SURVEY OF INDIA

GEODETIC REPORT

1940

PUBLISHED BY ORDER OF

THE SURVEYOR GENERAL OF INDIA

COMPILED AT THE WAR SURVEY RESEARCH INSTITUTE
AND
PRINTED AT THE OFFICE OF THE GEODETIC BRANCH,
1945

Price Two Rupees, or Three Shillings

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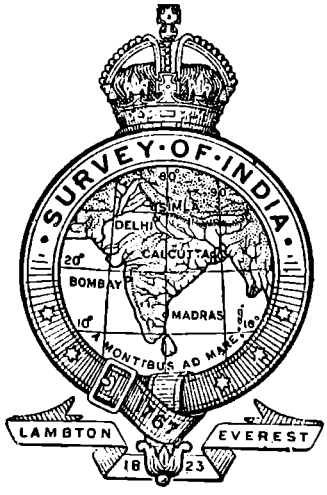

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CONTENTS

CHAPTER IV

Computing Office and Observatories

Charts

INTRODUCTION

The publication of this volume during the war has been decided on as a special measure in consideration of the fact that the work described completes the geodetic programme arranged before the outbreak of war. It includes work up to January 1941. The work belongs to the pre-war period and is followed by a break in geodetic activities already lasting nearly 4 years.

The volume has been kept down to the smallest practicable dimensions in view of paper economy and the pressure of publication work. This accounts for omission of the ordinary Introductory Notes and list of Sales Agents and also of the list of Survey of India Publications : all of which can be found in earlier volumes of the "Geodetic Reports".

This volume has been compiled in the War Survey Research Institute which, since its formation in August 1943, has been responsible for any geodetic matters. Mr. Gulatee has written up the materials derived from the observers concerned. While Brigadier Glennie has seen and commented on the gravity results, it has not been possible for him or anyone in the War Survey Research Institute to enter into a detailed discussion of them. In the same way, the results of Deviations of the Vertical are given without full discussion ; and drawing of the geoidal contours (vide Chapter II, para 13) has been deferred.

Variation of latitude observations were made at Dehra Dūn for the 3 year period 1930–33 and yielded an unexpectedly large amplitude of variations, not in sympathy with the results of the International Latitude Variation stations. As it was conjectured that this might be due to local peculiarities of the isopycnic surfaces in the Dūn valley between the Siwaliks and the outer Himalayas, it was decided to make further observations at Agra. This was carried out and results for the years 1937–40 at Agra are now published (Chapter IV, para 25). These have not been analysed, but they show the same unusually large amplitude of about one second as found previously at Dehra Dūn.

J. DE GRAAFF HUNTER,

September 1944. *Director, War Survey Research Institute.*

PERSONNEL* OF THE GEODETIC BRANCH 1939–40

Director, Geodetic Branch

COLONEL E. A. GLENNIE, D.S.O., R.E.

OFFICE OF THE DIRECTOR, GEODETIC BRANCH

Ministerial Service

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Assistants

Mr. Manindra Mohan Barary

Head Accountant

22 Clerks.

General Central Class I Service

Mr. B. L. Gulatee, M.A. (Cantab.), Mathematical Adviser

COMPUTING AND TIDAL PARTY

(RECORDS AND RESEARCH)

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Captain C. A. Biddle, R.E., in charge from 7th March 1940.

OBSERVATORY SECTION

Magnetic Observer

Mr. Shyam Narain, B.Sc.

Upper Subordinate Service

Mr. J. B. Mathur to 24th January 1940 and from 6th March 1940.

Lower Subordinate Service

4 Computers.

TIDAL SECTION

Upper Subordinate Service

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Lower Subordinate Service

5 Computers.

COMPUTING SECTION

Upper Subordinate Service

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Mr. Mohammad Faizul Hasan.

Mr. C. B. Madan, B.A.

Mr. A. N. Ramanathan, M.A.

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1 Leveller.

1 Librarian.

Service on deputation (from Burma Oil Co.)

1 officer from 12th February, 1940; and 2 officers from May 1940.

CHART SECTION

(ADMINISTERED BY O.C. 2 D.O.)

Lower Subordinate Service

4 Draftsmen.

No. 14 PARTY (GEOPHYSICAL)

Class I Service

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Class II Service

Mr. M. N. A. Hashmie, B.A., from 1st November 1939 to 17th March 1940.

Mr. P. S. Shinghal, O.B.E.

Lower Subordinate Service

1 Computer.

No. 15 PARTY (TRIANGULATION AND LEVELLING)

Class I Service

Colonel E. A. Glennie, D.S.O., R.E., in charge.

Class II Service

Mr. Jugal Behari Lal.

Upper Subordinate Service

Mr. A. A. S. Matlub Ahmad.

Mr. Muhd. Z. A. Qureshi from 9th October 1939 to 7th May 1940.

Lower Subordinate Service

3 Computers. 2 Clerks.

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* Excluding No. 1 Party, No. 20 (Cantt.) Detachment, No. 2 Drawing and Forest Map Offices, Printing, Photo-Zinco, Stores and Workshop Sections and War (training) Section.

INDIA

LINES OF

PRECISE LEVELLING

AND

TIDAL STATIONS

Corrected to Sept. 1941

60° 64° 68° 72° 76° 80° 84° 88° 92° 96° 100° 104° 108° 112°

32° 28° 24° 20° 16° 12° 8°

Kābul · Peshāwar · Srīnagar · Rāwalpindi · Indus R. · Nasratābād · Kandahār · Dera Ismail Khān · Chaman · Quetta · LAHORE · Amritsar · Ludhiāna · Multān · Sutlej R. · Dehra Dūn · Indus R. · Meerut · DELHI · Jumna R. · Ganges R. · Bikaner · Sukkur · Jodhpur · Agra · Lucknow · Fyzābād · Gwalior · Cawnpore · Hyderābād · Karāchi · Allahābād · Benares · Deesa · Kalianpur · Navānar · Hanstal · Okha Point · Ahmadābād · Jubbulpore · Bhāvnagar · Narbadā R. · Porbandar · Port Albert Victor · Raipur · NĀGPUR · Sambalpur · Bhadrak · Chāndbāli · Dublat (Sagar I.) (Shortt I.) · False Point · Cuttack · Kidderpore · CALCUTTA · Diamond Harbour · Darjeeling · Brahmaputra R. · Lhāsa · Dibrugarh · Shillong · Myitkyina · Salween R. · Chittagong · Chindwin R. · Mandalay · Irrawaddy R. · Salin · Akyab · Prome · Mekong R. · Lao-hai · Hanoi · Nan-ning · GULF OF TONG-KING · Prince's Dock · BOMBAY · Apollo Bandar · Poona · Godāvari R. · Vizianagram · Waltair · Vizagapatam · Cocanāda · Hyderābād · Raichūr · Kistna R. · Bagalkot · Belgaum · Marmagao · Karwār · Bellary · Mangalore · Bangalore · MADRAS · Calicut · Beypore · Trichinopoly · Negapatam · Cochin · Pāmban Pass · Tuticorin · Trincomalee · Nagarkoil · Minicoy · Colombo · CEYLON · Galle · B A Y o f B E N G A L · RANGOON · Bassein · Elephant Point · Diamond I. · Moulmein · Amherst · Bangkok · Mergui · ANDAMAN ISLANDS · Port Blair · Koh Hlak · GULF OF SIAM · Saigon · NICOBAR ISLANDS · SUMATRA · George Town

29 33 38 43 52 30 34 39 44 53 62 31 35 40 45 54 63 72 78 83 92 101 110 36 41 46 55 64 73 79 84 93 102 111 47 56 65 74 85 94 103 112 48 57 66 86 95 104 113 49 58 67 87 96 105 114 59 68 88 97 106

REFERENCES

Levelling of High Precision since 1914

- Projected
- One direction only completed this season
- One direction only completed in previous seasons
- Both directions completed this season
- Both directions completed, one this season and one previously
- Both directions completed previously

Levelling of Precision

- Completed 1858–1941
- Completed this season

Levelling of Secondary Precision

- Completed 1921–41
- " this season

- Tidal Stations on which levelling has been adjusted — Madras
- Other Tidal Station — Tuticorin
- Foreign Geodetic Levelling

Scale 1 Inch = 250 Miles or 1/15,840,000

Miles 100 0 100 200 300 400 Miles

Res. No. 91 D.D.D. 1939 (C.O.) S. I-360'325-40,315-44.

Heliozincographed at the Survey of India Offices. (P. Z. O.)

CHAPTER I

LEVELLING

BY MR. B. L. GULATEE, M.A. (Cantab.)

1. Summary.—The following programme was carried out by two levelling Detachments in 1939–40 :—

(*i*) High precision levelling from Balasore (Orissa) to Bhadrakh (Orissa) ; and from Sambalpur (C.P.) to Bhadrakh (Orissa).

(*ii*) High precision levelling from Cuttack (Orissa) to Vizianagram (Madras).

In 1940–41 one Detachment was sent to complete the remaining portions of lines 117 and 125 in the back direction. It carried out

(*i*) H.P. levelling from Raipur (C.P.) to Pithora (C.P.) and Sohela (C.P.) to Sambalpur (C.P.).

(*ii*) H.P. levelling from Bhadrakh (Orissa) to Cuttack (Orissa).

The total out-turn of levelling was :—

	1939–40	1940–41
High precision levelling in back direction	530 miles (643 gross)	176 miles (187 gross)

2. Balasore to Bhadrakh and Sambalpur to Bhadrakh.—No. 1 Detachment under Mr. A.A.S. Matlub Ahmad started work at Balasore on 6th November 1939 and carried out back levelling thence to Bhadrakh. This line forms part of line 121 (of the new level net) and follows the Orissa Trunk road.

After completing this line, the Detachment started work on 2nd December, 1939 in the back direction from Bhadrakh to Sambalpur. This line forms part of line 117 of the new level net, and proceeds along the road from Sambalpur up to Pāl Lahara via Deogarh, thence along mule path up to Keonjhargarh, thence along Jājpur R.S. road up to Ghasipara (Anandpur), thence along road to Bhadrakh.

The Detachment completed field work on 25th April, 1940.

3. Cuttack to Vizianagram.—The observations in the back direction of the line Vizianagram to Cuttack were undertaken by No. 2 Detachment under Mr. M.Z.A. Qureshi on 1st November 1939. This line which forms part of levelling line 125, runs from Cuttack along Orissa Trunk Road up to Ichahapuram town, thence along Grand Northern Trunk road to Natavalasa village, from which place it follows the Vizianagram–Natavalasa road to Vizianagram.

The Detachment completed field work on 25th April, 1940.

4. Sohela to Sambalpur, Raipur to Pithora & Bhadrakh to Cuttack.—A levelling Detachment under Mr. A.A.S. Matlub Ahmad commenced work at Sambalpur on 8th November, 1940 and finished observations in the back direction of the two portions Sohela to Sambalpur and Raipur to Pithora of line 117 on 14th January 1941.

The Detachment next took up levelling along line 125 (Bhadrakh to Cuttack) in the back direction at Cuttack on 20th January 1941. Starting from Bhadrakh, the line runs along Orissa Trunk Road up to the point where it crosses high level canal, thence it follows canal road on right bank of the above canal up to Chowduār, and thence after crossing Birupa river, it follows the Jagatpur–Patāmundai road to Jagatpur R.S. (Cuttack). Field work was completed on 18th February, 1941.

5. Probable errors.—The probable errors of the high precision lines completed in 1939–41 are tabulated below :—

Line No.	Name of line	Probable systematic error	Probable accidental error
		feet/miles	*feet/miles*
117	Raipur–Bhadrakh ..	±0·00056	±0·00319
121	Howrah–Bhadrakh ..	±0·00060	±0·00284
125	Bhadrakh–Vizianagram ..	±0·00118	±0·00337

6. Progress of the new level net.—The levelling under report has added 706 miles to the previously completed mileage of the new level net, thus making the total 10,790 miles. The total mileage of the new level net when completed is estimated to be about 15,800 miles.

TABLE 1.—*Tabular statement of out-turn of work, season 1939–41.*

Detachments and lines levelled	Months	Distance levelled			Total		Number of stations at which the instruments were set up	Number of bench-marks connected		
		Main-line	Extras and branch-lines	Total	Rises	Falls		Protected Primary		Others
								Rock-cut	Others	
		Mls.	*Mls.*	*Mls.*	*feet*	*feet*				
No. 1 Detachment.										
Line 117 (Raipur–Bhadrakh) Portion Bhadrakh to Sambalpur	Dec. 39 to April 40	209	17	226	9,379	12,310	4,687	5	6	261
Line 121 (Howrah–Bhadrakh) Portion Balasore to Bhadrakh	Nov. 39 to Dec. 39	44	9	53	356	2,100	937	1	2	76
No. 2 Detachment.										
Line 125 (Bhadrakh–Vizianagram) Portion Vizianagram to Jagatpur (Cuttack)	Nov. 39 to April 40	277	87	364	6,147	9,368	6,411	5	16	418
No. 1 Detachment.										
Line 117 (Raipur–Bhadrakh) Portion Sambalpur to Sohela and	Nov. 40 to Dec. 40	48	2	50	1,096	1,568	867	1	2	68
Portion Pithora to Raipur	Dec. 40 to Jan. 41	65	9	74	1,455	1,828	1,073	1	3	68
Line 125 (Bhadrakh–Vizianagram) Portion Bhadrakh to Jagatpur (Cuttack)	Jan. 41 to Feb. 41	63	..	63	610	636	855	..	1	59

TABLE 2.—*Check-levelling.*

Discrepancies between the old and new heights of bench-marks.

Bench-marks of the original levelling that were connected for check-levelling			Distance from starting bench-mark	Difference of orthometric height above (+) or below (−) starting bench-mark, as determined by			Difference (check − original). The sign + denotes that the height was greater and the sign −, less in 1939–41 than when originally levelled
No.	Degree sheet	Description		Date of original levelling	Original levelling	Check-levelling 1939–41 (unadjusted)	
			miles		*feet*	*feet*	*feet*
		At Balasore on line 121.					
78PP	73 K	S.B.M., (Type P) at Balasore ..	0·00	1881-83	0·000	0·000	0·000
135 (*76*)	,,	Flooring ..	0·94	,,	− 0·273	− 0·217	+0·056
136 (*94*)	,,	Step ..	1·15	1930-31	+ 1·833	+ 1·843	+0·010
137 (*86*)	,,	Milestone ..	1·60	1924-25, 1927-28	− 0·985	− 0·888	+0·097
85	,,	Bridge ..	3·43	,,	− 26·391	− 26·429	−0·038
79	,,	Flooring ..	0·94	1881-83	+ 4·176	+ 4·166	−0·010
91 (*61*)	,,	Step ..	1·45	1930-31	+ 3·888	+ 3·889	+0·001
		At Bhadrakh on line 117.					
7	73 K	E.B.M., Bhadrakh	0·00	1881-83	0·000	0·000	0·000
132	,,	Iron bolt ..	0·04	1930-31	− 3·338	− 3·338	0·000
131	,,	S. prism ..	0·04	,,	− 3·674	− 3·669	+0·005
130	,,	N. prism ..	0·04	,,	− 3·699	− 3·697	+0·002
129	,,	S.B.M., (Type M), Bhadrakh ..	0·04	,,	− 2·549	− 2·545	+0·004
120	,,	Flooring ..	0·18	,,	− 0·425	− 0·414	+0·011
		At Vizianagram on line 125.					
237PP	65 N	S.B.M., (Type M), Vizianagram ..	0·00	1938-40	0·000	0·000	0·000
18	,,	Culvert ..	0·71	1894-95	− 22·838	− 22·853	−0·015
17	,,	Culvert ..	1·71	,,	− 31·930	− 31·951	−0·021
16	,,	Bridge ..	1·98	,,	− 36·254	− 36·263	−0·009
15	,,	Bridge ..	2·76	,,	− 47·984	− 47·993	−0·009

TABLE 3.—*Revision levelling.*

Discrepancies between the old and new heights of bench-marks.

Bench-marks of the original levelling that were connected during the revisionary operations			Distance from starting bench-mark	Difference between orthometric heights, above (+) or below (−) the starting bench-mark			Difference (revision − original). The sign + denotes that the height was greater and the sign − less in 1939–41 than when originally levelled
No.	Degree sheet	Description		Date of original levelling	From published heights	From revision 1939–41 (unadjusted)	
			miles		*feet*	*feet*	*feet*
Revision of old line 40; new 117 (Raipur–Bhadrakh), portion Raipur to Sambalpur.							
173 (*75*)PP	64 G	S.B.M., (Type P), Raipur ..	0·00	1935-38	0·000	0·000	0·000
172 (*97*)	64 O	E.B.M., Kalamat rest-house ..	161·46	1891-94	− 465·594	− 465·856	−0·262
91	,,	Rock ..	167·66	,,	− 494·186	− 494·380	−0·194
182 (*88*)	,,	Step ..	168·74	,,	− 508·028	− 508·373	−0·345
82PP	,,	I.B.M., Sambalpur..	169·74	,,	− 484·982	− 485·177	−0·195
191 (*86*)	,,	E.B.M., Sambalpur	172·64	,,	− 508·759	− 509·044	−0·285
196 (*83*)	,,	Pillar ..	173·15	,,	− 502·986	− 503·301	−0·315
197 (*89*)	,,	Step ..	173·20	,,	− 498·099	− 498·369	−0·270
84PP	,,	S.B.M., (Type P), Sambalpur ..	173·55	,,	− 511·596	− 511·809	−0·213
Revision of old lines 75 D, 41, 42, 40, 75 E, 39, 39 B, 36 and 37; new 125 (Bhadrakh–Vizianagram).							
7	73 K	E.B.M., Bhadrakh	0·00	1881-83	0·000	0·000	0·000
132	,,	Iron bolt ..	0·03	1930-31	− 3·338	− 3·339	−0·001
131	,,	S. prism ..	0·03	,,	− 3·674	− 3·673	+0·001
130	,,	N. prism ..	0·03	,,	− 3·699	− 3·698	+0·001
129PP	,,	S.B.M., (Type M), Bhadrakh ..	0·03	,,	− 2·549	− 2·548	+0·001
120	,,	Flooring ..	0·15	,,	− 0·425	− 0·420	+0·005
268 (*134*)	,,	Bridge ..	4·65	,,	− 3·577	− 3·759	−0·182
289 (*100*)	73 L	Bridge ..	6·50	,,	− 0·919	− 1·025	−0·106
101	,,	Pillar ..	7·33	,,	− 8·380	− 8·417	−0·037
106	,,	Pillar ..	11·28	,,	+ 1·384	+ 1·303	−0·081
107	,,	Bridge ..	14·89	,,	+ 20·212	+ 20·097	−0·115
294 (*108*)	,,	Pier of anicut ..	18·14	,,	+ 6·837	+ 6·685	−0·152
109	,,	Monument ..	18·26	,,	+ 9·289	+ 9·126	−0·163
110	,,	Lock at head ..	18·74	,,	+ 19·660	+ 19·490	−0·170
111	,,	Step ..	19·13	,,	+ 16·307	+ 16·137	−0·170
112	,,	Pillar ..	19·48	,,	+ 9·589	+ 9·416	−0·173
114	,,	Bridge ..	20·69	,,	+ 7·593	+ 7·417	−0·176
139	,,	Bridge ..	39·49	,,	+ 27·490	+ 27·258	−0·232
264 (*198*)	73 H	Head lock ..	61·53	,,	+ 26·028	+ 25·812	−0·216
265 (*199*)	,,	Pillar ..	61·80	,,	+ 19·596	+ 19·363	−0·233

(*Continued*)

TABLE 3.—*Revision levelling*—(contd.)

Discrepancies between the old and new heights of bench-marks.

Bench-marks of the original levelling that were connected during the revisionary operations			Distance from starting bench-mark	Difference between orthometric heights, above (+) or below (−) the starting bench-mark			Difference (revision − original). The sign + denotes that the height was greater and the sign −, less in 1939–41 than when originally levelled
No.	Degree sheet	Description		Date of original levelling	From published heights	From revision 1939–41 (unadjusted)	
			miles		*feet*	*feet*	*feet*
Revision of old lines 75 D, 41, 42, 40, 75 E, 39, 39 B, 36 and 37; new 125 (Bhadrakh–Vizianagram)—(contd.)							
268 (*186*)	73 H	Head lock ..	63·39	1893-94	+ 25·313	+ 25·114	−0·199
272 (*192*)	,,	Pillar ..	68·78	,,	+ 19·072	+ 18·575	−0·497
273*	,,	Milestone ..	69·78	,,	+ 20·144	+ 20·283	+0·139
317 (*2*)	73 L	Baraboria lock ..	69·84	,,	+ 14·603	+ 14·355	−0·248
318 (*3*)	,,	Pillar ..	69·88	,,	+ 17·689	+ 17·401	−0·288
319 (*4*)	,,	Milestone ..	70·80	,,	+ 11·876	+ 14·018	+2·142
320 (*5*)	,,	Milestone ..	71·80	,,	+ 8·469	+ 6·348	−2·121
321 (*6*)	,,	Milestone ..	72·80	,,	+ 7·750	+ 7·256	−0·494
323 (*8*)	,,	Milestone ..	74·79	,,	+ 3·155	+ 2·761	−0·394
325 (*10*)	,,	Pillar ..	76·79	,,	+ 5·973	+ 5·587	−0·386
327 (*12*)	,,	Pillar ..	78·54	,,	− 5·214	− 5·599	−0·385
328 (*13*)	,,	Pillar ..	78·83	,,	+ 2·981	+ 2·532	−0·449
329 (*15*)	,,	E.B.M., Kendupatana ..	79·34	,,	+ 3·526	+ 3·110	−0·416
330 (*16*)	,,	Lock No. 3 ..	79·83	,,	+ 2·433	+ 2·071	−0·362
331 (*17*)	,,	Pillar ..	80·01	,,	+ 1·905	+ 1·449	−0·456
332 (*18*)	,,	Pillar ..	80·04	,,	+ 0·934	+ 0·360	−0·574
333 (*19*)	,,	Pillar ..	81·93	,,	− 0·211	− 0·768	−0·557
334 (*20*)	,,	Pillar ..	82·96	,,	− 1·925	− 2·571	−0·646
335 (*21*)	,,	Pillar ..	83·99	,,	− 3·683	− 4·205	−0·522
336 (*22*)	,,	Pillar ..	84·99	,,	− 5·491	− 4·471	+1·020
337 (*23*)	,,	Pillar ..	86·00	,,	− 7·395	− 7·872	−0·477
338 (*24*)	,,	Lock No. 4 ..	86·36	,,	− 10·884	− 11·202	−0·318
339 (*25*)	,,	Pillar ..	87·01	,,	− 9·045	− 9·373	−0·328
340 (*26*)	,,	Pillar ..	88·01	,,	− 10·715	− 11·090	−0·375
341 (*27*)	,,	Pillar ..	89·03	,,	− 11·568	− 12·022	−0·454
342 (*28*)	,,	Pillar ..	90·01	,,	− 13·041	− 13·470	−0·429
344 (*29*)	,,	Lock No. 5 ..	90·26	,,	− 16·790	− 17·084	−0·294
345 (*30*)	,,	E.B.M., Danapur ..	90·26	,,	− 13·750	− 14·037	−0·287
353 (*67*)	,,	Lock No. 7 ..	99·13	1881-82	− 30·778	− 31·203	−0·425
354 (*65*)	,,	Sluice ..	100·78	,,	− 29·797	− 30·830	−1·033
355 (*62*)	,,	Sluice ..	102·73	,,	− 28·993	− 29·438	−0·445
356 (*61*)	,,	E.B.M., Marsaghai ..	102·95	,,	− 35·023	− 36·069	−1·046
358 (*60*)	,,	Coping of N. lock ..	103·59	,,	− 33·951	− 34·927	−0·976
370 (*44*)	,,	E.B.M., Lighthouse	127·88	,,	− 35·637	− 36·094	−0·457
377 (*43*)PP	,,	E.B.M., Hukitola ..	136·06	,,	− 23·286	− 24·703	−1·417
379 (*47*)PP	,,	E.B.M., Hukitola ..	136·14	,,	− 23·272	− 24·702	−1·430
380 (*45*)PP	,,	Pillar ..	136·19	,,	− 40·512	− 41·133	−0·621

* Transferred from degree Sheet 73 L where it was numbered as B.M. 1.

(*Continued*)

TABLE 3.—*Revision levelling*—(contd.)

Discrepancies between the old and new heights of bench-marks.

Bench-marks of the original levelling that were connected during the revisionary operations			Distance from starting bench-mark	Difference between orthometric heights, above (+) or below (−) the starting bench-mark			Difference (revision − original). The sign + denotes that the height was greater and the sign −, less in 1939–41 than when originally levelled
No.	Degree sheet	Description		Date of original levelling	From published heights	From revision 1939–41 (unadjusted)	
			miles		*feet*	*feet*	*feet*
Revision of old lines 75 D, 41, 42, 40, 75 E, 39, 39 B, 36 and 37; new 125 (Bhadrakh–Vizianagram)—(contd.)							
276 (*201*)	73 H	Bridge ..	65·25	1930-31	+ 40·792	+ 40·553	−0·239
279 (*183*)	,,	Head lock ..	67·25	1893-94	+ 26·883	+ 26·649	−0·234
280 (*203*) (*182*)	,,	Milestone ..	67·40	1930-31	+ 27·411	+ 27·147	−0·264
282 (*181*)	,,	Plinth ..	68·50	1893-94	+ 29·215	+ 28·891	−0·324
204 (*179*)	,,	Pillar ..	68·96	1930-31	+ 27·955	+ 27·669	−0·286
178	,,	Flooring ..	69·25	1893-94	+ 29·275	+ 28·983	−0·292
283 (*180*)	,,	Stone slab ..	69·86	,,	+ 32·811	+ 32·538	−0·273
284 (*175*)	,,	Step ..	70·23	1891-94	+ 33·571	+ 33·316	−0·255
285 (*176*)	,,	Pillar ..	70·58	,,	+ 32·473	+ 32·157	−0·316
286 (*193*)	,,	Step ..	70·86	1893-94	+ 37·886	+ 37·632	−0·254
194PP	,,	S.B.M., (Type P), Barabati fort (Cuttack) ..	70·91	,,	+ 37·265	+ 36·972	−0·293
289 (*205*) (*177*)PP	,,	H.S. Cuttack ..	71·29	1930-31	+ 82·773	+ 82·792	+0·019
294 (*206*)	,,	Step ..	73·20	,,	+ 27·030	+ 26·979	−0·051
296 (*2*)	,,	Step ..	73·49	1894-95	+ 33·136	+ 33·089	−0·047
299 (*9*)	,,	Milestone ..	83·85	,,	+ 32·395	+ 31·281	−1·114
302 (*16*)	,,	E.B.M., Chandaka I.B. ..	83·03	,,	+ 89·285	+ 89·313	+0·028
15	,,	E.B.M., Chandaka I.B. ..	..	,,	+ 89·250	+ 89·205	−0·045
28	,,	E.B.M., Chatabar I.B.	93·06	,,	+ 107·387	+ 107·351	−0·036
309 (*29*)	,,	Stone slab ..	93·06	,,	+ 107·313	+ 107·225	−0·088
314 (*40*)	,,	E.B.M., Khurda I.B.	100·33	,,	+ 87·610	+ 87·447	−0·163
320 (*43*)PP	,,	H.S. Barnai ..	103·44	,,	+ 952·297	+ 952·090	−0·207
321 (*235*) (*44*)	,,	Milestone ..	100·43	1931-32	+ 94·734	+ 94·625	−0·109
323 (*234*) (*45*)	,,	Milestone ..	101·70	,,	+ 128·036	+ 127·746	−0·290
324 (*233*) (*46*)	,,	Milestone ..	102·70	,,	+ 120·712	+ 120·722	+0·010
230 (*49*)	,,	Milestone ..	105·80	,,	+ 146·337	+ 146·303	−0·034
328 (*229*) (*50*)	,,	Milestone ..	106·83	,,	+ 160·608	+ 160·481	−0·127
329 (*228*) (*51*)	,,	Milestone ..	107·83	,,	+ 80·718	+ 81·062	+0·344
330 (*226*) (*53*)	,,	Milestone ..	109·84	,,	+ 26·237	+ 27·135	+0·898

(*Continued*)

TABLE 3.—*Revision levelling*—(contd.)

Discrepancies between the old and new heights of bench-marks.

Bench-marks of the original levelling that were connected during the revisionary operations			Distance from starting bench-mark	Difference between orthometric heights, above (+) or below (−) the starting bench-mark			Difference (revision − original). The sign + denotes that the height was greater and the sign −, less in 1939–41 than when originally levelled
No.	Degree sheet	Description		Date of original levelling	From published heights	From revision 1939–41 (unadjusted)	
			miles		*feet*	*feet*	*feet*
Revision of old lines 75 D, 41, 42, 40, 75 E, 39, 39 B, 36 and 37; new 125 (Bhadrakh–Vizianagram)—(contd.)							
331 (*225*) (*54*)	73 H	Milestone	110·84	1931-32	+ 32·634	+ 33·131	+0·497
224 (*55*)	,,	Milestone	111·84	,,	+ 67·362	+ 67·327	−0·035
223 (*56*)	,,	Milestone	112·84	,,	+ 21·504	+ 21·476	−0·028
57	,,	E.B.M., Jankia I.B.	113·30	1894-95	− 3·793	− 3·818	−0·025
138 (*2*)	74 E	Milestone	118·89	,,	+ 103·315	+ 103·357	+0·042
140 (*4*)	,,	Milestone	120·88	,,	+ 58·964	+ 58·887	−0·077
8	,,	E.B.M., Tangi I.B.	124·48	,,	+ 38·978	+ 38·941	−0·037
148 (*20*)PP	,,	E.B.M., Sunākhala I.B.	134·51	,,	+ 13·771	+ 13·625	−0·146
159 (*35*)PP	,,	H.S. Chandikho	148·70	,,	+1470·785	+1471·730	+0·945
160 (*33*)	,,	E.B.M., Barakul I.B.	146·19	,,	− 32·428	− 32·550	−0·122
161 (*34*)	,,	Stone slab	146·20	,,	− 32·809	− 32·779	+0·030
178 (*59*)	,,	Pillar	168·25	,,	− 29·259	− 29·488	−0·229
56 (*6*)	74 A	Well	178·46	,,	+ 51·259	+ 51·184	−0·075
65 (*19*)	,,	Bridge	188·58	,,	− 15·630	− 15·759	−0·129
66 (*20*)	,,	Culvert	189·80	,,	+ 10·424	+ 10·327	−0·097
67 (*22*)	,,	Culvert	190·89	,,	+ 22·430	+ 22·344	−0·086
51	,,	Rock	191·03	,,	+ 33·051	+ 32·996	−0·055
52	,,	Rock	192·00	,,	+ 52·689	+ 52·634	−0·055
53PP	,,	S.B.M., (Type M), Berhampur	192·34	,,	+ 59·884	+ 59·832	−0·052
76 (*24*)	,,	Platform	193·96	,,	+ 14·117	+ 14·036	−0·081
25	,,	E.B.M., Berhampur	193·98	,,	+ 10·030	+ 9·967	−0·063
50	,,	Rock	194·03	,,	+ 6·727	+ 6·662	−0·065
32	,,	Culvert	202·56	,,	+ 34·822	+ 34·686	−0·136
89 (*33*)	,,	Culvert	202·78	,,	+ 23·672	+ 23·518	−0·154
34	,,	I.B.M., (Type B), Ichcheswara temple	202·89	,,	+ 17·858	+ 17·718	−0·140
90 (*35*)	,,	Bridge	203·71	,,	− 2·514	− 2·705	−0·191
69 (*3*)	74 B	Culvert	220·38	,,	+ 83·496	+ 83·172	−0·324
70 (*4*)	,,	Platform	221·00	,,	+ 93·480	+ 93·132	−0·348
71 (*6*)	,,	Culvert	222·23	,,	+ 62·713	+ 62·368	−0·345
74(*11*)PP	,,	I.B.M., (Type B), Bāruva R.S.	227·21	,,	− 8·919	− 9·330	−0·411
79 (*16*)	,,	Culvert	233·73	,,	+ 45·529	+ 45·106	−0·423
80 (*19*)	,,	Culvert	234·70	,,	+ 49·606	+ 49·222	−0·384
81 (*20*)	,,	Culvert	235·76	,,	+ 84·952	+ 84·554	−0·398

(*Continued*)

TABLE 3.—*Revision-levelling*—(concld.)

Discrepancies between the old and new heights of bench-marks.

Bench-marks of the original levelling that were connected during the revisionary operations			Distance from starting bench-mark	Difference between orthometric heights, above (+) or below (−) the starting bench-mark			Difference (revision − original). The sign + denotes that the height was greater and the sing −, less in 1939-41 than when originally levelled
No.	Degree sheet	Description		Date of original levelling	From published heights	From revision 1939-41 (unadjusted)	
			miles		*feet*	*feet*	*feet*
Revision of old lines 75 D, 41, 42, 40, 75 E, 39, 39 B, 36 and 37; new 125 (Bhadrakh–Vizianagram)—(concld.)							
87 (*30*)	74 B	Bridge ..	245·73	1894-95	− 17·731	− 17·807	−0·076
113 (*57*)	,,	Culvert ..	272·08	,,	+ 31·776	+ 31·245	−0·531
117 (*58*)	,,	Bridge ..	272·78	,,	+ 40·694	+ 40·150	−0·544
224 (35)	65 N	Pillar ..	333·93	1895-97	+ 135·382	+ 134·819	−0·563
239 (*37*)	,,	Bridge ..	336·96	,,	+ 143·281	+ 142·746	−0·535
175	,,	Bridge ..	337·05	1894-95	+ 144·672	+ 144·154	−0·518
240 (*174*)	,,	Bridge ..	338·41	,,	+ 142·013	+ 140·937	−1·076
173	,,	Bridge ..	338·81	,,	+ 127·279	+ 126·757	−0·522
172	,,	Bridge ..	340·23	,,	+ 90·060	+ 89·526	−0·534
Revision of old lines 75, 75 C and 75 D; new 121 (Howrah–Bhadrakh). Portion Balasore to Bhadrakh.							
78PP	73 K	S.B.M., (Type P), Balasore ..	0·00	1881-83	0·000	0·000	0·000
92 (*64*)	,,	E.B.M., Balasore ..	1·01	1930-31	+ 14·429	+ 14·436	+0·007
186 (*27*)	,,	Bridge ..	28·53	1881-83	− 4·079	− 4·087	−0·008
21	,,	E.B.M., I.B. Mārkuna ..	32·70	,,	− 5·421	− 5·526	−0·105
196 (*17*)	,,	Culvert ..	35·69	,,	+ 12·788	+ 12·716	−0·072
199 (*14*)	,,	Culvert ..	38·80	,,	+ 8·512	+ 8·461	−0·051
201 (*12*)	,,	Bridge ..	40·73	,,	+ 7·758	+ 7·654	−0·104
203 (*122*) (*10*)	,,	Bridge ..	42·79	1930-31	+ 13·921	+ 13·797	−0·124
7	,,	E.B.M., I.B. Bhadrakh ..	44·38	1881-83	+ 5·687	+ 5·522	−0·165

TABLE 4.—*List of triangulation stations connected by spirit-levelling season 1939–41.*

Name of station	Height above mean sea-level		Difference (Trian.—Lev.)	Remarks
	Spirit-levelling	Trian-gulation		
	feet	*feet*	*feet*	
Bilāspur Meridional Series (No. 58).				
Achola T.S.	918·141	916	− 2	Upper mark.
Lat. 21° 15′ 3″·03 Long. 82 5 6·78				
Chapora H.S.	1414·559	1409	− 6	Upper mark.
Lat. 21° 15′ 14″·99 Long. 82 14 22·09				
Sambalpur Longitudinal Series (No. 38).				
Lohar H.S.	1267·690	1271	+ 3	On rock in situ.
Lat. 21° 26′ 21″·76 Long. 83 53 11·22				
Adapal H.S.	1636·221	1639	+ 3	,,
Lat. 21° 31′ 31″·02 Long. 84 18 22·81				
Kohili Huri H.S.	2192·690	2191	− 2	,,
Lat. 21° 27′ 7″·51 Long. 85 46 27·04				
East Coast Series (No. 24)				
Bola H.S.	1815·806	1861	+45	On rock in situ.
Lat. 21° 15′ 42″·59 Long. 86 15 52·33				
Nilgiri H.S.	1786·037	1786	·0	Ground level mark-stone.
Lat. 21° 28′ 23″·72 Long. 86 46 5·22				
Cuttack H.S.	133·343	132	− 1	Top of mark-stone.
Lat. 20° 29′ 0″·68 Long. 85 52 1·43				
Barnai H.S.	1002·679	1002	− 1	Upper mark-stone.
Lat. 20° 9′ 31″·41 Long. 85 39 10·67				

(*Continued*)

TABLE 4.—*List of triangulation stations connected by spirit-levelling season 1939–41.*—(*concld.*)

Name of station	Height above mean sea-level		Difference (Trian.—Lev.)	REMARKS
	Spirit-levelling	Trian-gulation		
	feet	*feet*	*feet*	
Bodagiri H.S. Lat. 19° 2′ 29″·90 Long. 84 35 7·43	819·478	815	— 4	Upper mark.
Chandi Kho H.S. Lat. 19° 42′ 43″·59 Long. 85 9 9·45	1522·323	1517	— 5	On top of circular protecting pillar.
Badapad h.s. Lat. 18° 29′ 2″·49 Long. 84 8 3·64	251·405	249	— 2	On E. segmental top portion of circular pillar.

CHAPTER II

DEVIATION OF THE VERTICAL

BY MR. B. L. GULATEE, M.A. (Cantab.)

7. Summary.—Both components of the deviation of the vertical were measured at 98 stations in the Punjāb, Baluchistān and N.W.F.P. by Mr. P. S. Shinghal, C.E. The object of this programme was to provide a map of the Geoid in N.W. India.

8. Details of observation.—The instrument and system of work were the same as in previous years except the recording apparatus which was redesigned (see Geodetic Report 1939, Chapter V, page 64). One night's work with the astrolabe was normally done at each station. Greenwich time was obtained in the main from the Rugby 09.55 and 17.55 G.M.T. signals, but at some stations, Nauen 12.01 and Bordeaux 08.01 and 20.01 signals were made use of. The Admiralty corrections received from the Royal Observatory have been accepted for the times of emission.

The geodetic position was obtained by resection from existing trigonometrical data and an astronomical azimuth, sometimes supported by the determination of the distance of a near point by measurement of a short base.

9. Narrative of season's work.—The detachment, consisting of Mr. P. S. Shinghal (observer), 1 Computer, 10 inferior servants, 2 drivers and 1 cleaner left Dehra Dūn in two hired $1\frac{1}{2}$-ton motor lorries on the 10th of October, 1939, and started work on the 15th at Pārāchinār in the Kurram Agency. After completing the line Pārāchinār–Isākhel–Manzai, observations for 3 nights were carried out at Multān to determine the Personal Equation. The party then went into Baluchistān and completed the line Quetta to D.G. Khan. Another check observation was made at Multān and work was continued on the Western and Northern districts of the Punjāb up to Jammu. The remainder of the season's programme comprised of 33 stations in the Punjāb and Punjāb states. This was completed by the 23rd March and the detachment returned to Dehra Dūn on the 25th March, 1940. Roads were generally good except in the sandy tracts of Miānwāli district and Bahāwalpur State. Each of the two lorries covered a distance of 5,350 miles, and only one station had to be reached by train. The Detachment kept good health throughout. The wireless set behaved well, but over a period of 17 days from the 13th of January, Rugby signals were not received. During this interval and on a few other occasions, recourse had, therefore, to be taken to Bordeaux and Nauen signals.

INDIA

LATITUDE STATIONS

Corrected to Sept. 1940

Kābul
Peshāwar
Srinagar
Rāwalpindi
Nasratābād
Kandahār
Dera Ismail Khān
LAHORE
Amritsar
Ludhiāna
Quetta
Multān
Dehra Dūn
Meerut
DELHI
Sukkur
Bikaner
Jodhpur
Agra
Lucknow
Fyzābād
Cawnpore
Allahābād
Benares
Hyderābād
Karāchi
Deesa
Kalianpur
Ahmadābād
Jubbulpore
NĀGPUR
Sambalpur
BOMBAY
Poona
Godāvari R.
Vizagapatam
Hyderabad
Cocanāda
Belgaum
Bellary
Mangalore
Bangalore
MADRAS
Calicut
Trichinopoly
Minicoy
Nagarkoil
Trincomalee
CEYLON
Colombo
Osh
Kizil Rabat
Brahmaputra R.
Darjeeling
Dibrugarh
Shillong
Myitkyina
Salween R.
Nan-ning
Lao-hai
Hanoi
Mekong R.
CALCUTTA
Chittagong
Chindwin R.
Mandalay
GULF OF TONG-KING
Akyab
Irrawaddy R.
Prom
Bassein
RANGOON
Moulmein
Bangkok
Mergui
GULF OF SIAM
Saigon
ANDAMAN ISLANDS
Port Blair
NICOBAR ISLANDS
SUMATRA
BAY OF BENGAL
ARABIAN SEA

29 33 38 43 52
30 34 39 44 53 62
31 35 40 45 54 63 72 78 83 92 101 110
36 41 46 55 64 73 79 84 93 102 111
47 56 65 74 85 94 103 112
48 57 66 86 95 104 113
49 58 67 87 96 105 114
59 68 88 97 106

REFERENCES

Latitude stations (Departmental)
Additions since 1939
Latitude stations (Non Departmental & Foreign)

Where stations are close to each other, some are omitted.

Scale 1 Inch = 250 Miles or 1/15,840,000

Miles 100 0 100 200 300 400 Miles

60° 64° 68° 72° 76° 80° 84° 88° 92° 96° 100° 104° 108° 112°
32° 28° 24° 20° 16° 12° 8° 4°

Heliozincographed at the Survey of India Offices, (P.Z.O.).

Reg.No 3 D.D.D.1936 (C.D.)S.I-400-410-38,370-39,315-44.

INDIA

LONGITUDE STATIONS

Corrected to Sept. 1940

Kābul
Peshāwar
Srīnagar
Rāwalpindi
Nasratābād
Kandahār
Dera Ismail Khān
LAHORE
Amritsar
Quetta
Multān
Ludhiāna
Dehra Dūn
Meerut
DELHI
Bikaner
Sukkur
Agra
Lucknow
Fyzābād
Jodhpur
Cawnpore
Benares
Hyderābād
Karāchi
Ganges R.
Deesa
Kalianpur
Jubbulpore
Ahmadābād
NĀGPUR
Sambalpur
CALCUTTA
Darjeeling
Dibrugarh
Shillong
Myitkyina
Akyab
Prome
RANGOON
Bassein
Moulmein
Bangkok
Mergui
Chittagong
Mandalay
Lao-hai
Hanoi
Nan-ning
GULF OF TONG-KING
GULF OF SIAM
BOMBAY
Poona
Waltair
Hyderābād
Cocanāda
Belgaum
Bellary
Mangalore
Bangalore
MADRAS
Calicut
Trichinopoly
Minicoy
Nagarkoil
Trincomalee
CEYLON
Colombo
ANDAMAN ISLANDS
Port Blair
NICOBAR ISLANDS
SUMATRA
Saigon
Osh
Kizil Rabāt
Indus R.
Sutlej R.
Jumna R.
Brahmaputra R.
Godāvari R.
Irrawaddy R.
Salween R.
Mekong R.
from Basrah
from Jask
from Aden
B A Y o f B E N G A L
A R A B I A N S E A

REFERENCES

Telegraphic Longitude stations
Longitude arcs
Wireless Longitude stations (Departmental)
Additions since 1939
Longitude stations (Non Departmental)
Chronometer Longitude stations (do)

Scale 1 Inch=250 Miles or 1/15,840,000

Miles 100 0 100 200 300 400 Miles

Reg No. 4 D.D.D.1936(C.O)S.I:400-410-38, 425-38, 355-40, 315-44.

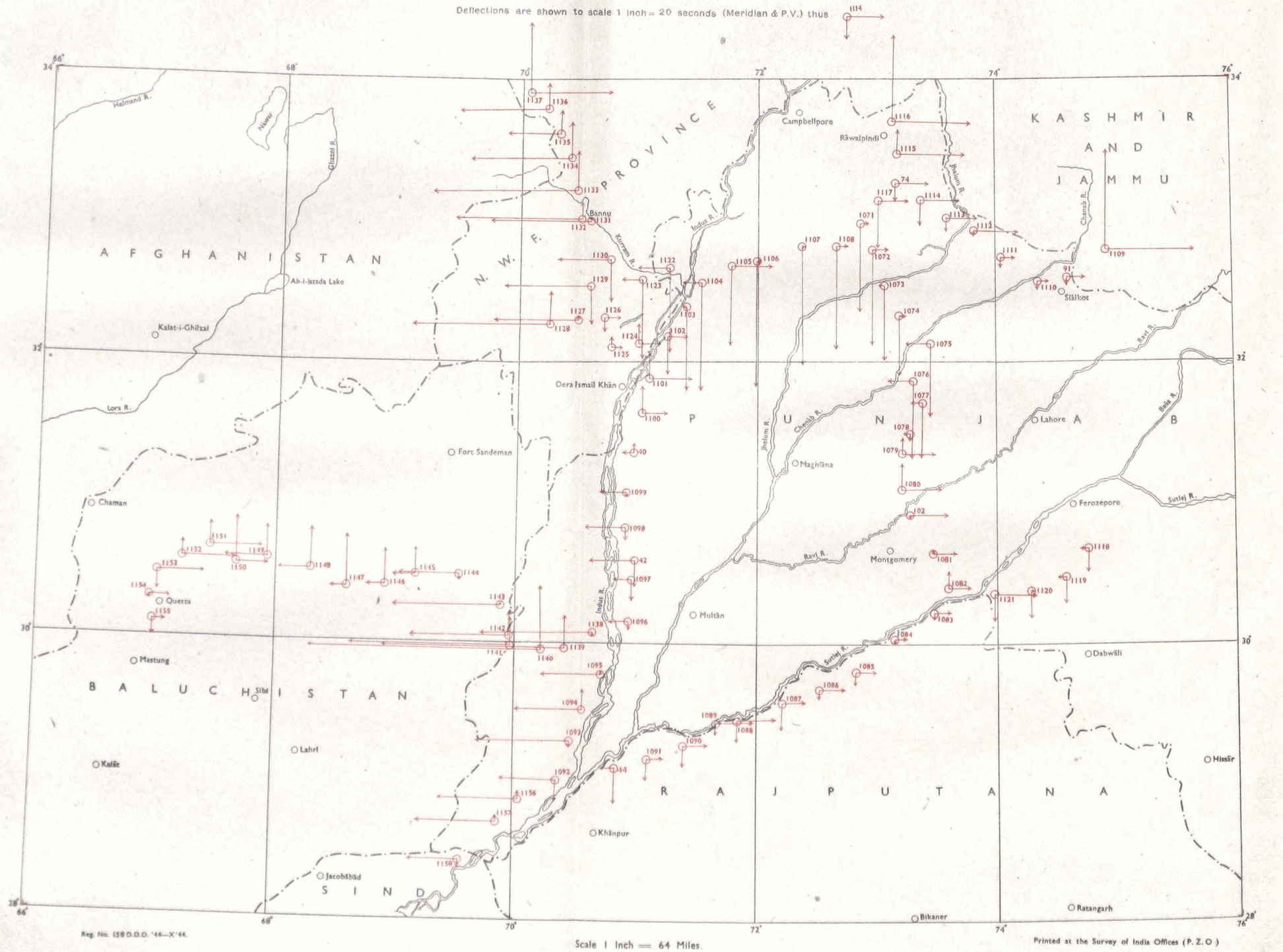
Heliozincographed at the Survey of India Offices, (P.Z.O.)

CHART OF DEFLECTION STATIONS

Season 1939–40

Geodetic Report Chart IV

Deflections are shown to scale 1 inch = 20 seconds (Meridian & P.V.) thus



Scale 1 Inch = 64 Miles.

Miles 50 40 30 20 10 0 50 100 150 200 Miles

Note:- The number of the deflection station corresponds with that allotted to it in chapter II, Table I. In this table a minus sign indicates easterly or northerly deflection and the plus sign a westerly or southerly deflection.

Reg. No. 158 D.D.D. '44—X'44.

Printed at the Survey of India Offices (P. Z. O.)

10. Personal equation.—The figures obtained for personal equation were as follows :—

Dehra Dūn.		Multān.		Multān.		Dehra Dūn 1940.	
	s		*s*		*s*		*s*
Sept. 29	−0·15	Nov. 13	−0·03	Dec. 24	−0·18	March 26	−0·08
Sept. 30	−0·16	Nov. 14	+0·02	Dec. 25	−0·11	March 28	−0·19
Oct. 2	−0·18	Nov. 15	−0·10			March 29	−0·04
Oct. 3	−0·15					April 2	−0·14
Oct. 7	−0·10						
Oct. 8	−0·10						

The considerable variation of personal equation between Dehra Dūn and Multān may be due to the varying pen lag that seemed to have started from station 6. This lag was measured for the different stations and has been allowed for in assessing the personal equation at the various stations. The results cannot be considered very satisfactory and at two stations, the lag was so large that they had to be rejected.

A further consideration of this case may be found possible at some more convenient time later.

11. Probable errors.—The average p.e. of a determination of latitude was $\pm 0{\cdot}31''$; of local time $\pm 0^s{\cdot}016$; and of the time keeping of the mean "Clock" between wireless time and star time $\pm 0^s{\cdot}012$.

12. Laplace stations.—Longitude observations on two nights each were made at the old azimuth stations of Dera-Din-Panah S. (Great Indus Series, 39 J), Jaoli H.S. (N.W. Himalaya Series, 43 G) and Akbar S. (Jogi-Tila Meridional Series, 44 F). The P.V. deflections and errors of azimuth developed in the triangulations are given in the table below :—

Laplace station			P. V. deflection (Everest)		Deduced error in triangulation
			By longitude	By azimuth	
1			2	3	4
	Lat.	Long.			
Dera Dīn Panāh S.	30° 34′	70° 56′	+10″·8	+12″·5	− 1″·0
Jāoli H.S.	33 17	73 10	− 2·8	+ 1·8	− 3·0
Akbar S.	30 54	73 17	− 3·5	+ 0·7	− 2·5

13. Geoidal section.—The stations observed during this season are marked on Chart IV. The drawing of geoidal contours is postponed to a later convenient date, when the charts VII and VIII of Geodetic Report 1936, showing the geoid and compensated geoid with respect to International Spheroid will be brought up to date by incorporating the results of observations taken in 1938–40.

DEFLECTION STATIONS

Eighth Addendum to Table 1 of "Supplement" to G.R. Vol. VI.

TABLE 1

Serial No.	Sheet No.	Observed at	Height in feet	International Spheroid Deflections		Calculated Deflections. Hayford System		Calculated Deflections. Uncompensated Topography	
				Meridian	P.V.	Meridian	P.V.	Meridian	P.V.
				"	"	"	"	"	"
1071	43 D	Baikal h.s.	1830	+13·4	− 1·4	− 1·8	− 1·0		
1072	D	Dhoktalia ..	1875	+14·4	− 2·5				
1073	H	Ghogiat ..	655	+11·4	+ 0·8				
1074	H	Gūnia T.S.	700	+ 9·1	− 1·1				
1075	H	Bāla T.S.	677	+11·0	+ 4·0				
1076	44 E	Hūjan T.S.	646	+12·1	+ 4·1				
1077	E	Sāngla Hill ..	650	+ 8·4	+ 1·7				
1078	E	Khurnawala T.S.	623	+ 1·0	+ 1·2				
1079	E	Rirāna T.S.	607	− 2·4	− 5·1				
1080	E	Bārāla T.S.	588	− 4·1	− 6·3				
102	F	Akbar S.	641	+ 0·2	− 5·9				
1081	F	Kadianwala T.S.	561	− 0·5	− 3·8				
1082	F	Pirghani T.S.	557	− 2·6	− 3·6				
1083	F	Akbar-da-Bunga T.S.	538	+ 1·0	− 2·8				
1084	F	Khāi Mosque ..	500	+ 0·2	− 2·1				
1085	C	Chisti Tomb ..	470	+ 2·2	− 3·2				
1086	C	Unnis Chak ..	460	+ 1·7	− 4·2				
1087	C	Tamiwali-Bhindi	450	+ 4·5	− 3·7				
1088	39 O	Bakhidera T.S.	431	+ 3·6	− 6·0				
1089	O	Godri T.S.	379	+ 2·0	− 5·9				
1090	O	Date Khan S.	397	+ 3·5	− 3·9				
1091	O	Pirhar T.S.	348	+ 3·4	− 2·7				
44	K	Paphra T.S.	316	+ 5·4	+ 2·2				
1092	K	Dhaggu-Suneri-wāla	300	+ 3·5	+ 8·9				
1093	K	Gangah T.S.	321	+ 0·9	+14·3				

COLUMN 4: Except at G.T. and other triangulation stations all heights are approximate and correct to within 10 to 20 feet.

DEFLECTIONS 1939–40

EVEREST'S SPHEROID						Serial No.
Latitude	Longitude	Azimuth	Name of station observed for Azimuth	Deflections		
				Meridian	P.V.	
° ′ ″	° ′ ″	° ′ ″		″	″	
A 32 58 38·9	A 72 52 22·2			+ 7·0	+ 1·3	1071
G 32 58 31·9	G 72 52 23·8					
A 32 47 43·6	A 72 58 36·1			+ 8·1	+ 0·2	1072
G 32 47 35·5	G 72 58 39·1					
A 32 32 53·5	A 73 04 05·5			+ 5·2	+ 3·4	1073
G 32 32 48·3	G 73 04 04·7					
A 32 19 17·51	A 73 11 11·39			+ 3·0	+ 1·4	1074
G 32 19 14·56	G 73 11 12·93					
A 32 08 57·03	A 73 27 48·78			+ 4·9	+ 6·3	1075
G 32 08 52·15	G 73 27 44·51					
A 31 52 28·17	A 73 18 07·04			+ 6·2	+ 6·5	1076
G 31 52 22·00	G 73 18 02·56					
A 31 42 44·4	A 73 23 01·1			+ 2·5	+ 4·1	1077
G 31 42 41·9	G 73 23 00·0					
A 31 29 48·65	A 73 16 24·88			− 4·7	+ 3·6	1078
G 31 29 53·31	G 73 16 23·87					
A 31 21 15·00	A 73 13 19·32			− 8·1	− 2·6	1079
G 31 21 23·08	G 73 13 25·50					
A 31 05 44·04	A 73 12 58·12			− 9·7	− 3·8	1080
G 31 05 53·73	G 73 13 05·76					
A 30 53 38·10	A 73 17 06·04			− 5·2	− 3·5	102
G 30 53 43·26	G 73 17 13·28					
A 30 37 59·71	A 73 28 49·55			− 5·8	− 1·5	1081
G 30 38 05·54	G 73 28 54·42					
A 30 22 52·78	A 73 35 06·97			− 7·8	− 1·4	1082
G 30 23 00·57	G 73 35 11·72					
A 30 12 28·28	A 73 28 47·84			− 4·2	− 0·5	1083
G 30 12 32·43	G 73 28 51·60					
A 30 01 45·5	A 73 08 27·1			− 4·9	+ 0·5	1084
G 30 01 50·4	G 73 08 29·7					
A 29 47 49·3	A 72 50 36·9			− 2·8	− 0·5	1085
G 29 47 52·1	G 72 50 40·7					
A 29 41 32·7	A 72 30 26·3			− 3·2	− 1·3	1086
G 29 41 35·9	G 72 30 31·0					
A 29 34 15·9	A 72 12 25·4			− 0·3	− 0·6	1087
G 29 34 16·2	G 72 12 29·2					
A 29 26 31·84	A 71 51 43·67			− 1·2	− 2·7	1088
G 29 26 32·99	G 71 51 49·93					
A 29 24 59·23	A 71 40 18·09			− 2·8	− 2·5	1089
G 29 25 02·00	G 71 40 24·13					
A 29 15 26·69	A 71 24 17·40			− 1·2	− 0·3	1090
G 29 15 27·92	G 71 24 20·85					
A 29 10 33·56	A 71 07 39·57			− 1·3	+ 1·1	1091
G 29 10 34·87	G 71 07 41·48					
A 29 05 50·20	A 70 49 49·72			+ 0·8	+ 6·2	44
G 29 05 49·37	G 70 49 45·82					
A 29 01 41·1	A 70 21 14·1			− 1·1	+13·1	1092
G 29 01 42·2	G 70 21 02·3					
A 29 17 01·99	A 70 27 57·08			− 3·9	+18·5	1093
G 29 17 05·89	G 70 27 39·06					

NOTE 1—*Minus* sign denotes N. or E. deflection of the plumb-line.

(*Continued*)

TABLE 1

Serial No.	Sheet No.	Observed at	Height in feet	International Spheroid Deflections		Calculated Deflections. Hayford System		Calculated Deflections. Uncompensated Topography	
				Meridian	P.V.	Meridian	P.V.	Meridian	P.V.
				"	"	"	"	"	"
1094	39 K	Kambar Shāh	335	− 3·2	+10·4				
1095	K	Jhakar T.S.	373	− 0·4	+ 9·3				
1096	J	Khemwala T.S.	409	+ 1·4	+ 3·1				
1097	J	Kotaddu ..	425	+ 3·2	+ 2·8				
42	J	Dera Dīn Panāh S.	441	+ 3·9	+ 6·9				
1098	J	Tibbi Pawha ..	470	+ 1·8	+ 6·5				
1099	I	Shahpur T.S.	504	+ 0·5	+ 4·2				
40	I	Jharkil T.S.	531	− 1·4	+ 1·8				
1100	M	Bakar T.S.	580	− 4·1	− 3·9				
1101	M	Ahmad Sindi ..	625	− 3·9	− 6·6				
1102	38 P	Kalurkot ..	625	+ 5·7	− 3·2				
1103	P	Alluwali ..	650	+12·7	+ 0·3				
1104	P	Mianwali ..	660	+16·3	+ 2·7				
1105	P	Kalwan Dak ..	940	+12·0	− 6·4				
1106	P	Changa h.s.	1556	+19·0	− 0·4				
1107	43 D	Jātla H.S.	2074	+17·8	− 0·3				
1108	D	Miani Dhok ..	2225	+15·5	− 1·9				
1109	L	Nagrota ..	1125	−15·2	−13·6	−12·1	− 8·7		
91	L	Ranjītgarh T.S.	879	+ 1·3	− 2·8				
1110	L	Chhanni Gondal	780	+ 1·3	− 1·6				
1111	L	Daulat Nagar..	925	+ 1·6	− 2·2				
1112	H	Taura Masumpur	850	+ 0·7	− 6·9				
1113	G	Dina ..	900	+ 2·0	− 4·7				
1114	G	Khabbal s.	1669	+ 3·8	− 6·0				
1115	G	Riwāt h.s.	1962	− 3·8	−10·4				

COLUMN 4: Except at G.T. and other triangulation stations all heights are approximate and correct to within 10 to 20 feet.

DEFLECTIONS 1939–40—(*contd.*)

EVEREST'S SPHEROID						
Latitude	Longitude	Azimuth	Name of station observed for Azimuth	Deflections		Serial No.
				Meridian	P V.	
° ′ ″	° ′ ″	° ′ ″		″	″	
A 29 31 51·0	A 70 33 39·0			− 8·1	+14·5	1094
G 29 31 59·1	G 70 33 25·5					
A 29 46 34·35	A 70 43 37·94			− 5·3	+13·3	1095
G 29 46 39·68	G 70 43 25·82					
A 30 09 42·03	A 70 56 51·21			− 3·7	+ 7·0	1096
G 30 09 45·76	G 70 56 46·32					
A 30 27 11·4	A 70 58 39·3			− 2·0	+ 6·7	1097
G 30 27 13·4	G 70 58 34·7					
A 30 34 00·60	A 70 56 16·67			− 1·3	+10·8	42
G 30 34 01·87	G 70 56 07·29					
A 30 49 44·5	A 70 56 04·8			− 3·6	+10·5	1098
G 30 49 48·1	G 70 55 55·8					
A 31 05 32·89	A 70 56 44·18			− 5·0	+ 8·1	1099
G 31 05 37·87	G 70 56 37·83					
A 31 21 06·69	A 70 59 48·23			− 7·0	+ 5·6	40
G 31 21 13·65	G 70 59 44·80					
A 31 37 36·9	A 71 03 24·0			− 9·8	− 0·1	1100
G 31 37 46·7	G 71 03 27·3					
A 31 52 22·0	A 71 07 54·4			− 9·7	− 2·8	1101
G 31 52 31·7	G 71 08 00·8					
A 32 09 10·3	A 71 15 01·6			− 0·3	+ 0·5	1102
G 32 09 10·6	G 71 15 04·2					
A 32 22 21·7	A 71 25 45·0			+ 6·6	+ 3·9	1103
G 32 22 15·1	G 71 25 43·5					
A 32 34 52·6	A 71 31 08·1			+10·1	+ 6·2	1104
G 32 34 42·5	G 71 31 03·8					
A 32 40 07·1	A 71 46 39·8			+ 5·8	− 3·0	1105
G 32 40 01·3	G 71 46 46·6					
A 32 43 55·4	A 71 59 56·2			+12·8	+ 2·8	1106
G 32 43 42·6	G 71 59 56·0					
A 32 48 34·76	A 72 22 36·81			+11·5	+ 2·7	1107
G 32 48 23·30	G 72 22 36·76					
A 32 48 13·3	A 72 39 37·8			+ 9·2	+ 1·1	1108
G 32 48 04·1	G 72 39 39·7					
A 32 46 59·1	A 74 53 47·5			−21·5	−12·1	1109
G 32 47 20·6	G 74 54 05·1					
A 32 35 07·09	A 74 37 08·05			− 5·0	− 1·1	91
G 32 35 12·10	G 74 37 12·48					
A 32 34 08·8	A 74 21 15·3			− 4·9	+ 0·1	1110
G 32 34 13·7	G 74 21 18·3					
A 32 44 49·9	A 74 04 45·4			− 4·7	− 0·3	1111
G 32 44 54·6	G 74 04 49·0					
A 32 56 21·0	A 73 49 55·2			− 5·7	− 4·8	1112
G 32 56 26·7	G 73 50 04·1					
A 33 01 26·0	A 73 36 15·1			− 4·4	− 2·5	1113
G 33 01 30·4	G 73 36 21·3					
A 33 08 40·2	A 73 23 50·7			− 2·7	− 3·7	1114
G 33 08 42·9	G 73 23 58·2					
A 33 29 45·1	A 73 11 27·7			−10·4	− 7·9	1115
G 33 29 55·5	G 73 11 40·3					

NOTE:—*Minus* sign denotes N. or E. deflection of the plumb-line.

(*Continued*)

TABLE 1

Serial No.	Sheet No.	Observed at	Height in feet	International Spheroid Deflections		Calculated Deflections. Hayford System		Calculated Deflections. Uncompensated Topography	
				Meridian	P.V.	Meridian	P.V.	Meridian	P.V.
				"	"	"	"	"	"
1116	43 G	Malpur ..	1800	−13·3	−12·0				
74	G	Jāoli H.S.	1912	+ 2·7	− 5·3				
1117	G	Kalriāla s.	1758	+ 7·3	− 4·8				
1118	44 J	Faridkot T.S.	683	+ 3·7	+ 1·3	− 0·9	− 1·0		
1119	J	Mukant Singhwala T.S.	698	+ 4·0	+ 1·3				
1120	J	Banawala T.S.	624	+ 4·2	− 0·2				
1121	F	Karni Khera ..	590	+ 4·3	− 6·5				
1122	38 P	Isa Khel Bāradari	700	+12·8	+ 4·9				
1123	P	Arsala ..	850	+12·1	+ 3·2				
1124	P	Kathgarh ..	600	− 2·9	− 3·3				
1125	L	Yārik bungalow s.	666	− 1·6	− 1·6				
1126	L	Pezo ..	930	+ 2·1	− 2·4				
1127	L	Tajori s.	817	− 0·7	+13·0				
1128	L	Manzai ..	1550	− 5·1	+20·9				
1129	L	Khairu Khel bungalow s.	1177	+ 5·8	+13·3				
1130	L	Gambila S.	935	+ 6·5	+ 8·4				
1131	L	Bannu fort s.	1287	− 0·6	+15·5				
1132	K	Kurram Garhi Fort NW. corner	1416	− 2·7	+19·4				
1133	K	Shawa (Post) ..	2000	− 6·1	+22·3				
1134	K	Manduri (Post)	2900	− 5·6	+15·4				
1135	K	Arawali Fort ..	3650	− 3·6	+ 8·1				
1136	K	Amalkot ..	4350	− 3·9	+13·7				
1137	K	Pārachinār (milestone) h.s.	5739	−10·7	+12·5				
1138	39 J	Churatta ..	400	+ 0·2	+17·4				
1139	K	Tombi ..	670	− 4·9	+28·0				

COLUMN 4: Except at G.T. and other triangulation stations all heights are approximate and correct to within 10 to 20 feet.

DEFLECTIONS 1939–40—(*contd.*)

EVEREST'S SPHEROID							
Latitude	Longitude	Azimuth	Name of station observed for Azimuth	Deflections		Serial No.
				Meridian	P.V.	
° ′ ″	° ′ ″	° ′ ″		″	″	
A 33 43 23·7	*A* 73 08 18·0			−20·0	− 9·5	1116
G 33 43 43·7	*G* 73 08 32·6					
A 33 16 45·02	*A* 73 10 20·00			− 3·8	− 2·8	74
G 33 16 48·85	*G* 73 10 26·50					
A 33 08 08·0	*A* 73 00 45·9			+ 0·8	− 2·2	1117
G 33 08 07·2	*G* 73 00 51·7					
A 30 40 02·15	*A* 74 45 21·62			− 1·7	+ 2·8	1118
G 30 40 03·87	*G* 74 45 21·55					
A 30 28 15·58	*A* 74 33 02·56			− 1·3	+ 2·9	1119
G 30 28 16·85	*G* 74 33 02·33					
A 30 22 42·17	*A* 74 16 11·26			− 1·1	+ 1·6	1120
G 30 22 43·28	*G* 74 16 12·62					
A 30 21 27·0	*A* 73 58 22·8			− 1·0	− 4·5	1121
G 30 21 28·0	*G* 73 58 31·2					
A 32 40 55·8	*A* 71 16 38·7			+ 6·6	+ 8·6	1122
G 32 40 49·2	*G* 71 16 31·6					
A 32 36 17·2	*A* 71 02 17·3			+ 6·0	+ 7·0	1123
G 32 36 11·2	*G* 71 02 12·1					
A 32 08 21·7	*A* 71 00 04·5			− 8·9	+ 0·5	1124
G 32 08 30·6	*G* 71 00 07·1					
A 32 06 10·2	*A* 70 47 34·3			− 7·6	+ 2·4	1125
G 32 06 17·8	*G* 70 47 34·7					
A 32 19 18·5	*A* 70 44 07·8			− 3·9	+ 1·6	1126
G 32 19 22·4	*G* 70 44 09·1					
A 32 18 32·7	*A* 70 29 56·4			− 6·7	+17·2	1127
G 32 18 39·4	*G* 70 29 39·2					
A 32 14 57·3	*A* 70 15 01·7			−11·1	+25·2	1128
G 32 15 08·4	*G* 70 14 35·0					
A 32 31 30·4	*A* 70 36 32·9			− 0·3	+17·3	1129
G 32 31 30·7	*G* 70 36 15·5					
A 32 41 23·50	*A* 70 47 02·79			+ 0·3	+12·4	1130
G 32 41 23·16	*G* 70 46 51·24					
A 32 59 34·2	*A* 70 36 40·9			− 6·9	+19·6	1131
G 32 59 41·1	*G* 70 36 20·7					
A 33 01 43·8	*A* 70 32 18·9			− 9·0	+23·5	1132
G 33 01 52·8	*G* 70 31 54·0					
A 33 13 32·4	*A* 70 29 14·0			−12·5	+26·5	1133
G 33 13 44·9	*G* 70 28 45·4					
A 33 27 36·0	*A* 70 25 56·0			−12·1	+19·6	1134
G 33 27 48·1	*G* 70 25 35·6					
A 33 37 52·2	*A* 70 19 38·9			−10·2	+12·3	1135
G 33 38 02·4	*G* 70 19 27·2					
A 33 46 53·5	*A* 70 12 44·7			−10·6	+18·0	1136
G 33 47 04·1	*G* 70 12 26·2					
A 33 53 50·3	*A* 70 06 03·6			−17·4	+16·9	1137
G 33 54 07·7	*G* 70 05 46·4					
A 30 04 04·7	*A* 70 39 04·2			− 4·8	+21·4	1138
G 30 04 09·5	*G* 70 38 42·6					
A 29 58 24·4	*A* 70 24 29·3			− 9·9	+32·2	1139
G 29 58 34·3	*G* 70 23 55·2					

NOTE :—*Minus* sign denotes N. or E .deflection of the plumb-line.

(*Continued*)

TABLE 1

Serial No.	Sheet No.	Observed at	Height in feet	International Spheroid Deflections		Calculated Deflections. Hayford System		Calculated Deflections. Uncompensated Topography	
				Meridian	P.V.	Meridian	P.V.	Meridian	P.V.
				"	"	"	"	"	"
1140	39 K	Rakhi Mithwan	1325	− 9·8	+35·9				
1141	G	Khar ..	5600	− 4·4	+24·7				
1142	F	Rakni ..	3590	− 3·6	+15·3				
1143	F	Rarkhan village peak	4234	− 0·2	+16·7				
1144	F	Saredhaka ..	4425	+ 0·8	+ 9·3	− 3·2	+ 3·6		
1145	F	Tor ..	4120	− 4·1	+ 3·6				
1146	B	Wahar ..	4040	− 5·5	+ 3·0				
1147	B	Loralai ..	4700	− 7·9	+ 2·6				
1148	B	Kach Ahmaqzai	5760	− 6·2	+ 4·9				
1149	34 N	Chinjan ..	7250	− 5·0	+ 6·5				
1150	N	Speraragha ..	7850	− 7·0	− 5·0				
1151	N	Yusuf Kach ..	7000	− 3·6	− 7·9				
1152	N	Gwal ..	5750	− 2·6	− 8·2				
1153	N	Bostan ..	5150	+ 3·1	− 7·5				
1154	J	Baleli ..	5230	+ 0·6	− 3·4				
1155	J	Sariab ..	5660	+ 2·6	− 2·1				
1156	39 L	Lalgoshi T.S.	315	− 1·3	+12·5				
1157	H	Mandadalari T.S.	273	− 1·1	+12·4				
1158	H	Kasmor T.S.	245	+ 1·3	+ 7·9				

COLUMN 4: Except at G.T. and other triangulation stations all heights are approximate and correct to within 10 to 20 feet.

DEFLECTIONS 1939-40—(*concld.*)

EVEREST'S SPHEROID						Serial No
Latitude	Longitude	Azimuth	Name of station observed for Azimuth	Deflections		
				Meridian	P.V.	
° ′ ″	° ′ ″	° ′ ″		″	″	
A 29 56 51·8	*A* 70 13 05·3			−14·8	+40·2	1140
G 29 57 06·6	*G* 70 12 22·0					
A 29 56 01·1	*A* 69 59 23·1			− 9·4	+29·1	1141
G 29 56 10·5	*G* 69 58 52·7					
A 30 02 37·5	*A* 69 55 50·5			− 8·6	+19·8	1142
G 30 02 46·1	*G* 69 55 30·8					
A 30 15 47·7	*A* 69 54 19·8			− 5·3	+21·2	1143
G 30 15 53·0	*G* 69 53 58·4					
A 30 28 32·1	*A* 69 31 51·5			− 4·4	+14·1	1144
G 30 28 36·5	*G* 69 31 38·2					
A 30 27 39·4	*A* 69 09 28·4			− 9·3	+ 8·6	1145
G 30 27 48·7	*G* 69 09 21·6					
A 30 24 25·5	*A* 68 55 29·4			−10·7	+ 8·2	1146
G 30 24 36·2	*G* 68 55 23·1					
A 30 22 19·3	*A* 68 35 50·5			−13·0	+ 7·9	1147
G 30 22 32·3	*G* 68 35 44·5					
A 30 29 55·8	*A* 68 17 34·8			−11·4	+10·4	1148
G 30 30 07·2	*G* 68 17 25·8					
A 30 34 05·0	*A* 67 56 45·9			−10·2	+12·2	1149
G 30 34 15·2	*G* 67 56 34·9					
A 30 32 22·7	*A* 67 39 18·9			−12·2	+ 0·9	1150
G 30 32 34·9	*G* 67 39 21·1					
A 30 37 00·3	*A* 67 26 14·8			− 8·7	− 1·8	1151
G 30 37 09·0	*G* 67 26 20·1					
A 30 31 28·6	*A* 67 12 12·6			− 7·7	− 2·0	1152
G 30 31 36·3	*G* 67 12 18·1					
A 30 25 59·3	*A* 67 00 30·0			− 1·9	− 1·2	1153
G 30 26 01·2	*G* 67 00 34·5					
A 30 16 06·0	*A* 66 56 06·3			− 4·4	+ 3·0	1154
G 30 16 10·4	G 66 56 05·9					
A 30 06 10·0	*A* 66 58 54·7			− 2·3	+ 4·3	1155
G 30 06 12·3	*G* 66 58 52·9					
A 28 52 53·59	*A* 70 03 10·43			− 5·8	+16·9	1156
G 28 52 59·35	*G* 70 02 54·33					
A 28 42 06·15	*A* 69 52 19·27			− 5·5	+16·9	1157
G 28 42 11·62	*G* 69 52 03·20					
A 28 26 25·69	*A* 69 34 08·23			− 3·0	+12·6	1158
G 28 26 28·66	*G* 69 33 57·04					

NOTE:—*Minus* sign denotes N. or E. deflection of the plumb-line.

CHAPTER III

GRAVITY

BY MR. B. L. GULATEE, M.A. (Cantab.)

14. Summary.—During the field season 1939–40, observations were made at 15 stations in South Burma and 1 station in the Andaman Islands. Mr. M. N. A. Hashmie, B.A., was the observer in charge of the detachment. He toured with 8 *khalāsis.*

15. Narrative.—The detachment left Dehra Dūn on 17-11-1939 and returned on 18-1-1940. Transport was by rail and locally hired lorries in the northern part of the work ; a Government launch was hired from Mergui for the journey down the coast to Victoria Point, up the Packchai river, and to Court Island, where landing was made with some difficulty.

The Marconi Wireless receiver R.P. 11 was used to receive the Rugby, Bordeaux and Nauen time signals on 16·00, 15·7 and 16·55 kilocycles respectively. The reception was satisfactory. A short wave set was also taken as an emergency measure, but necessity never arose for its use.

Heights were obtained from existing data on 1″ maps by plane-table resection with vertical angles and by spirit-levelling.

Computations in recess were done by Mr. Hashmie assisted by two computers.

16. Observations at Dehra Dun.—The times of vibration at Dehra Dūn at the beginning and end of the season and the adopted mean times of vibration are given in Table 1. The mean times of vibration by pairs are as follows :—

Pair	Nov. 1939	Jan. 1940	Apparent change
	s	*s*	*s*
AC	0·50792035	0·50792106	$+7·1 \times 10^{-7}$
AB	92432	92346	$-8·6$,,
CB	92035	92079	$+4·4$,,
Mean ..	0·50792167	0·50792177	$+1·0 \times 10^{-7}$

This shows that no change of any consequence has occurred in any pendulum. The mean of the times of vibration at Dehra Dūn has, therefore, been adopted for the whole period.

17. Differences in times of vibration.—The mean differences for pairs of pendulums are given in Table 2.

INDIA
PENDULUM STATIONS

Corrected to Sept. 1940

Kābul · Peshawar · Srinagar · Rāwalpindi · Nasratābād · Kandahār · Dera Ismail Khān · LAHORE · Amritsar · Quetta · Multan · Ludhiāna · Debra Dūn · Meerut · DELHI · Bikaner · Sukkur · Agra · Lucknow · Fyzābād · Jodhpur · Cawnpore · Allahābād · Benares · Hyderābād · Karāchi · Deesa · Kānianpur · Ahmadābād · Jubbulpore · Sambalpur · CALCUTTA · NAGPUR · BOMBAY · Poona · Godāvari R. · Vizagapatam · Cocanāda · Hyderābād · Belgaum · Bellary · Bangalore · MADRAS · Mangalore · Calicut · Trichinopoly · Nagarkoil · Trincomalee · Minicoy · Colombo · Maldive Islands · Laccadive Islands · Darjeeling · Dibrugarh · Shillong · Chittagong · Myitkyina · Mandalay · Akyab · Prome · RANGOON · Bassein · Moulmein · Bangkok · Mergui · Port Blair · Kisil Rabāt · Osh · Lao-hai · Hanoi · Nan-ning · Saigon

Indus R. · Sutlej R. · Jumna R. · Ganges R. · Brahmaputra R. · Salween R. · Irrawaddy R. · Mekong R. · Godāvari R.

GULF OF TONG-KING · GULF OF SIAM · BAY OF BENGAL · ANDAMAN ISLANDS · NICOBAR ISLANDS · SUMATRA · INDIAN OCEAN · Maldive Islands · Equator

REFERENCES

Pendulum stations (Departmental) ..... ● 104
Additions since 1939 ..... ○ 563
Pendulum stations (Non Departmental) ..... ■ 35
Dr. Vening Meinesz's submarine stations (Non Departmental) ..... ✱ 26

The work of Basevi and Heaviside has been omitted from this chart which shows only the operations carried out with the half-seconds pendulums subsequent to 1903.

Scale 1 Inch=250 Miles or 1/15,840,000

Miles 100 0 100 200 300 400 Miles

Heliozincographed at the Survey of India Offices, (P. Z. O.).

Reg. No. 32 D.D.D.1939(C.O)S.I.-425.-40.-355, 315-44.

18. Values of g.—The times of vibration of individual pendulums and the deduced values of g for each pair are given in Table 3.

19. Anomalies.—The Free Air, Bouguer and Hayford anomalies on the Helmert 1901 spheroid are given in Table 4 and Hayford anomalies referred to the International Spheroid in Table 6. It will be seen that the largest anomaly occurs at Port Blair. Table 5 gives Normal Warp anomalies (see Geodetic Report 1939, Chapter II para 11).

Contours of Hayford anomalies and the normal warp anomalies are given in Charts VI to VIII. In the light of these results, the crustal structure lines have been shown up to the coast line of Sumatra in Chart IX.

We see, that the downwarp lies over the sedimentaries of the Andamans. The red positive axis can be continued with the help of Vening Meinesz's chart in Geographical Journal 1931. It seems to pass through the middle of Sumatra through Java and Flores on to the Banda Sea.

TABLE 1.—*Times of vibration at Dehra Dūn, season 1939-40.*

Date	Weight	A	A	B	B	C	C
1939		s	s	s	s	s	s
Nov. 7	8	0·507 9210				0·507 9189	
,, 7/8	6	9192				9160	
,, 8	8	9221				9201	
,, 8	8			0·507 9214			0·507 9192
,, 8/9	6			9208			9184
,, 9	8			9219			9200
,, 9	8		0·507 9270		0·507 9266		
,, 9/10	6		9219		9211		
,, 10	8		9241		9238		
,, 10	6	0·507 9221				0·507 9196	
,, 10/11	6	9204				9180	
,, 11	8	9235				9216	
Weighted mean		$0·507\,9215_0$	$0·507\,9245_5$	$0·507\,9214_2$	$0·507\,9240_8$	$0·507\,9192_0$	$0·507\,9192_7$

Date	Weight	A	A	B	B	C	C
1940		s	s	s	s	s	s
Jan. 22	8	0·507 9218				0·507 9201	
,, 22/23	6	9218				9201	
,, 23	8	9221				9204	
,, 23	8			0·507 9220			0·507 9197
,, 23/24	6			9222			9196
,, 24	8			9219			9194
,, 24	8		0·507 9233		0·507 9228		
,, 24/25	6		9242		9237		
,, 25	8		9241		9229		
Weighted mean		$0·507\,9219_1$	$0·507\,9238_4$	$0·507\,9220_2$	$0·507\,9230_8$	$0·507\,9202_1$	$0·507\,9195_6$

Adopted mean times of vibration.

Pair Pendulum	AC A	AB A	BC B	AB B	AC C	BC C
Mean	s 0·507 9217	s 0·507 9242	s 0·507 9217	s 0·507 9236	s 0·507 9197	s 0·507 9194

TABLE 2.—*Mean differences of pairs of pendulums, season 1939-40.*

(The unit is 10^{-7} sec.)

Station No.	A–C	*v*	Station No.	C–B	*v*	Station No.	B–A	*v*
549	+ 8·6	− 5·6	550	− 1·5	+ 8·7	551	− 2·0	+ 0·4
552	+ 6·3	− 7·9	553	−14·2	− 4·0	554	− 1·2	+ 1·2
555	+ 8·7	− 5·5	556	+ 2·7	+12·9	557	+ 3·7	+ 6·1
558	+15·8	+ 1·6	559	+ 0·1	+10·3	..	..	..
..	..	..	560	+ 1·8	+12·0	561	− 8·9	− 6·5
562	+20·0	+ 5·8	563	−24·4	−14·2	564	+ 4·0	+ 6·4

TABLE. 3.—*Mean times of vibration and deduced values of g, season 1939–40.*

Station No.	Pendulums			Mean	*g*
	A	B	C		
	s	*s*	*s*	*s*	
549	0·508 1340		0·508 1331	0·508 1336	978·243
550		0·508 0703	0·508 0701	0·508 0702	978·486
551	0·508 0868	0·508 0866		0·508 0867	978·435
552	0·508 0611		0·508 0605	0·508 0608	978·523
553		0·508 0804	0·508 0790	0·508 0797	978·450
554	0·508 0750	0·508 0749		0·508 0750	978·481
555	0·508 0857		0·508 0849	0·508 0853	978·429
556		0·508 1258	0·508 1261	0·508 1260	978·271
557	0·508 1377	0·508 1380		0·508 1378	978·238
558	0·508 1486		0·508 1471	0·508 1478	978·187
559		0·508 1444	0·508 1444	0·508 1444	978·200
560		0·508 1318	0·508 1320	0·508 1319	978·248
561	0·508 1287	0·508 1278		0·508 1283	978·275
562	0·508 1249		0·508 1229	0·508 1239	978·280
563		0·508 1153	0·508 1129	0·508 1141	978·317
564	0·508 0960	0·508 0964		0·508 0962	978·399

TABLE 4.—*Modern gravity observations in India*
(Additions in field season 1939-40).

No.	Sheet No.	Station	Date	Height	Latitude N.	Longitude E.	g	$g-\gamma_A$	$g-\gamma_B$	$g-\gamma_O$
				feet	° ′ ″	° ′ ″	*cm/sec²*	*cm/sec²*	*cm/sec²*	*cm/sec²*
549	87 A	Port Blair ..	23 11 39	87	11 40 30	92 46 18	978·243	+·010	+·008	−·053
550	85 O	Letpadan ..	29 11 39	52	17 47 05	95 45 02	978·486	−·021	−·023	−·017
551	86 I	Diamond Island	3 12 39	51	15 51 38	94 16 36	978·435	+·025	+·023	−·003
552	94 C	Nyaunglebin ..	6 12 39	40	17 56 49	96 43 45	978·523	+·007	+·006	+·023
553	94 H	Moulmein ..	9 12 39	69	16 28 43	97 37 31	978·450	+·011	+·009	+·019
554	94 G	Shwegun ..	11 12 39	44	17 09 53	97 38 48	978·481	+·005	+·004	+·020
555	94 L	Kaw Kareik ..	15 12 39	53	16 33 10	98 14 32	978·429	−·015	−·017	+·005
556	96 E	Court Island	21 12 39	3	11 57 15	97 59 22	978·271	+·020	+·023	+·012
557	96 I	Bokpyin ..	24 12 39	10	11 15 45	98 45 52	978·238	+·012	+·012	+·008
558	96 K	Victoria Point	27 12 39	88	9 58 35	98 33 10	978·187	+·010	+·007	+·002
559	96 J	Marang ..	29 12 39	85	10 26 10	98 46 45	978·200	+·009	+·006	+·002
560	95 P	Tenasserim ..	2 1 40	42	12 05 30	99 00 48	978·248	−·005	−·006	−·004
561	95 L	Mergui ..	4 1 40	95	12 26 21	98 36 07	978·275	+·014	+·011	+·009
562	95 K	Palauk ..	6 1 40	33	13 16 07	98 37 39	978·280	−·019	−·020	−·013
563	95 J	Tavoy ..	8 1 40	113	14 04 17	98 12 08	978·317	−·007	−·011	−·002
564	95 E	Ye ..	10 1 40	9	15 14 30	97 51 05	978·399	+·014	+·014	+·022

NOTE:—This table is the ninth addendum to Table 2 of the Supplement to Geodetic Report, Vol. VI.

TABLE 5.—*Values of normal warp anomalies.*

Station No.	Corrections to $g-\gamma_{CH}$		Normal warp anomaly	Station No.	Corrections to $g-\gamma_{CH}$		Normal warp anomaly
	Compensation	Spheroid S. of I. II			Compensation	Spheroid S. of I. II	
549	− 1	+20	−34	558	− 2	+19	+19
550	− 1	+23	+ 5	559	− 3	+19	+18
551	0	+22	+19	560	− 3	+20	+13
552	− 2	+23	+44	561	− 1	+20	+28
553	− 1	+22	+40	562	− 5	+20	+ 2
554	− 2	+22	+40	563	− 4	+21	+15
555	− 6	+22	+21	564	− 3	+21	+40
556	0	+20	+32				
557	− 2	+19	+25				

INDIA

GRAVITY ANOMALIES

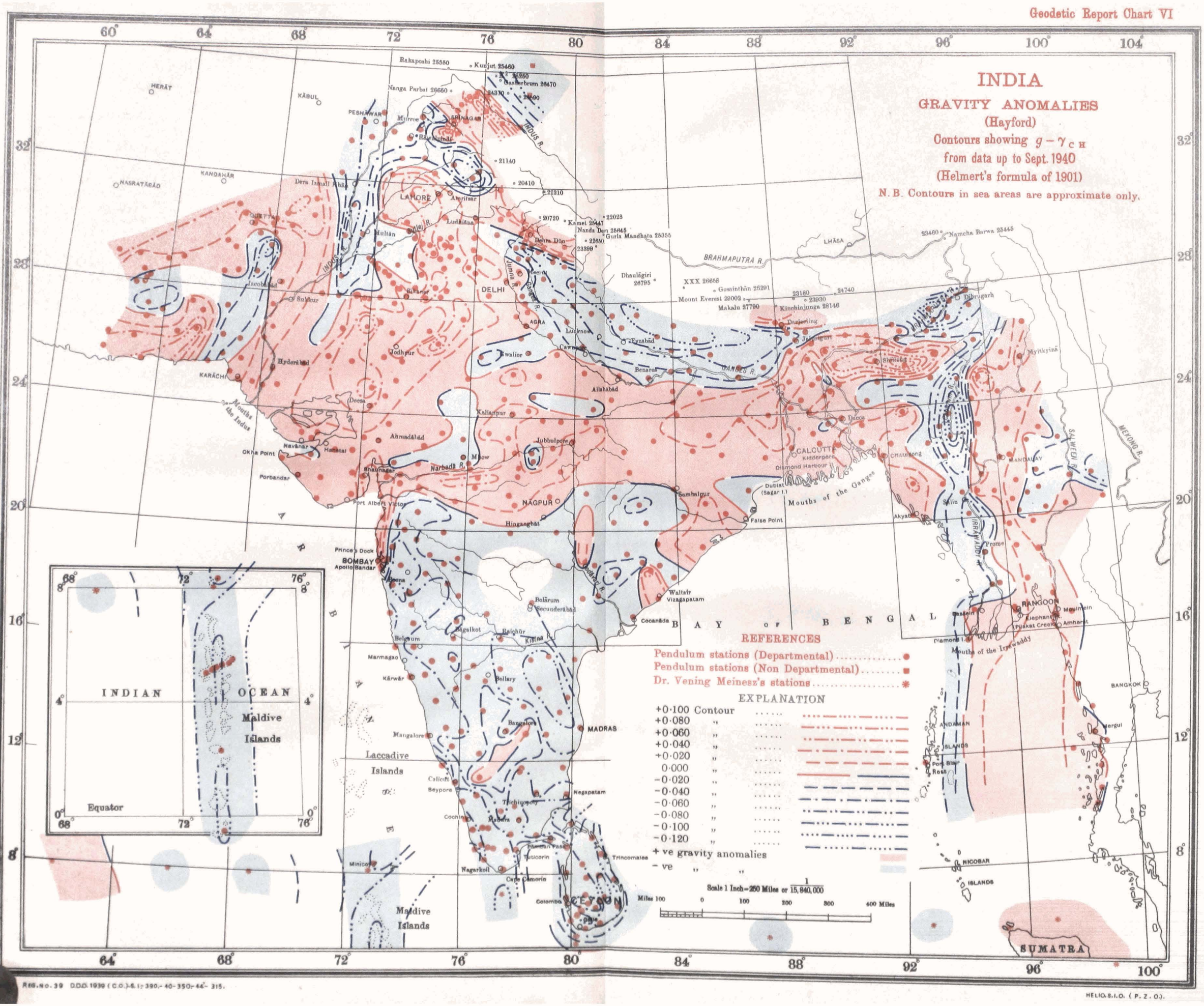
(Hayford)

Contours showing $g - \gamma_{cH}$

from data up to Sept. 1940

(Helmert's formula of 1901)

N.B. Contours in sea areas are approximate only.



REFERENCES

Pendulum stations (Departmental) ●

Pendulum stations (Non Departmental) ■

Dr. Vening Meinesz's stations ✱

EXPLANATION

+0·100	Contour
+0·080	"
+0·060	"
+0·040	"
+0·020	"
0·000	"
−0·020	"
−0·040	"
−0·060	"
−0·080	"
−0·100	"
−0·120	"

\+ ve gravity anomalies

\- ve " "

Scale 1 Inch = 250 Miles or $\frac{1}{15,840,000}$

Miles 100 0 100 200 300 400 Miles

REG. No. 39 D.D.O. 1939 (C.O.)-S.I.:-390-40-350-44-315.

HELIO. S.I.O. (P.Z.O.).

INDIA

GRAVITY ANOMALIES

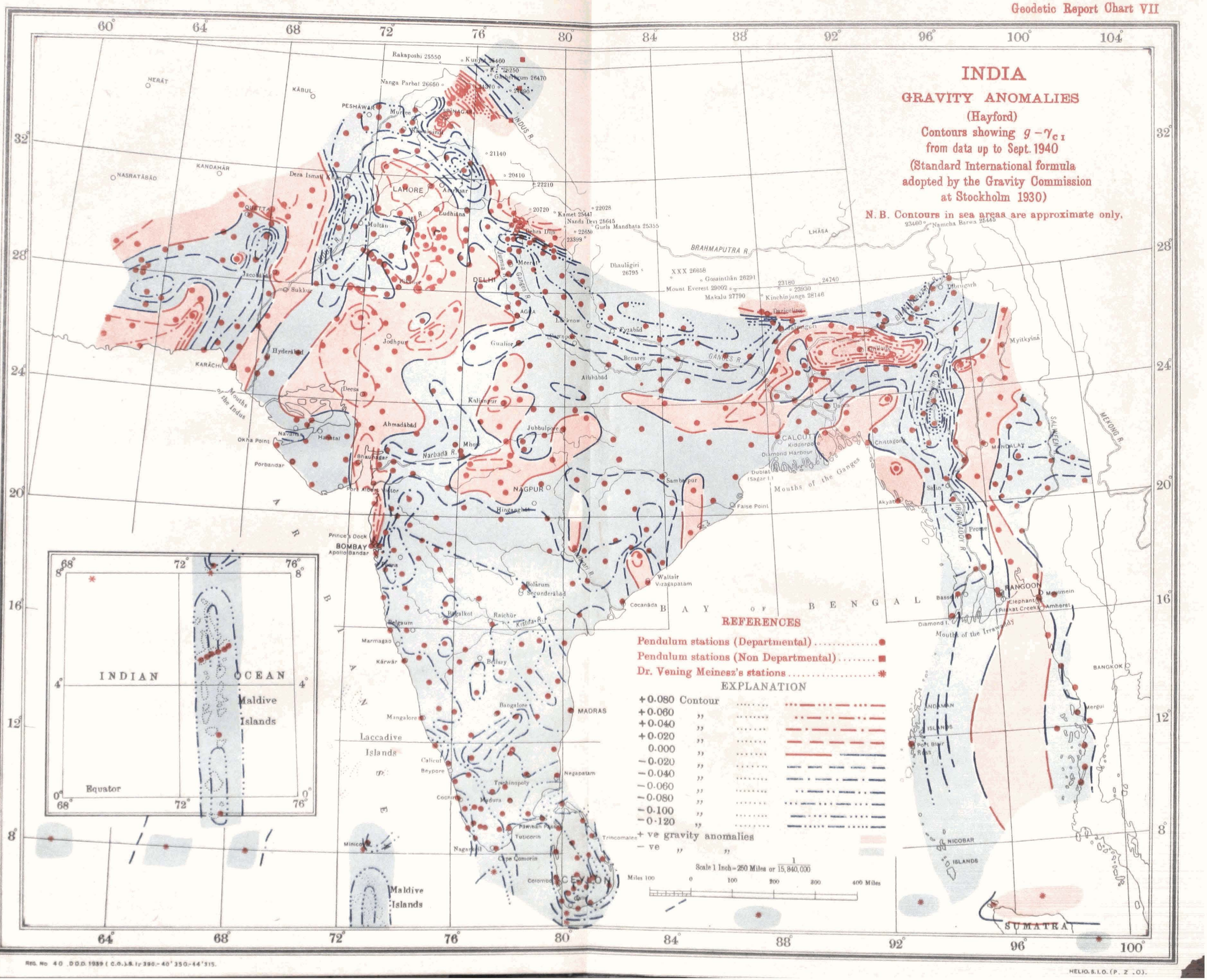
(Hayford)

Contours showing $g - \gamma_{C1}$

from data up to Sept. 1940

(Standard International formula adopted by the Gravity Commission at Stockholm 1930)

N. B. Contours in sea areas are approximate only.



REFERENCES

Pendulum stations (Departmental) ●

Pendulum stations (Non Departmental) ■

Dr. Vening Meinesz's stations ✱

EXPLANATION

+0·080	Contour
+0·060	,,
+0·040	,,
+0·020	,,
0·000	,,
−0·020	,,
−0·040	,,
−0·060	,,
−0·080	,,
−0·100	,,
−0·120	,,

\+ ve gravity anomalies

− ve ,, ,,

Scale 1 Inch = 250 Miles or 1/15,840,000

Miles 100 0 100 200 300 400 Miles

REG. No 40 .D.O.D. 1939 (C.O.I.S.) 1/250.-40'350.-44'315.

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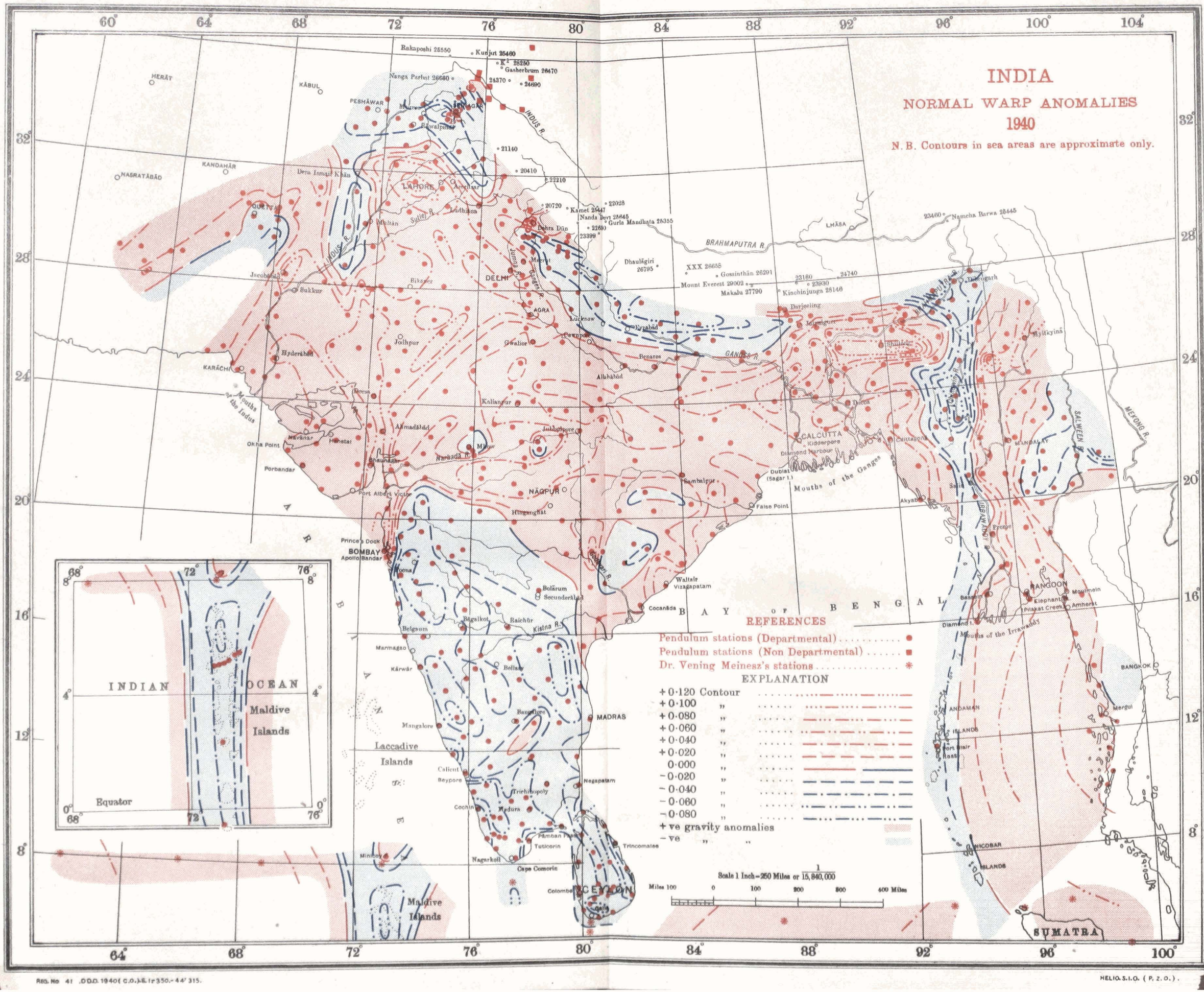
INDIA

NORMAL WARP ANOMALIES 1940

N. B. Contours in sea areas are approximate only.



REG. No 41 .D.O.D. 1940 (C.O.S.E.) 1/350.- 44/315.

HELIO. S.I.O. (P. Z. O.).

INDIA

CRUSTAL STRUCTURE LINES

1940

Rakaposhi 25550 · Kunjut 25460 · K2 28250 · Gasherbrum 28470 · Nanga Parbat 26660 · 24370 · 24690 · 21140 · 20410 · 22210 · 22028 · 20720 · Kamet 25447 · Nanda Devi 25645 · Gurla Mandhata 26355 · 22650 · 23399 · Dhaulāgiri 26795 · XXX 26858 · Gosainthān 26291 · Mount Everest 29002 · Makalu 27790 · 23180 · 23830 · 24740 · Kinchinjunga 28146 · 23100 · Namcha Barwa 25445

NERĀT · KĀBUL · KANDAHAR · NASHATĀBĀ · QUETTA · PESHĀWAR · Murree · SRĪNAGAR · Rāwalpindi · Dera Ismail Khān · LAHORE · Amritsar · Multān · Sutlej R. · Ludhiāna · Dehra Dūn · INDUS R. · Jacobābād · Sukkur · Bikaner · DELHI · Meerut · Jumna R. · Ganges R. · AGRA · Lucknow · Fyzabād · Cawnpore · Gwalior · Jodhpur · Hyderābād · KARĀCHI · Mouths of the Indus · Deesa · Kalianpur · Ahmadābād · Jubbulpore · Okha Point · Navānar · Hanstal · Mhow · Narbadā R. · Bīnaunagar · Porbandar · Port Albert Victor · NĀGPUR · Hinganghāt · Sambulpur · Prince's Dock · BOMBAY · Apollo Bandar · Poona · Bolārum · Secunderābād · Bāgalkot · Raichūr · Kistna R. · Belgaum · Godāvari R. · Waltair · Vizagapatam · Cocanāda · Mormagao · Kārwār · Bellary · Bangalore · MADRAS · Mangalore · Laccadive Islands · Calicut · Beypore · Negapatam · Trichinopoly · Cochin · Madura · Pāmban Pass · Tuticorin · Trincomalee · Minicoy · Nagarkoil · Cape Comorin · Colombo · CEYLON · Maldive Islands · Galle

LHĀSA · BRAHMAPUTRA R. · Dibrugarh · Dibrugarh · Jaipalguri · Shillong · Myitkyina · Dacca · CALCUTTA · Kidderepore · Diamond Harbour · Mouths of the Ganges · Dublat (Sagar I.) · False Point · Akyab · Sandoway R. · MANDALAY · SALWEEN R. · MEKONG R. · Sittang · IRRAWADDY R. · Prome · Diamond I. · Mouths of the Irrawaddy · RANGOON · Elephant Pt. · Pilakat Creek · Moulmein · Amherst · Bassein · BANGKOK · Mergui · ANDAMAN ISLANDS · Port Blair · Ross · NICOBAR ISLANDS · SUMATRA

B A Y O F B E N G A L

INDIAN OCEAN · Maldive Islands · Equator

EXPLANATION

Upwarps

Downwarps

Hidden Range { Crest / Trough

Scale 1 Inch = 250 Miles or 1 / 15,840,000

Miles 100 0 100 200 300 400 Miles

Rec. No 15 0.0.0.0. 1935 (C.O.)-8.1:580.-35-850-36-400-36,403-40,315-44.

HELIO. S. L. O. (P. Z. O.)

TABLE 6.—*Values of* $g-\gamma_{CI}$

(The unit is 1 mgal.)

Station No.	$g-\gamma_{CI}$	Station No.	$g-\gamma_{CI}$	Station No.	$g-\gamma_{CI}$
549	−72	555	−13	561	− 9
550	−34	556	− 7	562	−31
551	−22	557	−10	563	−20
552	+ 5	558	−17	564	+ 3
553	0	559	−17		
554	+ 3	560	−22		

NOTE :—This table is the seventh addendum to Table 6 of Chapter IV, Geodetic Report Vol. VIII.

CHAPTER IV

COMPUTING OFFICE AND OBSERVATORIES

BY MR. B. L. GULATEE, M.A. (Cantab.)

COMPUTING OFFICE

20. General.—The outbreak of the war seriously interfered with the normal activities of the Computing Office, which had to remain mainly occupied with the production of data required by the Army. The following paras give a summary of work carried out.

21. Hayford anomalies.—Out of the about 230 remaining stations (see Geodetic Report 1939, para 15), Hayford deflection anomalies have been computed at 70 stations.

22. Gravity anomalies for the Burma Oil Company.—Assistance has again been given to the Burma Oil Company in the computation of gravity anomalies.

23. Lambert Conical Orthomorphic Projection Tables.—The tables for 1/2M and smaller scales on Lambert Conical Orthomorphic projection with origin in latitude 24° N. and central scale factor 0·9804 were computed for a new edition of Auxiliary Tables, Part I (see Geodetic Report 1939, para 18, last but one sub-para).

24. Plumb-line Deflections in N. W. India, the Punjab and Punjab States.—Computations were completed of the 98 stations observed by the latitude and longitude Detachment of No. 14 Party, see Chapter II.

OBSERVATORIES

25. Latitude variation.—Mr. J. B. Mathur has completed the three-year programme of variation of Latitude at Agra. Table I shows the Right Ascension and the periods of observation of each pair. The group differences together with the closure errors are given in Table 2. The closure errors are very consistent and maintain the same signs during the 3 cycles, thus pointing to a systematic origin.

The latitude variation is tabulated in Table 3. It is noteworthy that there is a close agreement in the results of the 3 years, and that the variation remains large as in the case of Dehra Dūn.

26. Miscellaneous.—The usual magnetic, seismographic and meteorological observations have been carried on. The levelling party's invar staves were standardized as usual and repairs and adjustments were carried out to levels and theodolites used by parties in the field.

TABLE 1.—*Right Ascensions and period of observation of pairs*

Group–pair	Mean R.A. of Group		Year		
	Evening	Morning	1937–38	1938–39	1939–40
	h *m*	*h* *m*			
1*e*, 2*m*	6 20	10 22	(6, 7) Jan. to (2, 3) March	(3, 4) Jan. to (27, 28) Feb.	(3, 4) Jan. to (25, 26) Feb.
2*e*, 3*m*	10 22	14 21	(5, 6) March to (29, 30) April	(2, 3) March to (30, 31) April	(2, 3) March to (29, 30) April
3*e*, 4*m*	14 21	18 25	(4, 5) May to (18, 19) June	(5, 6) May to (17, 18) June	(3, 4) May to (19, 20) June
4*e*, 5*m*	18 25	22 22	(22, 23) June to (30, 31) Aug.	(22, 23) June to (1, 2) Sept.	(21, 22) June to (31, 32) Aug.
5*e*, 6*m*	22 22	2 26	(2, 3) Sept. to (31, 32) Oct.	(6, 7) Sept. to (29, 30) Oct.	(7, 8) Sept. to (30, 31) Oct.
6*e*, 1*m*	2 26	6 20	(4, 5) Nov. to (2, 3) Jan.	(1, 2) Nov. to (30, 31) Dec.	(3, 4) Nov. to (26, 27) Dec.

TABLE 2.—*Group Differences*

	1937–38	1938–39	1939–40	Mean	Adjusted
1*e*—2*m*	+ 0·13	+ 0·11	+ 0·12	+ 0·12	+ 0·09
2*e*—3*m*	+ 0·18	+ 0·22	+ 0·18	+ 0·19	+ 0·16
3*e*—4*m*	+ 0·13	+ 0·11	+ 0·02	+ 0·09	+ 0·07
4*e*—5*m*	− 0·09	+ 0·03	− 0·13	− 0·06	− 0·08
5*e*—6*m*	− 0·04	− 0·11	− 0·05	− 0·07	− 0·09
6*e*—1*m*	− 0·18	− 0·19	− 0·02	− 0·13	− 0·15
C	+ 0·13	+ 0·17	+ 0·12	+ 0·14	0·00

TABLE 3.—*Latitude variation at Agra as derived from the mean declination errors of the three cycles (1937–39).*

Year / Month	1937		1938		1939	
	Mean date of observation	Latitude	Mean date of observation	Latitude	Mean date of observation	Latitude
		° ′ ″		° ′ ″		° ′ ″
January ..	18·3	27 08 12·40	15·3	27 08 12·24	18·3	27 08 12·74
February ..	16·0	12·22	16·3	12·18	15·0	12·59
March ..	14·7	12·06	16·9	11·93	17·7	12·32
April ..	17·4	11·72	16·4	11·71	15·5	12·20
May ..	17·6	11·55	19·2	11·79	17·3	12·14
June ..	16·3	11·69	16·8	11·65	13·7	11·98
July ..	14·6	11·47	19·8	11·76	13·8	11·74
August ..	17·5	11·72	19·3	11·64	16·6	11·87
September	19·3	11·97	18·7	11·95	19·8	12·35
October ..	17·1	12·08	18·7	12·22	16·9	12·45
November ..	18·4	12·45	14·2	12·66	17·5	12·58
December ..	13·3	27 08 12·32	15·1	27 08 12·59	15·6	27 08 12·57
Annual mean		27 08 11·97		27 08 12·03		27 08 12·29

G.B.—P.O.—J.S. 505—6-10-44—300 bks.