348	347	347	346	345	345	363
July	348	349	350	349	348	345	349	358	372	396	410	415	404	390	373	359	347	343	346	348	347	349	349	351	362
August	349	348	349	350	350	352	355	362	380	401	414	416	411	400	386	374	362	356	357	355	354	354	356	358	369
September	348	349	348	349	350	351	350	361	388	421	442	442	415	382	357	345	347	355	359	355	352	352	353	352	368
Means	348	348	349	349	350	349	351	358	379	406	426	432	421	399	376	359	351	349	353	352	351	351	351	352	367

TABLE VI.

Diurnal inequality of the Horizontal Force at Kodaikânal as deduced from Table V.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
Months.	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	−13	−12	−11	−11	−10	−9	−5	+3	+15	+30	+34	+32	+27	+15	+6	−1	−7	−9	−9	−11	−10	−10	−10
February . . .	−17	−18	−16	−16	−15	−16	−14	−9	+4	+23	+40	+51	+49	+34	+14	+1	−5	−8	−10	−12	−13	−14	−15	−15
March	−23	−24	−23	−23	−22	−22	−23	−18	−0	+31	+62	+79	+74	+53	+29	+5	−11	−17	−16	−18	−20	−21	−21	−22
October . . .	−21	−21	−20	−18	−18	−17	−20	−16	+9	+38	+57	+65	+52	+31	+7	−5	−9	−8	−11	−14	−14	−16	−15	−16
November . . .	−22	−19	−20	−18	−16	−17	−14	−4	+17	+42	+59	+59	+39	+23	+6	−1	−3	−2	−9	−14	−18	−21	−21	−22
December . . .	−14	−15	−13	−12	−12	−12	−11	−4	+2	+17	+25	+29	+29	+28	+20	+9	+0	−3	−6	−9	−10	−9	−9	−12
Means	−19	−19	−18	−17	−16	−16	−16	−10	+5	+27	+45	+52	+45	+32	+15	+2	−5	−8	−11	−13	−15	−16	−16	−17
Summer.																								
April	−25	−25	−23	−23	−21	−22	−24	−20	+6	+44	+77	+91	+81	+50	+12	−16	−28	−25	−16	−16	−18	−18	−20	−19
May	−20	−20	−20	−20	−21	−22	−19	−15	+6	+32	+54	+66	+62	+47	+23	−2	−15	−20	−18	−17	−18	−18	−17	−17
June	−15	−15	−14	−13	−13	−14	−9	−0	+17	+38	+55	+59	+46	+33	+2	−13	−10	−19	−15	−16	−16	−17	−18	−18
July	−14	−13	−12	−13	−14	−17	−13	−4	+10	+34	+48	+53	+42	+28	+11	−3	−15	−19	−16	−14	−15	−13	−13	−11
August	−20	−21	−20	−19	−19	−17	−14	−7	+11	+32	+45	+47	+42	+31	+17	+5	−7	−13	−12	−14	−15	−15	−13	−11
September . . .	−20	−19	−20	−19	−18	−17	−18	−7	+20	+53	+74	+74	+47	+14	−11	−23	−21	−13	−9	−13	−16	−16	−15	−16
Means	−19	−19	−18	−18	−17	−18	−16	−9	+12	+39	+59	+65	+34	+32	+9	−8	−16	−18	−14	−15	−16	−16	−16	−15

NOTE.—When the sign is + the reading is above the mean. For January, means are taken from four quiet days.

TABLE VII.

Hourly means of the Declination as determined at Kodaikánal from the selected quiet days in 1903.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4	5	6	7	8	9	10	11	Means.
West 0°+													Winter.												
Months, 1903.																									
January	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October	23·5	23·4	23·4	23·5	23·5	23·6	23·2	23·0	22·6	22·7	23·7	24·5	24·7	24·3	23·7	23·2	23·0	23·4	23·5	23·5	23·6	23·6	23·6	23·6	23·5
November	23·6	23·5	23·6	23·6	23·9	24·1	24·3	24·3	23·8	23·5	23·4	23·8	23·5	23·3	23·2	23·1	23·1	23·3	23·5	23·4	23·4	23·5	23·6	23·6	23·6
December	24·2	24·1	24·2	24·2	24·5	24·6	24·7	25·0	24·9	24·5	24·4	24·6	24·8	24·4	23·9	23·9	24·0	24·0	24·2	24·1	24·1	24·2	24·3	24·3	24·4
													Summer.												
April	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
May	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
June	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
July	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
August	22·6	22·5	22·5	22·4	22·4	22·2	21·4	20·5	20·5	21·1	22·3	23·3	23·7	23·7	23·1	22·5	21·8	21·8	22·1	22·7	22·8	22·9	22·9	22·8	22·4
September	23·1	23·0	22·9	22·8	22·7	22·6	21·7	20·9	21·4	22·4	23·5	24·9	25·4	25·0	24·1	23·0	22·4	22·4	22·8	23·0	23·2	23·2	23·3	23·2	23·0

NOTE—Mean for August taken from 4 quiet days only.

TABLE VIII.

Diurnal inequality of the Declination at Kodaikánal as deduced from Table VII.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
Winter.																								
Months, 1903.																								
January	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
February	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
October	0·0	—0·1	—0·1	0·0	0·0	+0·1	—0·3	—0·5	—0·9	—0·8	+0·2	+1·0	+1·2	+0·8	+0·2	—0·3	—0·5	—0·1	0·0	0·0	+0·1	+0·1	+0·1	+0·1
November	0·0	—0·1	0·0	0·0	+0·3	+0·5	+0·7	+0·7	+0·2	—0·1	—0·2	+0·2	—0·1	—0·3	—0·4	—0·5	—0·5	—0·3	—0·1	—0·2	—0·2	—0·1	0·0	0·0
December	—0·2	—0·3	—0·2	—0·2	+0·1	+0·2	+0·3	+0·6	+0·5	+0·1	0·0	+0·2	+0·4	0·0	—0·5	—0·5	—0·4	—0·4	—0·2	—0·3	—0·3	—0·2	—0·1	—0·1
Summer.																								
April	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
May	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
June	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
July	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
August	+0·2	+0·1	+0·1	0·0	0·0	—0·2	—1·0	—1·9	—1·9	—1·3	—0·1	+0·9	+1·3	+1·3	+0·7	+0·1	—0·6	—0·6	—0·3	+0·3	+0·4	+0·5	+0·5	+0·4
September	+0·1	0·0	—0·1	—0·2	—0·3	—0·4	—1·3	—2·1	—1·6	—0·6	+0·5	+1·9	+2·4	+2·0	+1·1	0·0	—0·6	—0·6	—0·2	0·0	+0·2	+0·2	+0·3	+0·2

NOTE—When the sign is—the magnet points to the east of mean position and when the sign is + the magnet points to the west of mean position.

Statement of Loss of Magnetograph Records in 1903.

KODAIKÁNAL OBSERVATORY.

HORIZONTAL FORCE MAGNETOGRAPH.					DECLINATION MAGNETOGRAPH.					Cause of interruption.
PERIOD OF BREAK				Duration of break.	PERIOD OF BREAK				Duration of break.	
from	on	to	on		from	on	to	on		
h. m.	date	h. m.	date	h. m.	h. m.	date	h. m.	date	h. m.	
					14 0	12th January .	11 0	13th January .	21 0	Adjusted the instrument.
10 5	14th January .	15 10	15th January .	29 5	14 30	13th „ .	15 45	„ „ .	1 15	„ „ „
					10 5	14th „ .	19 0	19th „ .	128 55	„ „ „
13 15	17th „ .	14 10	17th „ .	0 55	...	...	...	...	...	Re-adjusted.
					6 50	7th February	8 30	7th February .	1 40	Film spoiled.
					12 10	9th „ .	18 40	9th „ .	6 30	„ „
					19 48	„ „ .	0 40	10th „ .	4 52	„ „
					9 0	7th March .	10 9	7th March .	1 9	Driving wheel was not put in position.
13 46	3rd April .	21 25	3rd April .	7 39	13 46	3rd April .	21 25	3rd April .	7 39	Clock stopped.
11 0	12th „ .	17 28	12th „ .	6 28	11 0	12th „ .	17 28	12th „ .	6 28	„ „
10 1	9th May .	10 7	10th May .	24 6	...	...	...	...	...	Shutters not opened.
3 0	2nd October .	10 20	2nd October .	7 20	...	...	...	...	...	Lamp failed.
17 30	31st „ .	18 40	31st „ .	1 10	...	...	...	...	...	Trace went off the paper owing to the very great disturbance.
19 20	„ „ .	20 30	„ „ .	1 10	...	...	...	...	...	
					14 6	4th December	10 9	5th December	20 9	Lamp failed.
					7 55	17th „ .	10 19	17th „ .	2 19	„ „
			TOTAL .	77 53				TOTAL .	201 56	

BARRACKPORE MAGNETIC OBSERVATORY.

General remarks.

1. During 1904 the instruments have given no trouble and the chief difficulty met with has arisen from the unhealthiness of the locality. Early in the year the regular observer had to be sent on leave owing to ill health and his place was taken temporarily by one of the field observers who was working in the neighbourhood, until the spare observer, who was also ill at the time, became available on his return from sick leave.

The recorder and menials of the staff have also suffered much from malaria and constant changes have been necessary in consequence. There seems little prospect of improvement in this respect and the best remedy seems to lie in the transfer of men to healthier observatories as soon as their health shows signs of suffering at Barrackpore.

The usual tables of results for the last 5 months of the year 1903 are appended.

The declination observations.

2. Mean magnetic collimation of magnet No. 20 during 1903:—

Months.	Magnetic Collimation. ′	″
August	—7	38
September	—7	37
October	—7	36
November	—7	34
December	—7	34

The Dip results.

3. Needles 1 and 2 have been used in Circle No. 45 without change.

Monthly mean differences between Needles 1 and 2 of Circle No. 45, 1903.

Months.	Needle 1—Needle 2.
August	+0·3
September	+0·5
October	+0·5
November	—1·3
December	—0·3

The force observations.

4. Monthly mean values of constants of Magnetometer No. 20 at Barrackpore. 1903.

Month.	M_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	REMARKS.
August . . .	952·59	6·89	7·92	The values of m_0 are computed from the mean P (at 22·5 and 30 cms) for the year.
September . .	952·53	6·79	7·00	
October . . .	952·53	6·92	7·15	
November . .	952·75	6·78	7·55	
December . .	952·77	6·80	7·60	

The variations in the value of P from 30 and 40 cms are unusually large but in other respects the results are normally good.

MEAN MONTHLY BASE LINE VALUES AND TEMPERATURES AT BARRACKPORE OBSERVATORY.

H. F. magnetograph No. 3 by Professor W. Watson, F.R.S., 1903.

Months.	Temperature of H. F. Instrument cent.	Scale value of 0·04 inch.	Base Line value C. G. S.	REMARKS.
	°	γ		
August . . .	31·64	4·79	0·36994	The base line values are referred to a temperature of 31° cent, the temperature coefficient used in the reduction being + 1° cent. = —12·6γ.
September . .	31·36	4·82	66	
October . . .	31·04	4·84	49	
November . .	30·37	4·83	46	
December . .	29·15	4·85	38	

There was considerable difficulty in maintaining uniformity of temperature in the magnetograph room, and the ventilation lamp had to be fully turned up in order to prevent too large a drop during the cold weather months. Accidenta variations during the day were larger than they should be owing to inequalities in the burning of the lamps. These difficulties continued throughout 1904 and it has now been decided to double the walls of the inner room by fixing planks to the outside of the frame work which supports the present wall and filling the space between them with sawdust. In addition, the open verandah round the building will be enclosed and these two measures will, it is hoped, largely reduce the radiation less and improve the temperature conditions.

The mean Base Line values show that the instrument was in a very unstable condition at first, and had not settled down entirely by the end of the year. During August and September the changes were so rapid that. separate values of the Base Line were used for each of the selected quiet days.

TABLE I.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Barrackpore Observatory.

1	2	3	4	5	6	7	8	9
Date.	Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903		C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
August 9	K. N. M.	952·62	6·88	6·97	·37225	·37213	·37017	·36994
9	„	·60	...	...	224		019	
12	„	953·10	6·83	8·37	226		006	
12	„	952·69	...	...	210		·36995	
15	„	·40	6·78	8·00	216		993	
15	„	·45	...	...	218		999	
19	„	...	6·72	8·00	...		...	
19	„	...	...	...	245		·37009	
19	„	...	...	...	...		...	
26	„	·36	6·88	8·98	150		·36974	
27	„	·73	6·91	7·20	193		970	
27	„	·73	...	...	193		970	
29	„	·64	6·91	7·67	225		987	
29	„	·66	...	...	225		988	
Sep. 2	„	·69	6·64	7·62	241	·37217	987	·36966
2	„	·60	...	...	237		984	
5	„	·66	6·88	7·58	231		979	
5	„	·58	...	...	227		977	
9	„	·47	6·88	7·86	211		958	
10	„	·60	6·98	8·56	226		962	
10	„	·55	...	...	225		964	
12	„	·55	6·64	7·95	216		964	
12	„	·47	...	...	213		964	
15	„	·66	6·88	8·14	218		970	
15	„	·51	...	...	212		965	
16	„	·62	6·70	7·95	216		965	
16	„	·16	...	...	198		947	

TABLE I—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Barrackpore Observatory.

1	2	3	4	5	6	7	8	9
Date.	Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.		C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Sep. 19	K. N. M.	·51	6·83	8·42	181	·37217	967	·36966
30	,,	·53	6·72	6·92	202		955	
October 3	,,	·55	6·85	7·62	211	·37208	957	·36949
3	,,	·27	...	...	200		949	
7	,,	·47	6·72	8·56	216		952	
7	,,	·53	...	...	219		954	
8	,,	...	...	6·97	204		951	
10	,,	·60	6·96	7·15	264		957	
10	,,	·29	...	...	252		949	
14	,,	·69	6·85	7·15	174		946	
14	,,	·62	...	...	171		948	
17	,,	·40	6·85	7·15	180		938	
17	,,	·60	...	...	188		945	
21	,,	·60	6·93	6·92	214		943	
21	,,	·53	...	...	212		946	
24	,,	952·64	6·57	7·76	·37212		·36954	
24	,,	·40	...	...	202		947	
28	,,	·69	6·67	7·90	210		952	
28	,,	·60	...	...	207		950	
Nov. 1	,,	·75	6·85	7·44	069	·37164	953	·36946
1	,,	·80	...	...	071		949	
4	,,	·86	6·64	7·53	160		958	
6	,,	953·04	6·88	6·92	184		955	
6	,,	952·55	...	...	166		945	
7	,,	·84	6·80	7·48	184		945	
7	,,	·62	...	...	176		941	
11	,,	953·10	6·91	7·67	165		954	

TABLE I—*concld.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Horizontal Force at Barrackpore Observatory.

1	2	3	4	5	6	7	8	9
Date.	Observer.	Values of m_0.	P from 22·5 and 30 cms.	P from 30 and 40 cms.	Observed values of Horizontal Force.	Monthly mean observed value of H. F.	Base Line values corrected for temperature.	Monthly mean Base Line value.
1903.		C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.	C. G. S.
Nov. 11	K.N.M.	952·69	...	...	148	·37164	937	·36946
25	„	·75	6·75	7·95	198		943	
25	„	·66	...	...	195		946	
28	„	·51	6·64	7·86	211		940	
28	„	·31	...	...	203		934	
Dec. 2	„	·82	6·57	8·42	180	·37196	946	·36938
2	„	·55	...	...	170		941	
2	„	·53	...	8·00	171		947	
5	„	·88	6·83	7·81	198		938	
5	„	·73	...	...	192		940	
9	„	·95	6·78	6·87	201		943	
9	„	·58	...	...	187		933	
9	„	·71	6·78	7·72	181		930	
9	„	·73	...	...	182		932	
12	„	·80	6·85	7·01	201		936	
12	„	·55	...	...	191		926	
19	„	·93	6·78	7·62	219		941	
19	„	·84	...	...	215		939	
23	„	953·26	6·85	7·67	218		951	
23	„	952·86	...	...	202		938	
30	„	953·04	6·88	8·23	187		935	
30	„	952·55	...	...	168		931	
26	„	·88	6·88	6·69	234		933	
		·86	...	...	233		936	

TABLE II.

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Barrackpore Observatory.

1	2	3	4	5	6	7
Date.	Observer.	Magnetic Collimation.	Observed Declination, East.	Monthly mean observed Declination, East.	Base Line values.	Monthly mean Base Line Values.
1903.		′ ″	° ′	° ′	′	′
August 10	K. N. M.	−7 41	1 24·3	1 25·7	16·2	16·0
14	”	−7 36	1 27·1		15·8	
15	”	−7 52	1 25·1		16·1	
18	”	−7 32	1 27·8		16·1	
18	”	−7 37	1 27·6		15·7	
21	”	−7 23	1 26·7		15·8	
21	”	−7 54	1 27·1		16·2	
25	”	−7 34	1 24·4		15·7	
25	”	−7 31	1 23·3		16·0	
25	”	−7 33	1 24·1		16·0	
27	”	−7 45	1 24·7		15·8	
September 1	”	−7 34	1 23·9	1 24·7	15·7	15·9
4	”	−7 40	1 24·3		15·8	
8	”	−7 27	1 24·5		16·1	
8	”	−7 52	1 25·5		16·2	
11	”	−7 33	1 26·9		15·6	
15	”	−7 23	1 24·1		15·8	
15	”	−7 48	1 24·7		15·9	
18	”	−7 38	1 23·7		15·9	
October 2	”	−7 43	1 26·3	1 26·1	15·9	15·8
6	”	−7 38	1 26·1		15·4	
9	”	−7 36	1 26·3		16·0	
13	”	−7 36	1 24·2		16·0	
16	”	−7 28	1 26·3		15·9	
16	”	−7 38	1 26·6		15·9	
20	”	−7 29	1 26·5		15·9	
20	”	−7 37	1 26·7		16·2	

TABLE II.—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Declination at Barrackpore Observatory.

1		2	3	4	5	6	7
Date.		Observer.	Magnetic Collimation.	Observed Declination, East.	Monthly mean observed Declination, East.	Base Line values.	Monthly mean Base Line Values.
1903.			′ ″	° ′	° ′	′	′
October	23	K. N. M.	−7 38	1 26·0	15·8	15·7	15·8
	27	"	−7 45	1 26·2		15·6	
	30	"	−7 32	1 25·4		15·7	
November	3	"	−7 30	1 26·0	1 25·8	15·9	15·6
	3	"	−7 42	1 26·6		15·8	
	6	"	−7 33	1 25·4		15·7	
	10	"	−7 40	1 27·0		15·8	
	24	"	−7 33	1 25·0		15·4	
	27	"	−7 24	1 25·1		15·3	
	27	"	−7 35	1 25·3		15·5	
December	1	"	−7 38	1 25·9	1 25·4	15·9	15·4
	1	"	−7 32	1 26·1		15·8	
	4	"	−7 41	1 25·7		15·7	
	8	"	−7 47	1 26·1		15·2	
	8	"	−7 41	1 26·0		15·4	
	11	"	−7 23	1 23·5		15·2	
	11	"	−7 23	1 24·1		15·5	
	15	"	−7 30	1 25·2		15·3	
	15	"	−7 34	1 25·2		15·2	
	18	"	−7 38	1 25·5		15·4	
	18	"	−7 29	1 25·3		15·2	
	22	"	−7 31	1 26·3		15·9	
	25	"	−7 36	1 25·4		15·3	
	29	"	−7 22	1 25·2		15·2	
	29	"	−7 49	1 25·2		15·2	

TABLE III.

ABSOLUTE MAGNETIC OBSERVATIONS.

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

Date.		Barrackpore L. M. time of observation (0 to 24 hours.)		Obser-ver.	Needle No.	Observed Dip.		Monthly mean for each needle.	Monthly mean.	REMARKS.
1903. Month.		h.	m.			°	'		° '	
August	17	17	16	K. N. M.	1	30	18·7	No 1 30° 16'·8 No. 2 30° 16'·5	30°16'·6	
	17	17	16	„	2	30	17·1			
	20	14	41	„	1	30	16·9			
	20	14	41	„	2	30	15·8			
	24	14	51	„	1	30	16·7			
	24	14	51	„	2	30	16·3			
	28	14	34	„	1	30	15·3			
	28	14	34	„	1	30	17·6			
	28	15	37	„	2	30	16·3			
	31	14	30	„	2	30	16·7			
	31	14	30	„	1	30	15·7			
September	3	14	39	„	1	30	16·1	No. 1 30° 16'·9 No. 2 30° 16'·4	30°16'·7	
	3	14	39	„	2	30	18·2			
	3	15	28	„	2	30	16·7			
	7	13	2	„	1	30	16·5			
	7	13	2	„	2	30	14·7			
	10	12	57	„	1	30	17·4			
	10	12	57	„	2	30	17·2			
	14	13	59	„	1	30	16·5			
	14	13	59	„	2	30	16·4			
	17	13	2	„	1	30	18·0			
	17	13	2	„	2	30	15·1			
	17	13	52	„	1	30	17·0			
October	1	13	30	„	1	30	17·9	No. 1 17'·1		
	1	13	30	„	2	30	16·3			
	5	13	7	„	1	30	18·5			
	5	13	7	„	2	30	16·6			
	8	12	55	„	1	30	17·8			

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

Observations of Dip at Barrackpore Observatory taken with Barrows Dip Circle No. 45, needles Nos. 1 and 2 by Dover.

Date.		Barrackpore L. M. time of observation (0 to 24 hours.)		Observer.	Needle No.	Observed Dip.		Monthly mean for each needle.	Monthly mean.	REMARKS.
1903. Month.		h.	m.			°	′		° ′	
October	8	12	55	K. N. M.	2	30	14·4	No. 2 30° 16′·6	30°16′·8	
	*8	13	44	„	2	30	18·3			
	12	13	18	„	1	30	14·9			
	12	13	18	„	2	30	14·7			
	15	13	11	„	1	30	18·3			
	15	13	11	„	2	30	15·9			
	19	13	11	„	1	30	16·5			
	19	13	11	„	2	30	16·4			
	22	12	59	„	1	30	16·6			
	22	12	59	„	2	30	16·0			
	26	13	17	„	1	30	17·2			
	26	13	17	„	2	30	20·0			
	26*	13	59	„	2	30	18·7			
	29	13	24	„	1	30	16·0			
	29	13	24	„	2	30	15·1			
November	2	13	26	„	1	30	19·2	No. 1 30° 17′·9 No. 2 30° 19′·2	30°18′·6	
	2	13	26	„	2	30	20·5			
	5	13	6	„	1	30	17·1			
	5	13	6	„	2	30	20·2			
	6	12	39	„	2	30	16·9			
	9	13	26	„	2	30	18·8			
	9	14	14	„	1	30	18·6			
	23	13	2	„	1	30	15·9			
	23	13	2	„	2	30	18·5			
	26	13	40	„	2	30	20·7			
	26	13	40	„	1	30	19·3			
	30	13	8	„	1	30	17·2			
	30	13	8	„	2	30	19·0			

TABLE III—*contd.*

ABSOLUTE MAGNETIC OBSERVATIONS.

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

Date.	Barrackpore L. M. time of observation (0 to 24 hours.)	Obser-ver.	Needle No.	Observed Dip.	Monthly mean for each needle.	Monthly mean.	REMARKS.
	h. m.			° ′		° ′	
1903. Month.							
December 3	13 30	K.N.M	1	30 17·2	No. 1 30° 19′·4	30°19′·6	
3	13 30	„	2	30 19·7			
4	13 5	„	1	30 17·8			
4	13 5	„	2	30 18·2			
7	13 8	„	1	30 18·3			
7	13 8	„	2	30 16·7			
10	13 22	„	1	30 15·4			
10	13 22	„	2	30 16·5			
11	13 13	„	1	30 20·2			
11	13 13	„	2	30 20·1			
12	15 5	„	1	30 18·8	No. 2 30° 19′·7		
12	15 5	„	2	30 19·2			
13	13 44	„	1	30 17·1			
13	13 44	„	2	30 20·1			
14	12 56	„	1	30 21·1			
14	12 56	„	2	30 22·3			
15	12 35	„	1	30 21·6			
15	12 35	„	2	30 20·0			
17	13 37	„	1	30 18·4			
17	13 37	„	2	30 19·1			
21	13 25	„	1	30 21·2			
21	13 25	„	2	30 20·0			
24	13 19	„	1	30 19·6			
24	13 19	„	2	30 18·4			
28	13 25	„	1	30 20·7			
28	13 25	„	2	30 21·8			
31	13 17	„	1	30 24·5			
31	13 17	„	2	30 24·1			

TABLE IV.

Dates of Magnetic Disturbances at Barrackpore Observatory in 1903.

Lat.—22-16-29.
Long.—88-21-39.

1903.	Months.				
	August.	September.	October.	November.	December.
1	...	S	S	G	S
2	...	S	S	M	S
3	...	(C)	(C)	S	(C)
4	...	S	S	S	M
6	...	S	S	S	S
5	...	S	S	S	S
7	...	(C)	S	(C)	S
8	...	S	S	S	S
9	S	S	(C)	S	C
10	C	S	S	S	(C)
11	M	S	S	S	C
12	S	M	M	S	C
13	S	S	G	C	M
14	S	C	S	(C)	M
15	C	C	(C)	C	C
16	C	(C)	C	(C)	(C)
17	(C)	C	S	S	C
18	C	C	S	S	C
19	(C)	M	...	M	C
20	S	M	(C)	C	S
21	S	S	C	S	S
22	M	(C)	S	S	(C)
23	S	S	(C)	S	C
24	C	S	S	C	C
25	C	C	S	(C)	C
26	M	(C)	S	C	S
27	C	S	C	C	C
28	...	S	C	S	(C)
29	...	M	S	S	C
30	S	S	S	C	M
31	C	...	VG	...	M
C	10	10	9	11	17
S	8	16	18	16	9
M	3	4	1	2	5
G	...	...	1	1	...
VG	...	...	1	...	...

TABLE V.

Hourly means of the Horizontal Force in C. G. S. units (corrected for temperature) at Barrackpore from the selected quiet days in 1903.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Mean.
Months, 1903		γ 37000+																							
											Winter.														
October . .	192	194	193	194	196	197	197	194	194	201	210	219	266	222	215	204	198	197	199	197	198	198	198	201	201
November . .	171	171	172	173	175	178	181	183	191	197	208	213	216	205	196	189	182	178	179	173	171	169	169	173	184
December . .	190	191	190	191	192	194	195	198	204	207	211	21	210	208	203	201	197	193	194	194	192	195	196	197	198
											Summer.														
August . .	183	185	189	187	189	192	193	193	193	194	196	201	208	214	213	209	204	198	195	195	191	191	196	196	196
September . .	204	204	205	204	206	206	206	200	197	202	221	220	226	225	221	216	210	205	207	207	206	205	205	208	209

TABLE VI.

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

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
Months 1903.																								
October . . .	-9	-7	-8	-7	-5	-4	-4	-7	-7	0	+9	+18	+25	+21	+14	+3	-3	-4	-2	-4	-3	-3	-3	0
November . . .	-13	-13	-12	-11	-9	-6	-3	-1	+7	+13	+24	+29	+32	+21	+12	+5	-2	-6	-5	-11	-13	-15	-15	-11
December . . .	-8	-7	-8	-7	-6	-4	-3	0	+6	+9	+13	+14	+12	+10	+5	+3	-1	-5	-4	-4	-6	-3	-2	-1
August . . .	-13	-11	-7	-7	-7	-5	0	-3	-3	-2	0	+5	+12	+18	+17	+13	+8	+2	-1	-1	-5	-5	0	0
September . . .	-5	-5	-4	-5	-3	-3	-3	-9	-12	-7	+2	+11	+17	+16	+12	+7	+1	-4	-2	-2	-3	-4	-4	-1

NOTE.—When the sign is + the reading is above the mean. In August the results have been compiled from 3 selected quiet days only.

TABLE VII.

Hourly means of the Declination as determined at Barrackpore from the selected quiet days in 1903.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11	Mean.
East 1°+													Winter.												
Months 1903.	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'	'
October . .	25·9	26·0	26·0	25·9	25·6	25·8	25·9	27·2	27·7	27·5	26·2	24·6	23·7	23·8	24·8	25·7	26·3	26·0	25·6	25·9	25·8	25·7	25·8	25·8	25·8
November . .	25·7	25·7	25·6	25·4	25·3	25·0	25·0	25·4	26·4	26·6	26·0	24·8	24·7	25·2	25·7	26·0	26·0	25·7	25·7	25·7	25·6	25·6	25·6	25·8	25·6
December . .	25·1	25·3	25·2	25·0	25·0	24·7	24·7	24·4	24·9	25·4	25·8	25·0	24·7	24·8	25·2	25·3	25·3	25·3	25·1	25·3	25·1	25·0	25·0	25·1	25·1
													Summer.												
August . .	26·5	26·7	26·8	26·8	26·9	27·0	28·3	29·7	29·5	28·1	26·2	24·9	2·44	24·7	25·5	26·2	27·0	27·1	26·4	26·1	26·0	26·0	26·0	26·1	26·6
September . .	25·9	26·1	26·1	26·2	26·3	26·5	27·5	29·0	29·0	27·4	25·4	23·3	22·7	23·3	24·5	25·9	26·8	26·9	26·1	26·0	25·9	25·9	26·0	26·0	26·0

August means are derived from 3 quiet days only.

TABLE VIII.

Diurnal inequality of the Declination at Barrackpore as deduced from Table VII.

Hours.	Mid.	1	2	3	4	5	6	7	8	9	10	11	Noon.	1	2	3	4	5	6	7	8	9	10	11
1903. Months.	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
October . . .	+0·1	+0·2	+0·2	+0·1	—0·2	—0·0	+0·1	+1·4	+1·9	+1·7	+0·4	—1·2	—2·1	—2·0	—1·0	—0·1	+0·5	+0·2	—0·2	+0·1	0·0	—0·1	0·0	0·0
November . . .	+0·1	+0·1	0·0	—0·2	—0·3	—0·6	—0·6	—0·2	+0·8	+1·0	+0·4	—0·8	—0·9	—0·4	+0·1	+0·4	+0·4	+0·1	+0·1	+0·1	0·0	0·0	0·0	+0·2
December . . .	0·0	+0·2	+0·1	—0·1	—0·1	—0·4	—0·4	—0·7	—0·2	+0·3	+0·7	—0·1	—0·4	—0·3	+0·1	+0·2	+0·2	+0·2	0·0	+0·2	0·0	—0·1	—0·1	0·0

August . . .	—0·1	+0·1	+0·2	+0·2	+0·3	+0·4	+1·7	+3·1	+2·9	+1·5	—0·4	—1·7	+2·2	—1·9	—1·1	—0·4	+0·4	+0·5	—0·2	—0·5	—0·6	—0·6	—0·6	—0·5
September . . .	—0·1	+0·1	+0·1	+0·2	+0·3	+0·5	+1·5	+3·0	+3·0	+1·4	—0·6	—2·7	—3·3	—2·7	—1·5	—0·1	+0·8	—0·9	+0·1	0·0	—0·1	—0·1	0·0	0·0

When the sign is + the magnet points to the east of the mea position when — to the west.

STATEMENT OF LOSS OF MAGNETOGRAPH RECORDS IN 1903.

Barrackpore Observatory.

HORIZONTAL FORCE MAGNETOGRAPH.					DECLINATION MAGNETOGRAPH.					
PERIOD OF BREAK.				Duration of Break.	PERIOD OF BREAK.				Duration of Break.	Cause of interruption.
From	On	To	On		From	On	To	On		
h. m.	Date	h. m.	Date	h. m.	h. m.	Date	h. m.	Date	h. m.	Started on the 8th August.
9 36	20th August .	10 41	20th August .	1 5	9 36	20th August .	10 41	20th August .	1 5	Shutters closed at wrong time.
18 30	28th ,, .	7 9	29th ,, .	12 39	13 20	28th ,, .	14 58	28th ,, .	3 38	Lamp blown out by wind.
				5 0	5 0	13th Sept. .	7 35	13th Sept. .	2 35	Lamps got smoky.
11 8	21st Sept. .	13 27	21st Sept. .	2 19	10 32	21st ,, .	17 4	21st ,, .	6 34	Observer was ill.
					13 40	14th Nov. .	10 42	15th Nov. .	21 2	Wheel not properly clamped.
					11 0	1st ,, .	13 0	1st ,, .	2 0	Ditto.
			Total .	21 3				Total .	36 54	

TOUNGOO MAGNETIC OBSERVATORY.

General remarks.

In anticipation of the arrival of the magnetographs for the Burma observatory, certain additions and modifications of the original observatory buildings near Rangoon were ordered towards the end of 1903, but before they could be put in hand, the question arose as to whether it would not be best to abandon the site altogether. The alignment of the large iron main for supplying Rangoon with water from the new Hlawga tank, passes within a few feet of the main building and a satisfactory re-alignment would have proved a very expensive matter, apart from the delay involved. This and the threatened approach of a circular railway would have rendered the existing buildings useless as a magnetic observatory and it was therefore wisely decided to build afresh in a safer locality. There was necessarily some delay in arriving at this conclusion and it was not till the end of April 1904 that the officer in charge of the magnetic party was able to set about the choice of a new site. By the middle of May, a suitable spot was selected in the old cantonment at Toungoo, a large town situated on the railway about 170 miles north of Rangoon. Plans were drawn up based on the existing observatory at Barrackpore and sanction to commence work was obtained in June. In spite of heavy and prolonged rain, the buildings were finished in the following November, an achievement which reflects great credit on the Executive Engineer of the Public Works Department at Toungoo. In the following month the instruments were erected but an account of them and of the observatory must be held over for the next report.

II

PENDULUM OPERATIONS.

Extracted from the Narrative Report of Major G. P. Lenox Conyngham, R.E., in charge No. 23 Party (Astronomical) for Season 1903-04.

Up to the date of my return from furlough No. 23 party had been joined with No. 22 and had been employed on Latitude observations.

I arrived in Dehra Dún on December 14th 1903 bringing with me the four pendulums of the new apparatus. The rest of this equipment did not arrive till some time later and in the meantime the construction of several accessories was put in hand.

As there is very little resemblance between the new pendulum equipment and the old one, belonging to the Royal Society, which was used by Captain Basevi and Captain Heaviside between 1864 and 1870, and which is described in Volume V of the operations of Great Trigonometrical survey, a short account of that now purchased for the Survey of India will not be out of place.

Differences between new and old apparatus.

The fundamental differences between the new equipment and the old are—

(*a*) That the new pendulums are half seconds pendulums instead of seconds pendulums and consequently only one quarter as long as the old.

(*b*) That the coincidences between the free pendulum and the clock pendulum are not observed directly, but by a method invented by Col. von Sterneck of the Austrian National Survey, which results in a reduction of the labour combined with an increase of accuracy.

A third point of difference is that the old pendulums were swung in vacuo whereas the new ones are not, but there is no reason why the new ones should not be swung in vacuo so that this difference is not essential.

Description of Apparatus.
Pendulums.

The present apparatus includes four pendulums, numbered, respectively, 137, 138, 139 and 140. They are made of brass heavily gilded. In the head of each a block of agate, ground to a knife edge on the underside, is securely fixed. The angle of the knife edge is about 90°. The edge is not continuous but consists of tooth-like portions, two on each side of the pendulum's stem. The inner teeth are the real or working edges, the outer being merely auxiliary or false edges on which the pendulum is hung when not in use, and on which it is placed by hand before being lowered into its final position by means of a slow motion screw; they serve in fact to save the real edges from unnecessary wear and from accidental shocks. A small mirror is fixed to the head of each pendulum in such a position that it is vertical when the pendulum is hanging on its edges. The purpose of this mirror will be explained later.

Stand.

The stand, on which the pendulums are in turn placed for observation, consists of a strongly made, hollow, truncated cone of brass, from the curved surface of which three large parts have been removed.

The base is circular and stands on three foot-screws which pass through threaded projections. In order to do away as far as possible with shake the central part of the thread of the female screws is cut away and clamping thumb-screws are provided, so that when the latter are tightened the foot-screws are firmly gripped by the upper and lower portions of the female screws and are not held in the middle at all.

A polished, circular, agate plate is fixed in the upper surface of the truncated cone. It is pierced by an oblong aperture through which the head of a pendulum can be passed: after passing the head up from below it is turned through a right angle so that it lies across the aperture, bridging it, when the edges may be rested on the polished surface. In order to avoid shocks two stirrups are provided for the reception of the auxiliary edges: they consist of brass blocks cut into Vs on the top and fastened to the ends of a fork-shaped bell-crank lever. The blocks pass through holes in the agate plate, one on either side of the oblong aperture. By means of a screw acting upon the other end of the lever the blocks can be made to protrude above the agate plate or can be withdrawn below it. When a pendulum is to be placed in position they are made to protrude and the false edges are placed in their Vs, then by turning the screw they are withdrawn until the weight of the pendulum is taken by the real edges. The false edges are not so wide as the blocks and thus when the latter are withdrawn into their holes the former are not in contact with anything.

The mirror mentioned above is now seen above the agate plane.

The stand is of such a height that the bob of a suspended pendulum is about 3 inches above the upper surface of the base plate.

Fixed to the base is the starting lever; by it the pendulum can be deflected from the vertical by any desired amount, and on withdrawing it the pendulum begins to oscillate with an amplitude equal to the angle through which it was deflected.

In order to make the stand as steady as possible means are provided for clamping it tightly, after it has been levelled, to a granite slab which forms part of the equipment. This slab is in turn cemented to a low pillar, built of brick in cement, so that as soon as the cement has set the whole forms a single fairly rigid mass.

Flash box.

The next part of the apparatus to be described is the flash box. It consists of an oblong rectangular brass box standing on three foot screws, so that it can be levelled, and having a small telescope, similar to that of an ordinary level, rigidly fixed on the top with its axis parallel to the longest side of the box.

In the front of the box is a small horizontal slit, and inside there is an electromagnet with an armature to which is connected a lever carrying a shutter with a similar slit in it. This shutter is close to, but not in contact with the front of the box. A spring attached to the lever draws the armature away from the magnet when current is not passing, but when current passes the attraction of the magnet overcomes the resistance of the spring.

By connecting the electromagnet with a break circuit clock the lever is made to rise and fall once in each second; on each occasion the slit in the shutter passes across the slit in the box, and as it does so a ray of light from a suitably placed lamp passes through. Thus an observer sitting in front of the flash box would see two flashes of light every second. Of these the first corresponds to the make of circuit and the second to the break. As the demagnetisation of an electromagnet takes place more instantaneously than the magnetisation, the second flash is selected for observation. The break circuit flashes are precisely one second apart if the clock is keeping true sidereal time.

Method of observing.

The flash box is now so placed that the flashes of light may fall on the mirror of the pendulum which is to be observed, and at such a height that when the pendulum is at rest an observer looking into the telescope sees the reflection of the flash on the horizontal wire. Thus the coincidence of a flash with the horizontal wire shows that at the instant at which the flash occurred the pendulum was vertical, or, at any rate, in a definite position very nearly vertical. If now the pendulum be set vibrating and if its vibration period be precisely half a second, at whatever part of the field of view of the telescope the first flash is seen (ignoring entirely the flashes which occur at make circuit) there also will all subsequent flashes appear, for at the end of each second the pendulum will always be in the same position. It will also be moving in the same direction as each flash occurs; it of course passes through the same point in the opposite direction at intermediate instants but there will be no corresponding flash.

The pendulums of this apparatus vibrate in about $0^{s}{\cdot}507$. Therefore when one of them is oscillating it does not complete a to and fro swing in one second, and successive flashes will be seen at different points in the field of view. Let us suppose that the first flash was seen on the horizontal wire and the second somewhat below it, then the third will be still lower and so on till they pass out of the field altogether, after the lapse of a short time they will begin to re-appear from below and will now form an ascending series; if the $(c+1)$th flash again coincides with the wire it will show that the pendulum is at this instant in the same position as it was at the first flash, but as the first flash belonged to a descending series and the $(c+1)$th to an ascending one, it is clear that the pendulum is moving in opposite directions at these two epochs and that it has lost one vibration in the interval. Hence in c seconds the pendulum has made $(2c-1)$ vibrations and if s be the time of vibration of the pendulum

$$s=\frac{c}{2c-1}$$

If the pendulum's time of vibration had been less than one second then it would have gained one vibration instead of losing one and the formula would be

$$s=\frac{c}{2c+1}$$

c is called the coincidence period.

With a new pendulum there might very well be some uncertainty as to whether its period was greater or less than half a second. The following considerations will serve to decide this question.

If the pendulum has a period greater than half a second, then at a high temperature its period will differ from half a second by more than it does at a low one, and consequently its coincidence period will be shorter at a high temperature than at a low one, whereas the reverse will be the case if the pendulum's period is less than half a second.

Again if on watching the reflection of the front of the flash-box it is seen to be flying up across the field as the flashes of a descending series occur, and to be flying down as the flashes of an ascending series occur, then the period of the pendulum is greater than half a second; and on the contrary if the reflection flies down with descending flashes and up with ascending ones the period is less than half a second.

The coincidence will not as a rule occur at the instant at which a flash is emitted, but somewhere between two flashes ; by observing the position of successive flashes with reference to the horizontal wire a good estimate can be made of the time at which the flash would have been exactly on the wire, this estimated time is recorded and the difference between two successive coincidences is the coincidence period. The interval between a coincidence in an ascending series of flashes and one in a descending series is only equal to the true coincidence period if the horizontal wire is in the exact position of the flash reflected by the pendulum at rest, if this be not the case there will be an inequality in the intervals from " ascending to descending " and from " descending to ascending." It is therefore better to compare ascending with ascending and descending with descending and take half the observed interval.

To the front of the flash box is attached a porcelain scale divided into parts of 3^{mm} each. By observing the reflection of this scale as the pendulum vibrates and counting the number of graduations that pass over the horizontal wire a measure of the amplitude of the vibration is obtained. If d be the distance from scale to mirror in millimetres and n be the number of graduations that pass, then the amplitude of the vibration, that is the angle from the position of rest to the extreme position on either side, is equal to $\frac{3n}{4d}$, for the angle is doubled by reflection.

The distance from scale to mirror may be conveniently made about 2 to 2½ metres.

Temperature.

The temperature of the pendulum is determined by two centigrade thermometers held by clips fixed to the stand, one on each side of the pendulum ; their height is so adjusted that the bulb of one is as much below the centre of the pendulum's stem as that of the other is above it, thus if the temperature of the air varies with the height above the floor the mean reading of the thermometers should give the mean temperature of the stem of the pendulum. Each degree of the scales of the thermometers is divided into five parts and the reading is made to fiftieths by estimation.

The thermometers are read by means of a telescope, so that the observer has not to go close to them for the purpose, the reading is moreover more accurate than it would be by eye.

Density of air.

In order to determine the density of the air and the correction to reduce the time of vibration to that which it would be in vacuo a barometer and a hygrometer have to be frequently read during the observation.

Clock.

The clock belonging to the equipment has a half-seconds pendulum made of invar.

The break circuit arrangement consists of a light lever fastened to the back of the case near one side, which is lifted by a short arm on the pendulum as the latter approaches the end of its swing in that direction. When the arm comes into contact with the lever circuit is made. The lever's position is adjustable so that the fraction of a second during which current passes can be varied. It is convenient to allow contact to continue for about 0·3 or 0·4 of a second : this separates the make and break flashes satisfactorily.

Though the pendulum beats half seconds yet it only comes to the extreme position at each side once every second, circuit is therefore only made and broken once in each second and not twice, as would be the case if the break circuit arrangement was connected with the escapement wheel.

Arrangement of the observations.

As no clock can be trusted to keep an even rate all through the 24 hours, even though its rate from day to day is steady, and as the effect of a small error in the adopted clock rate on the time of vibration of a pendulum is large compared with the effect of the variations in gravity which are being sought for, it is necessary to take measures to eliminate such errors as far as possible.

Pendulums vibrating in vacuo will go on swinging for many hours and so it was possible with them to cover nearly the whole 24 hours separating the determinations of the clock error ; but with these pendulums, which swing in air at the natural pressure, long swings are not possible.

The first plan adopted was to have two or more observers and to make series of observations one after another all through the night and day, but an analysis* of the results obtained by this laborious method showed that a value of very nearly equal precision could be obtained by making two observations separated by an interval of 12 hours. That is to say that the variation of the clock rate is such that the mean of the actual rates at two epochs 12 hours apart is very nearly equal to the average rate during the 24 hours.

The programme of observation is therefore arranged so as to take advantage of this fact.

Each of the four pendulums is observed twice in the period of 24 hours separating the star observations whence the clock rate is derived. About one hour is devoted to the observation of each pendulum, so that a set of observations occupies about 4 hours by day and 4 hours by night. It is to be remarked that neither a day nor a night observation would by itself be of much value.

The wag correction.

One of the most important advances in pendulum operations that has been made since 1870, when the former Indian series came to an end, is the invention of means of measuring the correction ro be applied to the time of vibration on account of the yielding of the stand. The effect of yielding is that the point of suspension moves horizontally to and fro following the pendulum as it swings, the amount of displacement in the case of small amplitudes being nearly proportional to the angle with the vertical which the pendulum makes at any instant. Thus the pendulum oscillates as if its length were a little greater than it really is, and if the amount of the horizontal displacement can be measured this virtual increase of length can be computed and thence the effect on the time of vibration.

This yielding of the stand is called by the Germans " Das Mitschwingen," or " Die Mitschwingung." The correction on account of it is called by American observers " The Flexure correction " and it may be called " The reduction to a rigid stand." Following the analogy of the term ' lag, ' universally used in connection with the rate at which a body takes up temperature, the word ' wag ' has been suggested as a good one to express the movement of the pillar now under discussion. It certainly seems to give a good idea of the action that takes place and it has the advantage of brevity. I propose to adopt it as the English equivalent of Mitschwingen.

Several methods have been devised for the determination of the wag and it will be of interest to mention some of them.

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* *Vide* report on the determinations of gravity between Kolberg and Schneekoppe in 1894 by L. Haasemann, published by Königl. Preus. Geodät. Institut in 1896.

One method was to apply a pull of known magnitude, (say 1 kg), to the top of the pendulum stand and observe with a microscope the displacement produced : hence the displacement produced by the pull of the oscillating pendulum could be computed and the effect on the time of vibration deduced. Another method was to apply successive measured impulses, at intervals equal to the double period of the pendulum under observation, and to observe the amplitude of the oscillation induced in the pendulum by any convenient number of impulses, whence a reduction could be made to the effect of the pull of the pendulum. Sometimes pushes only or pulls only were given to the stand and sometimes both, in the latter case the interval was made equal to the pendulum's vibration period. This is the method called by the Germans 'Das Wippverfahren' or 'rocking method.'

A third system consisted of attaching a simple pendulum to the stand and observing the oscillation set up in it by one of the ordinary pendulums swinging in the usual way. Finally this gave way to the method now employed, which was invented by Professor Schumann of the Prussian Geodetic Institute.

A special, heavy, adjustable pendulum is suspended in the position ordinarily occupied by the invariable pendulum, and the latter is hung on a bracket strongly fixed to the stand, so that the knife-edges of the two pendulums are parallel and in the same horizontal plane, and so that their planes of oscillation coincide. The heavy pendulum is adjusted until its time of vibration is very nearly the same as that of the invariable pendulum. This special or auxiliary pendulum has an arm, which carries a mirror, fixed to its head and the length and shape of this arm are such that when the two pendulums are suspended their mirrors are side by side and can be simultaneously viewed in the telescope. The auxiliary pendulum, which will now be called the driving pendulum, is made to oscillate, and by degrees the other (the driven pendulum) which was at first at rest, acquires an oscillation the amount of which depends on the rigidity of the stand, (by the stand I mean both the pillar and the stand for want of rigidity in either increases the wag). At the same time the amplitude of the oscillation of the driving pendulum is decreasing and, assuming that the driven pendulum was perfectly at rest when the oscillation was imparted to the other, Professor Schuman shows that at time *t* from the commencement of the oscillation.

$$\frac{\phi}{\psi} = \frac{\delta l}{2l} \sqrt{\frac{g}{l}}\, t$$

$$\text{where } \left.\begin{array}{l}\phi = \text{amplitude of driven pendulum}\\ \psi = \quad\text{,,} \qquad \text{driving} \quad \text{,,}\end{array}\right\}\text{at time } t$$

l = the length of the pendulum (*i.e.* of the equivalent simple pendulum)
δl = the small virtual increase in l due to the yielding of the stand.

The values of ϕ and ψ are obtained by observing with the telescope the movements of the reflections of the scale; l is unknown but we may express it in terms of g and the time of vibration common to both pendulums, calling the latter s

we have $l = \dfrac{s^2 g}{\pi^2}$

also $\dfrac{ds}{dl} = \frac{1}{2}\,\dfrac{\pi}{\sqrt{gl}}$ and δl, being a small increment in l, may be put $= d\,l$

Hence substituting and simplifying

$$\frac{\phi}{\psi} = ds\,\frac{\pi}{s^2}\,t$$

Since it is difficult to comply with the condition that the driven pendulum is to be at perfect rest when the driver begins to oscillate, it is better to assume that there is a small initial vibration and to put

$$\frac{\phi}{\psi} = x + ds \frac{\pi}{s^2} t$$

Taking two observations at times t_1 and t_2, and subtracting the resulting equations

we have $\frac{\phi_2}{\psi_2} - \frac{\phi_1}{\psi_1} = ds \frac{\pi}{s^2} (t_2 - t_1)$

and $ds = \frac{\frac{\phi_2}{\psi_2} - \frac{\phi_1}{\psi_1}}{t_2 - t_1} s^2$

ds is the correction to the observed time of vibration of the auxiliary pendulum : it is always negative.

When we wish to find the correction to be applied to another pendulum oscillating on the same stand we must consider that the yielding of the stand is proportional to the horizontal pull of the knife-edge on the agate plane, and that this pull is proportional to the moment of the pendulum about the knife-edge, so that representing the moments by M and M_1

$$d s_1 = ds \frac{M_1}{M}$$

To determine M and M_1 careful measuring and weighing would be required, but the ratio may be found by the following method.

Suspend the two pendulums as if for the wag observation, bring them to rest and read the reflections of the scale. Now pass a thread round their stems, as if to tie them together, and tighten it until both pendulums are somewhat deflected from their position of rest, but not so much as to throw the reflections of the scale out of the field of the telescope. If the thread be horizontal the deflections of the pendulums will be inversely proportional to their moments about their points of suspension ; and the differences between the scale readings before and after tying are measures of the deflections.

Thus the correction to the observed time of vibration of any pendulum which oscillates in the same time as the auxiliary pendulum can be found.

The four pendulums of this set are so similar that it is not necessary to determine their corrections separately. The auxiliary pendulum has been adjusted to vibrate in very nearly the same time as No. 137 and the correction obtained by the observation of this pendulum is applied to each of the others.

Temperature and density corrections.

The co-efficients of the temperature and density corrections have been determined empirically. The former is so nearly the same for each pendulum that a mean is employed, the formula being—

Temperature correction $= -49 \times t \times 10^{-7}$ where t is the temperature on the centigrade scale.

The density correction is not so constant for all the pendulums and separate co-efficients have to be employed.

If k represent the co-efficient the formula is

$$\text{Density correction} = -k \frac{B\left(1 - \frac{3}{8}e\right)}{760\left(1 + 0{\cdot}00367\, t\right)}$$

where e = elastic force of aqueous favour

B = height of barometer in millimetres

t = temperature centigrade

The co-efficients as determined at Potsdam are

For	137	594×10^{-7}
	138	571 ,,
	139	607 ,,
	140	606 ,,

Arc of vibration.

For the reduction to an infinitely small arc the simple expression.

$$s = s'\left(1 - \frac{a^2}{16}\right)$$

is found to suffice

where s' is the observed time of vibration and a the mean amplitude or semi-arc.

Clock rate.

If u be the clock's daily rate on sidereal time the correction to the observed time of vibration is

$$\frac{s\,u}{86400} \quad \text{or} \quad u \times 58{\cdot}7 \times 10^{-7}$$

Standardisation.

The apparatus is only capable of giving differential results. That is to say the difference in the time of vibration of the mean pendulum at two stations is used to deduce the difference in the force of gravity, hence it is necessary to begin by determining the time of vibration at a station where g is known.

Kew was selected as the most suitable base station for the Indian pendulums and observations were made there in June and October 1903 by Major Burrard, Mr. Constable (of the Kew staff) and myself. These observations have been described in detail elsewhere so I need not do more than put on record the result of the standardisation.

It is as follows :—

Time of vibration in vacuo, at temperature 0°C, on a perfectly rigid stand, when the arc is infinitely small, at Kew.

of pendulum	137 =	0·5067070
	138	0·5069490
	139	0·5066104
	140	0·5065339
	mean	0·5067001 $\pm 3 \times 10^{-7}$

Arrival in India.

On arriving in India the first step was to make observations at Dehra Dún, which is to be the base station of the survey. The pendulum pillar was therefore erected as nearly as possible over the spot on which Captain Basevi had swung his pendulums.

Dehra Dún.

A good many accessories which we had been able to borrow in England had to be made before I could begin observing in Dehra Dún and this took time. The first regular series began on January, 25th and was finished on February, 6th.

A preliminary reduction showed that every thing was working well and that the pendulums had undergone no appreciable changes of length during the voyage from England.

Season's programme.

The other stations which it was decided to visit during the first season were Calcutta, Madras, Bombay and Mussoorie, at all of which the old pendulums had been swung, and at the first three of which observations had been made by officers of the Austrian Navy.

Calcutta.

The party left Dehra for Calcutta on February, 13th.

In Calcutta Captain Basevi's station is no longer available, but the observatory belonging to St. Xavier's College, which is less than 100 yards from the spot in the old M. I. Office which Captain Basevi had occupied, afforded a suitable site, especially as it was here that the Austrian observations had been made. The rector of the College, the Very Revd. Father Lafont, C.I.E., S.J., acceded in the most cordial way to my request that I might be allowed to set up the apparatus in the building, and both he and Father de Clippelaire, who is in immediate charge of the observatory, allowed me every facility.

My first night's observations passed off without incident, but when I came to observe by day I found that the arc through which the pendulum was vibrating kept on varying in magnitude and that the time of oscillation was very irregular.

To exemplify this I may mention that in making the observation it is usual to observe eleven consecutive coincidences, thence to compute the time at which the sixty-first will occur and to observe it and the following nine. The computed and observed times of the 61st coincidence rarely differ by more than 1^s or $1^s.5$, but in Calcutta differences of 10^{sec} were commonly found. An uncertainty of this magnitude makes the observation quite valueless, and so after satisfying myself by several experiments that it was no accidental or temporary phenomenon that I had observed, and that it was not to be avoided by altering the hours of work or the plane of vibration of the pendulum, I reported the matter by telegram to the Superintendent of Trigonometrical Surveys and asked permission to abandon the attempt to determine the force of gravity in Calcutta.

Earth tremors are undoubtedly the cause of this irregularity; the whole city of Calcutta may almost be said to be floating and consequently the traffic sets up large vibrations. This had been found a serious hindrance to the use of the mercury trough for determining the dislevelment of the transit instrument, during longitude operations, as it was only in the stillest hours of the early morning that the surface of the mercury was sufficiently unruffled to give distinct reflections, but I had not expected the pendulums to be seriously affected, for I had thought that the tremors would be of very short period.

No difficulty of this sort is alluded to either by Captain Basevi or by the Austrian observers. In the case of the former it is probable that the long pendulum was not appreciably influenced owing to its greater period; but the latter observed at precisely the same spot as I did, and with an almost identical apparatus and it is curious that no remark has been put on record It is possible that they observed at night only, when the irregularity is not very serious though visible if one is on the look out for it, but as has been explained above it is not permissible to assume that the rate of a clock at any instant is equal to that derived from star observations separated by 24 hours. Apart from this consideration it is clear that a half seconds pendulum clock will be affected by the tremors just as much as the free pendulum so that no reliance could be placed on its indications.

Madras.

In the Madras observatory the room which Captain Basevi had occupied was available and I erected the apparatus there. The Austrian observer had also used this room.

Mr. R. Ll. Jones, Deputy Director of the Observatory, took the greatest interest in the work and helped me in every way. Under his direction special time observations were made by Mr. Solomon, the chief assistant, so that I was relieved of all care as to the determination of the clock rate.

Colába.

In Bombay the room in the Colába observatory which Captain Heaviside had occupied was kindly placed at my disposal by Mr. Moos the Director.

The fact that practice was going on with heavy guns mounted in a fort quite close to the observatory, caused me anxiety after my Calcutta experience. I was however so fortunate as to be able to finish all the observations during a period of 6 days which separated two parts of the artillery practice.

Being curious, however, to see what effect the tremendous vibration set up by the guns would have on the pendulums, I left the apparatus standing for another day, and carefully watched the behaviour of a suspended pendulum during a morning on which firing was going on. Though on each explosion the windows rattled and the whole house shook, I was not able, on any occasion to detect the slightest oscillation in the pendulum. Evidently the tremors caused by an instantaneous shock of this kind, at any rate in places where the ground is firm and rocky, have a period which is short in comparison with half a second. I was interested to see that the seismograph of the observatory which consists of a long period horizontal pendulum shows the same peculiarity. The shock of the guns does not produce the slightest irregularity in the trace of the recording pen, but a light pressure with one finger on the massive pillar which carries the pendulum, if continued for a sufficient time will drive the curve off the paper.

Mussooree.

The next station to be undertaken was Mussooree. Captain Basevi had observed in a small building in the grounds of Evelyn Hall, which was then the Trigonometrical Branch Office. This building was being enlarged when I reached Mussooree, but I was able to obtain permission to occupy the room in which the pendulums had formerly been swung.

As it will be desirable to have a station in Mussooree at which observations can be made at any time, and as the old building will probably not ordinarily be available, a new station was selected in Dunseverick, a house on Vincent's Hill.

Closing observations.

Finally a second series of observations were made in Dehra Dún at Captain Basevi's station to close the season's work and to test the invariability of the pendulums.

In the following table the results of the observations at the different stations are shewn :—

Time of vibration of Mean Pendulum.

No. of Set.	Dehra Dún, January and February.	Madras.	Colaba.	Mussooree. Dunseverick.	Mussooree. Camel's Back.	Dehra Dún, May and June.
1	·5072528	·5074547	·5073655	·5073260	·5073234	·5072510
2	30	62	43	71	17	31
3	25	54	38	71	14	26
4	23	57	41	66	...	14
5	31	...	...	...	...	15
6	28	...	...	...	...	...
Mean .	·5072528	·5074555	·5073644	·5073267	·5073222	·5072519

The average probable error of the result of one set of observations is $\pm 5{\cdot}2 \times 10^{-7}$, hence the average probable error of the mean of four sets, which is the usual number at a station, is $\pm 2{\cdot}6 \times 10^{-7}$.

On the basis of the observed value of the time of the vibration of the mean pendulum at Kew, *viz.*, 0·5067001 and of the assumed value of the force of gravity there, *viz.*, $g = 981{\cdot}200$ dynes, the values of *g* at the above stations have been computed.

Comparison with former values,

In the following table the values are given; and the results obtained by Captains Basevi and Heaviside, and also those derived from the Austrian observations are added.

TABLE II.

Station.	Dehra Dun.	Calcutta.	Madras.	Colaba.	Mussooree.	
					Dunseverick.	Camel's Back.
Basevi or Heaviside	978·962	978·776	978·237	978·605	...	978·751
Austrian	... ...	·827 ·838	·293	·652 ·662	... ...	... ...
New	979·065	...	·281	·632	978·778	·795
Differences, 3rd—1st	+0·103	...	+0·044	+0·027	...	+0·044

It will be observed that the differences between my results and the former Indian observations are of constant sign. This would be satisfactorily accounted for by the absence of the wag correction in the old series, and by the fact that when the pendulums were standardised at Kew the stand was erected, so far as can be judged, in a more rigid manner that was generally possible in India; so that a positive correction to all the old values of *g* would be required. The nature of the stand, which was of wood and was capable of being taken to pieces for transport, would lead one to expect that its rigidity would not be uniform in all climates or on each occasion that it was erected, so that some variation in the differences is not surprising, but for the large amount of the difference at Dehra Dún, *viz.*: 0·103, it is difficult to account. A change of 0·103 in *g* corresponds to a change of 0·0000258 in the time of vibration of a half-seconds pendulum. The ordinary wag correction with the present apparatus is about 50×10^{-7} or one-fifth of the above. Not having any experience of seconds pendulums or of other forms of stand I can hardly express an opinion as to the possibility of such a correction, but it is certainly larger than I should have expected.

Object of enquiry.

So far the time of vibration and the derived value of *g* have been considered merely as subjects of observation; but the value of *g* at a point in space of unknown position is a quantity of little intrinsic interest. It is only when it is considered in relation to the earth, so that it may throw light on the latter's form and structure, that it becomes worthy of study. If the earth's shape and the distribution of mass throughout the crust were precisely known the value of *g* at any point of the surface could be calculated; but as this is not the case, the reverse process is employed and we observe the value of *g* at different points and seek thence to infer the figure of the spheroid and the density of its crust.

By pendulum observations, and other means, the figure of the earth is now known well enough for us to be able to say with fair accuracy what the value of g would be in any latitude, at sea level, if the crust were homogeneous.

Theoretical formula.

The result is obtained by the formula given by professor Helmert in 1884.

$$\gamma_0 = 978·000\ (1 + 0·005310 \sin^2 \phi)$$

If then having observed g at any point of the earth's surface we can compute what the value would have been had the station of observation been at sea level, we can by comparing the value with γ_0 ascertain whether the density of the underlying crust is in excess or defect of the average or normal surface density.

If the station of observation were situated in a balloon floating over a level plain the only consideration to be taken into account would be the greater distance from the earth's centre. Now the attraction of a sphere of radius R on a point on its surface is $g_0 = G \frac{\frac{4}{3} \pi R^3}{R^2}$

Reduction to sea level.

where G is the attraction of unit mass. If the point is above the surface by the height h the attraction becomes $g = G \frac{\frac{4}{3} \pi R^3}{(R+h)^2}$

$$\text{Hence } \frac{g_0}{g} = \frac{(R+h)^2}{R^2}$$

$$\text{or } g_0 = g\ (1 + \frac{2h}{R}) \text{ neglecting the term in } h^2.$$

When, however, and this is the common case, the observations are made on terra firma we have to consider that between the surface of the sphere and the pendulum there is a quantity of matter which is exerting an attraction, and this must be allowed for before we can deduce from our observed g what the value of gravity at sea-level would be.

Correction for intervene mass.

If the station is on an extensive plain, or in country which does not deviate very much from a plain, the attraction of the matter between the pendulum and sea-level will be very nearly equal to that of an infinite disc of thickness equal to the height of the station. In comparing the attraction of such a disc with that of the sphere their relative densities must be considered. As our aim is to discover deviations from the average surface density we shall assume that the disc is of this density; now the ratio of surface to mean density is $\frac{1}{2}$ and the attraction of an infinite disc of thickness h on a point at the centre of its upper surface is $G\ 2 \pi h$.

$$\text{Hence } \frac{\text{attraction of disc}}{\text{attraction of sphere}} = \frac{2 \pi h}{\frac{4}{3} \pi R} \tfrac{1}{2} = \frac{3h}{4R}$$

Therefore taking in account both the increased distance from the centre of the sphere, and the intervening matter we have

$$g_0 = g\ (1 + \frac{2h}{R} - \frac{3h}{4R}).$$

Thirdly, if the station is situated on a mountain or in a valley, so that there is much deviation from an infinite plain, a further correction, sometimes called the topographical, but perhaps preferable the orographical correction must be applied.

Orographical correction.

Clearly if the station is on a peak the attraction of the matter between it and sea-level is less than that of an infinite plain, and the quantity $\frac{3h}{4R}$ must be diminished; and if it is in a valley with hills surrounding or partially surrounding it, all the matter that stands above the infinite plain exerts an upward attraction, that is, one of opposite sign to $\frac{3h}{4R}$ therefore in this case also $\frac{3h}{4R}$ must be diminished. Representing the orographical correction by O we have therefore

$$g_0 = g\left\{1 + \frac{2h}{R} - \left(\frac{3h}{4R} - O\right)\right\}$$

The computation of O is not a very easy matter, and cannot be explained in detail here. It is best done by dividing the country round the station into annular portions by means of concentric circles, finding the average height of each annulus from a contoured map, or in the absence of such a map by the best available means, and then computing the attraction of each cylindrical element of the difference between the existing hills and the imaginary infinite plain.

Summary of Results.

We are now in a position to study the results of the past season's work by applying the three corrections explained above to the observed value of g and then comparing the resulting quantities g_0 with the theoretical values γ_0 obtained by professor Helmert's formula. It must not be forgotten that the values of g are based on the assumption that the acceleration due to gravity at Kew is 981·200 cm. This is only an approximation and may hereafter have to be revised.

In Table III the various quantities that have been under discussion are given.

The orographical corrections at Dehra Dún and Mussooree Camel's Back are taken from Captain Basevi's Analysis which appears in volume V of the operations of the G. T. Survey. The correction for Dunseverick has not yet been computed.

TABLE III.

STATION.	Latitude.	Height above M. S. L. h.	Observed g.	$g\cdot\frac{2h}{R}$ =H.	$g\frac{3}{4}\frac{h}{R}$ =B.	Orographical correction =O.	g+H+B+O $=g_0$	Theoretical value at Sea Level γ_0	$g_0-\gamma_0$
	° ′ ″	feet.	cm.						
Dehra Dún . .	30 19 29	2241	979·063	+·210	—·079	+·007	979·201	979·324	—·123
Madras . .	13 4 8	23	978·281	+·002	—·001	0	978·282	978·266	+·016
Colába . . .	18 53 47	32	978·632	+·003	—·001	0	978·634	978·545	+·089
Dunseverick Mussooree.	30 27 31	7131	978·778	+·668	—·251	...	...	979·334	...
Camel's Back, Mussooree.	30 27 41	6924	978·795	+·649	—·243	+·027	979·228	979·335	—·107
Dehra Dún . .	30 19 29	2241	979·066	+·210	—·079	+·007	979·204	979·324	—·120

Interpretation.

We have now to consider what is the meaning of the differences between g_0 and γ_0. Let us take the case of Colaba.

Here we have a station situated so nearly at sea-level that there is no room for any appreciable error in the corrections H and B.

Owing to the peculiar situation of India between the Himalayas to the North and the Ocean to the South some doubt attaches to the initial latitude of the Survey, and thence to all derived latitudes : the amount of this uncertainty cannot exceed 15″.

$$\text{In the equation } \frac{d\gamma}{d\phi} = 5{\cdot}19 \sin 2\phi$$

$$\text{if we put } \phi = 19° \text{ and } d\phi = 15''$$

$$\text{we obtain } d\gamma = 0{\cdot}0002.$$

Which is insignificant in comparison with the difference between g_0 and γ_0.

We therefore conclude that the difference is due to an excess of density in the crust of the earth underlying Colába.

The attraction of a disc of thickness h and density 2·8,—the earth's mean density being 5·6,—is $g\,\frac{3h}{4R}$

Taking R, the earth's mean radius=20900000 feet, g=980, we find that to produce an attraction of 0·001, a thickness

$$h = \frac{4R}{3g} \cdot 001 \text{ is required}$$

$$= \frac{83600}{2940} = \overset{\text{ft.}}{28{\cdot}44}$$

Hence to produce an attraction of 0·089 there must be a disc 2,530 feet thick the density of which is 2·8 in excess of the average surface density.

If therefore we wished to estimate the deflection of the plumb line near Colába we should have to imagine a hill of density 2·8 and 2,500 feet high at the point vertically over the actual pendulum station. The form of this hill would have to be investigated by means of pendulum observations at neighbouring stations and ultimately a roughly contoured map, shewing the distribution not of the visible but of the real masses, could be drawn.

At Dehra Dún we have a defect of 0·103 in g_0; by the same rule as before this implies a deficiency of 2·8 in the density of the subjacent matter extending to a depth of 2,930 feet. As we have assumed that the surface density is 2·8, this means that we must imagine a cavity 2,930 feet deep under Dehra Dún; the height of Dehra above sea-level is 2,240, therefore for the effect on the plumb line we must consider that Dehra, far from being at a considerable attitude above sea-level, is 690 feet below it. Another way of stating the case is to say that the matter underlying Dehra Dún is so deficient in density—we do not know to what depth this deficiency may extend—that it would have to be pressed downwards until the surface of the land was 2,930 below its present position, before it would attain the average density of the crust of the earth. Likewise at Colába an expansion of the underlying strata until a hill 2,500 feet high had been formed would be requisite to reduce the excessively dense rock that is found here to the average density of 2·8.

There is another consideration to be taken into account. An examination of the soil at Dehra Dún shows that it is alluvium possessing an average density of about 2. If we could make borings it is not probable that we should find a diminution in this density. Therefore to produce a deficiency equivalent to a removal of 2,930 feet of matter of density 2·8, we shall have to suppose that the density remains at its surface value of 2 to the depth of 10,280 feet, and only at this depth returns to 2·8, which is approximately the average density of the crust of the earth. It is for geologists to say how such a state of things could have been brought about.

III

TIDAL AND LEVELLING OPERATIONS.

Extracted from the Narrative Report of Captain H. H. Turner, R.E., in charge No. 25 Party (Tidal and Levelling) for season 1903-04.

Work of the year.

4. During the year nine self-registering tide gauges recorded the tidal curves at different observatories from Aden on the west to Port Blair on the east. In the office at Dehra Dún the reduction by harmonic analysis of the observations of 1903 of 11 tidal stations has been completed. In England the work of publication of the tide-tables giving the predicted times and heights of every high and low water for the year 1905 for 40 ports has been in progress.

List of Tidal Stations.

5. The following table gives a complete list of the 42 ports at which observations have been and still are being taken; nine are now working, the remaining 33 having been closed on completion of their registrations.

The permanent stations are shown in italics, the others are minor stations at which only a few years registrations are required.

	Stations.	Automatic or personal observations.	Date of commencement of observations.	Date of closing of observations.	No. of years of observations.	Remarks.
1	Suez	Automatic	1897	1903	7	Closed on 18th February 1904.
2	Perim	Ditto	1898	1902	5	
3	*Aden*	Ditto	1879	Still working	24	
4	Maskat	Ditto	1893	1898	5	
5	Bushire	Ditto	1892	1901	8	
6	*Karáchi*	Ditto	1881	Still working	23	
7	Hanstal	Ditto	1874	1875	1	Tide tables not published.
8	Navánagar	Ditto	1874	1875	1	
9	Okha Point	Ditto	1874 re-started 1904	1875	1	Opened on 22nd January 1904.
10	Porbandar	Personal	1893	1894	2	
10A	Porbandar	Automatic	1898	1902	5	With certain interruptions.
11	Port Albert Victor (Kathiawar).	Personal	1881	1882	1	
11A	Port Albert Victor (Kathiawár).	Automatic	1900	1903	4	Closed on 21st April 1904.
12	Bhávnagar	Ditto	1889	1894	5	
13	*Bombay (Apollo Bandar)*	Ditto	1878	Still working	26	
14	Bombay (Prince's Dock)	Ditto	1888	Ditto	16	Property of Port Trust.
15	Mormugáo (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	

	Stations.	Automatic or personal observations.	Date of commencement of observations.	Date of closing of observations.	No. of years of observations.	Remarks.
20	Minicoy	Automatic	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 9 } 19	
27	Cocanada	Ditto	1886	1891	5	
28	Vizagapatam	Ditto	1879	1885	6	
29	False Point	Ditto	1881	1885	4	
30	Dublat (Saugor Island)	Ditto	1881	1886	5	
31	Diamond Harbour	Ditto	1881	1886	5	
32	*Kidderpore*	Ditto	1881	Still working	23	
33	Chittagong	Ditto	1886	1891	5	
34	Akyab	Ditto	1887	1892	5	
35	Diamond Island	Ditto	1895	1899	5	
36	Bassein (Burma)	Ditto	1902	1903	2	Closed on 1st January 1904.
37	Elephant Point	Ditto	1880 re-started 1884	1881 1888	1 5 } 6	
38	*Rangoon*	Ditto	1880	Still working	24	
39	Amherst	Ditto	1880	1886	6	
40	Moulmein	Ditto	1880	1886	6	
41	Mergui	Ditto	1889	1894	5	
42	*Port Blair*	Ditto	1880	Still working	24	

Observatories closed during the year.

6. The observatories at Suez, Port Albert Victor and Bassein were closed during the year. At Suez 7 complete years of observations have been recorded. At Port Albert Victor only 4 years' observations have been obtained, the usual five-year period being curtailed at the request of the State Engineer, Bhávnagar. At Bassein which is a riverain port, since the erection of the observatory in 1902, much trouble has been experienced owing to the sinking of the piles on which the observatory was built. The observations could not be continued without incurring very heavy expenditure, so that it was decided to close the observatory after a period of two years' observations.

New observatory opened.

7. A new observatory was erected at Okha Point on the site of the old observatory erected in 1873. The Gulf of Cutch was the scene of the earliest tidal operations with self-registering tide gauges in India; they were initiated originally with the intention of determining the secular changes in the relative level of the land and sea, and this more particularly in the Gulf of Cutch. Before however the observatories in the Gulf had been finally erected, it was recognised that a system of tidal investigations would be of the greatest value to

both science and commerce. In the years, that have elapsed since 1873, the idea of repeating the operations in the Gulf of Cutch has never been wholly lost sight of, a reconnaissance of the site of the old observatory at Hanstal was made in 1900, but the report was so unfavourable, that the idea of erecting an observatory there was discarded. In October 1903, Captain Turner accompanied by Mr. Shaw visited the site of the old observatory at Okha. The old cylinder and well of the former observatory were found to be intact, and after reconnoitring the coast, it was decided that no better spot could be selected than the original site. The original observatory with its cylinder stood on dry land well above high water mark and the cylinder was connected with the sea by means of a 2″ iron pipe acting as a syphon from about half tide. The pipe was 175 feet long running out to the lowest low water mark, at this point a flexible pipe was attached to the iron pipe by means of a brass connecting arrangement. The extreme end of this flexible pipe having a rose attached was supported 6 feet from the bottom of the sea by a small buoy fixed to an anchor by a chain, and this buoy again was chained to a mark buoy on the surface of the water. The whole being held in position at a point where there was 20 feet of water at lowest spring tides. The highest point of the iron pipe was close to the cylinder of the tide gauge, and here a stop cock was placed to enable air to be expelled from the pipe. The observatory cabin in which the tide gauge was placed, was built on a platform directly over the cylinder. The observations at Okha taken in 1874 were entirely successful, so that it seemed that no better plan could be devised than to exactly follow out the former system. This has been done, the only alteration being that the syphon pipe now passes into the cylinder just below the level of the stop cock and thence vertically down to the bottom of the cylinder instead of as formally passing down outside the cylinder and in at the bottom. This change was necessary, as without destroying the brick well by which the cylinder is surrounded the pipe could not be passed down outside the cylinder. Mr. Shaw superintended the work of erection of the observatory, the materials for its construction being first collected in Karáchi by him. He remained at Okha till the end of January, when the gauge was successfully started. The three bench-marks erected in 1873 close to the observatory were all found to be in good preservation, and their values *inter se* accorded with their old values. The gauge has been given the same zero with reference to bench-mark A, as was done in 1874. A line of levelling was run from the old observatory bench-marks to a bench-mark at Gadechi 10 miles distant and no change in their respective heights appears to have taken place.

The mean sea-level as obtained from observations from the 23rd January to the 31st August 1904 exclusive of a break of 18 days in March has been calculated and compared with the mean sea-level of 1874-75. If bench-mark A has not altered in height with reference to the surrounding country, then the mean sea-level of 1904 may be regarded as identical with that of 1874-75.

The following data show the difference of mean sea-level in 1874-75 and 1904:—

		Ft.
M. S. L. in 1874-75 above zero of gauge	=	9·66
Zero of gauge in 1874-75 below B. M. A.	=	20·07
M. S. L. in 1904 (6½ months observations) above zero of gauge	=	9·71
Zero of gauge in 1904 below B. M. A.	=	20·07
M. S. L. in 1874-75 below B. M. A.	=	10·41
M. S. L. in 1904 below B. M. A.	=	10·36
Difference of M. S. L.	=	0·05

From the above it would appear that no movement of land with reference to the sea has taken place along the Gulf coast in the last 30 years. Before however any final conclusion can be arrived at, it is necessary that the observations should extend over a period of at least one complete year, and that the height of the bench-marks near the observatory should be finally checked with the bench-marks further inland.

Proposals for erection of new observatories.

8. The project for the erection of a tidal observatory at Suakim in the Red Sea has been postponed. The Government of India have granted funds, and have obtained the sanction and co-operation of the Siamese Government to the erection of two observatories in the Malay Peninsula. The idea is to erect an observatory on either side of the peninsula, and by running a line of precise levelling from one to the other, to obtain the difference, if any, of mean sea-level in the Bay of Bengal and China Sea, these being connected respectively with the Indian and Pacific Oceans.

Personal tidal observations.

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

Inspection of observatories.

10. All the tidal observatories were inspected during the past year. Portable meteorological instruments were taken on the tours of inspection and compared with those working locally.

Working of tidal observatories.

11. The following is a description of the working of the several tidal observatories during the year, commencing with Suez and following the order of the stations round the coast to Burma.

Suez.

12. This observatory was inspected by Mr. Shaw between the 17th and 22nd February 1904, and everything found in order. On the latter date the tide gauge was dismantled, and all the instruments were packed ready for despatch to India. Seven complete years of tidal registrations have been obtained at this port by the self-registering tide gauge, during this period Captain N. Fleri has been indefatigable in carrying on the observatory work; there having been no serious break in the record during these seven years testifies to the care with which the several instruments were attended. During the year 1903, three short breaks of a few hours, due to the stoppage of the gauge clock, occurred in the tidal records. There were no interruptions in the records of the auxiliary instruments and all were in good order.

In addition to Captain Fleri our thanks are due to Captain J. Falconer, Director of the Port of Suez, who has always given his ready assistance and supervision over the work of the observatory.

Aden.

13. This observatory was inspected by Mr. Shaw between the 24th February and 5th March 1904. The tide gauge was found to be greatly in need of cleaning, the clerk in charge having been very remiss in looking after his instruments. There were several short and unimportant interruptions in the record of the tide gauge during the year, there were also several breaks in the registrations of the auxiliary instruments. All the instruments were thoroughly

cleaned and put in good working order. On the 17th March 1904 the observatory, which since it was first erected, had been under the supervision of the Port Officer, was handed over by him to the Port Engineer, and that officer in future will supervise the work of the observatory.

Karáchi.

14. Mr. Shaw inspected this observatory between the 15th and 30th November 1903. The instruments were all found in good working order, but in need of cleaning. There were only two short interruptions in the registration of the self-registering tide gauge during the year, these both occurred within the same 24 hours, and were due to the communication between the sea and cylinder being choked with mud. The S. R. anemometer has been several times out of order, and it is proposed to change the instrument at the next inspection. The large anemometer belonging to the Port Trust, which had also been out of order, was replaced by the large anemometer by Legé & Co. sent from Perim. The clock of the S. R. aneroid has not been working satisfactorily for some time, this will also be changed at the next inspection.

Okha Point.

15. This is a new observatory erected on the site of the old one demolished in 1875. The old cylinder and well were found to be in excellent preservation and were utilised for the new observatory. The site for the observatory was finally fixed by Captain Turner on the 1st November 1903, and the erection was carried out by Mr. Shaw, all materials having been brought from Karáchi. The S. R. tide gauge started working on the 22nd January 1904, but the record was broken on the 3rd March, owing to the rose of the inlet pipe becoming broken by entanglement with the buoy chain. The repairs to the piping were completed on the 20th March and the registrations of the S. R. tide gauge were resumed from that date, since then there has been no break in the record. The auxiliary instruments were started working at the beginning of March, and have continued to work satisfactorily. It was found on trial that the universal sundial which was supplied for the purpose of checking the time was too small, and not sufficiently sensitive to register time within 3 minutes, so that pending the erection of a sundial of Colonel Strahan's pattern, the observatory clerk has had to visit Dwarka once every week in order to check his chronometer time with the tide gauge time at Dwarka. For the description of the manner in which this S. R. tide gauge is worked, see para. 7 of this report.

Port Albert Victor.

16. This observatory was finally inspected and closed by Surveyor Dhondu Vinayek on the 19th April 1904. The S. R. tide gauge worked throughout the year without a break in its registrations. The auxiliary instruments have also worked satisfactorily. The observatory was opened in January 1900, so that four complete years of tidal registrations have been obtained. My thanks are due to the State Engineer, Bhávnagar, who has kindly supervised the work since the observatory was erected.

Apollo Bandar (Bombay.)

17. This observatory was inspected by Captain Turner between the 9th and 15th February 1904. The tide gauge was found to be very dirty, dust having accumulated on the gearing and bearings. There have been two breaks in the record of the S. R. tide gauge during the year both of less than 24 hours duration and both due to the stopping of the gauge clock. The curves registered for the last two years have been broken by small irregularities at intervals, along the curves caused by the drum continuing to rotate, while the

pencil stood still. The initial cause of the pencil standing still could not be discovered, but it was evidently due to some wear and tear on the gearing connecting the float with the pencil. In consequence, it was decided to replace the tide gauge by another No. 26 which had been lying in store with the Port Engineer for several years, the same clock only being utilised. The gauge had been working without intermission for 15 years. The old gauge No. 2 was dismantled on the 13th February at 2 P. M. and the new one No. 26 was erected and started at 6-20 P. M. the same evening since which time it has worked satisfactorily.

Prince's Dock, Bombay.

18. This observatory was inspected by Captain Turner between the 10th and 15th February 1904, the gauge was found to be working satisfactorily. There were several short interruptions during the year due to the wire to which the pencil is attached breaking. The instrument was cleaned and left in adjustment.

Madras.

19. This observatory was inspected by Captain Turner between the 17th and 21st February 1904. The instruments were found clean, and in good working order. The well was pumped out and the sluice thoroughly cleaned. There were no interruptions in the record of the S. R. tide gauge, nor in those of the auxiliary instruments during the year. The instruments were all cleaned and left in adjustment.

Kidderpore.

20. This observatory was inspected by Captain Turner between the 10th and 14th December 1903. The self-registering tide gauge and anemometer were both working and in good order, the self-registering aneroid had, however, stopped a few days previous. No interruptions in the record of the tide gauge occurred during the year. Of the auxiliary instruments the anemometer had worked without a break and the aneroid had only failed to register from the 1st December. The instruments were all cleaned and left in adjustment.

Bassein.

21. This observatory was visited by Captain Turner on the 13th January 1904. The working of the tide gauge had been stopped by order of the Port Officer from the 1st January, but as the float and band were still in position zero measurements were taken to a rising and falling tide. The tide gauge was then dismantled and the observatory finally closed. No break in the record of the tide gauge occurred during the year. As the clock had been stopped before the visit of the inspecting officer, there were no means of testing the correctness of time kept during the year; this is unfortunate, as at the previous inspection the clock was found to be over 10 minutes fast. There was no break in the registrations of the auxiliary instruments during the year. The observatory was started on the 1st January 1902, so that we have only two complete years of observations from which to predict future tides. Since the observatory was first erected, large sums of money have been expended in trying to keep the piles, on which the cabin stands, from collapsing and the observations could not be continued without erecting an entirely new structure; as the Port authorities were not willing to incur this expense, there was no alternative, but to close the observatory.

Rangoon.

22. This observatory was inspected by Captain Turner between the 19th and 24th December 1903. The self-registering tide gauge was working satisfactorily, though very much in need of cleaning. There was only one

break in the registrations of the tide gauge during the year, this was of four hours' duration, and was due to the pencil chain breaking. The gauge clock which had been losing from 2 to 4 minutes daily was rated correctly. There was a break of 6 days in the record of the self-registering anemometer, and one of 8 hours in that of the self-registering aneroid, both due to the stoppage of their respective clocks. The instruments were all cleaned and left in adjustment.

Port Blair.

23. This observatory was inspected by Captain Turner between 30th December 1903 and 8th January 1904. The instruments were working satisfactorily and the observatory was clean and tidy. No interruption has occurred during the year in the record of either the tide gauge or auxiliary instruments. The instruments were all cleaned and left in adjustment.

Supervision of Observatories.

24. As in former years each tidal observatory has been under the direct supervision of a responsible authority, the Port Officer or Engineer where possible. Thanks are due to these officers for the careful way in which their supervision has been exercised, and for the interest taken by them in the operations.

Tidal diagrams and Daily Reports.

25. The tidal diagrams together with the diagrams of the auxiliary instruments have been regularly forwarded from each observatory to the Tidal and Levelling office at Dehra Dún. The clerks in charge of the several observatories have also sent daily reports of the working of the tide gauges in their charge.

Tidal constants.

26. The tidal observations for a year at 11 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, SUEZ, 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 Observations at Suez; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1903 Observations.

Short Period Tides.

A_0=4·190 feet.

S H = R =	·102	M_6 R =	·011	Q_1 R =	·019	T_2 R =	·094
κ = ζ =	71°·99	ζ =	259°·64	ζ =	285°·33	ζ =	27°·45
S_2 H = R =	·455	H =	·010	H =	·024	H =	·094
κ = ζ =	12°·26	κ =	76°·68	κ =	177°·08	κ =	28°·86
S_4 H = R =	·004	M_8 R =	·002	L_2 R =	·074	$(MS)_4$ R =	·011
κ = ζ =	45°·00	ζ =	287°·35	ζ =	66°·89	ζ =	262°·52
S_6 H = R =	·001	H =	·002	H =	·067	H =	·010
κ = ζ =	69°·44	κ =	43·41	κ =	47°·30	κ =	201°·53
S_8 H = R =	·001	O_1 R =	0·30	N R =	·616	$(2SM)_2$ R =	·007
κ = ζ =	122°·01	ζ =	102°·99	ζ =	230°·07	ζ =	188°·13
		H =	·036	H =	·594	H =	·007
		κ =	208°·90	κ =	314°·93	κ =	249°·12
M_1 R =	·015	K_1 R =	·128	λ_2 R =	...	$2N_2$ R =	·107
ζ =	289°·63	ζ =	351°·12	ζ =	...	ζ =	19°·24
H =	·014	H =	·145	H =	...	H =	·103
κ =	308°·24	κ =	182°·93	κ =	...	κ =	249°·93
M_2 R =	1·915	K_2 R =	·107	ν_2 R =	·111	$(M_2N)_4$ R =	·019
ζ =	47°·53	ζ =	173°·58	ζ =	288°·37	ζ =	94°·18
H =	1·846	H =	·142	H =	·107	H =	·017
κ =	346°·54	κ =	16°·82	κ =	20°·13	κ =	118°·04
M_3 R =	·018	P_1 R =	·044	μ_2 R =	·067	$(M_2K_1)_3$ R =	·015
ζ =	134°·05	ζ =	315°·09	ζ =	358°·01	ζ =	192°·82
H =	·017	H =	·044	H =	·062	H =	·017
κ =	42°·57	κ =	125°·22	κ =	236°·04	κ =	323°·64

Short Period Tides.—contd.

M_4	R =	·029	J_1	R =	·006	R_2	R =	...	$(2M_2K_1)_3$	R =	·013
	ζ =	267·90		ζ =	143°·75		ζ =	...		ζ =	6°·13
	H =	·027		H =	·007		H =	...		H =	·013
	κ =	145°·93		κ =	191°·02		κ =	...		κ =	52°·36

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide . . .	·084	159·39	·074	13·55
„ Fortnightly „ . . .	·086	234·32	·136	141·52
Luni-Solar „ „ . . .	·100	135·21	·096	196·20
Solar-Annual „ . . .	·472	42·21	·472	322·08
„ Semi-Annual „ . . .	·327	292·26	·327	132 01

VALUES OF THE TIDAL CONSTANTS, ADEN, 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 Observations at Aden; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1903 Observations.

Short Period Tides.

A_0=5·964 feet.

S_1	H = R =	·085	M_6	R =	·011	Q_1	R =	·126	T_2	R =	·080
	κ = ζ =	164°·07		ζ =	189°·66		ζ =	141°·57		ζ =	264°·89
S_2	H = R =	·662		H =	·010		H =	·155		H =	·080
	κ = ζ =	245°·23		κ =	9°·23		κ =	34°·64		κ =	266°·33
S_4	H = R =	·011	M_8	R =	·003	L_2	R =	·052	$(MS)_4$	R =	·016
	κ = ζ =	258°·59		ζ =	357°·27		ζ =	238°·42		ζ =	255°·41
S_6	H = R =	·007		H =	·002		H =	·046		H =	·015
	κ = ζ =	216°·70		κ =	116°·71		κ =	219°·22		κ =	195°·27
S_8	H = R =	·002	O_1	R =	·547	N_2	R =	·446	$(2SM)_2$	R =	·011
	κ = ζ =	220°·24		ζ =	290°·72		ζ =	134°·45		ζ =	46°·83
				H =	·675		H =	·430		H =	·011
				κ =	37°·50		κ =	220°·60		κ =	106°·97
M_1	R =	·082	K_1	R =	1·149	λ_2	R =	...	$2N_2$	R =	·064
	ζ =	83°·36		ζ =	203°·17		ζ =	...		ζ =	327°·54
	H =	·076		H =	1·299		H =	...		H =	·062
	κ =	102°·40		κ =	34°·94		κ =	...		κ =	199°·98
M_2	R =	1·609	K_2	R =	·144	ν_2	R =	·064	$(M_2N)_4$	R =	·012
	ζ =	287°·04		ζ =	38°·58		ζ =	186°·63		ζ =	190°·83
	H =	1·551		H =	·191		H =	·062		H =	·011
	κ =	226°·89		κ =	241°·75		κ =	279°·63		κ =	216°·84
M_3	R =	·017	P_1	R =	·416	μ_2	R =	·056	$(M_2K_1)_3$	R =	·017
	ζ =	311°·19		ζ =	222°·62		ζ =	320°·40		ζ =	126°·53
	H =	·017		H =	·416		H =	·052		H =	·019
	κ =	220°·97		κ =	32°·78		κ =	200°·11		κ =	258°·16
M_4	R =	·005	J_1	R =	·089	R_2	R =	...	$(2M_2K_1)_3$	R =	·005
	ζ =	86°·63		ζ =	331°·35		ζ =	...		ζ =	242°·45
	H =	·005		H =	·107		H =	...		H =	·006
	κ =	326°·35		κ =	18°·14		κ =	...		κ =	290°·39

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide . . .	·037	145·66	·033	359·37
„ Fortnightly „ . . .	·022	162·56	·035	68·85
Luni-Solar „ „ . . .	·037	210·61	·036	270·75
Solar-Annual „ . . .	·301	88·00	·301	7·84
„ Semi-Annual „ . . .	·149	314·85	·149	154·53

VALUES OF THE TIDAL CONSTANTS, KARÂCHI, 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 Observations at Karâchi; and also the mean values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1903 Observations:—

Short Period Tides.

A_0 = 7·282 feet.

S_1	$H = R =$	·084	M_6	$R =$	·048	Q_1	$R =$	·127	T_2	$R =$	·143
	$\kappa = \zeta =$	176°·39		$\zeta =$	14°·33		$\zeta =$	153°·78		$\zeta =$	338°·65
S_2	$H = R =$	·964		$H =$	·043		$H =$	·156		$H =$	·143
	$\kappa = \zeta =$	323°·62		$\kappa =$	198°·37		$\kappa =$	49°·20		$\kappa =$	340°·15
S_4	$H = R =$	·011	M_8	$R =$	·006	L_2	$R =$	·087	$(MS)_4$	$R =$	·036
	$\kappa = \zeta =$	1°·52		$\zeta =$	132°·65		$\zeta =$	313°·77		$\zeta =$	8°·58
S_6	$H = R =$	·007		$H =$	·005		$H =$	·078		$H =$	·035
	$\kappa = \zeta =$	297°·68		$\kappa =$	258°·03		$\kappa =$	295°·26		$\kappa =$	309°·93
S_8	$H = R =$	·002	O_1	$R =$	·544	N_2	$R =$	·633	$(2SM)_2$	$R =$	·013
	$\kappa = \zeta =$	352°·57		$\zeta =$	298°·40		$\zeta =$	187°·92		$\zeta =$	57°·56
				$H =$	·671		$H =$	·610		$H =$	·012
				$\kappa =$	46°·73		$\kappa =$	276°·35		$\kappa =$	116°·22
M_1	$R =$	·073	K_1	$R =$	1·170	λ_2	$R =$	...	$2N_2$	$R =$	·072
	$\zeta =$	97°·07		$\zeta =$	214°·43		$\zeta =$	...		$\zeta =$	15°·59
	$H =$	·068		$H =$	1·322		$H =$	...		$H =$	·070
	$\kappa =$	116°·84		$\kappa =$	46°·14		$\kappa =$	...		$\kappa =$	251°·12
M_2	$R =$	2·690	K_2	$R =$	·215	ν_2	$R =$	·110	$(M_2N)_4$	$R =$	·018
	$\zeta =$	351°·94		$\zeta =$	115°·69		$\zeta =$	233°·87		$\zeta =$	327°·75
	$H =$	2·593		$H =$	·286		$H =$	·106		$H =$	·017
	$\kappa =$	293°·29		$\kappa =$	318°·73		$\kappa =$	329°·05		$\kappa =$	357°·53
M_3	$R =$	·042	P_1	$R =$	·417	μ_2	$R =$	·072	$(M_2K_1)_3$	$R =$	·023
	$\zeta =$	64°·82		$\zeta =$	232°·92		$\zeta =$	48°·76		$\zeta =$	167°·58
	$H =$	·040		$H =$	·417		$H =$	·067		$H =$	·025
	$\kappa =$	336°·84		$\kappa =$	43°·14		$\kappa =$	291°·45		$\kappa =$	300°·64
M_4	$R =$	·013	J_1	$R =$	·087	R_2	$R =$	...	$(2M_2K_1)_3$	$R =$	·024
	$\zeta =$	130°·91		$\zeta =$	346°·36		$\zeta =$	...		$\zeta =$	277°·61
	$H =$	·012		$H =$	·105		$H =$	...		$H =$	·025
	$\kappa =$	13°·61		$\kappa =$	32°·29		$\kappa =$	...		$\kappa =$	328°·59

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide	·029	275·47	·026	128·38
" Fortnightly "	·032	70·43	·050	335·12
Luni-Solar " "	·015	160·08	·014	218·73
Solar-Annual "	·236	176·09	·236	95·87
" Semi " "	·289	313·42	·289	152·98

VALUES OF THE TIDAL CONSTANTS, PORT ALBERT VICTOR, 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 Observations at Port Albert Victor; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1903 Observations.

Short Period Tides.

A_0 = 9·871 feet.

S_1	$H = R =$	·086	M_6	$R =$	·122	Q_1	$R =$	·145	T_2	$R =$	·158
	$\kappa = \zeta =$	187°·57		$\zeta =$	299°·16		$\zeta =$	178°·22		$\zeta =$	92°·53
S_2	$H = R =$	1·138		$H =$	·109		$H =$	·179		$H =$	·158
	$\kappa = \zeta =$	82°·34		$\kappa =$	124°·12		$\kappa =$	74°·12		$\kappa =$	94°·04

Short Period Tides—contd.

S_4	$H = R =$	·023	M_8	$R =$	·010	L_2	$R =$	·067	$(MS)_4$	$R =$	·167
	$\kappa = \zeta =$	255°·61		$\zeta =$	46°·49		$\zeta =$	200°·86		$\zeta =$	268°·85
S_6	$H = R =$	·011		$H =$	·009		$H =$	·060		$H =$	·161
	$\kappa = \zeta =$	34°·86		$\kappa =$	173°·11		$\kappa =$	182°·49		$\kappa =$	210°·51
S_8	$H = R =$	·002	O_1	$R =$	·610	N_2	$R =$	·825	$(2SM)_2$	$R =$	·034
	$\kappa = \zeta =$	320·19		$\zeta =$	317°·79		$\zeta =$	304°·84		$\zeta =$	8°·76
				$H =$	·752		$H =$	·796		$H =$	·033
				$\kappa =$	66°·44		$\kappa =$	33°·75		$\kappa =$	67°·11
M_1	$R =$	·103	K_1	$R =$	1·437	λ_2	$R =$	...	$2N_2$	$R =$	·052
	$\zeta =$	121°·35		$\zeta =$	232°·83		$\zeta =$	...		$\zeta =$	61°·25
	$H =$	·096		$H =$	1·624		$H =$	...		$H =$	·050
	$\kappa =$	141°·27		$\kappa =$	64°·52		$\kappa =$	...		$\kappa =$	297°·41
M_2	$R =$	2·988	K_2	$R =$	·206	ν_2	$R =$	·121	$(M_2N)_4$	$R =$	·102
	$\zeta =$	116°·35		$\zeta =$	240°·46		$\zeta =$	26°·35		$\zeta =$	126°·37
	$H =$	2·881		$H =$	·273		$H =$	·116		$H =$	·095
	$\kappa =$	58°·00		$\kappa =$	83°·48		$\kappa =$	121°·98		$\kappa =$	156°·94
M_3	$R =$	·033	P_1	$R =$	·459	μ_2	$R =$	·320	$(M_2K_1)_3$	$R =$	·028
	$\zeta =$	207°·45		$\zeta =$	252°·73		$\zeta =$	95°·86		$\zeta =$	295°·63
	$H =$	·031		$H =$	·459		$H =$	·298		$H =$	·031
	$\kappa =$	119°·93		$\kappa =$	62°·96		$\kappa =$	339°·16		$\kappa =$	68°·99
M_4	$R =$	·231	J_1	$R =$	·086	R_2	$R =$	...	$(2M_2K_1)_3$	$R =$	·039
	$\zeta =$	292°·96		$\zeta =$	19·°70		$\zeta =$	...		$\zeta =$	89°·69
	$H =$	·215		$H =$	·103		$H =$	...		$H =$	·041
	$\kappa =$	176°·27		$\kappa =$	65°·46		$\kappa =$	...		$\kappa =$	141°·31

Long Period Tides.

	R	ζ	H	κ
	°			°
Lunar Monthly Tide	·041	359°·31	·036	212°·05
„ Fortnightly „	·020	61·71	·032	326·07
Luni-Solar „ „	·041	140·78	·040	199·12
Solar-Annual „	·092	200·08	·092	119·85
„ Semi-Annual „	·295	309·06	·295	148·59

VALUES OF THE TIDAL CONSTANTS, BOMBAY (APOLLO BANDAR), 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 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 1903 Observations:—

Short Period Tides.

$A_0 = 10·321$ feet.

S_1	$H = R =$	·061	M_6	$R =$	.019	Q_1	$R =$	·127	T	$R =$	·223
	$\kappa = \zeta =$	184°·55		$\zeta =$	201°·56		$\zeta =$	157°·90		$\zeta =$	21°·37
S_2	$H = R =$	1·583		$H =$	·017		$H =$	·156		$H =$	·223
	$\kappa = \zeta =$	5°·51		$\kappa =$	26°·79		$\kappa =$	53°·95		$\kappa =$	22°·88
S_4	$H = R =$	·012	M_8	$R =$	·003	L_2	$R =$	·113	$(MS)_4$	$R =$	·143
	$\kappa = \zeta =$	193°·81		$\zeta =$	92°·29		$\zeta =$	342°·69		$\zeta =$	100°·28
S_6	$H = R =$	·005		$H =$	·003		$H =$	·101		$H =$	·138
	$\kappa = \zeta =$	80°·34		$\kappa =$	219°·27		$\kappa =$	324°·36		$\kappa =$	42°·02
S_8	$H = R =$	·003	O_1	$R =$	·556	N_2	$R =$	1·023	$(2SM)_2$	$R =$	·042
	$\kappa = \zeta =$	120°·65		$\zeta =$	300°·47		$\zeta =$	224°·78		$\zeta =$	54°·72
				$H =$	·685		$H =$	·986		$H =$	·041
				$\kappa =$	49°·21		$\kappa =$	313°·83		$\kappa =$	112°·97
M_1	$R =$	·085	K_1	$R =$	1·237	$_2$	$R =$	...	$2N_2$	$R =$	·120
	$\zeta =$	95°·10		$\zeta =$	213°·45		$\zeta =$	...		$\zeta =$	32°·74
	$H =$	·079		$H =$	1·398		$H =$	...		$H =$	·115
	$\kappa =$	115°·07		$\kappa =$	45°·15		$\kappa =$	...		$\kappa =$	269°·08
M_2	$R =$	4·146	K_2	$R =$	·319	ν_2	$R =$	·120	$(M_2N)_4$	$R =$	·027
	$\zeta =$	29°·48		$\zeta =$	154°·21		$\zeta =$	276°·54		$\zeta =$	327°·60
	$H =$	3·997		$H =$	·424		$H =$	·116		$H =$	·025
	$\kappa =$	331°·22		$\kappa =$	357°·22		$\kappa =$	12°·30		$\kappa =$	358°·39

Short Period Tides—contd.

M_3	R =	·088	P_1	R =	·421	μ_2	R =	·213	$(M_2K_1)_3$	R =	·016
	ζ =	116°·24		ζ =	233°·62		ζ =	73°·38		ζ =	97°·98
	H =	·083		H =	·421		H =	·198		H =	·018
	κ =	28°·85		κ =	43°·86		κ =	316°·87		κ =	231°·42
M_4	R =	·118	J_1	R =	·086	R_2	R =	...	$(2M_2K_1)_3$	R =	·068
	ζ =	101°·43		ζ =	347°·39		ζ =	...		ζ =	11°·41
	H =	·110		H =	·104		H =	...		H =	·072
	κ =	344°·92		κ =	32°·09		κ =	...		κ =	63°·21

Long Period Tides.

•	R	ζ	H	κ
Lunar Monthly Tide	·025	93°·97	·022	306°·67
„ Fortnightly „	·015	101·86	·024	6·12
Luni-Solar „ „	·006	340·72	·006	38·98
Solar-Annual „	·085	195·49	·085	115·25
„ Semi-Annual „	·259	326·64	·259	166·17

VALUES OF THE TIDAL CONSTANTS, BOMBAY (PRINCE'S DOCK), 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 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 1903 Observations:—

Short Period Tides.

A_0=8·290 feet.

S_1	H = R =	·065	M_6	R =	·005	Q_1	R =	·121	T_2	R =	·230
	κ = ζ =	182°·20		ζ =	202°·83		ζ =	156°·11		ζ =	21°·99
S_2	H = R =	1·602		H =	·004		H =	·149		H =	·230
	κ = ζ =	6°·27		κ =	28°·07		κ =	52°·15		κ =	23°·50
S_4	H = R =	·017	M_8	R =	·002	L_2	R =	·119	$(MS)_4$	R =	·126
	κ = ζ =	213°·22		ζ =	342°·90		ζ =	337°·34		ζ =	102°·21
S_6	H = R =	·006		H =	·002		H =	·107		H =	·121
	κ = ζ =	145°·49		κ =	109°·87		κ =	319°·01		κ =	43°·95
S_8	H = R =	·001	O_1	R =	·538	N_2	R =	1·027	$(2SM)_2$	R =	·046
	κ = ζ =	35°·54		ζ =	300°·71		ζ =	226°·25		ζ =	58°·78
				H =	·663		H =	·990		H =	·044
				κ =	49°·45		κ =	315°·30		κ =	117°·03
M_1	R =	·084	K_1	R =	1·226	λ_2	R =	...	$2N_2$	R =	·131
	ζ =	95°·05		ζ =	213°·78		ζ =	...		ζ =	34°·60
	H =	·079		H =	1·386		H =	...		H =	·126
	κ =	115°·02		κ =	45°·48		κ =	...		κ =	270°·95
M_2	R =	4·194	K_2	R =	·327	ν_2	R =	·127	$(M_2N)_4$	R =	·015
	ζ =	30°·21		ζ =	156°·04		ζ =	273°·37		ζ =	323°·79
	H =	4·044		H =	·435		H =	·123		H =	·014
	κ =	331°·95		κ =	359°·05		κ =	9°·13		κ =	354°·58
M_3	R =	·085	P_1	R =	·416	μ_2	R =	·225	$(M_2K_1)_3$	R =	·034
	ζ =	117°·37		ζ =	233°·69		ζ =	74°·29		ζ =	122°·46
	H =	·080		H =	·416		H =	·210		H =	·038
	κ =	29°·99		κ =	43°·92		κ =	317°·78		κ =	255°·90
M_4	R =	·108	J_1	R =	·081	R_2	R =	...	$(2M_2K_1)_3$	R =	·072
	ζ =	98°·49		ζ =	347°·60		ζ =	...		ζ =	15°·26
	H =	·100		H =	·097		H =	...		H =	·076
	κ =	341°·98		κ =	33°·30		κ =	...		κ =	67°·06

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·041	82°·22	·036	294°·92
„ Fortnightly „	·015	65·76	·024	330·02
Luni-Solar „ „	·011	6·49	·011	64·75
Solar-Annual „	·076	178·21	·076	97·97
„ Semi-Annual „	·295	324·35	·295	163·87

VALUES OF THE TIDAL CONSTANTS, MADRAS, 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 Observations at Madras; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1903 Observations.

Short Period Tides.

$A_0 = 2·334$ feet.

S_1	H = R =	·024	M_6	R =	·006	Q_1	R =	·008	T_2	R =	·051
	κ = ζ =	81°·13		ζ =	254°·06		ζ =	166°·29		ζ =	275°·93
S_2	H = R =	·459		H =	·005		H =	·010		H =	·051
	κ = ζ =	267°·54		κ =	80°·80		κ =	63°·13		κ =	277°·46
S_4	H = R =	·001	M_8	R =	·002	L_2	R =	·052	$(MS)_4$	R =	·002
	κ = ζ =	191°·31		ζ =	228°·01		ζ =	273°·70		ζ =	282°·53
S_6	H = R =	·002		H =	·001		H =	·046		H =	·002
	κ = ζ =	93°·18		κ =	357°·01		κ =	255°·61		κ =	224°·78
S_8	H = R =	·001	O_1	R =	·078	N_2	R =	·237	$(2SM)_2$	R =	·019
	κ = ζ =	92°·55		ζ =	212°·11		ζ =	141°·65		ζ =	165°·60
				H =	·096		H =	·229		H =	·018
				κ =	321°·37		κ =	231°·47		κ =	223°·35
M_1	R =	·017	K_1	R =	·261	λ_2	R =	...	$2N_2$	R =	·024
	ζ =	300°·55		ζ =	144°·30		ζ =	...		ζ =	355°·30
	H =	·016		H =	·295		H =	...		H =	·023
	κ =	320°·77		κ =	335°·97		κ =	...		κ =	232°·69
M_2	R =	1·123	K_2	R =	·092	ν_2	R =	·040	$(M_2N)_4$	R =	·007
	ζ =	296°·51		ζ =	65°·88		ζ =	175°·32		ζ =	146°·08
	H =	1·082		H =	·122		H =	·038		H =	·007
	κ =	238°·76		κ =	268°·86		κ =	271°·82		κ =	178°·15
M_3	R =	·005	P_1	R =	·098	μ_2	R =	·028	$(M_2K_1)_3$	R =	·010
	ζ =	99°·25		ζ =	165°·34		ζ =	301°·53		ζ =	102°·14
	H =	·004		H =	·098		H =	·026		H =	·011
	κ =	12°·62		κ =	335°·60		κ =	186°·02		κ =	236°·06
M_4	R =	·005	J_1	R =	·019	R_2	R =	...	$(2M_2K_1)_3$	R =	·004
	ζ =	293°·63		ζ =	260°·64		ζ =	...		ζ =	261°·03
	H =	·005		H =	·023		H =	...		H =	·004
	κ =	178°·13		κ =	306°·05		κ =	...		κ =	313°·85

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·029	264°·17	·026	116°·59
„ Fortnightly „	·006	211·06	·009	114·78
Luni-Solar „ „	·033	200·30	·032	258·05
Solar-Annual „	·437	284·51	·437	204·25
„ Semi-Annual „	·376	284·17	·376	123·65

VALUES OF THE TIDAL CONSTANTS, KIDDERPORE, 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 Observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1903 Observations.

Short Period Tides.

A_0 = 10·711 feet.

S_1	H = R =	·083	M_6	R =	·178	Q_1	R =	·010	T_2	R =	·201
	κ = ζ =	185°·93		ζ =	133°·69		ζ =	103°·47		ζ =	132°·57
S_2	H = R =	1·567		H =	·160		H =	·012		H =	·201
	κ = ζ =	98°·96		κ =	322°·06		κ =	1°·17		κ =	134°·13
S_4	H = R =	·095	M_8	R =	·078	L_2	R =	·268	$(MS)_4$	R =	·720
	κ = ζ =	108°·04		ζ =	144°·97		ζ =	91°·26		ζ =	132°·98
S_6	H = R =	·005		H =	·067		H =	·240		H =	·695
	κ = ζ =	331°·93		κ =	276°·14		κ =	73°·41		κ =	75°·77
S_8	H = R =	·004	O_1	R =	·168	N_2	R =	·713	$(2SM)_2$	R =	·090
	κ = ζ =	217°·15		ζ =	262°·92		ζ =	313°·17		ζ =	314°·18
				H =	·207		H =	·688		H =	·087
				κ =	12°·75		κ =	43°·82		κ =	11°·39
M_1	R =	·051	K_1	R =	·360	λ_2	R =	...	$2N_2$	R =	·154
	ζ =	333°·64		ζ =	222°·99		ζ =	...		ζ =	169°·76
	H =	·048		H =	·406		H =	...		H =	·148
	κ =	354°·12		κ =	54°·64		κ =	...		κ =	48°·28
M_2	R =	3·961	K_2	R =	·367	ν_2	R =	·163	$(M_2N)_4$	R =	·319
	ζ =	113°·59		ζ =	250°·20		ζ =	300°·93		ζ =	351°·66
	H =	3·819		H =	·488		H =	·157		H =	·297
	κ =	56°·38		κ =	93°·13		κ =	38°·23		κ =	25°·11
M_3	R =	·062	P_1	R =	·147	μ_2	R =	·276	$(M_2K_1)_3$	R =	·146
	ζ =	50°·98		ζ =	231°·78		ζ =	290°·76		ζ =	261°·20
	H =	·059		H =	·147		H =	·256		H =	·159
	κ =	325°·17		κ =	42°·06		κ =	176°·35		κ =	35°·64
M_4	R =	·830	J_1	R =	·036	R_2	R =	...	$(2M_2K_1)_3$	R =	·039
	ζ =	148°·59		ζ =	337°·06		ζ =	...		ζ =	243°·71
	H =	·771		H =	·043		H =	...		H =	·041
	κ =	34°·17		κ =	22°·15		κ =	...		κ =	297°·64

Long Period Tides.

	R	ζ	H	κ
		°		°
Lunar Monthly Tide	·327	147·22	·290	359·35
„ Fortnightly „	·206	124·84	·325	27·97
Luni-Solar „ „	·918	343·11	·885	40·32
Solar-Annual „	2·443	247·54	2·443	167·26
„ Semi-Annual „	·850	181·08	·850	20·52

VALUES OF THE TIDAL CONSTANTS, RANGOON, 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 Observations at Rangoon; and also the mean values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1903 Observations.

Short Period Tides.

A_0 = 10·259 feet.

S_1	H = R =	·107	M_6	R =	·272	Q_1	R =	·027	T_2	R =	·320
	κ = ζ =	127°·14		ζ =	250°·82		ζ =	166°·44		ζ =	166°·47
S_2	H = R =	2·173		H =	·243		H =	·033		H =	·320
	κ = ζ =	165°·65		κ =	80°·79		κ =	64°·97		κ =	168°·05
S_4	H = R =	·087	M_8	R =	·089	L_2	R =	·419	$(MS)_4$	R =	·453
	κ = ζ =	252°·65		ζ =	320°·99		ζ =	166°·03		ζ =	260°·49
S_6	H = R =	·008		H =	·077		H =	·375		H =	·436
	κ = ζ =	29°·40		κ =	94°·28		κ =	148°·43		κ =	203°·82

Short Period Tides—contd.

S_8	$H = R =$	·007	O_1	$R =$	·271	N_2	$R =$	1·043	$(2SM)_2$	$R =$	·171
	$\kappa = \zeta =$	97°·02		$\zeta =$	271°·23		$\zeta =$	20°·40		$\zeta =$	347°·35
				$H =$	·335		$H =$	1·006		$H =$	·165
				$\kappa =$	21°·61		$\kappa =$	111°·88		$\kappa =$	44°·03
M_1	$R =$	·032	K_1	$R =$	·619	λ_2	$R =$	...	$2N_2$	$R =$	·227
	$\zeta =$	112°·91		$\zeta =$	201°·50		$\zeta =$	...		$\zeta =$	266°·34
	$H =$	·030		$H =$	·699		$H =$	...		$H =$	·219
	$\kappa =$	133°·67		$\kappa =$	33·13		$\kappa =$	...		$\kappa =$	145°·96
M_2	$R =$	6·245	K_2	$R =$	·496	ν_2	$R =$	·214	$(M_2N)_4$	$R =$	·183
	$\zeta =$	183°·64		$\zeta =$	321°·05		$\zeta =$	41°·68		$\zeta =$	122°·80
	$H =$	6·021		$H =$	·659		$H =$	·206		$H =$	·170
	$\kappa =$	126°·96		$\kappa =$	163°·94		$\kappa =$	139°·76		$\kappa =$	157°·60
M_3	$R =$	·036	P_1	$R =$	·190	μ_2	$R =$	·554	$(M_2K_1)_3$	$R =$	·190
	$\zeta =$	107°·29		$\zeta =$	236°·55		$\zeta =$	35°·94		$\zeta =$	307°·23
	$H =$	·034		$H =$	·190		$H =$	·515		$H =$	·207
	$\kappa =$	22°·27		$\kappa =$	46°·85		$\kappa =$	282°·59		$\kappa =$	82°·18
M_4	$R =$	·485	J_1	$R =$	·027	R_2	$R =$	...	$(2M_2K_1)_3$	$R =$	·105
	$\zeta =$	276°·45		$\zeta =$	14°·90		$\zeta =$	...		$\zeta =$	340°·68
	$H =$	·451		$H =$	·033		$H =$	...		$H =$	·110
	$\kappa =$	163°·10		$\kappa =$	59°·70		$\kappa =$	...		$\kappa =$	35°·69

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·170	162°·71	·151	14°·56
„ Fortnightly „	·139	141·80	·219	44·36
Luni-Solar „ „	·475	350·31	·458	46·98
Solar-Annual „	1·354	237·35	1·354	157·04
„ Semi-Annual „	·151	225·41	·151	64·81

VALUES OF THE TIDAL CONSTANTS, BASSEIN, 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 Observations at Bassein; and also the mean values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1903 Observations.

Short Period Tides.

A_0 = 9·013 feet.

S_1	$H = R =$	·060	M_6	$R =$	·106	Q_1	$R =$	·008	T_2	$R =$	·059
	$\kappa = \zeta =$	133°·25		$\zeta =$	326°·48		$\zeta =$	260°·54		$\zeta =$	37°·52
S_2	$H = R =$	·739		$H =$	·095		$H =$	·010		$H =$	·059
	$\kappa = \zeta =$	91°·73		$\kappa =$	235°·05		$\kappa =$	29°·44		$\kappa =$	45°·00
S_4	$H = R =$	·016	M_8	$R =$	·016	L_2	$R =$	·197	$(MS)_4$	$R =$	·198
	$\kappa = \zeta =$	81°·82		$\zeta =$	170°·04		$\zeta =$	20°·90		$\zeta =$	275°·62
S_6	$H = R =$	·002		$H =$	·014		$H =$	·176		$H =$	·191
	$\kappa = \zeta =$	148°·00		$\kappa =$	168°·15		$\kappa =$	71°·06		$\kappa =$	5°·14
S_8	$H = R =$	·001	O_1	$R =$	·158	N_2	$R =$	·352	$(2SM_2)$	$R =$	·084
	$\kappa = \zeta =$	94°·40		$\zeta =$	135°·88		$\zeta =$	76°·11		$\zeta =$	32°·66
				$H =$	·194		$H =$	·340		$H =$	·081
				$\kappa =$	38°·29		$\kappa =$	32°·12		$\kappa =$	303°·14
M_1	$R =$	·013	K_1	$R =$	·318	λ_2	$R =$	...	$2N_2$	$R =$	·140
	$\zeta =$	186°·05		$\zeta =$	223°·29		$\zeta =$	...		$\zeta =$	205°·53
	$H =$	·013		$H =$	·360		$H =$	...		$H =$	·135
	$\kappa =$	279°·23		$\kappa =$	49°·08		$\kappa =$	...		$\kappa =$	28°·03
M_2	$R =$	2·333	K_2	$R =$	·116	ν_2	$R =$	·106	$(M_2N)_4$	$R =$	·086
	$\zeta =$	318°·35		$\zeta =$	254°·60		$\zeta =$	81°·02		$\zeta =$	256°·17
	$H =$	2·250		$H =$	·154		$H =$	·103		$H =$	·080
	$\kappa =$	47°·87		$\kappa =$	85°·78		$\kappa =$	33°·15		$\kappa =$	301°·71
M_3	$R =$	·013	P_1	$R =$	·123	μ_2	$R =$	·309	$(M_2K_1)_3$	$R =$	·088
	$\zeta =$	57°·80		$\zeta =$	233°·74		$\zeta =$	54°·37		$\zeta =$	23°·32
	$H =$	·012		$H =$	·123		$H =$	·288		$H =$	·096
	$\kappa =$	192°·09		$\kappa =$	49°·95		$\kappa =$	173°·42		$\kappa =$	298°·63

Short Period Tides—contd.

M_4	R =	·249	J_1	R =	·013	R_2	R =	...	$(2M_2K_1)_3$	R =	·073
	ζ =	141°·60		ζ =	281°·84		ζ =	...		ζ =	262°·61
	H =	·231		H =	·015		H =	...		H =	·076
	κ =	320°·65		κ =	242°·47		κ =	...		κ =	255°·88

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·132	251°·24	·117	24°·76
„ Fortnightly „	·085	284·65	·134	29·35
Luni-Solar „ „	·272	144·00	·262	54·47
Solar-Annual „	2·018	248·04	2·018	161·83
„ Semi-Annual „	·211	173·31	·211	0·89

VALUES OF THE TIDAL CONSTANTS, PORT BLAIR, 1903.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1903 Observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (*k*) for each particular tide evaluated from the 1903 Observations.

Short Period Tides.

Ao = 4·864 feet.

S_1	H = R =	·017	M_6	R =	·004	Q_1	R =	·005	T_2	R =	·113
	κ = ζ =	32° 01		ζ =	100°·31		ζ =	18°·78		ζ =	324°·41
S_2	H = R =	·956		H =	·003		H =	·007		H =	·113
	κ = ζ =	314°·41		κ =	289°·58		κ =	276°·95		κ =	325°·98
S_4	H = R =	·013	M_8	R =	·005	L_2	R =	·102	$(MS)_4$	R =	·021
	κ = ζ =	292°·62		ζ =	290°·38		ζ =	292°·41		ζ =	288°·08
S_6	H = R =	·002		H =	·004		H =	·092		H =	·021
	κ = ζ =	108°·44		κ =	62°·74		κ =	274°·71		κ =	231°·17
S_8	H = R =	·004	O_1	R =	·130	N_2	R =	·403	$2(SM)_2$	R =	·027
	κ = ζ =	304°·59		ζ =	189°·90		ζ =	181°·96		ζ =	88°·69
				H =	·160		H =	·388		H =	·026
				κ =	300°·04		κ =	273·07		κ =	145·60
M_1	R =	·027	K_1	R =	·346	λ_2	R =	...	$2N_2$	R =	·049
	ζ =	308°·86		ζ =	134°·86		ζ =	...		ζ =	23°·78
	H =	·025		H =	391		H =	...		H =	·047
	κ =	329°·49		κ =	326°·50		κ =	...		κ =	262°·92
M_2	R =	2·064	K_2	R =	·199	ν_2	R =	·066	$(M_2N)_4$	R =	·008
	ζ =	335°·88		ζ =	106°·45		ζ =	218·40		ζ =	82°·41
	H =	1·990		H =	·264		H =	·064		H =	·007
	κ =	278°·97		κ =	309°·35		κ =	316·14		κ =	116°·61
M_3	R =	·005	P_1	R =	·134	μ_2	R =	·093	$(M_2K_1)_3$	R =	·023
	ζ =	118°·07		ζ =	151°·02		ζ =	61°·03		ζ =	134°·11
	H =	·005		H =	·134		H =	·086		H =	·026
	κ =	32°·71		κ =	321°·31		κ =	307·21		κ =	268°·85
M_4	R =	·023	J_1	R =	·027	R_2	R =	...	$(2M_2K_1)_3$	R =	·006
	ζ =	218°·01		ζ =	257°·95		ζ =	...		ζ =	161°·26
	H =	·022		H =	·033		H =	...		H =	·006
	κ =	104°·20		κ =	302°·87		κ =	...		κ =	215°·80

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	·045	191°·34	·040	43°·32
„ Fortnightly „	·029	163°·38	·046	66·18
Luni-Solar „ „	·045	204°·49	·043	261·40
Solar-Annual „	·296	250°·51	·296	170·21
„ Semi-Annual „	·184	299°·88	·184	139·29

Date of commencement of computations.

28. The tidal computations for the several stations commenced on the 1st January.

State of tidal computations.

29. The present state of the tidal computations is shown in the following table, together with their state at the end of September 1903. The letters A. P. in this table indicate, that the actual times and heights of high and low water have been measured either from the tidal diagrams or from gratuated staves and compared with predicted values published in the tide tables.

Statement of the ordinary reductious of the yearly registrations at the beginning and end of the Survey year 1903-04.

Tidal observatory.	State at end of September 1903.	State at end of September 1904.
Suez	1902 incomplete, A. P. 1902	1902 calculations compl eted. 1903 ,, . ,, A. P. 1903.
Perim	1902 calculations completed, A. P. 1902.	Closed.
Aden	1902 calculations completed, A. P. 1902.	1903 incomplete, A. P. 1903.
Karáchi	1902 calculations completed, A. P. 1902.	1903 calculations completed, A. P. 1903.
Port Albert Victor . .	1902 calculations completed, A. P. 1902.	1903 incomplete, A. P. 1903.
Bhávnagar . . .	A. P. 1902 . . .	A. P. 1903.
Bombay (Apollo Bandar) .	1902 incomplete, A.P. 1902 .	1902 calculations completed. 1903 calculations completed, A. P. 1903.
Bombay (Prince's Dock) .	1902 incomplete, A. P. 1902	1902 calculations completed. 1903 Long Period Tides incomplete, A. P. 1903.
Madras	1902 calculations completed, A. P. 1902.	1903 calculations completed, A. P. 1903.
Kidderpore . . .	1902 calculations completed, A. P. 1902.	1903 calculations completed, A. P. 1903.
Chittagong . . .	A. P. 1902 . . .	A. P. 1903.
Akyab	A. P. 1902 . . .	A. P. 1903.
Bassein	1902 culculations completed	1903 calculations completed, A. P. 1903.
Rangoon . . .	1902 calculations completed, A. P. 1902.	A. P. 1903.
Port Blair . . .	1902 calculations completed, A. P. 1902.	1903 calculations completed, A. P. 1903.

Auxiliary Reports.

30. In addition to the computations enumerated in the foregoing table, reports on the operations carried on in the Bombay Presidency and in Burma were prepared and submitted, the former to the Local Government, the latter to the Principal Port Officer, Rangoon.

31. As far back as 1891 Professor G. H. Darwin drew the attention of Mr. Roberts of the Nautical Almanac Office to the fact that the incidences of the double hours in the forms of the M series were not correct. Mr. Roberts on looking into the matter found that the error was due to the fractional part of the hour of incidence having been ignored. It would appear, that the mistake was not communicated to the officer of this party till 1902, when Professor Darwin spoke to Major Burrard about it. On the matter being thoroughly investigated it was found that there were mistakes in the forms of all the series, and they were accordingly all corrected. In addition the computations for the main lunar semi-diurnal tide (M2) for three ports Perim, Bombay and Port

Blair were completely revised for the year 1901, using the data given by the corrected forms. It was found that this revision gave a difference of $0^{\circ}{\cdot}5$ in the epoch (K) and of 0·002 foot in the amplitude (H2) from the results of the original computations; *i.e.*, the principal tide was only affected in time by 2 minutes, and in height by $\frac{1}{42}$ of an inch. As the differences were so insignificant, it was evident that it was unnecessary to continue the revision for other tides and other ports. All the forms in stock have been corrected by hand.

Tide Tables.

32. The usual work in connection with the timely issue of tide tables for the year 1906 has been carried out. The tide tables now contain the predictions of high and low water for 40 ports.

Receipt and issue of tide tables.

33. The tide tables for 1904 were as usual received too late to complete their distribution before the end of the year 1903. It is hoped in future that this office will be able to undertake the distribution of the tables before the 1st December of the year preceding that for which the tables are predicted. The data for the predictions for 1905 tides were sent to England in July 1903, the tables should therefore be received in India sometime before the 1st December 1904.

Datum for tide tables.

34. The datum for the tide tables for 1905 is the datum of soundings of the latest Admiralty charts with the exception of Bassein. Tables giving the particulars of the datum at each tidal station will be found in the appendix to the General reports for 1891-92, 1893-94, 1895-96, in paragraph 24 of the annual report for 1898-99 and in paragraph 22 of the narrative report for 1900-01.

The datum for the tide tables of Bassein is the Indian Spring low water mark, which has not yet been connected with the Admiralty datum.

Sale of tide tables.

35. The amount realized from the sale of the tide tables in the financial year 1903-04 was Rs. 1,550-4-0.

Data supplied to the Tidal Assistant Physical Laboratory, Teddington.

36. The following data were furnished to the Tidal Assistant at the Physical Laboratory, Teddington.

(i) Mean values of the tidal constants for the tide tables for 1904 and 1905 calculated in the usual manner, and ready for use in the tide predictor.

(ii) Actual values during 1903 of every high and low water measured in duplicate from the tidal diagrams at 10 stations and of tide pole observations taken during daylight at 4 closed stations.

(iii) Comparison of the above with the predicted values for 1903, the errors being tabulated in a convenient form to assist the Tidal Assistant in his predictions.

Removal of the Tide Predicting Machine, to the Physical Laboratory at Teddington.

37. In 1902 the Surveyor-General brought to the notice of the Government of India, the fact that the tide predictions were undertaken by a private individual, and that should anything occur to prevent him continuing the work, very great delay and inconvenience might be entailed, before any work, then in hand, could be completed.

The India Office thereupon decided to transfer the work to some corporate body; and enquired of the Director of the National Physical Laboratory at Teddington whether that institution could undertake the work.

Dr. Glazebrook, F.R.S., the Director, accepted the responsibility, and it was arranged that the machine should be moved from the India Store Department at Lambeth after the predictions for 1904 were completed.

History of the tide predicting machine.

38. The tide predicting machine was constructed in the year 1879 by Messrs. A. Légé & Co. of London to the designs of Mr. Edward Roberts on the plan devised by Lord Kelvin. Twenty tidal components were then included; in 1891 four more components were added. From 1879 the running of the machine and the preparation of the tide tables were superintended by Mr. Roberts; early in 1903, however, the machine was removed from his charge, and handed over to the makers previous to being set up at the Physical Laboratory. Messrs. Légé found on examination that many of the wheels and worms were very much worn; most of these therefore were re-cut or renewed and the machine restored to a thoroughly good working condition. The machine had been in continuous use at Lambeth for a period of more than 20 years before these repairs became necessary. The work of restoration occupied some months, and it was not until August 1903, that the machine was erected in the Physical Laboratory at Teddington; it now occupies one of the ground floor rooms in Bushy House. It is driven by a small water motor, and has been running satisfactorily during the predictions for the 1905 tables. Some small alterations, for the attainment of greater accuracy of setting, had been carried out by the Laboratory mechanic.

Mr. F. J. Selby has been appointed as Tidal Assistant at the Laboratory to supervise the setting of the machine, and to be generally responsible for the work; under him is a computer, who makes the calculations and measures the curves.

Errors in predicted times and heights of high and low water.

39. The usual tabular statements Nos. 1 to 5 are appended showing the percentage and amount of errors in the predicted times and heights of high and low water for the year 1903 at 14 stations as determined by comparison of the predictions given in the tide tables, with actual values measured from the tidal diagrams at 10 stations, and from tide poles at 4 stations; the former are made by assistants in this office, and the later by port officials.

No. 1.

Statement showing the percentage and the amount of the errors in the predicted Times of High Water at the various Tidal Stations for the year 1903.

STATION.		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.
Suez		Au.	697	26	40	10	15	9
Aden		Au.	674	42	46	5	5	2
Karáchi		Au.	702	35	38	11	12	4
Port Albert Victor		Au.	699	25	40	13	15	7
Bhávnagar		T. P.	302	21	72	3	3	1
Bombay	Apollo Bandar	Au.	703	34	45	10	8	3
	Prince's Dock	Au.	685	41	43	7	6	3
Madras		Au.	679	46	45	5	3	1
Kidderpore		Au.	705	21	34	14	19	12
Chittagong		T. P.	365	14	32	10	15	29
Akyab		T. P.	365	96	4	...	...	...
Rangoon		Au.	705	20	34	16	24	6
Moulmein		T. P.	365	12	63	18	5	2
Port Blair		Au.	705	48	42	6	3	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 1903.

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.
Suez	Au.	697	25	37	11	14	13
Aden	Au.	673	39	47	6	6	2
Kárachi . . .	Au.	704	23	42	14	15	6
Port Albert Victor . .	Au.	705	26	39	9	13	13
Bhávnagar . . .	T. P.	303	15	76	8	1	...
Bombay Apollo Bandar	Au.	701	36	42	10	9	3
Prince's Dock	Au.	684	38	42	10	8	2
Madras . . .	Au.	680	46	44	6	3	1
Kidderpore . . .	Au.	705	22	43	14	14	7
Chittagong . . .	T. P.	365	9	31	9	22	29
Akyab	T. P.	365	80	20	...	...	...
Rangoon . . .	Au.	706	20	36	15	15	14
Moulmein . . .	T. P.	365	13	53	17	15	2
Port Blair . . .	Au.	705	42	45	6	6	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 1903.

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.
Suez	Au.	697	5·5	61	26	9	4
Aden	Au.	674	6·7	96	4	...	...
Karáchi	Au.	702	9·3	71	24	3	2
Port Albert Victor . .	Au.	699	11·7	42	30	20	8
Bhávnagar . . .	T. P.	302	31·4	38	38	14	10
Bombay Apollo Bandar	Au.	703	13·9	76	18	5	1
Prince's Dock	Au.	685	13·9	76	18	5	1
Madras . . .	Au.	679	3·5	77	19	4	...
Kidderpore . . .	Au.	705	11·7	36	19	16	29
Chittagong . . .	T. P.	365	13·3	32	19	16	33
Akyab	T. P.	365	8·3	74	15	10	1
Rangoon . . .	Au.	705	16·4	56	29	11	4
Moulmein . . .	T. P.	365	12·7	26	28	13	33
Port Blair . . .	Au.	705	6·6	75	22	3	...

No. 4.

Statement showing the percentage and the amount of the errors in the Predicted Heights of Low Water at the various Tidal Station for the year 1903.

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.
Suez	Au.	697	5·5	52	31	11	6
Aden	Au.	673	6·7	96	4	...	...
Karáchi	Au.	704	9·3	81	16	2	1
Port Albert Victor	Au.	705	11·7	53	34	10	3
Bhávnagar	T. P.	303	31·4	43	40	11	6
Bombay { Apollo Bandar	Au.	701	13·9	67	26	6	1
Bombay { Prince's Dock	Au.	684	13·9	65	27	6	2
Madras	Au.	680	3·5	82	15	3	...
Kidderpore	Au.	705	11·7	42	21	8	29
Chittagong	T. P.	365	13·3	28	20	15	37
Akyab	T. P.	365	8·3	77	18	4	1
Rangoon	Au.	706	16·4	29	27	21	23
Moulmein	T. P.	365	12·7	27	24	20	29
Port Blair	Au.	705	6·6	75	21	4	...

No. 5.

Table of Average Errors in the Predicted Times and Heights of High and Low Water at the several Tidal Stations for the year 1903.

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.								
Suez	Au.	5·5	14	15	·061	·076	4	5
Aden	Au.	6·7	8	9	·025	025	2	2
Karáchi	Au.	9·3	11	13	·036	·027	4	3
Port Albert Victor	Au.	11·7	14	16	·043	·036	6	5
Bhávnagar	T. P.	31·4	9	10	·019	·016	7	6
Bombay { Apollo Bandar	Au.	13·9	10	10	·018	·024	3	4
Bombay { Prince's Dock	Au.	13·9	9	10	·018	·024	3	4
Madras	Au.	3·5	7	8	·071	·071	3	3
Akyab	T. P.	8·3	2	3	·030	·030	3	3
Port Blair	Au.	6·6	7	8	·038	·038	3	3
GENERAL MEAN			9	10	·036	·037	...	...
Riverain.								
Kidderpore	Au.	11·7	16	14	·071	·064	10	9
Chittagong	T. P.	13·3	22	23	·063	·063	10	10
Rangoon	Au.	16·4	15	16	·025	·041	5	8
Moulmein	T. P.	12·7	12	13	·066	·066	10	10
GENERAL MEAN			16	17	·056	·059	...	...

The foregoing statement for the year 1903 may be thus summarised :—

Percentage of time predictions within 15 minutes of actuals.

		High Water. Per cent.	Low Water. Per cent.
Open coast Stations {	8 at which predictions were tested by S. R. Tide gauge	80	77
	2 ,, ,, Tide pole	97	96
Riverain Stations {	2 ,, ,, S. R. Tide gauge	55	61
	2 ,, ,, Tide pole	61	53

Percentage of height predictions within 8 inches of actuals.

		High Water. Per cent.	Low Water. Per cent.
Open Coast Stations.	8 at which predictions were tested by S. R. Tide gauge .	92	93
	2 ,, ,, Tide pole .	83	89
Riverain Stations.	2 ,, ,, S. R. Tide gauge .	70	60
	2 ,, ,, Tide pole .	53	50

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

		High Water. Per cent.	Low Water. Per cent.
Open Coast Stations.	8 at which predictions were tested by S. R. Tide gauge .	94	94
	2 ,, ,, Tide pole .	98	99
Riverain Stations.	2 ,, ,, S. R. Tide gauge .	88	87
	2 ,, ,, Tide pole .	78	80

Accuracy of Summary.

40. In the above summary the readings taken from the diagrams are accurate both as to time and height, but those from tide poles are occasionally subject to considerable errors as regards time, owing to the inaccuracy of the time kept locally.

Comparisons of the predictions at Riverain Stations for years 1902 and 1903.

41. The predictions for the riverain stations for the year 1903 as compared with those of the year before were as good in times and worse in heights at Kidderpore. At Rangoon the times for high waters were about the same, but for low waters were slightly inferior, the heights of high waters were about the same, the low waters below for the two stations Chittagong and Moulmein at which tide pole observations were taken, the predictions for time and height both for high and low waters were a little worse.

At Kidderpore the greatest difference between the actual and predicted heights of low water was 3 feet 4 inches on the 6th and 9th August: in both cases the predictions were in excess.

At Chittagong it was 2 feet 8 inches on 20th May, 3rd and 4th June, in each instance the actuals being in defect.

At Rangoon it was 3 feet on 29th January, the predictions being higher.

At Moulmein, it was 2 feet 11 inches on 22nd October, the prediction being lower.

LEVELLING OPERATIONS.

42. The strength of the Levelling Detachment on taking the field was as follows :—

Levellers	Mr. E. H. Corridon	1st Leveller.
	Munshi Syed Zille Hasnain . . .	2nd „
Recorders	Rikhi Ram.	
	Lachman Sing.	
	Gopal Sing.	

43. The detachment left Dehra for the field on the 17th October 1903 and arrived at Mandalay on the 28th idem.

44. In consequence of some discrepancies discovered in the heights of points between Mandalay and Myohaung, determined in season 1892-93 and again during last field season, it was considered necessary to continue the check levelling to the next embedded bench-mark at Myitngè Railway station. The detachment was employed on this work till the 4th November, leaving the following day for Shwebo where operations were closed last field season.

45. Regular levelling operations were resumed from Shwebo and carried along the Mu Valley section of the Burma Railway to Wuntho, where this line of levels was closed on 25th December. Orders having been received to return to Mandalay and take in hand the revision of the old levelling along the railway towards Rangoon to a considerable distance, as the check levelling done between Myohaung and Myitngè at the commencement of this field season, confirmed the discrepancies found between Mandalay and Myohaung in the previous field season.

The causes of these discrepancies are under investigation by the Superintendent of Trigonometrical Surveys.

46. Work was re-started at Mandalay on 29th December and carried along the railway line to Pyinmana connecting all the old points. The operations were closed for the season on the 12th April 1904, the detachment leaving Pyinmana for recess quarters on the 15th idem.

47. On arrival at Calcutta urgent orders were found awaiting the detachment to proceed at once, with all the menial establishment and the requisite stores and instruments, to Dehra in order to take up the levelling from Dehra to Mussooree which was urgently required in connection with the Pendulum observations. The detachment reached Dehra on 25th April and commenced work on 28th idem. This line of levels emanated from the bench-mark at the Trigonometrical Branch Office at Dehra and was carried along the main road to Rajpur, thence along the cart road *viâ* Bhatta to the Crown Brewery from where the levels branched off to the Library closing at the Great Trigonometrical Survey Stations at Camel's Back on 30th May 1904.

48. The personnel of the detachment on the Dehra-Mussooree section was the same as in Burma, with the exception that Mr. Corridon after levelling up to the 10th May was deputed to the tidal section of No. 25 Party at Dehra for a course of instruction in the duties of that section, Captain H. H. Turner, R.E. relieving him as first leveller till the close of the work at Mussooree.

49. The health of the establishment during the season under report was fairly good; one khalasie died of cholera at Kyaukse in January 1904.

50. The total rises and falls amounted to 9,125 feet and the outturn of work to 301·7 miles, in the course of which the instrument was set up at 4,035 stations. The heights of 11 new embedded and 78 inscribed bench-marks were

determined, 146 old embedded and inscribed bench-marks, 4 Great Trigonometrical Survey Stations and 9 Irrigation bench-marks were also connected.

51. The usual tabular statements are appended.

List of Great Trigonometrical Survey Stations connected by Spirit-Levelling Season 1903-04.

Name of Station.	Height in feet above mean Sea level.		Error of height by Triangulation in feet.	Remarks.
	By Δn.	By Spirit-Levelling.		
Pyinmana h.s. (Mandalay Meridional Series).	429·0	419·30*	+ 10·0	Uppermark-stone.
Camel's Back G. T. Survey h. s. (at Mussooree).	6937·0	6935·85	+ 1·15 ft.	
Eagle's Nest G. T. Survey h.s (at Mussooree.)	6927·0	6924·16	+ 2·84 ft.	
Dehra Dún pillar N. of Dome Observatory	2229·0	2237·35	— 8·35 ft.	

* This height is dependent on the value of the embedded B. M. at Mandalay, which has been assumed to be correct given on page 76, No. 1 Burma Pamphlet.

The height found by levelling from Rangoon in season 1892-93 was found to be 419·55 above mean sea level.

Results of Comparison of Staves, season 1903-04.

Place and Date of Comparison.	Staff No. 04.	Staff No. 05.	Staff No. 01.	Staff No. 03.
Shwebo, 6th November 1903	+0·0027293	+0·0039244	—0·0000224	+0·0004831
Madaunghla 15th " "	+·0021079	+·0032934	—·0001364	—·0002206
Tangôn 24th " "	+·0018602	+·0031322	—·0008383	—·0003103
Kanbalu 28th " "	+·0020582	+·0029113	—·0003451	—·0008574
Pintha 8th December "	+·0017063	+·0030655	—·0007848	—·0007876
Kawlin 21st " "	+·0016336	+·0027101	—·0012633	—·0013353
Wuntho 25th " "	+·0013930	+·0027477	— 0007209	—·0005313
Myitngè 4th January 1904	+·0016020	+·0029974	—·0011134	—·0006649
Singaing 11th " "	+·0016140	+·0025780	—·0007706	—·0007092
Kumè Road 26th " "	+·0010336	+·0016399	—·0017930	—·0021755
Samôn 3rd February "	+·0010046	+·0019103	—·0016129	—·0017299
Hanza 12th " "	+·0010925	+·0015939	—·0020421	—·0019813
Nyaungyan 22nd " "	+·0001146	+·0008011	—·0028112	—·0035322
Pyawbwè 29th " "	+·0001791	+·0009978	—·0025147	—·0031615
Shweda 6th March "	+·0002766	+·0007580	—·0030388	—·0032780
Hngetthaik 13th " "	—·0002997	+·0002536	—·0036836	—·0038645
Tatkôn 21st " "	—·0005745	+·0000243	—·0038338	—·0046403
Pyokkwe 31st " "	—·0000629	+·0005260	—·0038538	—·0042036
Pyinmana 12th April "	—·0004839	+·0002377	—·0035188	—·0041205
Dehra Dún 29th " "	—·0000461	+·0006098	—·0034487	—·0029614
Rájpur 9th May "	—·0009712	—·0003842	—·0048974	—·0045725
Bhatta 16th " "	—·0007759	—·0003997	—·0049518	—·0048908
Mussooree 23rd " "	—·0010676	—·0004736	—·0052767	—·0050703
Do. 31st " "	—·0007213	—·0000689	—·0048682	—·0048367

Tabular Statement of out-turn of work for the field season 1903-04.

Section.	During the month of	No. of Miles Double Levelling. Main Line. Ms.	Main Line. Chs.	Main Line. lks.	Branch Line. Ms.	Branch Line. Chs.	Branch Line. 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. Reference.	Old.	Embedded.	Inscribed.	G. T. S.	Ry.	Irrigation.	P. W. D.	Remarks.
Shwebo to Wuntho	November 1903	49*	73	86	8	37	86	238·650	103·755	579	...	6	4	22	...	...	2	...	*Includes Ms. 5-63-96 of check levelling between Mandalay and Myitnge.
	December „	55	11	52	0	57	86	548·740	379·754	598	...	...	7	25	...	...	...	...	
	Totals	105	5	38	9	15	72	787·390	483·509	1177	...	6	11	47	...	...	2	...	
Mandalay to Pyinmana	December 1903	2	79	98	4	40	42	10·437	13·528	93	...	8	...	...	...	...	...	...	Revision Work.
	January 1904	50	52	30	0	54	20	366·716	256·491	639	...	31	...	2	...	...	1	...	
	February „	43	31	36	0	25	96	376·729	103·719	551	...	41	...	...	...	...	...	...	
	March „	49	21	02	0	69	14	182·188	434·036	573	...	45	...	...	...	...	...	...	
	April „	14	34	40	0	74	36	71·984	138·399	174	...	14	...	...	1	...	...	...	
	Totals	160	59	06	7	24	08	1008·054	946·173	2030	...	139	...	2	1	...	1	...	
Dehra Dún to Mussooree	April 1904	2	70	30	0	17	72	289·724	4·308	60	...	1	...	1	1	...	2	...	
	May „	15	20	70	0	79	62	4660·116	45·290	768	...	...	...	28	2	...	4	...	
	Totals	18	11	00	1	17	34	4949·840	49·598	828	...	1	...	29	3	...	6	...	
	GRAND TOTALS	283	75	44	17	57	14	7645·284	1479·280	4035	...	146	11	78	4	...	9	...	

Ms. Chs. lks.
Season's outturn = 301—52—58 ; Rises and Falls 9124·564 feet.

IV

ASTRONOMICAL AZIMUTHS.

Extracted from the Narrative Report of Captain H. Wood, R.E., in charge of No. 24 Survey Party (Triangulation) for Season 1903-04.

The party remained under the charge of Captain H. Wood, R.E., until 2nd September 1904, when he handed over charge to Captain H. H. Turner, R.E. No changes occurred amongst the Provincial or Ministerial Officers.

The programme for the season was to continue the triangulation of the Great Salween Series southwards on the west of, but parallel to the Salween river with the eastern stations lying approximately along the meridian of 98° 30′.

The recess office closed in Mussooree on the 22nd September 1903 and the field establishment under Mr. Hunter proceeded to Burma. Lashio was reached on October 25th and the Provincial Officers immediately proceeded to the stations built at the close of the preceding year and commenced laying out the approximate work. They continued working until April 5th, when haze completely prevented further operations, by which time they had carried the advance work and built stations as far south as latitude 20° 30′. The two final stations are situated on hills on which stations of the Möng Hsât Secondary Series are located, but as the sites of these were not suitable for the stations of a principal series, other positions were chosen close by. No difficulty should be experienced in re-fixing from stations of the Great Salween Series the positions of four or five of the stations of the Möng Hsât Series. No angles were measured during the season on this series as on Captain Wood's return from Khatmandu (to which place he was deputed early in October to investigate the supposed identity between Mount Everest and a snow peak known to the inhabitants of the Nepal valley as Gaurisankar) it was decided that, as the season suitable for triangulation work in Burma was so far advanced, it would be better to employ him during the remainder of the cold weather on observing astronomical azimuths at some of the longitude stations of India and Burma. He observed azimuths at Jalpaiguri station, Orejhar station, Kyaunggyi station, Bolarum Public Works Department Office station, Deesa Telegraph Office station and Quetta Telegraph Office station. Fine weather was experienced at all the stations with the exception of Bolarum where cloudy weather delayed the completion of the work for nearly four weeks. An astronomical latitude was observed at Quetta, and the presence of Captain Pirrie (No. 15 Party) at Nushki was taken advantage of and the difference of longitude between these two places was determined telegraphically.

The recess office was opened at Mussooree on 2nd May, but the party working in Burma did not arrive till a week later.

Owing to the change in the locale of the party's operations from Burma to Baluchistan, the programme for the ensuing year is to commence a new principal series starting with the base Zibra-Zawa on the Kalat Secondary Series about longitude 66° 35′ and running westwards along the parallel of 29°. This series will eventually be connected to the Great Indus Series, but at present the section between that series and the base Zibra-Zawa will remain in abeyance.

As many years may elapse before work is recommenced in Burma, it may be useful, to put on record here what principal triangulation remains to be completed in that country. Up to the present the Great Salween Series has been carried along parallel of latitude 23° 30′ from the Mandalay Meridional Series to the river Salween, where the series turns to the south. Stations have been built (but no angles measured) along the meridian of 98° 30′ as far south as 20° 30′.

When the series is continued, the stations built south of parallel 22° may have to be rejected, as the series will probably be deflected eastwards through Kwengtung to the French frontier on the Mekong, and thence south-westwards to the eastern extremity of the Möng Hsât Secondary Series. From this point it should follow the Siamese boundary to latitude 17°, keeping east of the Salween, closing eventually on the Eastern Frontier Series.

During the recess the computation of the work done during the field season was completed, and the observations made by Captain Wood in Nepal were re-computed in duplicate. These observations were originally computed while he was in Nepal, but time did not permit of an independent check, and on re-computation a slight mistake was found in the computations of the observations taken at Mahádeo Pokra hill station. This error does not affect the results appreciably.

In addition, the co-ordinates of the stations of observations were computed on a different system and with these values the positions of three prominent buildings in the Khatmundu valley and 24 prominent snow peaks, previously unfixed, ascertained. The heights were re-computed using a co-efficient of refraction obtained by the method of minimum squares from equations furnished by the observations made to seven of the Great Trigonometrical peaks.

The method employed in computing the azimuths at longitude stations was that laid down in the Trignometrical Hand Book, second edition, with the exception that 7 place logs were used on page 12 of the form in lieu of the 5 and 6 place ones recommended.

In the tabular form given below, in addition to the usual results the deflection of the plumb-line in the prime vertical, as obtained from the azimuth observations and from the longitude work, are shown for the purposes of comparison :—

STATION.	Lat. N. =φ	Long. E.	DIFFERENCE IN SECONDS OF ARC BETWEEN		DEFLECTION OF PLUMB-BOB IN PRIME VERTICAL IN SECONDS OF ARC DEDUCED FROM	
			Results obtained from stars at E. elongation and stars at W. elongation or E.—W.	Astronomical value and Geodetic value or O—C	Azimuth observations (O—C) cot φ	Longitude observations.*
	° ′ ″	° ′ ″	″	″	″	″
Jalpaiguri . .	26 31 15	88 46 41	+0·03	−5	10·02 E.	18·26 E.
Orejhar (Fyzabad)	26 46 56	82 14 35	−0·66	−4·06	8·04 ,,	0·40 ,,
Kyaunggyi (Prome)	18 49 21	95 15 24	−0·55	−7·80	22·89 ,,	15·48 ,,
Bolarum . .	17 30 11	78 33 38	+0·34	−1·1	3·49 ,,	3·29 ,,
Deesa . .	24 15 30	72 13 33	−0·62	−4·59	10·18 ,,	3·28 ,,
Quetta . .	30 11 57	67 2 59	+1·73	−4·86	8·35 ,,	2·07 ,,

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* The deflections of the plumb-line in the prime vertical as derived from longitude observations are extracted from page 15 of Major Burrard's work on "The attraction of the Himalayas, etc." Professional paper No. 5 of 1901.

The latitude of Quetta Telegraph Office station was observed with the 12-inch theodolite No. II. The method employed was that known as "circum-meridian zenith distances." Stars with zenith distance varying from 1° to 70° were used and carefully paired at equal distances north and south of the zenith. Their co-ordinates were taken from the Nautical Almanac, Connaissance des Temps or Berliner Astronomisches Jahrbuch.

The chronometer error was obtained by timing the transits of stars of small zenith distance across the meridian both at the commencement and on the completion of the latitude work, a correction being afterwards applied for deviation.

The collimation error was reduced to as small a quantity as possible before the work began, but in the computations a correction deduced from the azimuth observations was applied. The body of the theodolite was carefully levelled before work began, and the body levels read in the four positions both before and after the observations were made. The transit axis level was also read and a correction for inclination applied. Observations to a latitude star were commenced five minutes before the time of its meridian passage and four measures of its zenith distance made, two being taken face right and the others face left. The level was read at each observation. As the time required for each intersection was about two minutes this method gave two observations (one face right and one face left) before transit and two similar ones after. The observations were spread over three nights, and the zenith distance of twelve pairs of stars measured. During the measurements it was found very difficult to find the stars of small zenith distance to drop in sufficient time to enable four observations to be made and on computing the results, it was obvious that during the measurement of the stars with 1° zenith distance some mistake had been made and consequently the result obtained from that pair was rejected.

The formula employed in the computations was $\zeta_1 = Z_1 \pm Am + Bn$

where $A = \frac{\cos\phi \cos\delta}{\sin\zeta_1}$ $\quad B = A^2 \cos\zeta_1$

$m = \frac{2\sin^2 \frac{1}{2}t}{\sin 1''}$ $\quad n = \frac{2\sin^4 \frac{1}{2}t}{\sin 1''}$

The second term was only computed when the correction was over 0″·01″ and wherever the correction obtained by the first term was larger than 1′, the computation was repeated using the new value for the approximate zenith distance and latitude.

Each pair of observations (*i.e.*, one face right and one face left) was corrected for level and computed out separately, thus two values of the co-latitude were obtained from each star or four from each pair. (In two cases the second value from one of the stars of a pair was largely discordant and evidently a different star had been observed. These discrepant results were rejected and three values only of co-latitude for those pairs employed). The mean co-latitude from each star having been thus obtained, the mean for each pair was deduced and received a weight of 1 if it was derived from four observations, and 0·5 if derived from 3. The weighted mean of the 11 pairs was then obtained with the probable error of the mean result.

STATION.	LATITUDE.		O—C.	No. of pair of stars used.	Probable error.
	Geodetic C.	Astronomical O.			
	° ′ ″	° ′ ″	″		″
Quetta Telegraph Office station.	30 11 57·37	30 11 55·82	−1·55	11	±0·089

The greatest difference between the two values of co-latitude from a star is 2″·3, the mean being 0″·84. The difference between the greatest and least values of co-latitude obtained from stars of the same aspect is for north stars 3″·65, and south stars 4″·05, and the difference between greatest and least values obtained from pairs of stars is 1″·62.

There is a constant difference of about 6″ between the values obtained from north and south stars, but the reason of this is not apparent, and owing to the early close of the recess season there has been no time for investigating it.

The determination of the difference of longitude between Quetta and Nushki was made by sending groups of signals telegraphically from either place alternately, and the observers noting their time of receipt and despatch. Captain Pirrie at Nushki using a 6-inch theodolite obtained his chronometer correction by the method known as "east and west" stars. He employed on an average 12 stars (6 east and 6 west) for each determination and took two observations (one face right and one face left) to each star. Captain Wood at Quetta used the 12-inch theodolite No. II and obtained the correction for his chronometer in a similar way to that described in the paragraph referring to the latitude observations. Determinations of the clock errors were made both immediately before and after the interchange of telegraphic signals. These signals consisted of groups of five single short signals at irregular intervals (but averaging about 15 seconds) the sender noting the exact moment he pressed the key, while the receiver watching his chronometer noted the exact moment he heard the sounder at his end. At the completion of five signals the receiver became the sender, and the double set was called a group and the mean of the differences between the local times (corrected for the chronometer errors) of receipt and despatch of the 10 signals formed one determination of the difference of longitude. The order of sending the first set of signals was alternated in each group and seven groups were sent and received on an average, on each of three nights.

On the last night, there was a certain amount of interference on the telegraph line and for this reason in place of taking the arithmetical mean of all the groups as the final value of Δ L, this quantity was obtained by weighting the mean of each night's work in inverse proportion to the square of its probable error.

An abstract of the results is given below:—

Date.	Daily mean of Δ L.	Probable error.	Weight.	Final mean and probable error.
	m. s.	s.		m. s. s.
7 April 1904 . .	3 59·52	±0·055	150·40	3 59·57 ±0·058
8 " " . .	3 59·53	±0·053	161·96	or 0° 59′ 53″·55 ±0″·87
9 " " . .	3 59·90	±0·104	42·06	

The final value of the longitude of Nushki Longitude Station is therefore 66° 3′ 5″·07 ±0″·87.

V

UTILIZATION OF OLD TRAVERSE DATA FOR MODERN SURVEYS IN THE UNITED PROVINCES OF AGRA AND OUDH.

Extracted from the Narrative Report of Captain H. L. Crosthwait, R.E., in charge of No. 14 Party (United Provinces of Agra and Oudh) for season 1903-04.

In the case of "Supplementary" survey it may be useful to place on record, in some detail, the methods adopted.

The old material available for this work consisted of:—

I. main circuit traverse data, each main circuit being run down from a separate origin;

II. Village traverses, each village having a separate origin;

III. Congregated village maps, on a scale of 4 inches = 1 mile.

In order to make the best use of this data, for purposes of "Supplementary" survey, the following procedure was adopted, instead of the former method which was not found to give good results.

The plane-table was prepared for the field in four stages (i) The values of main circuit traverse points were reduced to the origin of the new survey, through the medium of mutually connected Great Trigonometrical stations. These were then plotted in the usual manner on the plane-table section. (ii) On each of the old congregated village maps, is found a table of the values of trijunctions of neighbouring sheets run down from the same origin as the main circuits, mentioned above. After reduction to the new origin these were also plotted on the plane-table. Thus a number of accurate fixed points were scattered over the table, all plotted from the same origin. These were used as a basis for fixing the village origins, thereby making it possible to immediately utilise the independent village traverses described above in II. (iii) Each village origin was then laid off graphically on the plane-table from at least three fixed points. The village trijunctions were then plotted in the usual manner. (iv) Details, omitting limits of cultivation, were pantagraphed down from the congregated village sheets, and inked in blue on the field sections. The plane-table was then ready for "Supplementary" survey in the field.

Z 2

VI

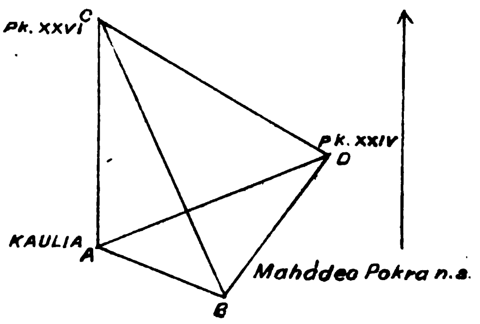
IDENTIFICATION OF SNOW PEAKS IN NEPAL.

Extracted from the Narrative Report of Captain H. Wood, R.E., for Season 1903-04.

As the computation of the results of Captain Wood's visit to Khatmandu published in "The Identification and Nomenclature of the Himalayan Peaks as seen from Khatmandu, Nepal" had been made in Nepal during the field season without an independent check, advantage was taken during the recess to make a duplicate copy of the observations, and to re-compute the work in duplicate. A slight mistake was discovered, which did not affect the results practically, but a corrected copy of Appendices* Nos. 1 and 2 of the report on the Identification and Nomenclature of the Himalayan Peaks, etc., is attached.

On the completion of these computations, it was decided to compute the positions of the two stations of observation by a different method. In the report mentioned above, it will be seen that from Mahádeo Pokra hill station, the cairn marking the station of observation on Kaulia hill was visible and that its azimuth was measured. This azimuth is of a much greater order of accuracy than those taken to the snow peaks, as the cairn formed a distinct and easily recognized mark, while the snow peaks gave no very definite points to which observations could be taken, and also it was a matter of chance whether the points selected were exactly the same as those fixed from the plains of India. Starting then with this known azimuth and the astronomical latitudes observed at the two stations, it is an easy matter to compute the reverse azimuth and the distance apart of the stations; and with this distance and the measured angles at the stations between any two peaks (observed at both stations) to obtain the distances and azimuths of the stations from the peaks, and consequently the latitudes and longitudes of the stations. The only complication introduced by this method is due to the difference between the astronomical and geodetic latitudes at the stations of observation and the fact that the stations observed from happened to lie in an almost east and west direction. These conditions required the computations to be gone through three times before obtaining a correct reverse azimuth and the distance apart of the stations.

In the figure, let A represent the position of Kaulia hill station; B that of Mahadeo Pokra hill station; C and D those of the Snow Peaks. (XXVI and XXIV were the ones selected as they formed the most symmetrical figure with the stations of observation and their summits were well defined and suitable for observing to)



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* The differences in the heights of the peaks observed from Kaulia hill station are due to a different value being used for one division of the level scale in the correction made for dislevelment. In the original computations the value used for 1 division of the scale was 5″, *i. e.*, the value engraved on the tube by the makers but in the revised computations 6″ was employed, this being the value obtained from observations made with a bubble tester.

Then we have—

Known latitude and longitude of C.	Previously determined from stations in the plains of India.
„ „ „ of D.	
„ azimuth of C from D, and D from C.	
„ distance DC.	
„ latitude of A and B.	From observations made at A and B.
„ azimuth of A from B.	
„ angles CAD; ABC; CBD.	

And from the observed quantities we can compute the azimuth of B from A, the distance AB, and obtain the angle DAB.

Then in the triangles ACB, ADB, knowing the side AB and the angles, CBA, BAC, and DAB, ABD respectively, the lengths of the remaining sides can be computed and from the triangles ACD, BCD, knowing the two sides and the included angles at A and B respectively, the third side CD and the other angles can be obtained. But this side CD has already a value, obtained from previous observations, and consequently the difference between this known value and its computed one (the mean obtained from the two triangles) affords a correction to be applied to the base AB to get a more approximate result.

With this new value for AB, and the observed azimuth of A from B, the reverse azimuth is again computed, and a new value obtained for the angle DAB and with the re-computation of the triangles affording a second correction to AB. (This correction will be very small and will not affect the azimuth of A from B appreciably).

Then with the computed values for the angles DCB, BCA, CDA, and ADB, the azimuths of A and B from C and D are obtained, and with these azimuths and the computed lengths of the distances CA, CB, DA, DB, the latitude and longitude of Kaulia hill station (A), and Mahádeo Pokra hill station (B) are computed. These are approximately correct geodetic values, and with these values for the latitudes and the observed azimuth, the reverse azimuth and distance between them were again determined. With these data the triangles were finally computed, spherical excess being applied to the angles; and with the new lengths and azimuths a final value for the geodetic co-ordinates obtained. These values are given below and for comparison the values obtained by the method described in the "Report of the Identification and Nomenclature of the Himalayan Peaks, etc." are also recorded :—

STATION.		Latitude N.	Longitude E.	Azimuth.	Log Distance. Feet.	Height. Feet.
		° ′ ″	° ′ ″	° ′ ″		
Kaulia hill station	new	27 48 58·9	85 16 47·9	296 10 34	5·0091648	7,110
	old	27 48 58·6	85 16 47·9	296 10 25	5·0090052	7,050
Mahádeo Pokra hill station.	new	27 41 31·8	85 33 47·6	116 18 29		7,158
	old	27 41 31·6	85 33 47·3	116 18 20		7,090

The heights of Kaulia hill station and Mahádeo Pokra hill station were also re-computed. In the note on page 5 of the "Report on the Identification, etc." it will be seen that the vertical angles to the snow peaks could not be taken at the time of minimum refraction owing to cloudy weather, and that a co-efficient of refraction of 0·075 had been employed in the computations. These computations were made in Nepal, where no books of reference were available. As the subject was a controversial one, and it did not seem desirable therefore to introduce any factor that might be made a matter for discussion, a co-efficient very little larger than the normal one was employed; although at that time the heights were computed with varying co-efficients, and it was noticed that as the co-efficients increased up to about 0·1 the resulting values became more accordant. On the return from the field an investigation into the value to be used for the co-efficient was made in the following way:—

Let H=height of any known peak.
Y= „ of the station from which observations to H are taken.
E=the angle of elevation from Y to H.
c=distance in feet between Y and H.
K=co-efficient of refraction.

$$\text{Then } H-Y=c\tan\left\{E+c\left(\frac{1-2K}{2}\right)\frac{\rho+\nu}{2\rho\nu}\operatorname{cosec}1''\right\}.$$

$$\text{or approx. } K-\frac{2\rho\nu}{c^2\ (\rho+\nu)}\cos 1''\ Y=\frac{E.\ 2\rho\nu\ \sin 1''}{c\ (\rho+\nu)}+\tfrac{1}{2}-\frac{H.\ 2\rho\nu}{c^2\ (\rho+\nu)}\cos 1''.$$

Seven snow peaks to which observations had been made on different days were selected, and substituting in the above equation the values of the known quantities, seven equations of the form K—fY=F were formed.

These equations were solved by the method of minimum squares for K and Y with the resulting values—

for Kaulia h. s., K (co-efficient of refraction)=0·0975 Y (height)=7,143 feet.
„ Mahádeo Pokra h. s., K „ „ =0.0847 Y „ =7,183 „

The formula used is only an approximate one, but sufficiently accurate to obtain the values of K as it is small; Y being large, however the value given above was not accepted as correct; the final value adopted being the mean of the results obtained from the seven peaks computed independently, the co-efficient of refraction as obtained above being employed. These values are given in the table with the revised co-ordinates.

With the new values for the co-ordinates of Kaulia hill station and Mahádeo Pokra hill station, the positions of Kukani Bungalow, Khatmandu Clock Tower, Khatmandu Pillar and Budhnáth Pagoda were obtained; Khatmandu Pillar was fixed by Major Wilson in 1883, the two values are given for comparison.

Observer.	Year.	Station.	Latitude N.			Longitude E.		
			°	′	″	°	′	″
Major Wilson	1883	Khatmandu Pillar.	27	42	0	85	21	16
Captain Wood . . .	1903	„	27	40	49·0	85	21	48·2

In addition the co-ordinates of twenty-one of the snow peaks, previously unfixed, which had been seen from both stations of observation were computed and in order to obtain some idea of the accuracy of their fixings, the co-ordinates of any previously fixed peak in the vicinity of the new peaks were also computed. A synopsis of the new and old values is given below but it should be borne in mind that the observations are being used for a purpose which is very different to that for which they were originally made; and that the angles subtended at the peaks by the base Kaulia hill station—Mahádeo Pokra hill station in only one case (S31) exceeds 30° the average being under 18°, while at Everest the angle is under 7° the lengths of the sides being 90 and 106 miles.

STATION.	LATITUDE N.		LONGITUDE E.		HEIGHT.	
	Old.	New.	Old.	New.	Old.	New.
Peak XV (Everest) .	27° 59′ 16″·22	27° 59′ 18″·1	86° 58′ 7″·09	86° 58′ 11″·1	29,002	28,706
„ XVIII . .	27 52 50·52	27 52 51·9	86 31 58·62	86 32 2·0	21,980	21,866
„ XX (Gaurisankar)	27 57 51·97	27 57 53·8	86 22 43·27	86 22 49·7	23,440	23,372
„ XXI . .	27 57 28·83	27 57 29·6	86 9 8·85	86 9 9·7	19,550	19,475
„ B. 484 . .	28 6 14·6	28 6 17·4	85 56 35·7	85 56 38·1	19,740	19,941
„ S. 31 . .	28 10 10·0	28 10 9·4	85 43 17·7	85 43 17·7	...	20,993

Revised Appendix No. 1 of the Report on the Identification and Nomenclature of the Himalayan Peaks.

Results of Observations for Latitude and Azimuth at Kaulia hill station.

Date.	Latitude.		Azimuth of Referring Mark.		
	Star.	Latitude N.	Polaris.	ζ Ursæ Minoris.	Mean of day.
1903.					
Oct. 24th .	Polaris . .	27° 48′ 28″·6	93° 26′ 48″·0	93° 26′ 36″·4	93° 26′ 4339
	α Gruis . .	21·6	52·0	37·3	
„ 26th .	Polaris . .	25·2	45·6	44·2	45·76
	γ Gruis . .	24·9	52·0	41·3	
„ 27th .	Polaris . .	26·8	37·1	49·3	41·73
	α Piscis Australis.	28·1	34·1	46·5	
	Mean .	27 48 25·9	93 26 44·78	93 26 42·47	93 26 43·63

Azimuth of R. M. from hill station (from S. by. W.) = 273° 26′ 43″·6.

Mean computed Distances and Azimuths.

Object.	Distance.		Azimuth.
	Log feet.	Miles.	
			° ′ ″
To Kaulia hill station from Peak XXII .	5·3678987	44·184	61 4 22
„ „ XXIV .	5·3381499	41·259	53 31 38
„ „ XXV .	5·2638643	34·772	29 30 28
„ „ XXVII .	5·2984811	37·657	345 16 47
„ „ XXVIII .	5·4708605	56·005	319 18 0
„ „ XXX .	5·5372321	65·253	320 34 41

Resulting Co-ordinates for Kaulia hill station.

Computed from	Latitude N.	Longitude E.	Height in feet.
Peak XXII	27° 48′ 58″·31	85° 16′ 48″·78	7,088
„ XXIV	58·88	47·34	7,068
„ XXV	58·31	48·75	7,084
„ XXVII	58·79	47·16	7,032
„ XXVIII	58·40	48·50	7,025
„ XXX	58·82	46·89	7,005
Mean . .	27 48 58·6	85 16 47·9	7,050

Observed Latitude = 27° 48′ 25″·9.
Computed „ = 27 48 58·6.
∴ O − C = −32·7.″

Results of Identification of Snow Peaks.

NAME OF PEAK.	Latitude N.			Longitude E.			AZIMUTH.						HEIGHT IN FEET.	
							Computed.			Observed.			Computed.	Observed.
	°	′	″	°	′	″	°	′	″	°	′	″		
Peak XV	27	59	16·22	86	58	7·09	263	4	51	263	4	14	29,002	28,773
„ XVIII	27	52	50·52	86	31	58·62	266	23	49	266	23	6	21,980	21,881
„ XX	27	57	51·97	86	22	43·27	261	6	44	261	6	18	23,440	23,385
„ XXI	27	57	28·83	86	9	8·85	259	26	8	259	25	51	19,550	19,500
„ XXIII	28	21	6·74	85	49	21·76	221	49	7	221	49	11	26,290	26,281
„ XXXIII	28	29	23·77	84	13	57·42	126	13	2	126	10	13	22,920	22,844
„ XXXIV	28	32	4·99	84	9	52·78	126	16	48	126	16	51	26,040	25,997
„ XXXV	28	32	11·32	84	7	32·33	125	25	22	125	26	51	24,690	24,664
„ XXXVII	28	29	40·71	83	59	22·12	120	58	40	121	1	2	22,940	22,899
„ XXXVIII	28	29	53·64	83	59	20·56	121	6	10	121	6	17	22,960	22,922
„ XXXIX	28	35	44·31	83	51	46·52	122	10	12	122	10	50	26,492	26,477
„ XL	28	31	5·21	83	50	55·72	119	17	52	119	18	16	23,607	23,592
„ XLVII	28	40	26·10	83	19	7·02	116	44	41	116	44	32	23,539	23,424
„ S. 12	28	15	51·0	85	14	10·3	175	3	15	175	5	8	19,130	19,105
„ B. 7	28	22	45·3	85	6	0·9	164	14	12	164	13	32	23,310	23,369
„ B. 484	28	6	14·6	85	56	35·7	243	48	5	243	46	25	19,740	19,907
„ S. 31	28	10	10·0	85	43	17·7	227	52	40	227	54	5	...	20,956
„ T. 8 or S. 30	28	14	59·1	85	47	32·0	226	14	11	226	14	24	...	22,569
„ M. a	28	23	27·3	84	49	55·2	145	27	7	145	27	21	...	18,730
„ S. 7	28	19	55·1	85	12	7·2	172	22	49	172	22	1	...	22,259
„ S. 8	23	19	53·8	85	12	22·0	172	46	22	172	45	48	...	22,363

Revised Appendix No. 2 of the Report on the Identification and Nomenclature of the Himalayan Peaks.

Mean values of angles measured at Mahádeo Pokra hill station between the Snow Peaks.

Name of Peak.	Horizontal Angle.	Vertical Angle.
	° ′ ″	° ′ ″
R. M.	0 0 0	
Peak XXIV	63 59 33·1	E. 4 25 9
„ XXV	89 42 38·9	E. 4 23 28
„ XXVI	115 50 8·3	E. 3 8 2
„ XXVII	120 10 12·8	E. 3 1 33
„ XXVIII	135 39 29·6	E. 2 16 35
„ XXX	133 59 19·1	E. 2 2 6

Results of Observations for Latitude and Azimuth.

Date.	Latitude.		Azimuth of Referring Mark.		
	Star.	Latitude N.	Polaris.	ζ Ursæ Minoris.	Mean of day.
		° ′ ″	° ′ ″	° ′ ″	° ′ ″
1903. Nov 7th	Polaris	27 40 53·2	89 25 64·1	89 25 46·8	89 25 56·53
	β Gruis	52·5	55·2	60·1	
„ 8th	Polaris	54·5	56·6	58·9	56·99
	α Gruis	52·3	60·3	52·3	
Mean	...	27 40 53·1	89 25 59·01	89 25 54·50	89 25 56·76

Azimuth of R. M. from hill station (from S. by W.) = 269° 25′ 56″·8.

Mean computed Distances and Azimuths.

Object.	Distance.		Azimuth.
	Log feet.	Miles.	° ′ ″
To Mahádeo Pokra h. s. from Peak XXIV	5·2875372	36·720	25 33 3
„ „ „ „ XXV	5·3117720	38·827	359 43 0
„ „ „ „ XXVI	5·4535693	53·819	333 24 30
„ „ „ „ XXVII	5·4419195	52·394	329 3 22
„ „ „ „ XXVIII	5·5926676	74·137	313 22 3
„ „ „ „ XXX	5·6428891	83·225	314 59 30

Resulting Co-ordinates for Mahadeo Pokra hill station.

COMPUTED FROM.		Latitude N.	Longitude E.	Height in feet.
		° ′ ″	° ′ ″	
Peak	XXIV	27 41 32·08	85 33 48·17	7,114
„	XXV	31·54	47·20	7,133
„	XXVI	31·71	47·65	7,069
„	XXVII	31·29	46·92	7,092
„	XXVIII	31·08	46·50	7,074
„	XXX	31·65	47·24	7,060
	MEAN	27 41 31·6	85 33 47·3	7,090

Observed Latitude = 27 40 53·1″
Computed „ = 27 41 31·6
∴ O—C = −38″·5

Results of Identification of Snow Peaks.

NAME OF PEAK.		Latitude N.	Longitude E.	AZIMUTH.		HEIGHT IN FEET.	
				Computed.	Observed.	Computed.	Observed.
		° ′ ″	° ′ ″	° ′ ″	° ′ ″		
Peak	XV	27 59 16·22	86 58 7·09	256 21 16	256 20 39	29,002	28,950
„	XVII	27 45 15·54	86 36 58·10	265 57 27	265 56 43	22,820	22,777
„	XVIII	27 52 50·52	86 31 58·62	257 26 24	257 25 44	21,980	21,945
„	XIX	27 58 13·82	86 28 33·08	250 46 44	250 45 41	23,560	23,544
„	XX	27 57 51·97	86 22 43·27	249 13 19	249 13 53	23,440	23,402
„	XXI	27 57 28·83	86 9 8·85	242 57 16	242 56 44	19,550	19,480
„	XXIII	28 21 6·74	85 49 21·76	199 11 7	199 11 2	26,290	26,254
„	XXXIII	28 29 23·77	84 13 57·42	124 22 46	124 21 55	22,920	23,018
„	XXXIV	28 32 4·99	84 9 52·78	124 31 44	124 31 46	26,040	...
„	XXXV	28 32 11·32	84 7 32·33	123 51 50	123 52 56	24,690	24,828
„	XXXVII	28 29 40·71	83 59 22·12	120 16 24	120 17 55	22,940	23,052
„	XXXVIII	28 29 53·64	83 59 20·56	120 22 40	120 22 26	22,960	23,079
„	XXXIX	28 35 44·31	83 51 46·52	121 20 46	121 21 2	26,492	26,558
„	XL	28 31 5·21	83 50 55·72	118 55 35	118 55 33	23,607	23,771
„	XLVII	28 40 26·10	83 19 7·02	116 48 19	116 47 54	23,539	23,761
„	B. 439	27 57 11·2	86 25 18·2	250 55 20	250 54 44	...	21,823
„	B. 522	28 16 20·3	85 35 48·9	182 57 2	182 57 12	22,010	22,142
„	B. 495	28 10 36·4	85 51 41·7	208 36 10	208 36 0	21,760	21,748
„	B. 484	28 6 14·6	85 56 35·7	219 15 14	219 14 55	19,740	19,894
„	S. 31	28 10 10·0	85 43 17·7	196 23 18	196 23 11	...	20,977
Kaulia hill station		27 48 58·6	85 16 47·9	116 18 20	116 18 29	7,050	7,028

VII

TOPOGRAPHICAL SURVEYS IN SIND.

Extracted from the Narrative Report of Mr. C. F. Erskine, in charge of No. 12 Party (Sind) for Season 1903-04.

GENERAL PLAN OF SURVEY OPERATIONS.

During the year under report, detail survey operations were carried on in the Hyderabad, Thar and Párkar and Karáchi districts.

Triangulation in advance was carried out in the Thar and Párkar and Karáchi districts, and also in Berar.

Detail survey was carried out entirely by interpolation.

The total number of fixings from which the work was checked by the camp officers is 1,212. The total area topographically surveyed on the 2-inch scale is 2715·31 square miles.

COMPOSITION OF DETACHMENTS EMPLOYED.

At the commencement of the field season the composition of the detachments employed on the various survey operations was as follows :—

Detail Survey—2-inch scale.

Mr. Warwick's camp consisting of six men averaged per man per mensem 35 square miles and 554 fixings.

Munshi Rahmatullah's camp consisting of 10 men averaged outturn per man per mensem 32 square miles and 444 fixings.

Late in the season, one man from Mr. Warwick's camp and two men from the traverse camp were added to Munshi Rahmatullah's camp to finish all the remaining area in the northern part of the 2-inch detail survey.

In the traverse camp under Mr. Vander Beek the average outturn of chaining per man per mensem was 54 linear miles.

Mr. Bond and Babu Dhani Rám were employed in running net-works of triangulation, the former in the desert of Thar and Párkar district and the latter in the Karáchi district in continuation of the previous season's work.

TRIANGULATION AND TRAVERSING.

Two net-works of triangulation were run to afford reliable points to the detail surveyors working in the desert portion of Thar and Párkar district and in a portion of the Karáchi district.

(*a*) A net-work covering 3,252 square miles, was carried over the desert portion of Thar and Párkar district, situated on the east of the Nára river, by Mr. Bond in well planned triangles with an average of 10-mile sides. The stations of this net-work were marked by platforms of bricks and clay, two bricks marked with a dot and circle were embedded, one flush with the upper surface of the platform and the other buried about two feet below the surface.

(*b*) A second net-work covering 970 square miles, was completed by Babu Dhani Rám in the Karáchi district, east of the Indus river.

The stations of this series were marked in the same manner as those of net-work (*a*).

For observing, Mr. Bond used a 6-inch theodolite and Babu Dhani Rám a 7-inch. Lieutenant E. T. Rich, R.E., was employed in running a net-work of triangulation in Berar for the greater part of the field season. His outturn of work was 1,772 square miles, and the instrument used was a 6-inch theodolite.

Traversing by theodolite was carried over the lands watered by the Jamrao, Nasrat and Dád canals and consisted of main circuits, sub-circuits and connections with triangulated points.

During the past season 6 main circuits and 25 sub-circuits were measured and in addition to this 29 connecting lines were run over the Sanghar táluka where the village boundaries were not demarcated.

The total area traversed is 2,033 square miles which together with the area triangulated and traversed in former seasons and not yet topographically surveyed makes an area of about 5,300 square miles available for detail survey during the coming field season. The total number of stations observed at was 6,159 and the angular work was checked by observations for azimuth taken at 99 stations of main and sub-circuits.

The total linear measurements amounted to 2,456 miles and were checked by 17 connections with the stations of the minor triangulation executed by this party and with some stations of the Sehwán Secondary Series.

The average correction per 1,000 links being 0·39 link and the angular error per station being 0′-53″.

No permanent marks were erected at traverse stations, but wherever possible the stones embedded by the Revenue authorities to demarcate village boundaries were utilized.

The country topographically surveyed on the 2-inch scale during the year under report was generally of the same monotonous description as that met with in former seasons; near the river Indus the country is well populated and highly cultivated, moving eastward the population becomes noticeably scantier and large tracts of uncultivated ground interspersed with sand hills are met with; the eastern portion is desert, the sand hills, rising to a height of about 150 feet above the surrounding ground level, are perfectly bare and destitute of water.

DURATION AND CLOSE OF FIELD SEASON.

The recess office of the party was closed at Karáchi on 26th October 1903 and re-opened at Nawábsháh on 1st November. The head-quarter and traverse camps were located at Nawábsháh during the entire season. Survey operations were brought to a close by the end of March and the office was then transferred to Karáchi for recess.

GENERAL REMARKS ON WORK COMPLETED AS TO COST RATES, ETC.

9. The total cost of the party during the year ending 30th September 1904, is R82,712-7-5 and the cost rates per square mile are as follows:—

	R	a.	p.	
Triangulation in Sind	3	2	6	per square mile.
„ „ Berar	4	15	10	„ „
Traversing „ Sind	9	15	9	„ „
Detail survey on 2-inch scale . . .	10	3	3	„ „
Fair mapping on ½ inch „ . . .	0	14	0	„ „
„ „ 2 „ „ . . .	3	10	7	„ „

VIII

NOTES ON TOWN AND MUNICIPAL SURVEYS.

By Captain Coldstream, R.E., and Mr. R. B. Smart.

I.—Consideration of scale and description of survey.

The scale and method to be adopted for the survey of a town or municipality must depend on the special purpose for which the survey is required.

A town survey may be wanted for one or several of the following reasons:—

(i) For general administration purposes.

(ii) To enable a water supply or drainage scheme to be designed and carried out.

(iii) For the purpose of checking encroachments on the public roads and streets.

(iv) To provide site plans for new buildings and works.

(v.) To provide an index and basis for a record-of-rights.

In deciding the scale and description of survey, care should be taken that the Chairman or Magistrate of a municipality understands the limits and advantages of the scale proposed. If the map is required merely for general purposes, a comparatively small scale of from 6 inches to 16 inches to the mile will probably meet all requirements. For a drainage or water supply scheme the scale should be large enough to show each street and alley clearly, and should not be less than 16 inches to the mile, but if the map is also required to check encroachments and decide disputes, some larger scale, from 32 inches to 64 inches to the mile, or 100 feet to the inch, should be adopted, while if one of the objects is the preparation of a record-of-rights of holdings, the survey of every detail will be necessary, and nothing smaller than a scale of 64 inches to the mile, or 50 feet to the inch, will suffice for the sheets which include streets and blocks of buildings. In the last case it may, however, save expenditure and meet all requirements if the open spaces and cultivation, where these areas form a large proportion of the whole, are surveyed on some smaller scale, 16 inches to the mile or 200 feet to the inch.

II.—Arrangments to be made with Chairman.

The chairman of the municipality should be asked to appoint some responsible local official to point out to the surveyors all boundaries, *e.g.*, those of *mahallas*, wards, or villages, which are to be shewn on the maps, or to arrange that all such boundaries may be clearly demarcated on the ground before survey.

A list of all names to be entered on the maps should be provided by the chairman, or prepared by the survey establishment, and sent to the chairman for additions or alterations.

An estimate of the duration and cost of the work under different headings should be prepared for submission to the administrative officer, and a copy should be sent to the chairman of the municipality. If a record-of-rights is to be written on the basis of the survey, the share to be taken by the survey establishment in the record-writing, should be arranged before operations commence, and should be very clearly defined. In this case, whether the records are to be written by the survey establishment or not, co-operation between the survey and municipal officials will be particularly necessary, and the chairman should be informed that want of energy on the part of the municipality will delay the completion of the work and enhance the cost.

The number of copies of the maps, which will be required, and the method of reproduction to be adopted, should be ascertained before survey. The wishes of the chairman should also be ascertained on such points as the entry of temporary buildings, *e.g.*, galvanised iron sheds, plague huts, etc., and the necessity or otherwise for distinguishing between masonry and half masonry, as well as between masonry and mud buildings.

III.—Triangulation and traverse work.

For the survey of a large municipality it will be useful to fix a few prominent points, both within the town and on its outskirts, by triangulation, on which to base the traverse work; but for both large and small towns it will be sufficient if the exterior traverse circuit is connected directly with neighbouring G. T. stations, or if no G. T. stations are available at a short distance, with the traverse stations of adjacent cadastral work.

The preliminary net-work of theodolite traverse should be closer and more detailed for town surveys than for surveys on the same scales of open ground, and for the larger scale surveys, every street and alley should be traversed.

The exterior circuit (which will generally follow the municipal boundary) and if the area is extensive, the sub-circuits also, should be executed with the same precision and care as the main circuits of traverses for cadastral surveys. Observations for azimuths should be taken both on main and sub-circuits.

Where the scale of survey is expressed in feet to the inch and areas are required in square feet, the setting up and proving should be done in feet, and all measurements should be made and recorded in feet and decimals of a foot, both in the operations of traverse and detailed survey. If, however, the scale adopted is a multiple of the ordinary cadastral scale, 16 inches to the mile, and areas are required in acres, it will be more convenient to use Gunter's chains and links throughout.

The theodolite stations on the exterior circuit should be marked permanently by stones, theodolite stations on the interior traverses may be marked by embedded bricks, or by iron pegs, or where possible, by marks chiselled on the pavement or on curb stones, etc. It will greatly facilitate the finding of all stations, if a distinctive sign and the distance in feet or links to the station are marked in tar on the nearest wall. If municipal boundary pillars exist, they should be utilised as theodolite stations, and if possible, the lines of the traverse should run direct from pillar to pillar.

IV.—Detailed survey.

The detailed survey of towns on small scales (6 inches to the mile and under) should be carried out by professional topographers, but for the larger scales, cadastral *amins* make the best and most economical surveyors. Cadastral *amins* should not be employed on small scale work, as they invariably fail in the delineation of detail that requires generalisation and judgment, and cannot as a rule even read a small scale map correctly. Their work in towns should be confined, as far as possible, to the merely mechanical measuring and plotting of offsets from traverse lines and the description, by conventional signs or reference lists and numbers, of the detail thus surveyed.

If the survey is on a small scale, the plane-table sections should be thoroughly tested and passed by a superior officer. Where the scale is large and *amins* are employed, one Inspector should be appointed to the charge and supervision of every 6 *amins.* The Inspector's chief duty is to run check lines while the work is in progress, so that bad work may be discovered and rejected at the outset, and the perpetrator dismissed, and a substitute appointed by the officer in charge.

In addition to this, a superior officer should personally check as much as possible of the work 'in situ,' but in large scale surveys it will frequently be impossible for an officer to check every sheet in this way, and the system of independent *partáls* should be resorted to. These should consist of the re-survey along lines and of small areas in each sheet, and should be carried out after the sheet has left the surveyor, and is in the custody of the officer in charge. The selection of lines and areas for re-survey in this way should be made by a superior officer, and on the results of the re-survey, the sheets are returned for correction or passed by the officer in charge. If bad work necessitating resurvey is discovered, the Inspector as well as the *amin* concerned should be held responsible, but such cases should be very rare if the Inspector has done his duty conscientiously.

V.—Completion of original sheets, traces and area statements.

When the original sheets of a large scale survey have been passed and inked in, it will generally be found well worth the extra labour and expenditure involved, to examine them on the ground. Mistakes are liable to occur in inking in, and a detail that has been correctly surveyed may be shewn incorrectly; for instance owing to mistakes in the reference lists, or on the part of the draftsman, fences may be inked in as walls, and *vice versâ.* As much as possible of this work should be done by a superior officer. Very little actual measurement will be required as the survey should be correct, and it can generally be seen at a glance whether the map represents the detail on the ground faithfully or not.

VI.—Preparation of index charts.

In order to facilitate reference to the sheets of large scale surveys, an index chart on some smaller scale should be prepared. The sheets or tracings should be numbered consecutively, and arranged in portfolios, either by *mahallas* or other administrative or fiscal divisions or, if the limits of these are not known, as is sometimes the case, by arbitrary blocks.

IX

NOTES ON RIVERAIN SURVEYS IN THE PUNJAB.

Extracted from the Narrative Report of Captain E: A. Tandy, R.E., in charge of No. 18 Party (Punjab) for season 1903-04.

Riverain Surveys.—The original decisions on the subject were naturally tentative, and based on theoretical conceptions of the conditions. The 8-inch scale originally suggested was abandoned almost at once, as quite impracticable, and the practice of placing markstones on traverse points was given up at an early date from motives of economy; at the same time there are probably circumstances in which both these items might be feasible and worth while.

Last year, when the stage of fair mapping was first reached, definite orders were given as to the style of drawing, etc., but nothing of the sort was obtainable for the treatment of discrepancies disclosed by compilation; both the Settlement Commissioners who inspected the work leaving the officer-in-charge to make the best of it, with a very fair impression, which was clearly shared by the Deputy Surveyor-General, that its utility was dubious.

The officer-in-charge has, however, felt, in the face of considerable scepticism, that there must be some way in which the scientific aid of the department might be utilised to help the Punjab out of its riverain difficulties, and that it was his business to discover it. The more muddle and chaos he has found, the more deeply has he been convinced of the urgent need for scientific assistance, if only it could be so directed as to meet the needs of those for whom it is required. Until he had had some personal experience in the field it was impossible for him to form any satisfactory opinion; but his whole policy during the field season was aimed at gathering as wide a variety of experience as possible, with a view to getting the work placed on a satisfactory basis during the recess.

As the Settlement Commissioner could not himself spare the necessary time, he deputed an officer with settlement experience about the end of July, to go thoroughly into the matter on his behalf.

Both these officers, very soon came to the conclusion, repeatedly prophesied by the Deputy-Surveyor-General, that, for the legal settlement of disputes, no use could be made of fair maps in which discrepancies had been adjusted without authority.

This difficulty, together with a proposed solution of the whole question, has been fully discussed in a report which received the complete approval of the Settlement Commissioner and now only awaits the orders of the Surveyor-General and of the Financial Commissioner of the Punjab.

Previous to 1899 the boundaries of riverain estates were adjusted to the movements of the Punjab rivers according to local usage, which varies sometimes from village to village, but could generally be classed under 3 heads :—

(i) fixed boundaries irrespective of the position of the rivers.

(ii) boundaries fluctuating with the centre of deep stream.

(iii) modified deep stream boundaries, where large tracts unmistakeable belonging to an estate were retained by it in spite of being cut off by changes in the river.

District boundaries generally coincided with those of the villages, though sometimes they were apparently dependent on the deep-stream rule, irrespective of petty local adjustments between opposite estates.

The immense amount of litigation which occurred annually, with little or no definite evidence to elucidate it, was further complicated by the fact that in the case of villages lying on the boundaries of districts or states, the village boundary was generally also the boundary of jurisdiction, so that when the possession of a certain area was disputed by opposite estates, it was never certain, until the dispute was settled, which of the two administrations was the proper court of jurisdiction.

Considering the immense areas of water and sand and the way their positions are continually shifting, it will be seen that there must, under any system, be a great deal of luck in the amount of arable land in any particular estate at a given time; so that pedantic accuracy is absurd, and what is required is rapid and substantial justice, to enable men to proceed with their ploughing before the season is passed.

Punjab Act No. 1 of 1899 was accordingly passed to effect a uniform system of fixed boundaries, both for property and jurisdiction in all British districts. The Act cannot be forced on Native States. They have for the most part acquiesced in its provisions, but occasionally the fixed boundary has only been accepted by them for purposes of jurisdiction, and the owners of estates have refused to relinquish their old usages as to the boundaries of property.

As stated above the fixed boundary system was already in force in many localities, sometimes continuously throughout whole tahsils and districts, though often, even in these cases, groups of 2 or 3 villages had never accepted it; while there were other tracts where the fixed boundary system was nowhere recognized as determining the rights to property.

It is to these latter tracts that Settlement Officers have been sent, since the passing of the Act, and in determining fixed boundaries they have to arrange all sorts of exceptions whereby arable ground shall continue in possession of its present recognized owners in spite of the newly settled boundary, until such time as it shall be finally washed away. There are also many other difficulties arising from the whole principle of fixed boundaries being opposed to local usage.

Riverain Settlement Officers have therefore a great deal to consider and attend to besides the bare necessities of survey work, though they have to make some sort of maps, on which to record their decisions, and enable future measurements to be made.

The most approved system is for the river to be divided into sections of a few miles each, and to lay out over each section, a single system of squares including the villages on both sides of the river; but a good many varieties of procedure have been adopted in different places. Lately they seem to have tried as far as possible to lay down boundaries consisting entirely of straight lines; pointer pillars are generally erected on the high banks to assist in relaying the points of intersection of the boundary lines, though they are often so close together that they could only afford a very rough approximation.

The Settlement Officer's survey, therefore, only includes the state or district boundary and its immediate vicinity, so that sometimes large villages on the boundary are not surveyed in their entirety; the inland boundaries have generally been surveyed and mapped at some previous district settlement, and the riverain settlement would become extremely laborious and would probably raise many extraneous difficulties if it attempted to embrace and reconcile itself with the old surveys. These difficulties will be more apparent if we remember that sometimes one district will have been surveyed by the old patwari system of triangulation, and the other by the square system, and also that the Karm or unit of measurement may have been quite different in two contiguous districts; several different Karms, varying from about 4½ feet to 5½ feet in length, are in use in the Punjab. The riverain officer, moreover, will often skip a lot of riverain villages, where the fixed boundary system has always obtained and is shown in the old district settlement surveys and he considers further intervention unnecessary or undesirable.

As this variegated patchwork is all the Settlement Department has been able to do for itself, it has very naturally called on the Survey of India to make a clear and complete compilation of the riverain settlements, which shall have such a definite geographical value and be so based on permanent points on the high banks that whatever changes may occur in the river, it may be possible through all time to relay disputed boundaries with reasonable accuracy. Considering how very much "in the air" the riverain settlement maps usually are, and the generally nebulous state of their connection with the district surveys, this is evidently a matter where properly directed scientific work, even if somewhat imperfect in its details, may be of inestimable value, in narrowing down all future uncertainties to definite limits, and enabling disputed boundaries to be relaid with substantial accuracy and the minimum of delay.

It has naturally taken some time and considerable actual experience of the conditions to get into satisfactory touch with this work; the difficulty has been enhanced by the large number of changes in personnel both on the survey and the settlement side. It is hoped that the proposals now under consideration will eventually lead to a feasible and satisfactory procedure being adopted.

So far the work has been chiefly confined to special new settlements under the Riverain Boundaries Act. But the Settlement Commissioner appears so sanguine of the usefulness of the latest proposals, that he seems inclined to get the old settlements, which have always shown fixed boundaries, also included in the riverain programme of the party, so that the whole of the riverain tracts in the Punjab should be eventually completed.

G. I. C. P. O.—No. 47 S. G.—27-8-06—350.—J. W

EXTRACTS
FROM
NARRATIVE REPORTS
OF OFFICERS OF THE
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FOR THE SEASON
1903-04.

PREPARED UNDER THE DIRECTION OF
COLONEL F. B. LONGE, R.E.,
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