GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1908-09

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E., A.D.C.

SURVEYOR GENERAL OF INDIA

CALCUTTA

SUPERINTENDENT GOVERNMENT PRINTING, INDIA

1910

Price Two Rupees or Three Shillings

Major James Rennell, F.R.S.,

'The first great English Geographer'.

James Rennell

Reproduced from a Medallion in the possession of the Asiatic Society of Bengal.

Born near Chudleigh in Devonshire on the 3rd December 1742. Entered the Navy in 1756 and served with the expedition of the Duke of Marlborough to Brittany in 1758. Volunteered for service in the East Indies and was employed on Marine Surveys till 1764, when he went to Bengal and was appointed Probationer Engineer in Fort William. The Survey of the Delta of the Ganges and Brahmaputra, commenced in the same year under the orders of the Governor, Mr. Vansittart, and subsequently extended under Lord Clive and Warren Hastings to the remainder of Bengal, occupied him till his retirement, owing to ill health, in 1776, with the rank of Major. During the progress of this work he was severely wounded in a skirmish with a band of fanatic rebels, the Sunyasi Fakirs, in Northern Bengal. He was appointed "Surveyor of the East India Company's Dominions in Bengal" by Lord Clive on the 1st January 1767, with a staff of four Assistants :—Capt. Lewis DuGloss, Capt. John Adams, Lieut. Carter, and Ensign William Richards. On his retirement he settled in London, and devoted himself to the study of scientific geography His chief publications were:—The "Bengal Atlas, containing Maps of the Theatre of War and Commerce on that side of Hindoostan", 1779; "A Memoir of a Map of Hindoostan", 1783; and "The Geography of Herodotus", 1800. He was elected a fellow of the Royal Society in 1781, received the Copley Medal of the Society in 1791, and the Gold Medal of the Royal Society of Literature in 1825. He died at the age of 88 on the 29th March 1830, and was buried in the Nave of Westminister Abbey.

Extract from a note supplied by T. H. D. LaTouche, Esq., Director, Geological Survey of India.

Engraved and printed by, the Survey of India Offices.

GENERAL REPORT

SURVEY OF INDIA

1908-09

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

IN ENGLAND.

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

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

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

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

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

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

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

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

DEIGHTON, BELL & Co., Cambridge.

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

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

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

ON THE CONTINENT.

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

OTTO HARRASSOWITZ, Leipzig, Germany.

KARL HIERSEMANN, Leipzig, Germany.

RUDOLF HAUPT, 1, Dorrienstrasse, Leipzig, Germany.

ERNEST LEROUX, 28, Rué Bonaparte, Paris.

MARTINUS NIJHOFF, The Hague, Holland.

IN INDIA.

THACKER, SPINK & Co., Calcutta and Simla.

NEWMAN & Co., Calcutta.

S. K. LAHIRI & Co., Calcutta.

R. CAMBRAY & Co., Calcutta.

B. BANERJEE & Co., Calcutta.

HIGGINBOTHAM & Co., Madras.

V. KALYANARAMA AIYER & Co., Madras.

G. A. NATESAN & Co., Madras.

THOMPSON & Co., Madras.

MURTHY & Co., Madras.

TEMPLE & Co., Madras.

COMBRIDGE & Co., Madras.

A. R. PILLAI & Co., Trivandrum.

THACKER & Co., LD., Bombay.

A. J. COMBRIDGE & Co., Bombay.

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

RADHABAI ATMARAM SAGOON, Bombay.

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

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

SUPERINTENDENT, AMERICAN BAPTIST MISSION PRESS, Rangoon.

SUNDER PANDURANG, Bombay.

A. M. & J. FERGUSON, Ceylon.

A. CHAND & Co., Lahore and Punjab.

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

GOPAL NARAYAN & Co., Bombay.

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

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1908-09

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E., A.D.C.

SURVEYOR GENERAL OF INDIA

CALCUTTA

SUPERINTENDENT GOVERNMENT PRINTING, INDIA

1910

CONTENTS.

PART I.

SUMMARY.

	Page
Administration	1
Field Parties, Distribution of	3
Trigonometrical Surveys	5
Scientific and Special Operations	5
Topographical Surveys	6
Forest Surveys	7
Cantonment Surveys	8
Results	8
Head-quarters Offices	9
Branch Offices	16
Forest Map Office	18
Local Drawing Offices	19
New Standard Maps	21
Establishment	26
Expenditure	26

PART II.

THE OPERATIONS OF FIELD PARTIES.

Party.		Page
	Trigonometrical Surveys.	
24.	Triangulation	27
	Scientific Operations.	
22.	Astronomical Latitudes	31
23.	Pendulums	31
25.	Tidal and Levelling	33
26.	Magnetic	36
	Topographical Surveys.	
1.	Central Provinces and Central India Agency	47
2.	Berár	49
3.	Burma	55
9.	Northern Circle	42
10.	Upper Burma	56
11.	Shan States, Burma	58
12.	Northern Circle	43
14.	„ „	44
17.	Bombay	50
18.	Northern Circle	45
19.	Madras	53
20.	Assam	59
	Coorg detachment	54
	Cantonment Surveys.	
Sections, 1 and 2.	India	60
	Tabular Statements.	
	Outturn of work of Field Parties	63
	Cost-rates	65

ILLUSTRATIONS.

1. Portrait of Major James Rennell, F.R.S. . . . . Frontispiece
2. Sacred cave at Alaungdaw, Lower Chindwin . . . . . To face page 56

MAPS.

	TO FACE PAGE
1. Index chart to the Great Trigonometrical Survey	1
2. „ shewing the progress of Imperial Surveys	1
3. Sheet 47 of the Million series	11
4. Index to the sheets of India and Adjacent Countries	26
5. „ „ „ Indian Atlas Sheets published up to 1st October 1909	26
6. India shewing stations of Observations of Magnetic Survey	40
7. Index Map shewing progress of publication, Northern Circle	46
8. „ „ „ „ of Topographical Surveys, Northern Circle	46
9. „ „ „ „ of publication, Southern Circle	54
10. „ „ „ „ of Topographical Surveys, Southern Circle	54
11. „ „ „ „ of publication, Eastern Circle	62
12. „ „ „ „ of Topographical Surveys, Eastern Circle	62
13. India „ „ of Forest Surveys	66

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1908-09.

PART I.

SUMMARY.

ADMINISTRATION.

1. This report deals with the operations of the Survey of India for the year ending the 30th September 1909.

Colonel F. B. Longe, R.E., A.D.C., administered the department throughout the year.

Colonel S. G. Burrard, R.E., F.R.S., continued as Superintendent, Trigonometrical Surveys, except for a short period from 15th August 1909 to the end of the year, when he was deputed to England to represent the Government of India at the triennial conference of the International Geodetic Association, and Captain H. H. Turner, R.E., officiated for him. Colonel G. B. Hodgson, I.A., held the appointment of Deputy Surveyor General up to 20th April 1909, when he proceeded on combined leave and Colonel T. F. B. Renny-Tailyour, R.E., was appointed to officiate in that appointment. The superintendence of the parties working in Bombay, Berár and Central Provinces and the Cantonment sections was under Colonel Hodgson, I.A., up to 11th October, under Lieutenant-Colonel J. M. Fleming, I.A., from 12th October to 16th April and under Colonel Renny-Tailyour, R.E., from 17th April up to the close of the year. The superintendence of the parties working in Southern India, Burma and Assam was under Lieutenant-Colonel P. J. Gordon, I.A., up to 21st October and again from 17th April up to the close of the year, and under Colonel Hodgson, I.A., from 22nd October to 16th April. The post of the Superintendent, Northern Circle, was held by Major C. H. D. Ryder, D.S.O., R.E., up to 6th June and thereafter by Lieutenant-Colonel W. J. Bythell, R.E.

2. In January 1909 a building site comprising 7½ acres of the Langford house estate in the civil and military station of Bangalore was acquired by Government with the view of erecting a building for the accommodation of the party and circle offices of the Southern Circle.

3. Two officers of the Federated Malay States survey were attached to field parties during the field season for instruction in the Indian method of surveying.

4. During the year under report, orders have been received for the formation of the new Provincial Service and the Upper Subordinate Service. The former will consist of 77 posts with salaries commencing at R250 and rising by triennial increments of R50 to R600 with 10 additional posts carrying salaries from R650 to R1,000 to be filled by selection. The latter will consist of 116 posts with a salary of R80 rising by triennial increments of R15 to R200 with 9 additional posts of R250 which will be filled by selection.

Inspection Tours of Administrative Officers.

5. Colonel F. B. Longe, R.E., Surveyor General of India, as previously reported, arrived in India on return from leave, on the 25th September 1908, and proceeded at once to Bangalore on inspection duty. He left Bangalore on October 8th for Mussooree, where he inspected the parties of the Northern Circle and the United Provinces, and Mussooree Drawing offices; from there he proceeded to Simla arriving on the 26th October. At Simla he inspected the Simla Drawing office, and on the 1st November left for Roorkee, arriving the same day. He discussed the question of the future training of soldier-surveyors with Colonel Heath, R.E., Commanding the 1st Prince of Wales' Own Sappers and Miners, who is now entrusted with their preliminary training; also matters connected with the reproduction of maps in the field. He visited the Corps printing establishments. On the 4th November he went to Dehra Dún where he inspected the Trigonometrical Branch office, and the Forest Survey office. He proceeded to Calcutta on the 10th November, and remained there till the 7th March 1909, when he proceeded on tour in Northern India. *En route* he satisfied himself that the maps in the neighbourhood of Lucknow were very much out of date, and deficient in minor details; while those of the country round Delhi, and of the country between Lucknow and Delhi, require careful revision. A party will commence the necessary preliminary work in this area next field season. He arrived at Lahore on the 16th March. After inspecting the river-ain detachment of No. 18 Party he decided that its drawing office should remain there throughout the year instead of proceeding to Mussooree. He also inspected the special traverse detachment under Mr. J. de G. Hunter, and visited the Revenue and Settlement Commissioners. The Superintendent, Northern Circle, Major Ryder, D.S.O., R.E., joined him at Lahore on the 19th and together they proceeded, *viâ* Pesháwar, Kundián Samásata, Bhátinda, to Simla. As this tour took him through country under survey at the time, he was able to see the actual work in progress, being met at various stations on the line, and at halting places, by the officers and surveyors working in the immediate neighbourhood. He arrived at Simla on the 31st March. His camp office opened there on the 1st April, remaining until the 15th June, when it returned to Calcutta. On the 19th June he left Simla for Mussooree, where he inspected the parties of the Northern Circle. He left Mussooree on the 21st July for Dehra Dún, where he inspected the Trigonometrical Branch office, and the Forest Map office. He left Dehra Dún on the 24th July, and arrived at Poona on the 26th. Here he inspected the parties of the Southern Circle, and having arranged their programme for the coming field season, left for Bangalore on the 1st August.

At Bangalore he presided at the annual conference of administrative officers which commenced on the 4th and concluded on the 14th August. The pamphlet containing instructions for the preparation of maps, published in 1907, was thoroughly gone into and revised, in the light of the experience gained in the last two years. The rules regarding pay, and promotion, of all classes of subordinate and ministerial officers with field parties, other than surveyors, were laid down. The application of the existing travelling allowance rules to subordinate officers was also gone into. It was decided that all triangulation and levelling, in the Northern and Southern Circles, should be handed over to the Trigonometrical Branch, after the close of next field season, but for want of a sufficient number of officers, such work for the Eastern Circle could not be undertaken for some time. The rules regarding the preparation of maps for the Forest Department, and regarding the 4-inch boundary survey, were considered and settled. The selection of surveyors who should be rewarded for past services, and who were worthy of promotion to the Upper Subordinate Service, was made.

During his stay at Bangalore he inspected the Circle office, and all the parties recessing there. On the 1st September he proceeded to Ootacamund and arranged with Mr. Brazier of the Forest Department and Mr. Hatchell of the Madras Survey Department, the programme of work and other matters affecting those departments. He returned to Bangalore on the 7th and left Bangalore the same day for Bombay arriving there on the 9th. On the following day he left for Ráwalpindi where he arrived on the 12th. Next day he left for Murree and from thence he proceeded to Srínagar, where he arrived on the 19th. After a short tour, and several interviews with the local authorities, he was able to

estimate and arrange for the execution of the more urgent surveys. Leaving Kashmir on the 24th, he arrived in Calcutta on the 31st October. *En route*, he inspected the field office of No. 14 Party at Ráwalpindi.

6. Colonel S. G. Burrard, R.E., F.R.S., Superintendent, Trigonometrical Surveys, visited Mussooree during May and June 1909, and inspected the recess offices of Nos. 22, 23, 24 and 26 Parties and the levelling detachment of No. 25 Party. He also inspected at Dehra Dún in May 1909, the Forest Map office and No. 25 Party and the Survey Training School, from time to time during the year.

7. Colonel G. B. Hodgson, I.A., Deputy Surveyor General, inspected the Coorg detachment at Mercara in December 1908, and Nos. 3 and 10 Parties in Burma during January 1909.

8. During January 1909, Lieutenant-Colonel J. M. Fleming, I.A., inspected in the field Nos. 1, 2, and 17 Parties and on several occasions inspected the office of No. 1 Cantonment section at Dum Dum. During recess, Colonel T. F. B. Renny-Tailyour, R.E., officiating Deputy Surveyor General, inspected the above parties in recess, and also visited No. 2 Cantonment section at Secunderábád on his return from attending the departmental conference of Superintendents at Bangalore during July. He also inspected on several occasions the office of No. 1 section at Dum Dum.

9. Lieutenant-Colonel P. J. Gordon, I.A., Superintendent in charge Burma Surveys, made a short tour in South Canara and Cochin in May 1909. On the 8th September 1909 he proceeded to Burma where he inspected Nos. 10 and 11 Parties in recess at Maymyo and returned to Bangalore *vid* Calcutta on the 5th October 1909.

10. Major C. H. D. Ryder, D.S.O., R.E., Superintendent, Northern Circle, was at Simla from the 1st to the 7th October 1908 inspecting the Simla Drawing office. He returned to Mussooree on the 9th October. On the 3rd December he left Mussooree, arriving at Leiah on the 5th to inspect No. 9 Party, reaching Dera Ismail Khán on the 11th where he inspected No. 18 Party, and then proceeded to Basal to inspect No. 14 Party. He inspected No. 12 Party at Abbottábád and Pesháwar and the riverain detachment of No. 18 Party at Lahore, returning to Mussooree on the 24th December 1908. He left Mussooree in February 1909 and inspected the Bári Doáb traverse section of No. 18 Party at Multán on the 17th February and after inspecting No. 9 Party at Kot Sultán, and No. 18 Party at Miánwáli, he arrived at Pesháwar on the 25th, where he inspected No. 12 Party. He then proceeded to Ráwalpindi to inspect No. 14 Party and returned to Mussooree on the 4th March 1909. He again left Mussooree on the 18th March, meeting the Surveyor General and accompanying him on his tour through the Punjab, in the course of which Nos. 9, 12, 14 and 18 Parties were visited, and after an inspection of the Simla Drawing office, he returned to Mussooree on the 6th April. On the 7th June he handed over the office of the Superintendent, Northern Circle, to Lieutenant-Colonel W. J. Bythell, R.E., on the return of the latter from furlough, and took over charge of No. 14 Party from Lieutenant Trenchard, R.E., on the 15th June.

11. Lieutenant-Colonel W. J. Bythell, R.E., proceeded to Bangalore on the 30th July 1909 to attend the survey conference and returned to Mussooree on the 20th August. He proceeded to Simla on the 8th September to inspect the Simla Drawing office, returning to Mussooree on the 13th September. He inspected all the recess offices of the parties under his administrative control between the 7th June and the 30th September, besides visiting them frequently.

DISTRIBUTION OF FIELD PARTIES.

12. Field operations were carried out by 17 parties and 3 sections or detachments. Of the parties, 12 were employed on topographical surveys, 1 on principal triangulation, and 4 on purely scientific operations. A new detachment was formed on the 1st November 1908 for the purpose of commencing survey operations in Coorg. No. 7 Party (Burma Cadastral) having completed the work assigned to it was disbanded in December 1908. The following table

shows the distribution according to the nature of the work on which the parties were employed :—

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale.	Administrative Superintendent.
	TRIGONOMETRICAL.				
24	India	27	Captain C. M. Browne, D.S.O., R.E.	...	S. T. S.
	SCIENTIFIC.				
22	India (Latitudes) . .	31	Captain H. McC. Cowie, R.E . / Lieutenant H. J. Couchman, R.E.	...	S. T. S.
23	„ (Pendulums) . .	31	Captain H. McC. Cowie, R.E. .	...	Ditto.
25	„ (Tidal and Levelling).	33	Mr. C. F. Erskine . . .	...	Ditto.
26	„ (Magnetic) . .	36	Captain R. H. Thomas, R.E. .	...	Ditto.
	TOPOGRAPHICAL.				
9	Northern Circle . .	42	Captain G. A. Beazeley, R.E. . / Lieutenant E. C. Baker, R.E. .	1″=1 M.	Supdt., Northern Circle.
12	„ „ . .	43	Brevet-Major E. T. Rich, R.E. . / Lieutenant E. C. Baker, R.E. .	2″=1 M. / 1″=1 M.	Ditto.
14	„ „ . .	44	Major C. H. D. Ryder, D.S.O., R.E. / Lieutenant O. H. B. Trenchard, R.E.	2″=1 M.	Ditto.
18	„ „ . .	45	Captain E. A. Tandy, R.E. . / Captain L. C. Thuillier, I.A. .	2″=1 M. / 1″=1 M.	Ditto.
1	Central Provinces and Central India Agency.	47	Major C. L. Robertson, C.M.G., R.E. / Lieutenant M. N. MacLeod, R.E. / Lieutenant K. W. Pye, R.E. .	2″=1 M. / 1″=1 M.	Supdt., Southern Circle, (D. S. G.)
2	Central Provinces and Berár.	49	Captain H. Wood, R.E. . .	2″=1 M. / 1″=1 M.	Ditto.
17	Bombay Presidency, Central India Agency and Hyderábád.	50	Lieutenant S. W. S. Hamilton, R.E.	2″=1 M. / 1″=1 M.	Ditto.
19	Madras . . .	53	Major C. W. H. Symonds, I.A.	2″=1 M.	Supdt., Burma Surveys.
...	Coorg Detachment .	54	Mr. R. Waller-Senior . .	2″=1 M.	Ditto.
3	Burma . . .	55	Captain C. P. Gunter, R.E. .	2″=1 M. / 1″=1 M.	Ditto.
10	„ . . .	56	Captain A. A. McHarg, R.E. . / Captain L. G. Crosthwait, I.A.	2″=1 M. / 1″=1 M.	Ditto.
11	Shan States . . .	58	Captain R. H. Phillimore, R.E.	1″=1 M.	Ditto.
20	Eastern Bengal and Assam.	59	Major A. Mears, I.A. . .	2″=1 M. / 1″=1 M.	Ditto.
Section No.	CANTONMENT SURVEYS.				
1	Punjab, Bengal, United Provinces and Assam.	60	Mr. E. G. Little . . .	64″=1 M. / 16″=1 M.	Supdt., Southern Circle, (D. S. G.)
2	Central Provinces, Hyderábád and Burma.	61	Mr. L. J. Pocock . . .	105·6″=1 M. / 16″=1 M.	Ditto.

TRIGONOMETRICAL SURVEYS.

13. The triangulation party (No. 24) was divided into 5 principal and 4 secondary detachments of which 1 principal detachment worked in Baluchistán, 1 in the North-West Frontier Province, 2 principal and 2 secondary in Burma, 1 principal in Kashmir, 1 secondary in Assam, and 1 secondary in the Punjab.

Principal Triangulation.

(*a*) In Baluchistán during the summer of 1908 the North Baluchistán series was carried northward from its initial side (Zawa-Zibra of the Kalát longitudinal series) up to latitude 31°, a length of 100 miles. Eight triangles were completed covering an area of 3,500 square miles, the average triangular error being 0·41″.

(*b*) In the North-West Frontier Province the North Baluchistán series was commenced from the starting from the side Bani-Sakesar of the Great Indus series; a length of 50 miles was completed; the seven triangles enclose an area of 1,900 square miles, the average triangular error being 0·602″.

(*c*) In Burma (Shan States) the Great Salween series was continued eastwards to longitude 99° 24′, a length of new series of 100 miles; nine triangles were completed covering an area of 4,200 square miles, the average triangular error was 0·47″.

(*d*) In Upper Burma the selection and building of stations for the Upper Irrawaddy series was carried northward from the side Song-Tangte of the Great Salwèen series as far as latitude 25° 30′.

(*e*) In Kashmir the new series was commenced from the side Nehr-Khagriani of the North-Western Himalaya series and the work is still in progress.

Secondary Triangulation.

(*f*) In the Punjab a traverse was run with the Jäderin apparatus from Burála T. S. of the Jogí Tílá series to Shorkot h. s., and to Doráwálá s., a total length of about 118 miles.

(*g*) In Assam the selection and building of stations for the Khási hills secondary series along parallel 25° 49′ was commenced.

(*h*) In Lower Burma the selection and building of stations for the Mawkmai secondary series was carried from the side Letpataung-Suletaung of the Mandalay meridional series eastwards along the parallel of 19° 30′ up to longitude 98° 15′.

(*i*) In Upper Burma the selection and building of the stations for a secondary series along the meridian of 97° 0′ was carried northwards from the side Tangte-Taungkalat of the Great Salween series up to latitude 24° 30′.

SCIENTIFIC AND SPECIAL OPERATIONS.

14. On the return of the Standard Bar A from France it was carefully compared at Dehra Dún against the secondary standards I_B and I_S by Captain Turner and Captain Cowie. The comparisons showed that no appreciable change in length had occurred during its journeys from India to Europe and back.

15. Captain Cowie took pendulum observations at twelve stations in Central India with the object of investigating the structure of the Vindhya and Sátpura ranges.

16. The new tidal observatory at Moulmein was opened, and satisfactory observations were obtained. Tidal operations were continued at the eight permanent stations. Levelling operations were carried out by three separate detachments. Three important main lines of levelling were completed, *viz.*:—from Ferozepore to Ahmadábád, from Katni to Nágpur, from Wardhá to Secunderábád. Twenty-six new standard bench-marks were connected.

17. With the completion of observations along the coast of Burma, the preliminary magnetic survey was finished with the exception of the Himalayan-Karakoram regions: the detail survey was commenced by the examination of three obviously disturbed localities.

The reduction of the preliminary survey is in hand; in connection therewith several questions are still under investigation.

18. The following statement shows the cost of the more purely scientific work of the department for the survey year under report:—

			R
Field Parties, No. 22 Party,	Astronomical		7,440
" " " 23 "	Pendulums		27,423
" " " 24 "	Triangulation		2,13,122
" " " 25 "	Tidal and Levelling:—	R	
	Tidal observations	15,278	
	Preparation of Tide Tables.	26,672	
	Levelling operations	53,620	95,570
" " " 26 "	Magnetic:—		
	Magnetic observatories.	14,841	
	Magnetic field work	59,146	73,987
	TOTAL		4,17,542
Controlling and Administrative Staff	Trigonometrical	57,772	
Trigonometrical Branch Office		1,37,392	1,95,164
	GRAND TOTAL		6,12,706
Last year the cost of the field parties was			4,13,283
Controlling and Administrative staff			63,569
Trigonometrical Branch Office			1,59,874
	GRAND TOTAL		6,36,726

19. Surveyor Pertab Singh of No. 3 Party accompanied an expedition under Lieutenant-Colonel Lumsden, C.B., into the Mishmi country in the beginning of 1909, and surveyed an area of 250 square miles of hitherto unmapped country on the ¼-inch scale.

TOPOGRAPHICAL SURVEYS.

20. *Central Provinces and Central India Agency.*—No. 1 Party continued to carry out supplementary survey, for the most part, on the 2-inch scale, of the area previously cadastrally surveyed in the Central Provinces. An area of 1,716 square miles was thus revised and contoured, in addition to an area of 951 square miles which was done on the 1-inch scale. A further area of 477 square miles was resurveyed, mainly on the 1-inch scale, in the Central India Agency. An area of 3,099 square miles was also triangulated in advance.

21. *Central Provinces and Berár.*—No. 2 Party constituted as an ordinary topographical instead of an instructional party as in previous years, continued the topographical survey of Berár, and extended operations into the Wardhá district of the Central Provinces. An area of 2,448 square miles was surveyed on the 1-inch scale, while 240 square miles, mainly forest area, was surveyed on the 2-inch scale. An area of 2,229 square miles was triangulated in advance. The boundaries of all A and B class forest reserves falling within the area surveyed, aggregating 461 linear miles, were surveyed on the 4-inch scale for the Forest Department.

22. *Bombay Presidency, Central India Agency and Hyderábád.*—No. 17 Party revised and contoured on the 1-inch scale an area of 2,985 square miles, falling mainly in the Central India Agency. In addition, an area of 603 square miles, consisting generally of reserved forests in the East and West Khándesh districts, was mapped on the 2-inch scale, while 205 linear miles of forest boundaries in the same districts were surveyed for the Forest Department on the 4-inch scale. 2,100 square miles were triangulated in advance, mainly in the Hyderábád State.

23. *Eastern Bengal and Assam.*—No. 20 Party triangulated 680 square miles and surveyed 1,512 square miles on the 2-inch and 521 square miles on

the 1-inch scale in the Sylhet and Cáchár districts and in the Hill Tippera State. 119 linear miles were also traversed for topographical purposes.

24. *Coorg.*—A detachment was formed in November 1908 and surveyed 558 square miles on the 2-inch scale in Coorg. An area of 2,565 square miles in Coorg and the South Canara and Malabar districts was also triangulated.

25. *Burma.*—Nos. 3, 10 and 11 Parties continued surveying on the 1-inch and 2-inch scales in the Pakôkku, Upper and Lower Chindwin, Ruby Mines and Bhamo districts and in the Shan States. An area of 9,509 square miles was surveyed, 330 being on the 2-inch scale and 9,179 on the 1-inch scale. An area of 2,906 square miles was also triangulated.

26. *Madras Presidency.*—No. 19 Party triangulated 5,850 square miles in Travancore State and surveyed 1,483 square miles on the 1-inch and 1,065 on the 2-inch scale in Mysore State and in the Nílgiri, Malabar and Coimbatore districts.

27. *Northern Circle.*—No. 9 Party triangulated 309 square miles, traversed 52 linear miles and levelled 115 linear miles. It surveyed 4,598 square miles, of which 285 were revision survey on the 1-inch scale in the Dera Ismail Khán and Dera Gházi Khán districts.

No. 12 Party carried out no triangulation during the year under report, as its programme of detail survey for the following season is based entirely on traverses. It surveyed 1,359 square miles on the 2-inch scale and 953 square miles on the 1-inch scale in the Hazára and Attock districts.

No. 14 Party triangulated 750 square miles for the 2-inch scale and 3,760 square miles for the 1-inch scale in the Ráwalpindi district and Kashmir, and surveyed 2,830 square miles on the 2-inch scale in the Attock, Ráwalpindi and Hazára districts.

No. 18 Party triangulated 1,800 square miles in the Miánwáli, Sháhpur and Attock districts and surveyed 945 square miles on the 2-inch scale and 1,500 square miles on the 1-inch scale in the Dera Ismail Khán and Miánwáli districts. It also traversed 420 linear miles for topographical survey in the Dera Ismail Khán, Miánwáli and Sháhpur districts, 1,827 linear miles in the Bári Doáb completing that work, and 395 linear miles for the riverain work.

FOREST SURVEYS.

28. The forest survey operations of the year were carried out, in nearly every case, by the various topographical parties in whose sphere of operations the forests lay. The surveys were for the most part on the 2-inch scale, but a few small areas were done on the 4-inch scale, and boundary surveys on the 4-inch scale were carried on over a considerable area. The revision of a small area previously surveyed on the 4-inch scale by the Forest Survey Branch was also effected.

29. *Central Provinces (Berár Circle).*—In the course of the 1-inch topographical survey of Berár, No. 2 Party surveyed on the 2-inch scale all the A and B class forests falling in the area under survey in the districts of Akola and Yeotmál, and their boundaries were traversed on the 4-inch scale. The area surveyed on the 2-inch scale amounted to about 160 square miles, and the boundary traversing to 461 linear miles.

30. *Northern Circle.*—No. 12 Party surveyed the Manakrai reserve, and parts of the Tanglai and Lachi Khán reserves in the Hazára district, on the 1-inch scale. The total area amounted to 8 square miles. In addition to this, 4-inch forest surveys previously done by the Forest Survey Branch in a part of the Masar reserve, the Batrasi and Tandiani reserves, and parts of Dunga Gali and Samundar reserves, Hazára division, were revised on the small scale, new details inserted, all the roads classified, and perennial water shown. The total area thus revised on the 4-inch scale amounted to 70 square miles. Part of the Gianthal reserve, in Ráwalpindi district, amounting to 0·80 square mile, was also surveyed on the 1-inch scale by No. 12 Party.

31. *Burma.*—Two parties surveyed forest areas in Burma in the course of their regular operations. No. 3 Party completed 39 square miles on the 2-inch scale in the Myittha and Lower Chindwin divisions, and No. 10 Party surveyed 152 square miles on the same scale in the Bhamo, Mu and Upper Chindwin divisions. The reserves surveyed by No. 3 Party were the Mahamyaing extension, Myittha division, and Thingadôn extension, Lower Chindwin division; and by No. 10 Party, the Simaw, Munsin, Nanhan, Mohlaing, Mainghein, and

Punraung reserves, Bhamo division; the Nanbyan, Nangyitha and Maingwun reserves, Mu division, and Kanti reserve, Upper Chindwin division. As these surveys were conducted in the course of the regular topographical survey, their cost will be borne by the Survey of India. As arranged last year, No. 10 Party surveyed the Mosit reserve in the Bhamo division, area 106 square miles, on the 2-inch scale, in advance of its programme. This being a special survey, its cost will be borne by the Forest Department. Next season only a small area of some 12 square miles is proposed for survey.

32. *Eastern Bengal and Assam.*—Parts of Sonai, Inner Line and Katakhal reserves, in the Cáchár division, Eastern Circle, comprising an area of 367 square miles, were surveyed on the 2-inch scale by No. 20 Party. Owing to the difficult nature of the ground, the early rains, and the presence of a man-eating tiger, the programme of the party was not completed. The work will be completed next season, when parts of the Sonai, Inner Line, Katakhal, Barali, Langai and Singlá reserves will be surveyed.

Madras Presidency.—Forest surveys on the 2-inch scale were carried on during the year by No. 19 Party in the following divisions:—In South Malabar, Attapádi blocks 1, 3 and 4, Erambadam, Nellikkutt, Old and New Amarapalam, Silent valley and Karunipoya reserves, and parts of Attápadi blocks 2, 5 and 6, aggregating 201 square miles. The unsurveyed portions of the last three blocks will be completed next season. The traversing of the Silent valley reserve boundary was completed, and the remainder of the New Amarapalam reserve boundary was traversed as far as possible. In the Nílgiris, 209 reserved forests, of the total area of 357 square miles, were surveyed. Thirty-seven reserves were partially surveyed but the area is so small that it was thought better to report the total area of each on completion. In North Coimbatore, the Akkur reserve, area 2 square miles, and in Central Coimbatore, the Nellimalai reserve, area 3 square miles, were surveyed. These two reserves have been afforested since the 4-inch survey was carried out. The total forest area thus surveyed in the Madras Presidency is 563 square miles, and the whole cost is debitable to the Survey of India.

33. *Bombay Presidency.*—An area of about 394 square miles of forest, falling within Shirpur taluk, of the Western Khándesh district, and Chopda and Yával taluks, of the Eastern Khándesh district, was surveyed on the 2-inch scale by No. 17 Party. The boundaries of these areas, about 205 linear miles, were surveyed on the 4-inch scale. The area is a part of the Sátpura reserves, and is a continuation of the work commenced in 1906.

34. *Coorg.*—In Coorg an area of 56 square miles of forest, comprising parts of the Attur, Dubare, Yedavanad, Devamachi, Mawkal, and Mercara reserves, and the whole of the Anekadu reserve, was surveyed on the 2-inch scale. It is hoped that the Coorg survey will be completed during 1909-10.

CANTONMENT SURVEYS.

35. The survey of Cantonments was continued by the same two detachments as last year. The surveys were as formerly carried out on the 16-inch scale, with bazaars on the 64-inch scale. An exception was, however, made in the case of the bazaars of Secunderábád and Bolárum, the survey of which was the main task of one section throughout the year; for these the large scale of 1-inch =50 feet or 105·6 inches=one mile was employed. Besides the above, the survey of seventeen Cantonments, including the 7 Gallies, was completed. Added portions of four more were surveyed, and preliminary traversing of four other Cantonments in India and Burma was also commenced.

RESULTS.

36. The total outturn of detail topographical and forest surveys on all scales is 42,600 square miles against 35,968 of the previous year. No surveys on a scale smaller than 1-inch=1 mile were carried out during the year except the small area of 250 square miles mentioned under special operations, in the Mishmi country. The total area triangulated for topographical surveys

	Sq. miles.
4-inch scale	70
2 „ „	13,999
1 „ „	28,531
TOTAL	42,600

is 35,550 square miles against 37,396 for the previous year. The area of the maps compiled in standard sheet form for publication on the 1-inch scale by the United Provinces and Bengal drawing offices amounted to 10,042 square miles. Adding this 10,042 square miles to the area surveyed we get a total outturn of mapping on the 1-inch scale of 52,642 square miles and this is a very considerable improvement on the outturn of previous years but the area compiled still requires to be examined in the field and these maps are being published as a preliminary edition.

HEAD-QUARTERS OFFICE, CALCUTTA.

37. The general superintendence of these offices remained in the hands of Colonel F. B. Longe, R.E., Surveyor General, throughout the year.

Major J. M. Burn, R.E., held charge of the Surveyor General's office from the 1st October 1908 to the 10th January 1909 when he was relieved by Colonel T. F. B. Renny-Tailyour, R.E., who remained in charge of it till the end of the year.

Colonel J. M. Fleming, I.A., held charge of the Map Publication offices up to the 11th October 1908 when he was relieved by Major W. M. Coldstream, R.E., who continued in charge throughout the remainder of the year.

Major J. M. Burn, R.E., held charge of the Mathematical Instrument office from the 1st October 1908 to the 10th January 1909 and again from the 21st April 1909 to the close of the year. From the 11th January to the 20th April inclusive the office was under the supervision of Colonel T. F. B. Renny-Tailyour, R.E.

38. *Map Publication Office.*—Major W. M. Coldstream, R.E., continued to act as Superintendent of Map Publication during the year. The charge of the Drawing, Engraving and Map Record and Issue offices was held by Lieutenant A. A. Chase, R.E., up to the 17th December 1908 and from that date till the 7th April 1909 by Lieutenant G. F. T. Oakes, R.E., and for the remainder of the year by Captain M. O'C. Tandy, R.E., Lieutenant V. R. Cotter, I.A., held charge of the Photo.-Litho. office until the 2nd of January 1909, Lieutenant G. F. T. Oakes, R.E., held charge from that date up to the 23rd June 1909 when he handed over to Lieutenant O. H. B. Trenchard, R.E., who remained in charge to the close of the year.

39. This is the first year in which the reorganisation of the publication offices could be fully tested by results, and these are even more satisfactory than were at first anticipated. For the first time since the inception of the new surveys, the publication of standard sheets has kept pace with the survey and drawing. Between 1st October 1908 and 30th September 1909, 175 new standard sheets were received for publication, while 195 sheets were printed, and a considerably larger number could have been printed, had more sheets been received sufficiently early in the year.

If a few standard sheets which have been returned to the field parties for further information and which have not yet been re-submitted, are excluded, only 3 of the sheets received at head-quarters before October 1st, 1908, have not been printed and the publication of these 3 sheets has been delayed solely on account of references in connection with boundaries, etc., and not on account of delays or difficulties in the publication offices. The increase in labour and the difficulties involved in the new system of publishing sheets half the size of the old maps, in black and 4 colours, were described in some detail in last year's report, and it is satisfactory to be able to report this year that they have been met successfully. In quality also as well as in quantity this year's results have been satisfactory and a steady improvement in the quality of the reproduction has been maintained. The Topographical maps of the United Kingdom and of some foreign countries which are reproduced by better but more expensive methods, are superior to the Indian standard sheets in finish, but there is probably no other country which has so large an annual outturn of new maps of this class to produce as India, and for India to adopt the more expensive methods would necessitate an expenditure not warranted by the very small demand that can be expected for quite 80 per cent. of the Indian sheets. Since its reorganisation was begun in 1906 the Photo.-Litho. office has already printed new standard sheets representing a combined area greater than that of England, but a glance

at the index map indicating the state of map publication will show that as yet only a small fraction of the work to be done has been dealt with.

40. In addition to the new 1-inch standard sheets 126 of the old 1-inch standard sheets covering areas for which new material is not yet available have been reprinted during the year to replenish stock. The number of the old sheets which are out of print is still large. Some of them are, however, so incomplete and out of date that pending new surveys they are not worth the expense of reprinting.

41. New material for some 10 degree sheets is now available and 7 are under preparation in the various Circle drawing offices. An important simplification in the method of preparing these and other maps to be compiled from the new surveys has been effected by an arrangement made in the Photo.-Litho. office to supply, on one sheet of drawing paper, complete combined reductions of the 16 component standard sheets which form a degree sheet, on a scale of $2\frac{2}{3}$ miles=1 inch. These reductions are printed in cobalt and the detail to appear in the $\frac{1}{4}$-inch map is selected and fair drawn in black over the blue detail. The map is then completed by the addition of the lettering, etc., in the ordinary way, and reduced by photography to its correct dimensions on the scale of 1 inch=4 miles. The degree sheets will be printed in the same colours as the standard sheets, the plates for each colour being obtained from different negatives of the outline map by "duffing" in exactly the same way as with standard sheets. The hill features will be shown by brush or stump shading printed in half-tone and possibly supplemented by approximate contours at 500 feet intervals. A good deal of experimental work has been done during the year in the direction of obtaining artistic results in half-tone shading that will retain scientific accuracy. The chief difficulty lies in the preparation of the original shaded drawings, as the number of draftsmen who can yet do work of this description is very limited. The difficulty is, however, being overcome as the men acquire the requisite skill, and some very fair results have also been obtained from drawings executed in stump shading which is a more easily acquired art than brush shading. Another difficulty caused by the reproduction of the blue detail over which the shading is executed has been almost entirely removed by the substitution of blue prints prepared by the "dust on" process, for ordinary blue prints. The office is indebted to Mr. R. Taylor for the invention of the "dust on" process.

The method by which the shading is reproduced by half-tone photography was alluded to in paragraph 55 of the summary of the Annual Report for 1905-06, and in paragraph 66 of the summary of the Annual Report for 1906-07. It also is the invention of Mr. R. Taylor, the head of the photo. branch of the Photo.-Litho. office and has been communicated to the Ordnance Survey at Southampton where it is believed to be now in use. The process consists in printing a sensitised plate from two negatives superimposed in the printing frame. The light is thrown on the printing frame from a large mirror so arranged that the rays fall perpendicularly on the negatives. One of the negatives, a plain or continuous tone negative, is underexposed and developed so that the high lights are as soft and even as possible, the other is an ordinary half-tone negative taken through a ruled screen.

42. While material is rapidly becoming available for the preparation of degree sheets, it will be some years yet before the new surveys yield material for new maps of the $\frac{1}{\text{million}}$ or "India and adjacent countries" series. Each $\frac{1}{\text{million}}$ sheet includes 16 degree sheets and 256 standard sheets. In the meantime, as stated in the last year's report, provisional editions of the $\frac{1}{\text{million}}$ sheets prepared from the most reliable information available are being brought out. The progress on this work during the year has been real, though the published results are very meagre. The maps of this series already published leave much to be desired and are to some extent experimental. Captain M. O'C. Tandy, R.E., the officer in charge of the head-quarters drawing office, has devoted much of his time to improving the $\frac{1}{\text{million}}$ sheets, and although some minor points have yet to be settled and a good deal of redrawing has had to be faced (to this the small outturn of the year is due), it is believed that a great improvement both in quality and outturn will be reported next year, and by the time new material is

available, the department will be in a position to deal with it efficiently and expeditiously. The standard maps as the first results of survey and as the eventual basis of all other departmental maps must remain the most important work of the department, but the degree and $\frac{1}{\text{million}}$ sheets, which are the tactical and strategical maps of the country, are only second to them in importance.

As a sample of the form in which it is intended that these provisional maps should eventually appear, a specimen of sheet 47 of the $\frac{1}{\text{million}}$ series is given here.

43. The six general maps of India maintained by the department are as follows:—

1. India and adjacent countries on the scale of 32 miles = 1 inch.
2. " " " " " 64 " = 1 "
3. India on the scale of . . . . 80 " = 1 " (as a railway map).
4. India and adjacent countries on the scale of 96 " = 1 "
5. " " " " " 192 " = 1 "
6. " " " " " 256 " = 1 "

In addition to these the 128-mile map is still maintained for departmental purposes.

An edition of 1,000 copies of the 32-mile map has been printed in the colouring prescribed by the Government of India for the various Provinces and States and their boundaries. This is the largest coloured map that the department has yet undertaken and 6 to 8 colour plates have been used for each of the 6 sheets. The result is satisfactory although there are some minor defects, due to the inexperience of the offices in this class of the work, which will be avoided in future. The compilation for the new engraved 32-mile map in 12 plates has been completed and an original drawing for the hills, to be reproduced in half-tone, is practically completed for one sheet. The rough estimate given in last year's report for the publication of the outline map some time in 1911 will, it is believed, be found correct.

Preliminary work for a new edition of the 64-mile map is in progress, and it is proposed to bring out a fully coloured edition of the existing 64-mile map in 1909-10.

The 80-mile railway map has been brought up to date and published for the Railway Board and a new railway map on a slightly larger scale in several colours is under consideration.

44. A number of special maps have been prepared and printed during the year and a large number of maps, plans and diagrams have been reproduced for other departments. Owing to the successful manner in which the Photo.-Litho. office has been able to cope with the publication of standard sheets and to clear off arrears of departmental work, more extra-departmental printing work of small size is wanted and can easily be dealt with.

45. *Drawing Office.*—The statement below gives a summary of the outturn of the offices during the year ending 30th September 1909. As mentioned above it is hoped that next year a considerable improvement in the preparation of the maps of India and adjacent countries on the scale of $\frac{1}{\text{million}}$ will be reported, and already a marked improvement in the quality of the drawing and typing has been effected through the efforts of the officer in charge.

Statement.

Class of map.	Scale.	Number of sheets in hand during 1908-09.	Number published.
General maps of India	1"=32 miles to 1"=256 "	40	14
India and adjacent countries . . .	$\frac{1}{\text{million}}$	30	5
Provincial maps	Various . .	25	9
District maps	½" and ¼" = 1 mile	20	15

Class of map.	Scale.	Number of sheets in hand during 1908-09.	Number published.
Standard maps	Various . .	512	368
Administration Report maps . . .	1" = 8 miles .	20	9
Plans of Cities and Cantonments . .	Various . .	136	133
Triangulation and Traverse charts . .	Various . .	136	117
Index maps	Various . .	72	23
Miscellaneous maps	Various . .	82	49
Maps for other departments	Various . .	214	162
	TOTAL .	1,287	904

46. *Engraving Office.*—The chief work of this office has consisted in the preparation of the general maps of India and about two-thirds of the outline and lettering of the new 32-mile map of India referred to in paragraph 43 has been cut on the copper. The plates of the 96 and 192-mile maps are undergoing correction and that of the 256-mile map has been brought up to date and an edition of it has been published.

In the copper plate printing section 58,241 impressions were pulled, and 218 plates were steel faced.

A new scheme for the payment and grading of the establishment very similar to those initiated by Major W. C. Hedley, R.E., for the Drawing and Photo.-Litho. offices in 1907 has come into force during the year. It is too early yet to report on the results, but there is every reason to believe that the greater power the scheme grants to the Surveyor General of dealing with good and bad workers according to their deserts, will lead to greater efficiency.

47. *Photo.-Litho. Office.*—The following statement shows the cost and the outturn of the office for the past few years :—

Statement.

Year.	Cost of the office.	Number of negatives taken.	Area of negatives taken in sq. inches.	Number of impressions pulled.	Number of departmental maps printed.	Number of extra-departmental maps, plans, etc., printed.	Total number of maps, plans, etc., printed.
	₹						
1905-06	1,87,634	1,926	1,025,942	1,284,968			
1906-07	1,77,529			1,123,001			
1907-08	1,88,966	2,361	1,581,286	1,563,453	891	1,175	2,066
1908-09	1,58,643	3,428	2,173,868	1,506,607	2,047	726	2,773

It is satisfactory to note that the outturn has increased considerably. This result has been obtained concurrently with the improvement in the quality of the maps which has been alluded to in paragraph 39 above. The marked decrease in extra-departmental work during 1908-09 is probably due in some measure to the fact that the Governments of Bengal and Eastern Bengal and Assam are undertaking

more of their own map reproduction. In spite of the increase of departmental work a much larger amount of small extra-departmental work than is now asked for could be undertaken by the Photo.-Litho. office. The improvement in outturn, quality and economy is primarily due to reorganisation of the office in 1906-08, but it has only been obtained through the efforts made by the officers in charge and their establishments and more particularly through the exertions of Messrs. Taylor and Vandyke, the heads of the photo. and litho. branches.

48. The new scheme of grading and paying the men according to their skill and outturn, as well as their length of service, alluded to in paragraph 52 of last year's report, is proving a success, and the officer in charge considers that the satisfactory results of the year's working are in great measure due to it. Colonel S. C. N. Grant, C.M.G., R.E., in his report on the Map Reproduction offices (Indian Survey Committee Report, pp. 141, 142) stated as his opinion that the Photo.-Litho. office, which had just been strengthened by the addition of 2 experts from England, could attain to an outturn of about 4,000 negatives a year, instead of 2,000 it could deal with in 1904, and that from 1,500,000 to 2,000,000 impressions could be obtained from the machines instead of the 1,300,000 obtained in 1904. In the year under report 3,428 negatives were taken and 1,506,600 pulls obtained; this cleared off all arrears.

In last year's report (paragraph 52) it was stated that the Photo.-Litho. office was believed to be in a position to deal with the yearly outturn of survey work; it has now been proved that this estimate was correct.

49. This year has been a good one in the matter of minor improvements in methods. Among these may be mentioned:—the introduction of "quick scaling" plan boards and of a large plan board upon which the fair drawings, on the 2-inch scale, of 16 standard sheets can be pinned up and photographed together for the preparation of degree sheets; the alteration of the large camera to take a negative $45\frac{1}{2}'' \times 31\frac{1}{2}''$, which allows of the reproduction on one negative of maps $43\frac{1}{2}'' \times 29\frac{1}{2}''$, and an important improvement in the treatment of helio plates with bitumen, which improves their printing qualities and prevents their deterioration.

50. The new plant received in 1908 and referred to in paragraph 53 of last year's report has had its effect on the outturn of process work, and during the last months of the year the process section of the office has also benefited considerably by the purchase of a large "Levy" diamond-ruled screen (133 lines to 1 inch). The process section pays for its own upkeep in the value of work done and forms a useful school for the training of the establishment in the higher methods of map reproduction, and experimental work in connection with these methods.

51. The cost of the Photo.-Litho. office for the year, excluding the cost of stores and plant obtained from England, is as follows:—

	R
Supervision charges	8,837
Establishment	1,29,974
Contingent	19,832
TOTAL	1,58,643

The cost for 1907-08 was about R30,000 higher, but the expenditure of that year cannot be considered normal, as it included the pay of Major Hedley and his assistant, Sergeant Lucas. The normal cost of the establishment will probably rise slightly in the next few years as the men attain more skill and earn higher rates of pay but provided that the survey outturn increases, as is likely, the rise in cost will be small in proportion to the increased value of the work done. A sum of R42,531, as compared with R49,828 in 1907-08, has been recovered in cash and book debit payments for extra-departmental work and the value of the uncharged for work carried out for the Government of India and the department at office rates is R1,29,703 as compared with R1,30,178 in 1907-08.

52. *Map Record and Issue Office.*— The face value of the maps received in the Map Record and Issue office amounts to R2,33,034; of this sum, R46,654 is the face value of maps printed at Dehra Dún and in the Engraving office; the

remainder is the face value of maps printed in the Photo.-Litho. office. The following statement shows the details:—

Statement.

Class of maps.	Scale.	Number of different maps of each class published.	Value.
			₹
(1) General maps of India . .	1″=32 to 1 =256 miles	5	4,576
(2) India and adjacent countries .	$\frac{1}{\text{million}}$	8	2,854
(3) Provincial maps . . .	Various	20	12,458
(4) District maps . . .	¼″ and ½″=1 mile	9	1,950
(5) Standard sheets . . .	Various	337	1,48,053
(6) Atlas sheets . . .	1″=4 miles	255	24,766
(7) Administration Report maps	Various	47	1,488
(8) Plans of Cities and Cantonments.	Various	74	20,014
(9) Triangulation and Traverse charts.	Various	110	2,750
(10) Index maps	Various	20	2,000
(11) Miscellaneous maps . .	Various	101	12,125
	TOTAL . .	986	2,33,034

The number of original maps, volumes of computations, etc., received into store from other departments or branches of the office was 8,515, and 4,985 were issued.

53. The original Revenue survey records of the districts in Bengal were transferred to the Bengal Drawing office for storage. The records transferred were the following:—

(1) Atlas volumes	81
(2) Village plans	426
(3) Traverse records	234
TOTAL	741 volumes.

54. The total number of printed maps issued during the year was 1,04,661 of an aggregate value of ₹1,00,200. The details were as follows:—

	No. of sheets.	Value.
		₹
To Government officials .	52,783	40,653
„ India Office . . .	6,538	9,171
„ Departmental issues .	21,400	27,519
„ Private individuals .	20,118	18,448
„ Agents	3,822	4,409
TOTAL .	1,04,661	1,00,200

55. The transfer of the Forest maps to the Forest Map office, Dehra Dún, was continued during the year. The sheets of districts Damoh, Nimár, Hoshangábád and Betúl in the Central Provinces, comprising some 20,114 copies, together with 2,574 copies of the Punjab Forest maps being despatched for storage to the officer in charge of that office.

56. The revision of the map catalogues is still in hand.

57. The work of overhauling and registering the original maps and volumes has also been steadily proceeded with and that of examining the coloured originals, corrected prints, etc., has been completed. Most of the originals have been classified and stored in volumes, and it is hoped shortly to complete this work which was begun five years ago.

58. The new method of enclosing the printed copies of the 1-inch standard sheets in zinc cases with let-down fronts and storing these in racks arranged in groups for those composing each $\frac{1}{\text{million}}$ and degree sheet has been continued during the year and all the new 1-inch standard sheets have been stored in this manner. Considerable improvements have also been effected in the arrangements of the rooms used for the sale of maps to the general public and in the office generally, by the provision of additional fans and electric lighting.

59. *Mathematical Instrument Office.*—During the year under report, *i.e.*, from 1st April 1908 to 31st March 1909, there has been a decrease in the demand made on this office for instruments. During the last three years, *i.e.*, 1906-07, 1907-08, and 1908-09, the value of instruments, etc., issued to public offices has been R3,82,345, R3,66,334 and R3,31,230, respectively; the value of the repairs to instruments received for repair has been R42,181, R42,542 and R52,278 respectively; and the value of instruments received from Government officers when "no longer required" has been R58,128, R70,486 and R71,241, respectively.

The book value of the stock in the serviceable store at the end of each year during that triennial period was R5,35,535, R7,62,415 and R9,77,261, respectively. The larger stock in hand at the end of the year under report is due to an excess of receipts over the issues; the receipts included nearly four lacs worth of instruments, for which indents had been sent Home in previous years in order to replenish the stock which had run very low.

The book value of the instruments, etc., in the repairable store at the end of each of the last three years was R1,12,389, R98,578 and R1,21,746, respectively. All instruments for which there was any great demand were sent to the workshop for repairs and transferred to the serviceable store for issue, as soon as possible.

Two "profit and loss" statements have been prepared in accordance with the orders of the Comptroller General—one showing the results of the operations of the stores branch and the other of the workshop. The stores statement shows a profit of R14,606, and the workshop statement a loss of R6,782 due to the issue of grain compensation allowance to the men, which was an exceptional charge.

The number of men and boys employed at the end of each of the last three years was 451, 457 and 464, respectively.

The total value of issues during the year under report shown in the "profit and loss" statement on account of stores, amounts to R3,44,971 as against R3,77,118 for the previous year, and the value of the work done in the workshop during each of the last three years, was R2,16,730, R2,54,916 and R2,41,215 respectively.

The value of instruments, etc., manufactured in the workshop during each of the last three years was R87,588, R1,11,901 and R91,571, respectively, and the value of instruments, etc., purchased locally during each of the last three years, was R4,189, R1,943 and R3,052, respectively.

The value of instruments, material, etc., obtained from England through the Director General of Stores, during each of the last three years was R4,36,240, R4,94,985 and R4,56,322, respectively.

During the year Mr. Woodhouse, the senior Assistant Manager, took leave for three months to England.

Towards the end of the year under report two additions to the main building were completed; one consisted of an extension to the theodolite and general repair room on the ground floor, with a drawing office and painter's shop on the first floor; the other, an extension to the main porch for the storing of packages, etc., until the invoices of their contents are received and they can be disposed of, with a room for packing and despatching above it. These additions have been needed for many years and give great relief to the over-crowded workshops. Certain alterations were made to the brass foundry and main workshops to ensure better ventilation and light, and these have also proved satisfactory.

To the workshop have been added several machines, amongst them a large planing machine for the manufacture of straight-edges and metal rules of all sorts which were formerly obtained from England, and also for "trueing up" lathes and machines.

Many more self-centring stands for theodolites have been fitted up during the year. The workshops have made further progress in the way of repairs and manufactures, and it is hoped that a great many more instruments which have in the past been procured from England may in future be manufactured here, and unless there are very exceptional demands during the next two years there will not be any necessity to import many instruments from England except those of the most delicate construction, or such as are only required in small quantities, or those which for special reasons it is advisable to continue importing, such as thermometers and optical glasses.

Stock-taking of all the stores has been carried on during the year, and where discrepancies have been found, the necessary enquiries and book corrections have been made.

The price list mentioned in the last report is nearing completion, and it is hoped that it will be issued shortly.

BRANCH OFFICES.

TRIGONOMETRICAL OFFICE.

60. The Trigonometrical Branch was under Colonel S. G. Burrard, R.E., F.R.S., Superintendent, Trigonometrical Surveys, to the 15th August 1909, when he was deputed to England in connection with the triennial conference of the International Geodetic Association. He made over charge of his duties to Captain H. H. Turner, R.E., who continued in office to the end of the year.

Captain H. H. Turner, R.E., held charge of the technical offices up to the 15th August from which date Lieutenant G. F. T. Oakes, R.E., continued the duties to the end of the year.

Mr. T. A. Pope, in charge of the Forest Map office, continued the supervision of the Photographic office throughout the year.

Five Probationary Sub-Assistant Superintendents of the Survey of India and six Probationary Assistant Superintendents of the Burma Land Records, were put through a course of training during the year.

61. *Computing Section.*—The following computations were carried out in the Computing office:—

(*a*) Computations of the remaining heights and extra azimuths and discrepancy per mile in common sides of triangles of the North-East Longitudinal series.

(*b*) Compilation of the azimuth list of intersected points, co-ordinate list and alphabetical index of stations and well-known intersected points.

(*c*) Examination of the triangulation charts of the North-East Longitudinal series.

(*d*) Captain Gibbon's triangulation examined, and experimental computations done in connection therewith, and Khan Bahadur Sher Jang's observations for heights in Persia reduced.

(*e*) The cause of discrepancy between the triangulations in Persia by Lieutenant Crookshank and Yusuf Sharif was investigated.

(*f*) Rai Bahadur Lal Singh's observations for heights in Chinese Turkistán and Kansu were reduced.

(*g*) Certain computations were done for Sir F. Younghusband in connection with the ascent of peak K-2 in Kashmír by the Duke of Abruzzi.

(*h*) Old records were examined and experimental computations made to determine the cause of discrepancy pointed out by the Superintendent in charge Burma Surveys between the Great Trigonometrical values of certain points and those obtained by No. 3 Party and No. 19 Party in Burma and Malabar Coast series respectively.

(*i*) Computations were carried out and information supplied to the Geodetic Institute. Ferraro's and Merriman's formulæ for computing mean and probable errors of triangulation were compared and tested.

(*j*) Computations for extending Bessel's Table of refraction were done for the Director of the Hongkong Observatory.

(*k*) Information for the adjustment of level circuits was collected from the English and American publications.

(*l*) The heights of stations of the Calcutta Longitudinal series were adjusted in terms of the values obtained by spirit levelling.

(*m*) Two computers were employed for three months on computations in connection with the levelling volume.

(*n*) The computations of a table of distances in feet corresponding to a subtense bar of ten feet are in hand.

(*o*) Certain Tables of the 4th Edition of the Auxiliary Tables are being extended to 45° in latitude for incorporation in a smaller edition of the Tables for use of explorers and surveyors.

(*p*) Computations of the Bangkok Secondary series are being revised with the object of determining the best triangulated co-ordinate value of Bangkok, the capital of Siam.

(*q*) Compilations of data for Frontier and Trans-Frontier Degree triangulation charts are in progress.

(*r*) Major Lenox-Conyngham's papers on Pendulum Observations were printed and distributed.

(*s*) *Routes in the Western Himalaya and Kashmir* and a catalogue of scientific books and subjects in the Trigonometrical Branch office were passed through the press.

(*t*) The synoptical volume of the North-East Longitudinal series is nearly ready and will shortly be issued.

(*u*) "A series of papers on the measurement of bases by means of wires" is passing through the press.

(*v*) Data from the records was supplied to 53 officers.

(*w*) The meteorological observations were continued as usual.

(*x*) The necessary professional aid in connection with the protection of stations was rendered to the office of the Superintendent, Trigonometrical Surveys.

Five hundred and twenty-two stations were repaired by the district officers at a cost of ₹3,296.

Out of 333 districts from which the reports are annually due, 14 failed to make returns.

62. *Drawing Section.*—Ninety-four sheets on the ¼-inch scale of Dr. Stein's exploration in Chinese Turkistán were compiled. The drawing of all, except 4 hill sheets, has been completed. The sheets are now being sent to press, as rough corrected proofs of the outline sheet are being received back from Dr. Stein.

The following maps have been drawn and sent to press:—

(1) Thirteen Geological charts for Part IV of the Himalayan Geography.

(2) Forty-two Triangulation charts and 3 special charts on the 1-inch scale of the North-East Longitudinal series for inclusion in the Synoptical volume.

(3) An Index chart to the Great Trigonometrical Survey of India to be printed in colours, scale one inch=96 miles.

(4) A magnetic chart, scale one inch=96 miles.

(5) Four degree triangulation charts, scale one inch=4 miles.

(6) One plate showing progress of triangulation in India for the International Conference.

(7) One orographical chart of Region No. 7, scale one inch=128 miles.

(8) One chart to illustrate the areas in which gravity is in excess and defect, scale one inch=256 miles.

(9) Three preliminary isomagnetic charts.

(10) Triangulation charts for Professor Helmert.

(11) One levelling chart for International Conference.

(12) Index Map of Dr. Stein's Explorations for the Viceroy.

(13) Index Map of Dr. Stein's Explorations for the Board of Scientific Advice.

(14) Index Map to $\frac{1}{\text{million}}$ and degree sheets.

(15) Punjab survey sheet No. 308 S.W.

(16) Five miscellaneous maps.

The following are in hand:—

(1) An Index chart of the North-East Longitudinal series.
(2) Index chart of the degree triangulation charts on the Frontier of India.
(3) Map of Persia, scale one inch=40 miles.
(4) Six Punjab level sheets.
(5) Ninety-six degree triangulation charts of the Frontier.
(6) Four $\frac{1}{\text{million}}$ sheets.
(7) Dehra Dún Municipality and Cantonments in 4 sheets, scale 12 inches =1 mile.
(8) Guide Map of Mussooree and Landour, 8 inches=1 mile.
(9) Captain Wahab's Height Indicator for 1-inch scale.

The proofs of all maps have been examined and corrections carried out as usual. Eight hundred and one maps were coloured.

63. *Photo.-Zinco. Section.*—One thousand four hundred and seventy-eight maps and diagrams were photographed against 1,467 during 1907-08 and 267,732 pulls taken against 258,510 taken during the previous year. The lithographic machine press has been in full work throughout the year on Cantonment and Forest maps and triangulation charts. The printing of Dr. Stein's 94 maps, in 6 and 7 colours, commences next season. These alone will keep the machine fully occupied for two years without printing other departmental work. It will therefore be necessary to ask for the assistance of the Calcutta office in the publication of these maps in order that there may be no delay in publication of other maps.

64. Photographs of the sun were taken on 336 days during the year.

FOREST MAP OFFICE.

65. This office remained throughout the year under the superintendence of Mr. T. A. Pope, Superintendent, 2nd Grade, except for one month from the 3rd May 1909, while he was absent on privilege leave, when Mr. A. Descubes, Superintendent of Forest Map Records, officiated in charge.

The number of maps issued to Forest and other officials and to the public during the year was 7,689, of which 3,335 were coloured maps. The number issued last year was 11,177. The value of the maps issued was, however, considerably greater during the past year, the amount realised by the sale of maps being R3,312, as against R2,018 realised last year, and R1,750 in 1906-07. Of this amount, R2,244 was adjusted by book debit, and R1,068 accrued from sales to private individuals and trading companies.

66. The following is a brief summary of the mapping executed during the year:—Of the standard sheets of Forest Surveys 62 were published, 17 were in the press, and 94 were in various stages of preparation. Of the working plan and other special Forest maps, 8 were published, 9 were in the press, and 19 were in hand. Two general maps of India, on the 48-mile scale, were put in hand for the Inspector General of Forests' Quinquennial Report for 1904-09, and also 6 on the 96-mile scale, showing distribution of the principal Indian timber growth.

Provincial Forest maps of Burma and the Central Provinces, on the 32-mile and 16-mile scales respectively, were published. A similar map of Bengal, on the 32-mile scale, was completed and sent to press, and one of the Punjab, on the 16-mile scale, was commenced.

The drawing of the new district Forest maps of the Madras Presidency, on the quarter-inch scale, which was commenced last year at the instance of the Conservators of the three Circles, has made good progress during the year. The fair drawing of the South Canara, Madura, Tinnevelly and Cuddapah maps was nearing completion at the end of the year and they will be sent to press early in the ensuing year; that of the Coimbatore district map has recently been put in hand. Arrangements are being made to publish these district maps in the first place as ordinary editions omitting all special Forest features.

Blue impressions of 18 of the new 2-inch standard sheets have been received during the year, for the insertion of additional Forest details in order to publish them as special Forest editions. Of these, two have been published and the remainder are in hand. Out of the 36 blue impressions of 2-inch sheets received last

year, 16 have been published and distributed, 6 returned to press for publication and the others are in various stages of progress. In future the Forest details are to be inserted on *black* impressions of the sheets, carefully printed on thick drawing paper, instead of on blue prints as heretofore. This method has the advantage of furnishing originals for photography complete in every respect, thus saving the trouble of making separate helio-plates from the blue prints containing the forest information only, and of sur-printing from these plates upon previously printed copies of the public edition.

During the year, 30,944 copies of Forest maps were received from the Map Record and Issue Office, Calcutta, and other offices, for storage. A large number of maps have yet to be received from Calcutta, and the erection of new racks for their reception has gone on steadily throughout the year. As mentioned in paragraph 68 of last year's Report, there is insufficient space in the present building for the accommodation of these maps when received, and proposals have been submitted for an extension of the building. It is roughly estimated that space will eventually be required for about 5 lakhs of printed maps, whereas there is at present only sufficient rack accommodation for about half that number. The proposed scheme of extension includes the erection of an upper storey over a portion of the present building for the accommodation of the tidal establishment of No. 25 Party.

LOCAL DRAWING OFFICES.

67. *United Provinces Drawing Office.*—(*a*) This office was under the administrative control of the Superintendent, Northern Circle, and Mr. J. M. Kennedy, Extra Deputy Superintendent, was in charge. The working establishment was 1 surveyor, 1 computer, 1 typer and 17 draftsmen, permanent or temporary.

(*b*) Eight 2-inch standard sheets in the old form, namely, 54 $\frac{I}{2 \& 6, 3 \& 7}$, 54 $\frac{J}{9 \& 13}$, 54 $\frac{M}{1 \& 5}$, 63 $\frac{F}{9 \& 13}$, 63 $\frac{I}{11 \& 15}$, 63 $\frac{J}{1 \& 5, 11 \& 15}$ and nine in the new, namely, 54 $\frac{N}{3, 7, 11, 12, 15, 16}$, 54 $\frac{O}{9, 13}$, 63 $\frac{K}{2}$ were drawn, wholly or in part, and one 1-inch old standard sheet was partially revised, namely, 63 $\frac{C}{12 \& 16}$; the total area compiled and mapped being 5,532 square miles. The 29 traverse charts prepared cover an area of 5,087 square miles. Three district maps, namely, Farrukhábád, Mainpuri and Etah, were prepared on the $\frac{1}{2}$-inch scale, comprising an area of 5,121 square miles.

(*c*) The total cost for this office for the year under report was R17,745.

(*d*) The proposed work for the ensuing year is the 2-inch mapping of standard sheets in which the districts of Hamírpur and Bándá fall, using the latest Land Records surveys and supplementing where necessary for the compilation of the sheets by the best other material available. The traverse charts will also be continued and Jálaun, the last of the series of districts maps, will be completed.

68. *North-West Frontier Drawing Office.*—(*a*) This office was under the administration of the Superintendent, Northern Circle, and was under the executive charge of Mr. G. P. Tate throughout the year.

(*b*) The map of Turkistán is nearly completed and will be finished by about November 1909.

(*c*) $\frac{1}{\text{million}}$ sheets Nos. 30 and 35 are in hand, and the hills are being reduced by pentagraph from the $\frac{1}{4}$-inch sheets and $\frac{1}{2}$-inch sheets, from which the $\frac{1}{\text{million}}$ sheets have been compiled. These features will be transferred, to "dust on" blue prints and then brush shaded.

(*d*) Degree sheets 8 D and K, and 9 M were redrawn and submitted for publication.

69. *Simla Drawing Office.*—(*a*) Lieutenant J. D. Campbell, R.E., held charge of this office which consisted of four permanent and five temporary draftsmen. On the 1st October 1908, the compilation of 13 degree sheets had been completed and 19 more were in hand. The fair drawing of 4 sheets had been commenced. During the year under report the number of sheets in hand has risen to 45, whilst 18 more have been asked for by the Chief of the Staff and the collection of materials for the latter has been started. The fair drawing of

13 outline sheets has been completed and 7 more are in hand. Experiments have been made in hill shading with various mediums and fair results have been obtained with pencil and stump shading on Bristol boards. Eight degree sheets (numbers 25 I, J, K, M; 10 C; 3 M, N, O) with hills thus drawn, have been forwarded to Calcutta for proofs. The histories of all the degree sheets which have been compiled in manuscript will be sent for publication at the same time as the sheets concerned.

(*b*) The total cost of this office for the year under report was R13,736.

70. *Burma Drawing Office.*—(*a*) Mr. T. Shaw who was re-employed in 1907 after retirement from the department remained in charge throughout the year. Messrs. O. D. Smart and C. S. Littlewood were attached to the office for short periods. Mr. A. J. Smith, one of the two draftsmen whose services were lent to the department by the Ordnance Survey of England was temporarily posted to the office in June for the purpose of giving instruction to the draftsmen. A photographic section was added to the office at the beginning of the recess and Mr. Murphy of the head-quarters office, Calcutta, was attached to the office for the few weeks for the purpose of starting the section and training a photographer. The office now carries out all the photographic and vandyking work of the parties recessing at Bangalore with excellent results and much time and expense are thereby saved. The work of the office consisted of the preparation of degree sheets, carrying out the arrears of the mapping of field parties, examination of fair maps and proofs and the preparation of colour patterns.

(*b*) One degree sheet No. 93 L was completed and will be sent to press before the end of the year. Four standard sheets, namely, $58\frac{A}{1}$, $84\ \frac{M}{13, 15, 16}$ comprising an area of 1,778 square miles were completely drawn and 14 partly. Sixty-four standard maps were examined and sent to press, 54 colour patterns were prepared, and 74 proofs were examined. In the photographic section 42 outline sheets were vandyked and 48 enlargements and reductions were made. The services of several draftsmen were lent to various parties during the recess.

(*c*) The cost of the office for the year under report was R20,403.

71. *Bengal Drawing Office* (*Standard Mapping Section*).—(*a*) This section of the Bengal drawing office has remained under the administration of the Surveyor General through the Director of Surveys, Bengal, throughout the year; the remainder of the office having been transferred to the Bengal Government from 31st January 1909.

(*b*) The following 22 standard maps on the scale of 2 inches=1 mile and covering a land area of 4,510 square miles have been completed and submitted for publication during the year, *viz.*, sheets $72\frac{N}{11}$, $72\ \frac{O}{5, 6, 7}$, $79\ \frac{B}{12, 16}$, $79\ \frac{C}{1, 5, 6, 9}$, $79\ \frac{F}{4, 7, 8, 11, 12, 16}$, $79\ \frac{G}{5, 9, 10, 13}$, $79\ \frac{K}{1, 5}$. Sheets $72\ \frac{N}{12, 15, 16}$, $72\ \frac{O}{9, 10}$ and $79\ \frac{F}{3, 15}$, are nearing completion; sheets $72\ \frac{O}{13, 14}$, $72\ \frac{K}{8, 12}$, $72\ \frac{L}{5}$, the northern section of $72\frac{P}{7}$ and $64\ \frac{O}{10}$, have complete details transferred on them in pencil; sheets $72\frac{P}{6}$ and $64\ \frac{O}{11}$ are completely plotted, and the following sheets have been projected but not plotted as yet,— $72\ \frac{K}{4}$, $72\ \frac{L}{1, 2, 6, 7, 9, 10}$, $72\ \frac{O}{12}$, $72\ \frac{P}{9, 10, 11}$ and $64\frac{O}{15}$. Sheet $72\ \frac{K}{11, 15}$ (old No. 203) in four sections although ready in all other respects could not be completed during the year owing to the non-receipt of the village lists of two *thánas* of South Monghyr which are required to correct the spelling of the village names. Sheet $72\frac{N}{8}$, of which the preliminary edition was published without village boundaries, has since had village boundaries drawn on it in black. The work of adding boundaries in black for the publication of special provincial editions has now since been stopped pending further instructions.

(*c*) The following items of work have been done for the Map Publication office :—

1. Twenty-eight grey prints have been coloured.
2. Fiscal limits and cultivation have been coloured on 42 black prints.
3. Forty-nine uncorrected proofs have been examined and corrected with regard to colours and other details. An additional copy of each

of these prints has been kept for reference in the office. In addition, 54 copies of maps not published in colours have been coloured for the office.

(*d*) Twenty-seven traverse charts of North Bihár, 8 of Ránchi district and 3 of Chittagong district have been sent for publication during the year. Their numbers are as follows :—$72\frac{F}{11, 12, 15, 16}$, $72\frac{G}{1, 5, 9, 10, 13, 14}$, $72\frac{J}{3, 4, 7, 8, 11, 12, 14, 15, 16}$, $72\frac{K}{1, 2, 5, 6, 9, 10, 13, 14}$, $73\frac{B}{1, 2, 3, 5, 6, 7, 9, 11}$, and $79\frac{N}{9, 10, 15}$. One other chart of Chittagong district $79\frac{N}{14}$ is practically ready and will be sent for publication very shortly. All the other charts of this district will in future be drawn in the Eastern Bengal and Assam Drawing office.

(*e*) The publication of a special edition of the standard maps of Bengal on the 1-inch scale with village boundaries is under consideration. If it is decided to publish this edition, all future traverse charts of Bengal will be prepared from them, except such as may be urgently needed for topographical surveys which will have to be separately projected and plotted and the village boundaries transferred on to them from the *thána* maps which are prepared on the 1-inch scale.

(*f*) The 8 traverse charts of Ránchi district which have been completed, have been prepared by projection, plotting of trijunctions and transferring of village boundaries on to them from 1-inch reductions of cadastral maps, as no standard maps of this area have yet been commenced. In addition the following 17 charts of this district have been projected and plotted, *viz.*, $73\frac{A}{3, 4, 6, 7, 8, 11, 12, 14, 15, 16}$, $73\frac{B}{10, 13, 14, 15}$ and $73\frac{E}{3, 4, 8}$. Of these, $73\frac{A}{8, 12}$ and $73\frac{B}{10}$ have village boundaries partially transferred on to them in pencil. Further work on these charts has been postponed pending final orders on the question of publication of a special provincial edition of the standard maps.

(*g*) The total cost of the office for the year under report was ₹33,069.

NEW STANDARD MAPS.

72. The following statements show that the number of sheets surveyed is considerably more than the number drawn, but this is due to the fact that in column 4 only those sheets which have been drawn and finally passed by Circle Superintendents up to September 30th, 1909, have been included. A large number of those sheets shewn in column 6 will very shortly be submitted for publication. The number of sheets published in the year under report is 174, which compares very favourably with the number published in 1907-08, namely, 85, and it is not anticipated that it will be difficult in future for the publication office to keep well up to date in dealing with the number of maps submitted for publication. The Table as now published gives a complete record of the preparation and the publication of all the new standard maps for the year under report.

Statement showing the progress made in the preparation of the "Standard Sheet" Series of Maps on the scale 1-inch=1 mile during the year ending September 30th, 1909.

Locale.	Sheets surveyed or compiled.	Total.	Sheets drawn.	Total.	Sheets in hand on September 30th, 1909.	Total.	Remarks.
1	2	3	4	5	6	7	8
Central Provinces, Central India and Berár.	46 K/9, 13; 46 O/1, 2, 5, 6, 9, 10, 13, 14		54 P/4, 7, 8, 12, 16; 55 M/13		46 K/9, 13; 46 O/1, 2, 5, 6, 9, 10, 13, 14		
...	55 H/1, 2, 3, 5, 6; 55 I/10		.....		55 H/1, 2, 3, 5, 6; 55 I/10		
...	55 L/2, 3, 4, 6, 7; 55 M/1, 2 3, 5, 9		.....		55 L/2, 3, 4, 6, 7; 55 M/1, 2, 3, 5, 9		
...	55 N/5; 64 A/1, 5, 9, 10, 13	32	.....	6	55 N/5; 64 A/1, 5, 9, 10, 13	32	
United Provinces	54 I/2 & 6, 3 & 7; 54 J/9 & 13		54 I/2 & 6, 3 & 7; 54 J/9 & 13		54 M/9; 54 O/1, 5, 7, 10, 11, 12, 14, 15, 16		
...	54 M/1 & 5; 54 N/3, 7, 11, 12, 15, 16		54 M/1 & 5; 54 N/3, 7, 11, 12, 15, 16		63 C/2, 3, 4, 6, 7, 8		
...	54 O/9, 13; 63 C/12 & 16		54 O/9, 13; 63 C/12 & 16		63 G/12, 16; 63 K/2, 4, 8		
...	63 F/9 & 13; 63 I/11 & 15; 63 J/1 & 5		63 F/9 & 13; 63 I/11 & 15		.....		
...	63 J/11 & 15; 63 K/2	18	63 J/1 & 5, 11 & 15; 63 K/2	18	.....	21	
Bombay	46 O/3, 7, 11	3	46 K/1, 2, 5, 6, 14	5	46 O/3, 7, 11	3	
Madras and Coorg	48 P/15; 49 N/13, 14		49 M/5, 9, 10, 13		48 P/15; 49 M/14; 49 N/13, 14		
...	58 A/7, 8, 9, 10, 13, 14	9	58 A/1, 2, 3, 4, 5, 6	10	58 A/7, 8, 9, 10, 13, 14	10	
Bengal	72 N/11; 72 O/5, 6, 7, 9, 10		72 N/11; 72 O/5, 6, 7		64 O/10, 11, 15; 72 K/4, 8, 11, 12, 15		
...	79 B/12, 16; 79 F/7, 11; 79 K/1, 5		79 B/12, 16; 79 C/1, 5, 6, 9; 79 F/4, 7, 8, 11, 12, 16		72 L/1, 2, 5, 6, 7, 9, 10; 72 N/12, 15, 16		

Bengal—*contd.*	.....		79 $\frac{G}{5, 9, 10, 13}$, 79 $\frac{K}{1, 5}$		72 $\frac{O}{9, 10, 12, 13, 14}$		
...	.....	12	.....	22	72 $\frac{P}{6, 7, 9, 10, 11}$, 79 $\frac{F}{3, 15}$	30	
Eastern Bengal and Assam.	78 $\frac{P}{9, 10, 12, 13, 15, 16}$	6	.....	0	78 $\frac{P}{9, 10, 12, 13, 15, 16}$	6	
Burma	84 $\frac{J}{9, 10, 11, 12, 13, 14, 15, 16}$		84 $\frac{K}{2, 4, 5, 6}$		84 $\frac{J}{9, 10, 11, 12, 13, 14, 15, 16}$		
...	84 $\frac{K}{9, 13, 14}$, 84 $\frac{M}{1, 5, 9, 13, 15, 16}$		84 $\frac{M}{13, 15, 16}$		84 $\frac{K}{9, 13, 14}$, 84 $\frac{M}{1, 5, 9}$		
...	93 $\frac{A}{9, 10, 11, 12, 13, 14, 15, 16}$		.....		93 $\frac{A}{9, 10, 11, 12, 13, 14, 15, 16}$		
...	93 $\frac{N}{8, 12, 16}$, 93 $\frac{O}{5, 6, 9, 10, 13, 14}$		.....		93 $\frac{N}{8, 12, 16}$		
...	102 $\frac{C}{1, 2, 3, 6, 7, 11, 14, 15}$		.....		93 $\frac{O}{5, 6, 9, 10, 13, 14}$		102 $\frac{G}{1}$ and $\frac{G}{2}$ are being drawn in one sheet.
...	102 $\frac{G}{1, 2, 3}$		.....		94 $\frac{F}{6}$		102 $\frac{C}{10}$ and $\frac{C}{11}$ are being drawn in one sheet.
...	.....		.....		102 $\frac{C}{1, 2, 3, 6, 7, 11, 14, 15}$		
...	.....	45	.....	7	102 $\frac{G}{1, 2, 3}$	43	102 $\frac{B}{4}$ and $\frac{C}{1}$ are being drawn in one sheet.
Punjab	38 $\frac{L}{3, 4, 7}$, 38 $\frac{P}{1, 2, 5, 6, 7, 8, 9}$		38 $\frac{K}{12}$, 38 $\frac{L}{3, 6, 7}$, 38 $\frac{N}{8, 11, 12, 16}$		38 $\frac{L}{4}$, 39 $\frac{I}{2, 3, 4, 8, 16}$		38 $\frac{K}{12}$ was redrawn during year under report.
...	39 $\frac{I}{2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16}$		38 $\frac{O}{2, 6, 8, 10, 11, 12, 13, 14, 15, 16}$		39 $\frac{J}{1, 5, 13, 14}$, 39 $\frac{M}{1, 2, 3}$, 43 $\frac{B}{15, 16}$		
...	39 $\frac{J}{1, 5, 13, 14}$, 39 $\frac{M}{1, 2, 3}$		38 $\frac{P}{1, 2, 5, 6, 7, 8, 9}$		43 $\frac{F}{3, 4, 7, 8}$, 52 $\frac{D}{12, 16}$, 52 $\frac{H}{4, 8}$		38 $\frac{N}{8, 11}$, second edition.
...	43 $\frac{B}{7, 8, 12, 15, 16}$		39 $\frac{I}{5, 6, 7, 9, 10, 11, 12, 14, 15}$		53 $\frac{A}{2, 12}$, 53 $\frac{E}{1, 2, 5, 6}$		38 $\frac{O}{13}$, rejected and redrawn.
...	41 $\frac{C}{4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}$		43 $\frac{B}{4, 7, 8, 11, 12}$		.....		
...	43 $\frac{F}{3, 4, 7, 8}$		43 $\frac{C}{2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}$		.....		
...	.....	53	43 $\frac{G}{12}$, 43 $\frac{H}{5, 9}$	57	.....	29	
TOTALS		178		125		174	

Statement showing progress made in the publication of the "Standard Sheet" Series of Maps on the scale 1-inch=1 mile during the year ending September 30th, 1909.

Locale.	Sheets received for publication during the year.	Total.	Sheets published during the year.	Total.	Remarks.
1	2	3	4	5	6
Central Provinces, Central India and Berár.	54 L/8, 12, 16; 54 P/4, 7, 8, 12, 16		54 L/8, 12, 16; 54 P/3, 4, 7, 8, 11, 12, 15		
...	55 I/5, 6; 55 H/4, 7, 8, 12, 16; 55 M/13		55 H/4, 7, 8, 12, 16; 55 I/5, 6, 11; 55 M/13		
...	.....	16	55 N/1	20	
United Provinces	54 L/7; 54 N/3, 7, 12, 15, 16; 54 O/1, 5, 9, 13		54 L/7, 11, 15; 54 N/4, 8, 11, 12, 15, 16		
...	.....	10	54 O/1, 5, 9, 13; 63 G/15; 63 J/12, 16	16	
Bombay	46 K/6, 10, 14, 16; 46 O/4, 8, 12, 16		46 K/4, 6, 7, 10, 11, 12, 14, 15, 16		
...	.....	8	46 O/4, 8, 12, 16	13	
Madras and Coorg	49 M/5, 9, 10, 11, 13, 15, 16; 58 A/5	8	49 M/5, 11, 16	3	Sheets 57 H/14, 58 A/1, 2, 3, 4, 6; 78 P/8; 93 E/4; 93 P/13, 14; 102 D/1, 2, were despatched by Superintendent, Burma Surveys, on September 30th, 1909, but were received in Calcutta in October 1909 and have been registered for column 2 for year 1909-10.
Bengal	72 N/7, 11; 72 O/5, 6, 7; 79 B/12, 16		72 N/2, 3, 7, 8; 72 O/3, 5; 79 C/2, 10, 13, 14		
...	79 C/1, 5, 6, 9; 79 F/7, 8, 11, 12, 16		79 G/1, 2, 6, 10, 13		
...	79 G/1, 5, 9, 10, 13	22	.....	15	

Eastern Bengal and Assam.	78 P/1, 2, 3, 4, 5, 6, 7, 11, 14; 79 J/4		78 P/3, 4, 5, 6, 11; 79 J/4		
...	79 K/1, 5; 83 A/12; 83 B/9		79 K/1, 5; 83 A/12		
...	.....	14	83 B/5, 9, 13	12	
Burma	84 1 K/2, 3, 4, 5, 6, 8, 11, 12, 15, 16; 84 L/1		84 J/4, 8; 84 K/1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 15, 16		
...	84 M/2, 6, 10, 13, 14, 15, 16; 93 A/1, 5; 93 C/5		84 L/1, 2; 84 M/2, 3, 4, 7, 8, 11, 14; 84 N/5, 12, 16		
...	93 E/8; 93 P/11, 15; 94 B/9, 10, 13, 14, 15		84 O/5; 93 E/8; 93 O/15, 16; 93 P/10		
...	94 F/2, 3; 102 C/4, 8, 12; 102 D/3, 5, 9		94 A/2, 11; 94 B/9, 10, 11, 12, 14, 15, 16		
...	.....	37	94 C/9, 10, 13, 14; 94 F/1, 2, 4, 7, 8, 10, 11, 12	52	
Punjab	38 K/12; 38 L/12, 15, 16; 38 N/8, 11, 12, 16		38 K/11, 12, 16; 38 L/1, 5, 6, 8, 9, 15, 16		38 N/8, 11, second edition.
...	38 O/2, 5, 6, 8, 9, 10, 11, 12, 14, 15, 16; 38 P/3, 4		38 N/8, 14, 15, 16; 38 O/3, 4, 5, 7, 9		
...	39 F/15, 16; 39 I/13		38 P/4; 39 I/13; 39 J/2, 3, 6, 7, 8, 9, 10, 11, 12		
...	39 J/2, 3, 4, 6, 7, 8, 9, 10, 11, 12; 43 B/4		39 K/1; 39 O/5, 11; 43 B/1, 2, 3, 4; 43 C/1		
...	43 C/1, 2, 3, 4, 6	40	53 A/6, 7, 11, 15, 16	43	*Note.*—In addition 11 Standard Sheets in the old form were printed as new publications during the year, and 4 were received for publication.
	TOTAL	154		174	

ESTABLISHMENT.

73. The following officers have been appointed to the department:—
Lieutenants P. G. Huddleston, R.E., and K. Mason, R.E.

74. From the Provincial Service five officers retired:—
Messrs. W. M. Kelly, S. F. Norman, L. F. Berkeley, C. S. Kraal and A. Descubes: two resigned: Messrs. F. W. Marten and B. F. Cooper; and five died: Messrs. C. G. S. Wood, Rahmatulla, K. S., M. J. Sheehan, H. W. McDonald and A. G. Wiseman.
Five officers have been appointed to the Provincial Service as probationers.

75. Four officers have been transferred from the old to the new Provincial Service and nine surveyors have been promoted to the Upper Subordinate Service.

76. The services of the following officers are deserving of special mention:—
Colonel Burrard, R.E., F.R.S., Bt.-Colonel Renny-Tailyour, R.E., Lieut.-Colonel Gordon, I.A., Majors Ryder, D.S.O., R.E., Pirrie, I.A., and Coldstream, R.E., Captains Wood, Gunter, M.O'C. Tandy and Phillimore, and Lieutenants Baker, Campbell, and Chase, R.E.

Provincial Service.—Messrs. L. F. Berkeley, J. M. Kennedy, A. Ewing, M. Gastaud, A. B. Smart, H. G. Shaw, J. H. Nichol, Aulad Hossein, J. O. Greiff, W. Newland, E. C. J. Bond, Hanuman Prasad, Dhani Ram, J. R. Newland, Syed Zille Hasnain, C. West, E. B. West, H. D. W. Stotesbury, C. H. Tresham, V. D. B. Collins, M. M. Mudaliar, A. J. A. Drake and F. H. Grant.

Upper Subordinate Service.—Anantarao Dhondiba, Abdul Hakk, Dalbir Rai and Hayat Muhammad.

Surveyors, Draftsmen, etc.—Paras Ram, Hamid Gul, Ahmad Shah and Raj Ali of the Northern Circle. and Ram Saran, Nain Singh, Pertab Singh, and B. V. Narain Rao of the Eastern Circle.

Head Quarters Offices.—Mr. T. A. Ferrier of the Mathematical Instrument office, Messrs. R. Taylor, F. R. Vandyke, R.E., S. Colquhoun, J. Vieux, J. D'Silva, Hingoo Jan and Nasir Ahmed of the Photo.-Litho. office, T. J. Jellicoe, and Suropada Roy Chowdhuri of the Drawing office, and Babu Chuni Lal Dey, Mr. E. A. Rundlett and Babu Norendra Nath Mukarji of the Clerical Establishment.

EXPENDITURE.

77. The total cost of the department for the survey year ending 30th September 1909 is R32,35,460, while that for the financial year ending 31st March 1909 is R33,81,569 against an estimated cost for 1909-10 of R33,90,750.

78. The actual expenditure on topographical surveys for the survey year 1908-09 amounts to R16,51,677 against R16,04,831 of the previous year. The expenditure on topographical surveys compares favourably with that of last year, as a reference to the areas surveyed will show. These are 42,600 square miles for the year under report against 35,968 square miles for 1907-08.

79. The cost of the trigonometrical and scientific parties is R4,17,542 against R4,13,283 of the preceding year. But this expenditure as in the case of last year is abnormal and temporary.

80. The cost of cantonment surveys amounts to R54,811 against R52,906 for 1907-08.

81. The expenditure on the local drawing offices, excluding the North-West Frontier and Simla Drawing offices, which are included in the expenditure of the office of the Superintendent, Northern Circle, amounts to R71,217 against R53,412 of the previous year.

82. The expenditure on cadastral operations in Burma amounts to R8,282 only against R1,57,847 of last year. The decrease is due to the abolition on the completion of its work of No. 7 Party that was employed there.

PART II.

THE OPERATIONS OF FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

NO. 24 PARTY.*

83. The party was under the charge of Captain C. M. Browne, D.S.O., R.E., throughout the year under report and was divided into 5 principal and 4 secondary detachments.

Personnel.

Imperial Officers:

Captain C. M. Browne, D.S.O., R.E., in charge.
Mr. J. de G. Hunter, M.A.
Lieutenant E. B. Cardew, R.E.
Lieutenant G. F. T. Oakes, R.E.

Provincial Officers:

Messrs. C. H. Tresham, J. H. Johnson, Abdul Hai, V. D. B. Collins, F. W. Smith, G. A. Norman, B. T. Wyatt, Abdul Karim, K. S. Gopalachari, Mohan Lal Arora, V. P. Wainwright, C. S. McInnes.

The detachments were distributed as follows:—

Principal.

(*a*) Baluchistán detachment, working on the North Baluchistán series.

(*b*) North-West Frontier Province detachment, working on the North Baluchistán series.

(*c*) Burma (Shan States) detachment, on the Great Salween series.

(*d*) Burma (Upper) detachment, on the Upper Irrawaddy series.

(*e*) Kashmir detachment, on the new Kashmir series.

Secondary.

(*f*) Punjab detachment, on the traverse from Burála T. S. of the Jogí Tílá series to Shorkot h. s. and to Doráwálás.

(*g*) Assam detachment, on the selection and building of stations for the Khási hills secondary series.

(*h*) Lower Burma detachment, on the selection and building of stations for the Mawkmai secondary series.

(*i*) Upper Burma detachment, on the selection and building of stations for a secondary series along the meridian of 97°.

84. *Baluchistán detachment.*—The programme was to commence the North Baluchistán series from the side Zawa-Zibra of the Kalát Longitudinal series and to carry the triangulation as close to the western and northern borders of Baluchistán as practicable, closing on the Great Indus series if possible about latitude 32° 30′.

Lieutenant Oakes, R.E., was the observer and his detachment was formed mostly of newly recruited men with a nucleus of old men.

The detachment assembled at Mastung Road on the 16th May 1908 and left shortly after for the first station.

Observations were taken at Zawa and Zibra stations of the Kalát Longitudinal series and new stations were fixed at Koi Maran, Rastari Taing, Mashelak, Takatu, and Khwája Amrán.

An astronomical azimuth was observed at Mashelak (Lat. 30° 14′, Long. 66° 47′) and the difference found between the value so obtained and that computed from the triangulation was 1″·25, the sign of this difference was positive which is in accordance with other values found in that region.

*The statement on page 24 of the General Report of the Survey of India for 1907-08, that the computed values of azimuth are always larger than the astronomical values, was incorrect. In Baluchistán, the computed values are smaller, as has been well known for years. The persistency of their deficiency shows that our triangulation is being taken too far south. The incorrect statement in the report for 1907-08 was not due to any difference of opinion on the point, but to a clerical mistake that escaped detection.

The work was greatly hindered by dust haze which is prevalent in the summer, but the height of the stations made it impracticable to carry out the work in the winter.

Lieutenant Oakes carried the series up to the Toba plateau (Lat. 31°). The 8 completed triangles have an average error of 0″·41 and contain an area of 3,500 miles.

The side Koi Maran-Takatu is remarkable for being the longest side yet employed in the principal triangulation of India; its length is over 68 miles.

The detachment suffered considerably from malarial fever owing to the unusual amount of rain that fell. Work was closed at the end of November and the detachment recessed at Dehra Dún.

85. In August 1909, Mr. Tresham recommenced the work from the point where Lieutenant Oakes left off and up to date has fixed new stations at Padughar, Nari Shan Shela, Ghandak, Kand, Barsha, and Sakir.

The work is still in progress and consequently full details cannot be given in this year's report.

86. (*b*) *N.-W. Frontier Province detachment.*—Lieutenant Cardew, R.E., was the observer and his programme was to start the North Baluchistán series from the east and to carry it southwest over the Sulaimán range with the intention of joining up with the western part of the North Baluchistán series which had been begun in 1908. In addition to this a secondary series was to be run in order to fix the positions of Pakkalota, Jinighar and Darweshta Sar with accuracy in order to co-ordinate the triangulation in the Tochi and Kurram valleys.

87. The detachment was formed in the beginning of October 1908 and proceeded to Dera Ismail Khán and thence to Umar Khel, a station of the Great Indus series, but it was found that the triangulation could not be commenced from here as the station of Maidán had been destroyed. The series was therefore commenced from the sides Bani-Sakesar and Sakesar-Umar Khel, and a new station, which has been called Maidán II, was built near the site of the former one. On the hill a broken stone with a single dot cut on it was found covered with a cairn and Lieutenant Cardew's observations shew that it must have been almost exactly on the site of the former station; this is clearly shewn by the data of the two points given below.

I represents the data of the stone found from observations by Lieutenant Cardew.

II represents the data of Maidán H.S., from the synoptical volume of the Great Indus series.

	Lat.	Long.	Height.
I	32°51′5″·70	71°10′39″·99	4256·7 feet.
II	32°51′5″·70	71°10′40″·00	4275·0 ,,

88. Observations were made by Lieutenant Cardew at the following principal stations:—Bani, Sakesar, Umar Khel, Maidán No. II, Sheikh Ullah, Baindarra, and Shistarg; the last four being newly constructed stations; Shistarg is on Sheikh Budin, but is lower than either the principal or the subsidiary station, which formerly stood there.

Owing to the building of the cantonment both these had been lost.

Baindarra is near the site of an old station. From this station and from Shistarg only the back angles were observed as the station which was intended to be on Kaisarghar or the Takht-i-Sulaimán could not be built for political reasons.

Stations have been built on Ziárat, Surkund, and Sangarghar, but no observations have been taken and it is probable that a junction will now have to be made with the Great Indus series in the neighbourhood of Dera Gházi Khán.

Work was closed and the detachment returned to recess quarters at Mussooree in the middle of April.

89. The health of the men was on the whole good, but on first leaving Dera Ismail Khán many suffered from malarial fever which was very prevalent at that time in the district.

90. (*c*) *Burma* (*Shan States*) *detachment.*—The programme was to continue the Great Salween series from where it had been left off in 1907-08, but to bend the series to the eastward taking it across the Salween so as to include as much as possible of the country within the British border. Captain C. M. Browne

was the observer and the detachment assembled at Lashio on the 9th November, but heavy rain fell continually until almost the end of November and no work was possible until the first week in December.

New stations were fixed at Kiip Ma, Hpa Hpak, Paning Lung, Aunglawn, and Wán Wa.

An astronomical azimuth was observed at Kiip Ma and the difference between the value so obtained and that computed from the triangulation was 8″·60, the sign of this difference was negative which is in accordance with other values obtained in Burma.

In addition to the principal work Captain Browne fixed several of the topographical triangulation stations on which No. 2 party were basing their work.

The dust haze came on early in the year and work had to be closed on the 2nd of March, the detachment arriving at Lashio on the 21st March.

The country on the east of the Salween is very difficult to traverse, the hills being steep and roads practically non-existent. The health of the detachment was on the whole good although in the early part of the season fever was very prevalent and in the district small-pox was rife in the villages. A detailed statement of the outturn of work is given at the end of this report.

(*d*) *Upper Irrawaddy detachment.*—Mr. Smith with a small party of men selected and built the stations for this series from the initial side Song-Tangte of the Great Salween series up to Latitude 25°30′. Lieutenant Cardew, R.E., will, during the next field season, observe these stations and continue the selection and building. The series, which is at present trending northwards, will be deflected to the west in latitude 25° 30′ and will be eventually joined to the Mandalay series in longitude 96°.

(*e*) *Kashmir detachment.*—The programme for this detachment was to commence a series from the side Nerh-Khagriáná of the N.-W. Himalaya series and to carry it northward to connect up with the existing series in Kashmir. The detachment was formed in Dehra Dún in the middle of April and proceeded to Ráwalpindi. The observations were delayed by stations ahead not being ready in advance, and in July and August by the monsoon. Mr. Wyatt with a small party was detached to inspect and repair the stations of the old Kashmir series. This detachment is still in the field.

91. *Secondary triangulation.*

(*f*) In the Punjab a traverse was run with the Jäderin apparatus from Burála T. S. of the Jogí Tílá series to Shorkot h. s. and Doráwálá s. in order to co-ordinate the various traverses on which the topographical and revenue work of that district are based. The observers were Messrs. Tresham, Wyatt and McInnes. The difference found between the values thus obtained for Shorkot and Doráwálá and those given in the synoptical volume is considerable. Considering the accuracy of the methods used in the traverse it is more probable that the error lies in the secondary series of which Shorkot and Doráwálá are stations, unless the assumed length of "C" wire is in error. Comparative data are given below:—

I represents values obtained from the traverse.

II represents values from the synoptical volume.

Station.	Latitude.	Longitude.
Shorkot	(I) 30°49′ 57″·80	72°06′ 42″·30
	(II) 30°49′ 58″·51	72°06′ 43″·23
Doráwálá	(I) 30°27′ 51″·64	72°29′ 55″·725
	(II) 30°27′ 52″·60	72°29′ 56″·02

The total length of traverse was 118 miles and as a bench mark has been embedded every 6 miles the height of which was obtained by spirit levelling the line should be of permanent utility when the error has been located and distributed.

(*g*) In Assam Mr. Johnson commenced the selection and building of the stations for the Khási Hills secondary series, his detachment consisted of 22 men and field work was begun from Shillong in the beginning of November. Some difficulty was experienced in obtaining transport and supplies and the detachment

suffered a good deal from malarial fever but satisfactory progress was made in the work.

(*h*) In Lower Burma the selection and building of stations for the Mawkmai secondary series was carried from the starting side, (Letpataung-Suletaung) of the Mandalay meridional series, up to longitude 98°15′.

Two observers will be employed this field season and it is hoped that it will be completed at an early date. In the year under report Mr. Collins was in charge of the detachment and 28 stations were selected and built.

(*i*) In Upper Burma a small detachment under Mr. Mohan Lal Arora was employed on the selection and building of the stations for a secondary series in Bhamo district starting from the side Tangte-Taungkalat of the Great Salween series. The series is intended to run north along the meridian of 97° and Lieutenant Cardew will try to fix the stations already built from his stations of the Upper Irrawaddy series which will run parallel to the secondary series.

92. The party was inspected in recess by the Superintendent, Trigonometrical Surveys, during June 1909.

STATEMENT OF OUTTURN OF WORK.

Baluchistán detachment (North Baluchistán series).

Number of the Principal Stations at which observations were taken	8
Number of Principal Stations newly fixed	6
Length of new series in miles	100
Area of triangulation in square miles	3,500
Average triangular error of 8 triangles	0″·41
Value of Astronomical-Geodetic Azimuth at Mashelak	+1″·25

N.-W. Frontier detachment, North Baluchistán series.

Number of the Principal Stations at which observations were taken	7
„ secondary „ „	4
Number of the Principal Stations newly fixed	4
„ secondary „ „	4
Length of new series in miles Principal	50
„ „ „ secondary	50
Area of triangulation in square miles Principal	1,900
„ „ „ secondary	1,200
Average triangular error of 7 triangles of the Principal triangulation	0″·60
Average triangular error of 11 triangles of the secondary triangulation	3″·58
Value of Astronomical-Geodetic Azimuth at Umar Khel	+7″·66

Burma (Shan States) detachment (Great Salween series).

Number of the Principal stations at which observations were taken	8
Number of the Principal stations newly fixed	8
Length of new series in miles	100
Area of triangulation in square miles	4,200
Average triangular error of 9 triangles	0″·47
Value of Astronomical-Geodetic Azimuth at Kiip Ma	−8″·60

SECONDARY.

Punjab detachment.

Length of traverse in miles	118
No. of stations at which observations were taken	76
Number of Mark-stones embedded and fixed	22

SCIENTIFIC OPERATIONS.

GEODETIC.

STANDARD BAR COMPARISONS.

No. 22 Party.

93. During the field season of 1908-09 No. 22 Party was combined with No. 23 Party under Captain Cowie, R.E., and assisted that party in the pendulum operations. Previous to this, between the middle and end of November 1908, the party undertook the second series of comparisons of the Standard Bar A with the secondary standards I_B and I_S.

Personnel.

Imperial Officers:

Captain H McC. Cowie, R.E., in charge till 30th April 1909.

Lieutenant H. J. Couchman, R.E., in charge from 1st May 1909.

94. Standard Bar A had been sent, in 1908, to Sèvres for comparison with the International Metre. In the winter of 1907, before the Standard Bar left Dehra Dún, and again in November 1908, on its return from France, comparisons were made against the secondary Bars for the purpose of testing the constancy of its length during the interval between its departure from and its return to Dehra Dún. The result of the first series of comparisons and also the value of Bar A in terms of the International Metre formed the subject of the report submitted by the party for the year 1907-08.

Briefly, the results of the first set of comparisons were :—

I_S—A, at 62° F.=83·12 millionths of a yard.

I_B—A, at 62° F.=196·73 millionths of a yard.

And Bar A at 62° F.= 3047·996 millimetres.

95. The second series of comparisons was commenced on November 17th and concluded on December 1st, 1908. The observers were Captains H. H. Turner, R.E., and H. M. Cowie, R.E. The arrangement of the apparatus, and the procedure of the observations were the same as in the first series of comparisons. Twenty sets of comparisons were made of each of the bars I_B and I_S with Bar A.

During the observations involving I_S and A the temperature ranged from 61°·2 to 64°·9 F. and in the case of I_B and A from 57°·6 to 65°·5 F.

The results obtained were :—

I_S—A at 62° F.=81·13 millionths of a yard$\pm$0·36 m. y.

The mean temperature during the observations was 63°·74 F.

I_B—A at 62° F.=193·38 millionths of a yard$\pm$0·52 m. y.

The mean temperature during the observations was 61°·99 F.

The 1908 results differ from those of 1907 by 1·99 m. y. in the case of I_S—A and 3·55 m. y. for I_B—A.

These quantities correspond approximately to $\frac{1}{1,700,000}$ and $\frac{1}{1,000,000}$ of the length of Bar A and they show that it is improbable that any change took place in length of the Standard Bar A between the time it left Dehra Dún and the date of its return from Sèvres. Complete reliance may, consequently, be placed upon the value, stated above, of Bar A, in terms of the International Metre.

96. The health of the party throughout the year has been good.

97. The party was inspected by the Superintendent, Trigonometrical Surveys, during June 1909.

98. The programme for next season consists of latitude observations on the N. E. Quadrilateral, the stations to be visited lying approximately between Sítápur and Gorakhpur.

PENDULUM OPERATIONS.

No. 23 Party.

99. During the winter of 1908-09, as a first step towards the investigation of the variation of gravity in the northern portion of peninsular India, pendulum operations were carried out in the western tracts of the Sátpura hills and the Vindhyan plateau.

Personnel.

Imperial Officer:

Captain H. McC. Cowie, R.E., in charge.

Provincial Officer:

Mr. Hanuman Prasad.

100. The accompanying table shows the stations visited and the result of the observations. These latter depend on the base (Dehra Dún) values

$$g=979{\cdot}063 \text{ dynes}$$
$$s=0^{s}{\cdot}5072497$$

The quantity g is the observed value of gravity at the level of the station. g is derived from g by correcting for height above sea level only.

g''_0 is the final value of gravity at sea level, obtained after applying corrections for height and mass above sea level and for uneven terrain.

γ_0 is the theoretical value at sea level computed by Helmert's formula of 1884.

$$\gamma_0=978{\cdot}00\,(1+0{\cdot}005310\sin^2\phi)$$

TABLE.

Station.	Latitude.	Height above mean sea level.	Observed value of gravity g.	g_0	Value of gravity at sea level g_0''	γ_0	$g_0''-\gamma_0$	$g_0-\gamma_0$
	° ′ ″	Feet.	Dynes.	Dynes.	Dynes.	Dynes.		
Ujjain . .	23 11 0	1,612	978·677	978·827	978·771	978·802	−0·031	+0·025
Mhow . .	22 33 10	1,903	978·620	978·797	978·730	978·763	−0.033	+0·034
Mukhtiára .	22 33 40	926	978·664	978·750	978·718	978·755	−0·035	−0·003
Mortakka .	22 13 20	756	978·703	978·757	978·737	978·743	−0·006	+0·014
Khandwá .	21 49 30	1,014	978·692	978·787	978·752	978·714	+0·038	+0·073
Asírgarh .	21 28 10	2,077	978·584	978·778	978·711	978·694	+0·017	+0·084
Jálgaon .	21 0 0	760	978·633	978·704	978·677	978·665	+0·012	+0·039
Amraotí .	20 55 50	1,123	978·609	978·714	978·675	978·665	+0·010	+0·049
Ellichpur .	21 18 20	1,314	978·618	978·740	978·694	978·685	+0·009	+0·055
Hoshangábád	22 45 0	1,002	978·719	978·812	978·777	978·773	+0·004	+0·039
Sháhpur .	22 11 30	1,286	978·663	978·783	978·738	978·743	−0·005	+0·040
Badnúr .	21 54 10	2,103	978·607	978·803	978·730	978·724	+0·006	+0·079

101. A noticeable feature of the results given in this table is that at seven stations situated at from 750 feet to 2,100 feet above sea level, excesses of gravity have been found. The work of past years has comprised observations at twenty-eight places at heights of over 750 feet, at none of which has gravity been proved to be in excess. In that the great majority of these twenty-eight stations are in extra-peninsular India, the results are interesting, as pointing to a dissimilarity of conditions prevailing in the crust in peninsular and extra-peninsular regions.

102. In the table above, the quantity $g_0-\gamma_0$ is the actual effect of masses surrounding the station, in excess or defect of the normal crust. Where complete compensation occurs, $g_0-\gamma_0$ should be *nil*. This condition is nearly attained at Mukhtiára. At the other stations an excess of mass is indicated. The average effect of excess of mass, as indicated by $g_0-\gamma_0$, taking all the stations into account, is almost exactly equal to the average attraction of the masses above sea level, calculated on the assumption that the density is 2·8. From this it may be inferred that in the portion of peninsular India under consideration, treated as a whole, the degree of compensation of visible masses is very small.

103. The determination of the clock rate was undertaken by Mr. Hanuman Prasad. The results were thoroughly satisfactory, the average p. e. of the daily rate deduced from observations on two successive nights being $\pm 0^{s}{\cdot}012$.

104. The times of vibration of the mean pendulum, at Dehra Dún, were

in December 1908 $s=0^{s}{\cdot}5072499$
May 1909 $s=0^{s}{\cdot}5072496$

The mean value, $0^{s}{\cdot}5072497$ was accepted as representative of the period December 1908 to May 1909.

Since January 1904, the date of the commencement of operations with the half-seconds pendulums, the length of the mean pendulum has decreased, the time of vibration having changed by about 23 in the seventh decimal place of a second.

Of the individual pendulums, the times of Nos. 137, 138, 139 have all changed in a similar way and by about like amounts, all showing a decrease. No. 140, on the other hand, appears to have altered but little, the indications not being very decided, and the change would seem to tend to an increase of the time of vibration.

On the assumption that these alterations of length are due to molecular influences, it would be natural to suppose that with increasing age of the pendulums there would be a gradual approach to molecular stability, and that consequently, for equal periods of time, the absolute amounts of change in length would become smaller and smaller. If the course of the variations of length were represented by a curve, we should expect, dividing this curve into three major periods, that the first period, representing the earlier life of the pendulum would exhibit changes comparatively large and varying little in value; that after passing through an intermediate period, during which the changes corresponding to equal intervals of time decreased rapidly in amount, we should reach the last period where the changes from time to time were infinitely small and approximately equal. A consideration of the Indian pendulums shews that they must still be considered to be in the first period, and it is a matter for surprise that this should have lasted for as long as five years.

Further particulars of the changes in the times of vibration are given in the narrative report submitted by the officer in charge of the party.

105. The health of the party was good.

106. The party was inspected by the Superintendent, Trigonometrical Surveys, during June 1909.

107. The future work of the party will be the gradual extensions of the gravimetric survey to the east and north, over Rájputána, the Vindhya plateau and the Sátpurá hills to the Gangetic plain. In the season of 1909-10 pendulum operations will be undertaken in the eastern Sátpurá hill tracts.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

Personnel.

Imperial Officer:

Mr. C. F. Erskine, in charge.

Provincial Officers:

Messrs. J. P. Barker, H. G. Shaw, E. H. Corridon, Syed Zille Hasnain A. M. Talati, O. N. Pushong, P. N. Sur, D. H. Luxa, T. F. Kitchen and H. St. J. Kenny.

Subordinate Establishment:

1 Surveyor, 24 Computers and Recorders, 2 Artificers and 3 Observatory Clerks.

108. Mr. C. F. Erskine held charge of the party throughout the year.

Tidal Operations.

109. Observations were taken by means of self-registering tide-gauges during the year at the stations enumerated in the following list:—

Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1. *Aden*	1879	Still working	29	
2. *Karáchi*	1869*	1880*	13*	*Small tide-gauge working.
	1881	Still working	28 41	
3. *Bombay (Apollo Bandar)*	1878	" "	31	
4. *Bombay (Prince's Dock)*	1888	" "	21	Property of Port Trust.
5. *Madras*	1880	1890	10	
	restarted 1895	Still working	14 24	
6. *Kidderpore*	1881	" "	28	
7. *Rangoon*	1880	" "	29	
8. *Port Blair*	1880	" "	29	
9. *Moulmein*	1880	1886		
	restarted 1909	Still working	6	

110. In addition to the above, readings to tide-poles were taken at Bhávnagar, Chittagong and Akyab.

111. The nine tidal observatories at work were inspected during the year, and the registrations have been satisfactory.

112. In the following tables are given the annual and decadal percentages of the predicted time and height errors of high and low waters at open coast and riverain stations:—

Percentage of errors in Predicted Times and Heights at open coast stations from automatic registrations.

Year.	Number of Stations.	In Time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
1906	6	85	81	96	97	94	95
1907	6	84	83	98	98	98	99
1908	6	84	84	98	97	99	99
Average of 10 years	8	78	73	95	95	95	95

Percentage of errors in Predicted Times and Heights at riverain stations from automatic registrations.

Year.	Number of Stations.	In Time.		In Height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
1906	2	59	53	74	64	92	95
1907	2	58	47	78	60	96	90
1908	2	58	52	77	60	97	92
Average of 10 years	2	57	58	74	61	93	91

113. At Moulmein a new observatory was erected in August 1908, on a site close to the old one which was dismantled in 1886. The tide-gauge was duly installed and registrations were commenced on the 1st of January 1909. The true zero of the gauge is identical with that adopted in 1880, when the gauge was first started. The results derived from the observations which are now being registered, will serve as a check on the accuracy of the predictions already published.

Levelling Operations.

114. Three detachments were employed on the levelling operations during the past season.

115. No. 1 Levelling detachment connected the standard bench-marks at Sátára, Belgaum, Bangalore, Salem, Trichinopoly, Negapatam, Madura, Tinnevelly, Calicut, Bijápur and Akola and carried out a line of levels from

Secunderábád to Warora, connecting the standard bench-marks at Secunderábád, Trimulgherry and Bolárum. The outturn amounted to 332·2 miles. The field season commenced on 8th October 1908 and ended on 15th April 1909.

116. No. 2 Levelling detachment levelled from Nagaur to Ahmadábád *viâ* Jodhpur and Pálanpur, connecting the standard bench-marks at Jodhpur and Ahmadábád. A branch line of levels was run from Pálanpur to Deesa, connecting the standard bench-mark at Deesa. The standard bench-mark at Roorkee was then connected and a line of levels was carried from Hardwár to Dehra Dún. The total outturn of levelling was 450·5 miles. The duration of field season was from the 3rd October 1908 to 9th April 1909.

117. No. 3 Levelling detachment was employed on levelling operations from Katni *viâ* Jubbulpore and Seoni to Nágpur and from Wardha to Warora. The standard bench-marks at Jubbulpore, Nágpur, Hinganghát, Saugor, Raipur, Biláspur and Sambalpur were also connected. The outturn amounted to 302·3 miles. The field season lasted from the 14th October 1908 to 16th April 1909.

118. During the past field season three important lines of levels which were undertaken principally to break up the larger level circuits were completed, *viz.*, (1) from Ferozepore across Rájputána to Ahmadábád, (2) from Katni *viâ* Jubbulpore and Seoni to Nágpur, and (3) from Wardha *viâ* Warora and Nirmal to Secunderábád.

119. During the past year 16 standard bench-marks were erected and 16 connected, 32 are under construction and 39 have been proposed for erection.

120. The health of the members of the levelling detachments was generally far from good. At the commencement of the field season a large percentage of the establishment suffered from malarial fever, but later on the health of the men improved, and in the latter portion of the season was on the whole good.

121. The Superintendent, Trigonometrical Surveys, inspected the party in May 1909.

PROGRAMME FOR NEXT YEAR.

122. Tidal operations during the coming year will be confined to the 9 observatories now working.

123. During the coming field season No. 1 Levelling detachment will be employed in Burma on new levelling from Wuntho to Myitkyina, and revision levelling from Pyinmana to Rangoon, and the connection of the standard bench-marks at Rangoon, Pegu, Toungoo, Mandalay, Shwebo, Meiktila, Magwè, Wuntho and Myitkyina. No. 2 Levelling detachment will be employed on levelling from (1) Siliguri to Tindhária, (2) Bareilly to Naini Tál, (3) Ambála to Solon, (4) Hardwár to Lansdowne, and the connection of standard bench-marks at Nellore, Bezwáda, Cocanáda, Vizagapatam, Berhampur, Cuttack, Balasore, Burdwán, Gauháti, Dhubri, Dinájpur, Purnea, Bhágalpur, Patna (Bankipore), Muzaffarpur, Motíhári, Rewah and Lucknow (new).

No. 3 Levelling detachment will be employed on levelling from (1) Laluwali T. S. near Khánpur to Rohri, (2) Shikárpur to Jacobábád, (3) Páli h. s. to Godhra, (4) Lahore to Dharmkot, and the connection of standard bench-marks at Sadikganj, Baháwalpur, Khánpur, Sukkur, Jacobábád, Hyderábád (Sind), Karáchi, Godhra, Baroda, Rájkot, Surat, Dhúlia, Mhow and Bhopál.

Tabular Statement of outturn of work of Levelling Detachments Nos. 1, 2 and 3.

	Number of miles of Double Levelling, including Branch Lines.	NUMBER OF BENCH-MARKS CONNECTED.							
		Old.			Standard.	Embedded.	Inscribed.	G. T. Survey.	Irrigation, Railway and other Departments.
		Standard.	Embedded.	Inscribed.					
Levelling Detachment No. 1	332	...	14	36	14	25	185	2	25
Ditto No. 2	450	1	2	9	4	41	297	5	2
Ditto No. 3	302	...	7	49	7	24	143	6	7
TOTAL	1,084	1	23	94	25	90	625	13	34

MAGNETIC OPERATIONS.

No. 26 Party.

124. The party remained in charge of Lieut. H. J. Couchman, R.E., until 31st March 1909, when he was relieved by Captain R. H. Thomas, R.E., on return from furlough.

Personnel.

Imperial Officers :

Captain R. H. Thomas, R.E., in charge from 1st April 1909.
Lieutenant H. J. Couchman, R.E., till 30th April 1909 (in charge till 31st March 1909).
Lieutenant H. T. Morshead, R.E., till 31st March 1909.

Provincial Officers :

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

Subordinate Establishments :

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

125. *Work of the field detachments.*—During the year under report field operations were continued by four detachments.

Two of these were employed in Burma in completing the areas allotted to the preliminary survey: the two remaining commenced the detailed survey by the examination of several obviously disturbed areas.

The field season commenced on the 26th October 1908, and the party proceeded to recess quarters on May 3rd, 1908.

126. *Work of the Imperial Officers.*—The officer in charge with his assistant (Lieut. H. T. Morshead, R.E., temporarily posted to the party) visited all the repeat stations, 22 in number, and also re-observed at a number of old field stations. Comparative observations were also taken at the four survey base stations and at Alíbág to determine the differences from the survey standard at Dehra Dún.

127. *Total work to date.*—Forty-one new stations of the preliminary survey were occupied: the total number of stations of the preliminary survey thus becomes 1,255. Twenty-six old field stations were re-occupied, making 57 in all, at which observations have been repeated.

A new repeat station was established at Port Blair: this had long been considered advisable, but no opportunity had occurred before.

One hundred and twenty-two stations were occupied in the detailed survey.

128. *Work during recess.*—During the recess season the computations of the field work and the reduction and tabulation of the base station results for 1908 have been completed.

The triangulation carried out in 1907-08 by Mr. Morton, of this party, in connection with the Chin-Lushai-Arakan Boundary Survey, was re-computed and the results submitted to the Superintendent in charge, Burma Surveys.

The correction of the horizontal force and declination observations for diurnal variation and instrumental differences in declination is in hand, the repeat stations and re-observed field stations being dealt with in the first instance.

With regard to the correction for instrumental differences in H. F., the whole question is now under investigation, the main points being considered are—

(*a*) Whether any correction should be made to the standard on account of change in the moment of inertia.

(*b*) Whether the discrepancies in different seasons in the differences from the standard can be eliminated by using for the distribution factor $\log\left(1-\frac{p}{r^2}-\frac{q}{r^4}\right)$ instead of $\log\left(1-\frac{p}{r^2}\right)$.

As regards (*a*), observations for the moment of inertia have been taken with the standard magnet No. 17 every year, and, allowing for the change in weight of inertia bar No. 17 (see Narrative Report for 1904-05), there appears to be a gradual and regular fall in the value, corresponding in 1908 to a correction of 19γ in H. F.

With regard to (*b*), the expression for the connection between M, H, the deflecting distance (r) and the angle of deflection (u) is—

$$\frac{H}{M}=\frac{2}{r^3 \sin u}\left(1+\frac{p}{r^2}+\frac{q}{r^4}+ \ldots\right)$$

where p and q are the distribution constants. The expression $1-\frac{p}{r^2}$ which is now employed is obtained on the assumption that $\frac{q}{r^4}$ is negligible: this is, however

far from being the case; the correction to the observed value of H. F. varying from 0 to +60γ at Dehra Dún with various instruments. The magnitude of the correction, moreover, is not a constant for any particular instrument, but may vary within considerable limits from time to time; there is further considerable liability to sudden change when there is a sharp drop in the magnetic moment, though the distribution factor now applied may show little or no alteration.

The investigation has necessitated considerable computation, but a preliminary reduction of the instrumental differences correcting as above gave promising results, and the investigation will therefore be continued. It may be mentioned that this investigation has considerable bearing on the question of H. F. disturbance corrections, owing to the resulting changes in the monthly base lines: it will also affect the secular change values, since various instruments have been used at the repeat stations and re-observed field stations.

An approximate reduction of the H. F. observations at repeat stations and re-observed field stations has also been done: it has indicated that the present number of repeat stations is far too small for the correct appreciation of the annual change, and the present policy of re-observing at a number of old field stations will, as far as time permits, be continued.

During the year values of magnetic declination were supplied as under :—

For standard 1-inch maps	433
For degree sheets	26
To private individuals	34
TOTAL	493

129. *The base stations.*—The magnetographs have given good results during the year.

Serious trouble has, however, been experienced in Dehra Dún observatory owing to the heavy rainfall; it was found impossible to prevent water forcing its way into the magnetograph room, and finally, on August 15th, it was deemed advisable to remove the instruments.

The H. F. and declination magnetographs had been working since January 1903 with only minor interruptions, while the V. F. instrument was erected in 1905. The instruments were re-erected on September 11th and 12th, but the break of record is a great misfortune.

In the Narrative Report of 1902-03 an account is given of the measures taken to obviate a recurrence of the flooding of the observatory in the autumn of 1901, but the experience of the last few years has shown that the hopes then expressed were unduly optimistic.

In 1904-06 water entered the magnetograph room: in 1905-07 the rainfall was less than the normal, and, though in 1908 the total rainfall was heavy, the room remained practically dry, as there was no prolonged period of heavy rainfall as in the present year.

After three or four days' heavy rain the subsoil becomes waterlogged, water increases in the catchment pit faster than it can be pumped out, and the walls and floor are subjected to a head of 10 feet or more, a pressure which they are ill-calculated to resist.

Pumping with two pumps had been going on day and night for over a week before the instruments were removed, yet at the time of their removal, the water had risen to within an inch of the top of the driving clock pillar, while subsequently on the same day this pillar was submerged: at the time the water level in the catchment pit was 11 feet above the level of the floor of the observatory.

130. *Mean values of magnetic elements.*—The mean values of the magnetic elements at the four survey base stations for 1908 are as follows :—

Dehra Dún	Lat. 30°19′	Long. 78° 3′
Declination	2° 36′·7 E.	
Dip.	43° 42′·2 N.	
H. F.	·33293 C. G. S.	
V. F.	·31819 ,,	
Barrackpore	Lat. 22° 46′	Long. 88° 22′
Declination	1° 5′·7 E.	
Dip.	30° 34′·5 N.	

H. F.		·37031 C. G. S.
V. F.		·22038 „
Toungoo	Lat. 18° 36′	Long. 96° 27′
Declination		0° 34′·4 E.
Dip.		23° 2′ N.
H. F.		·38763 C. G. S.
V. F.		·16479 „
Kodaikánal	Lat. 10° 14′	Long. 77° 28′
Declination		0° 45′·4 W.
Dip.		3°33′·2 N.
H. F.		·37434 C. G. S.
V. F.		·02324 „

131. A table showing the approximate preliminary values (uncorrected) at the field and repeat stations in 1908-09 is appended, together with a reference index chart showing all the stations of observation to date.

132. *Health of party.*—The health of the party was on the whole satisfactory, though the detachments working in Burma at times suffered severely from malaria.

133. *Inspection visits.*—The party was inspected in recess by the Superintendent, Trigonometrical Surveys, on June 24th, 1909.

134. *Work projected for 1909-10.*—During the next field season the detailed survey will be continued on the same lines as last year by two detachments.

Two detachments will be employed in re-observing at old field stations, particularly in the area lying between Lat. 16° —19° and Long. 73°—78°, where the secular change in H. F. appears to be particularly abnormal.

The computing section in Dehra Dún will continue the reduction of the preliminary survey, in addition to its normal work of computing and tabulating the base station results.

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season 1908-09.

DETAIL SURVEY STATION.

Serial No.	Name of Station.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
		° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
1D	Mhow	22 33 0	75 45 0	30 1	E 0 49	0·3646	H. is derived from Mean M° throughout.
2D	Mánpur	22 25 50	75 36 40	29 23	„ 0 42	0·3670	
3D	Gujri	22 18 40	75 30 40	29 52	„ 1 0	0·3639	
4D	Lunera	22 27 40	75 25 20	30 2	„ 0 52	0·3647	
5D	Nímkhera	22 26 10	75 11 30	29 57	„ 0 55	0·3648	
6D	Decla	22 19 0	75 5 30	29 29	„ 1 35	0·3627	
7D	Liwáni	22 18 50	75 18 30	29 43	„ 1 4	0·3631	
8D	Bákáner	22 11 10	75 9 30	29 16	„ 1 4	0·3629	
9D	Dharmpuri	22 9 0	75 21 10	28 3	W 0 4	0·3886	
10D	„ A	22 10 0	75 19 30	30 50	E 0 33	0·3532	
11D	„ B	22 9 50	75 20 40	31 43	„ 0 47	0·3485	
12D	„ C	22 9 20	75 20 50	29 50	E 0 46	0·3661	
13D	Degáwa	22 10 10	75 22 10	29 9	„ 1 24	0·3618	
14D	Dasora	22 10 59	75 20 50	31 24	„ 1 13	0·3583	
15D	Dhegda	22 12 20	75 21 50	29 8	„ 0 58	0·3643	
16D	Chota Pípliá	22 11 20	75 18 40	29 26	„ 0 52	0·3622	
17D	Khárpura	22 9 10	75 17 30	29 35	„ 0 49	0·3604	
18D	Mahápura	22 8 40	75 14 50	30 51	„ 0 43	0·3596	
19D	Dédgaon	22 10 30	75 15 30	29 6	„ 0 53	0·3714	
20D	Baikhera	22 12 10	25 12 50	28 52	„ 0 46	0·3667	
21D	Potwár	22 8 20	75 11 30	30 59	„ 1 27	0·3562	
22D	Brahmangaon	22 6 0	75 16 50	30 30	„ 0 56	0·3597	
23D	Balgaon No. 1	22 3 20	75 17 20	30 11	„ 0 32	0·3459	
24D	Khurrampur	22 1 10	75 21 0	28 45	„ 0 42	0·3649	
25D	Thíkri	22 4 10	75 24 10	29 47	„ 1 1	0·3604	
26D	Abáli	22 5 20	75 20 50	33 14	„ 0 44	0·3356	
27D	Chichili	22 7 40	75 23 50	29 58	„ 1 10	0·3668	
28D	Khalgsháť A	22 8 30	75 27 10	31 12	„ 0 53	0·3578	
29D	Dhámnod	22 11 30	75 27 50	29 23	„ 1 10	0·3635	
30D	Regwán	22 6 0	75 29 40	27 33	„ 0 18	0·3744	
31D	Doláni	22 2 20	75 28 40	28 38	„ 0 31	0·3694	
32D	Dángri	22 0 0	75 14 40	28 48	„ 0 38	0·3665	
33D	Talwára	22 4 40	75 12 10	30 52	„ 0 26	0·3583	
34D	Kirmoi	22 5 30	75 8 50	30 46	„ 1 25	0·3623	
35D	Mundiakheri	22 2 30	75 8 10	31 8	„ 1 12	0·3649	
36D	Salkhera	21 54 10	75 9 30	31 4	„ 1 18	0·3556	

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season 1908-09 – contd.

DETAIL SURVEY STATION—*contd.*

Serial No.	Name of Station.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
		° ′ ″	° ′ ″	° ′	° ′	C G S.	
37D	Pipri	21 57 10	75 11 40	28 51	E 1 10	0·3663	
38D	Danund	21 53 20	75 5 0	28 4	,, 1 22	0·3552	
39D	Raita	21 51 50	75 8 30	30 20	,, 0 39	0·3634	
40D	Balgaon No. 2	21 51 20	75 12 40	28 14	,, 0 11	0·3773	
41D	Nágalwári	21 45 30	75 15 40	29 30	,, 1 12	0·3641	
42D	Kheri	21 52 30	75 20 50	28 42	,, 1 0	0·3643	
43D	Likhi	21 55 20	75 27 50	30 19	,, 0 40	0·3619	
44D	Khargon	21 50 0	75 36 0	29 34	,, 0 41	0·3657	
45D	Sirkandi	21 44 20	75 27 30	29 21	,, 0 33	0·3631	
46D	Dhúlkot	21 36 30	75 33 10	28 49	,, 0 45	0·3631	
47D	Pipal Jopa	21 33 10	75 41 20	27 49	,, 0 41	0·3670	
48D	Islámpura	21 39 10	75 37 50	28 7	,, 0 57	0·3683	
49D	Ghári	21 39 40	75 43 50	28 28	,, 0 33	0·3671	
50D	Mogargaon	21 42 0	75 49 30	28 31	,, 1 19	0·3640	
51D	Bistán A	21 42 0	75 40 10	27 59	,, 0 38	0·3690	
52D	Deoli	21 45 10	75 33 30	29 34	,, 0 28	0·3686	
53D	Piparker	21 45 20	75 39 20	25 25	W 0 31	0·3885	
54D	Julwána	21 48 40	75 44 0	30 22	E 1 2	0·3614	
55D	Sultánpur	21 52 10	75 47 0	29 30	,, 0 45	0·3653	
56D	Lohári	21 57 40	75 37 50	28 4	,, 0 56	0·3667	
57D	Kamuthwára	22 2 20	75 47 10	30 27	,, 0 28	0·3656	
58D	Kaori	22 2 50	75 41 40	29 54	,, 0 51	0·3631	
59D	Dogaonwa	22 7 20	75 38 40	29 45	,, 0 49	0·3634	
60D	Chamu	26 39 20	72 34 50	37 38	,, 1 54	0·3459	
61D	Rájabás	26 34 30	72 28 50	37 14	,, 1 49	0·3448	
62D	Loharan	26 39 30	72 22 20	36 58	,, 0 47	0·3424	
63D	Gilankor	26 45 50	72 26 40	37 37	,, 1 55	0·3435	
64D	Pílu	26 50 50	72 26 20	37 56	,, 1 42	0·3415	
65D	Kolu	26 55 0	72 18 10	37 53	,, 2 2	0·3412	
66D	Sagra	26 47 20	72 17 20	36 57	,, 1 25	0·3404	
67D	Márla No. 1	26 51 10	72 13 0	36 45	,, 1 9	0·3375	
68D	Untwália	26 45 10	72 12 10	39 37	W 0 38	0·3345	
69D	Chansuma	26 46 10	72 9 10	40 9	E 1 2	0·3368	
70D	Márla No. 2	26 48 40	72 12 30	41 20	,, 0 53	0·3207	
71D	Kaláo	26 39 40	72 6 30	39 9	,, 2 24	0·3410	
72D	Bhurkia	26 43 0	72 10 10	39 45	,, 0 58	0·3404	
73D	Shetráwa	26 35 50	72 17 20	36 28	W 2 1	0·3500	
74D	Rainsar	26 29 0	72 18 50	36 59	E 0 36	0·3400	
75D	Soália	26 26 50	72 12 40	37 37	,, 1 1	0·3398	
76D	Somésar	26 34 20	72 10 0	37 56	,, 1 33	0·3513	
77D	Jethania	26 37 50	72 11 40	39 17	,, 0 18	0·3465	
78D	Rataria	26 36 50	72 1 50	38 34	,, 2 44	0·3416	
79D	Sardar-Singh-ki-Dhoni	26 38 20	71 48 50	35 17	,, 3 19	0·3297	
80D	Dhursar	26 49 30	72 0 10	40 6	,, 2 25	0·3347	
81D	Marwa	26 45 0	71 54 10	38 6	,, 4 45	0·3552	
82D	Modadri	26 49 50	71 44 10	37 19	,, 2 19	0·3414	
83D	Udhánia	26 58 0	71 43 10	37 35	,, 2 17	0·3405	
84D	Rathora	27 6 40	71 53 10	37 24	,, 2 7	0·3439	
85D	Khara	27 1 50	72 7 30	36 7	,, 1 51	0·3414	
86D	Bengti (Bari)	27 9 10	72 10 30	38 31	,, 2 16	0·3429	
87D	Jalóra	26 59 40	72 24 30	38 15	,, 2 12	0·3417	
88D	Uparli	27 3 10	72 16 0	38 20	,, 2 11	0·3419	
89D	Dádu	26 55 10	72 8 0	38 5	,, 1 38	0·3367	
90D	Ékka	26 57 30	71 59 30	38 23	,, 1 55	0·3310	
91D	Dédia	26 50 30	72 6 30	39 57	,, 1 1	0·3280	
92D	Moru	26 42 10	71 58 30	39 20	,, 1 22	0·3475	
93D	Shetráwa (*a*)	26 35 50	72 17 20	36 9	W 0 12	0·3463	
94D	Garawad	24 14 20	75 10 20	34 23	E 1 31	0·3562	
95D	Jíran	24 18 40	74 53 30	33 35	,, 2 9	0·3542	
96D	Thara	24 11 0	74 51 20	33 12	,, 1 24	0·3555	
97D	Palsoda	24 21 40	74 59 20	33 22	,, 1 0	0·3552	
98D	Neemuch	24 27 0	74 52 50	34 18	,, 1 11	0·3551	
99D	Beri	24 23 10	74 45 10	33 51	,, 1 21	0·3540	
100D	Bamora	24 24 50	74 34 10	33 57	,, 1 41	0·3547	
101D	Bári	24 30 50	74 39 40	34 16	,, 1 39	0·3544	
102D	Badésar	24 41 10	74 30 30	34 29	,, 1 49	0·3522	
103D	Bhadaura	24 42 40	74 21 50	34 21	,, 1 50	0·3524	
104D	Akola	24 45 0	74 12 0	34 13	,, 1 38	0·3523	
105D	Newánia	24 38 20	74 3 0	34 1	,, 1 33	0·3525	
106D	Hita	24 33 40	74 11 40	34 15	,, 1 49	0·3506	
107D	Padampurá	24 34 50	74 20 0	34 5	,, 1 51	0·3530	
108D	Bhanuja	24 32 0	74 29 20	34 12	,, 1 42	0·3535	
109D	Pachar	24 24 20	74 25 50	33 49	,, 1 38	0·3538	
110D	Bhairvi	24 19 40	74 34 30	33 46	,, 1 39	0·3552	
111D	Barol	24 17 50	74 43 20	33 43	,, 1 27	0·3550	

H. is derived from Mean M° throughout.

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season 1908-09—contd.

DETAIL SURVEY STATION—*concld.*

Serial No.	Name of Station.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ′ °	Declination. ° ′	Horizontal Force. C. G. S.	REMARKS.
112D	Barawarda	24 11 30	74 42 0	33 23	E 1 27	0·3555	H. is derived from Mean M° throughout.
113D	Bamotar	24 4 20	74 45 20	33 21	„ 0 58	0·3555	
114D	Kalianpura	24 4 30	74 54 20	33 21	„ 1 16	0·3555	
115D	Khiraut	23 57 20	74 48 0	33 23	„ 1 1	0·3508	
116D	Ságthali	23 49 10	74 48 10	32 52	„ 1 18	0·3564	
117D	Dhanderio	23 50 10	74 56 40	32 42	„ 1 23	0·3564	
118D	Jawásia	23 57 30	74 59 30	33 9	„ 1 10	0·3556	
119D	Mandsaur	24 4 10	75 4 40	34 1	„ 1 15	0·3637	
120D	Sunti	24 6 0	75 13 50	33 4	„ 1 18	0·3582	
121D	Barwan	23 56 50	75 11 0	32 55	„ 0 58	0·3573	
122D	Kachnara	23 50 30	75 6 20	32 30	„ 1 2	0·3553	

FIELD STATIONS.

Serial No.	Name of Station.	Survey No.	Latitude. ° ′ ″	Longitude. ° ′ ″	Dip. ° ′	Declination. ° ′	Horizontal Force. C. G. S.	REMARKS.
1215	Kyauktaw	3	20 50 30	92 58 40	26 52	E 0 39	0·3818	H. is derived from Mean M°. throughout.
1216	Paletwa	8	21 18 10	92 51 40	27 50	„ 0 45	0·3807	
1217	Kaletwa	9	21 44 0	92 47 50	28 39	„ 0 49	0·3798	
1218	Kyaukpyu	12	19 26 0	93 33 30	23 58	„ 0 35	0·3862	
1219	Ramree	13	19 5 50	93 52 0	23 20	„ 0 34	0·3872	
1220	Cheduba	1	18 51 10	93 43 30	22 44	„ 0 34	0·3882	
1221	Sandoway	2	18 27 50	94 22 0	21 53	„ 0 32	0·3889	
1222	Kyeintali	3	18 0 0	94 29 10	20 56	„ 0 29	0·3898	
1223	Gwa	4	17 35 20	94 34 50	20 1	„ 0 24	0·3907	
1224	Bawmi	5	17 18 30	94 34 40	19 22	„ 0 25	0·3912	
1225	Taseng	2	16 54 20	94 23 40	18 27	„ 0 23	0·3911	
1226	Ngo-yôn-kaung	3	16 30 20	94 18 0	17 33	„ 0 20	0·3923	
1227	Kábaung-hmau	4	15 59 50	94 16 40	16 17	„ 0 19	0·3931	
1228	Labutta	5	16 8 40	94 45 20	16 48	„ 0 38	0·3936	
1229	Wakéma	2	16 36 0	95 10 10	17 50	„ 0 36	0·3925	
1230	Mya-tha	3	16 14 10	95 17 0	17 4	„ 0 24	0·3924	
1231	Ma-ubin	4	16 44 20	95 39 10	18 13	„ 0 24	0·3916	
1232	Pyapôn	5	16 17 10	95 40 50	17 15	„ 0 23	0·3925	
1233	Kadôn-kani	6	15 46 40	95 12 50	16 17	„ 0 19	0·3932	
1234	Yandoon	11	17 2 50	95 38 10	18 55	„ 0 27	0·3925	
1235	Me-za-li-gôn	12	17 52 50	95 14 0	20 39	„ 0 27	0·3909	
1236	Petyè	13	18 18 30	95 8 20	21 33	„ 0 29	0·3894	
1237	Tabee	6	18 38 20	94 40 20	22 16	„ 0 32	0·3888	
1238	Taungup	7	18 51 40	94 14 50	22 42	„ 0 33	0·3884	
1239	Mai	14	19 17 10	94 8 0	23 44	„ 0 35	0·3873	
1240	Sakamau	15	19 38 50	94 0 10	24 23	„ 0 36	0·3863	
1241	Thanbaya	3	16 7 20	98 2 10	16 56	„ 0 35	0·3936	
1242	Kyunghaung	4	15 32 10	98 15 20	15 37	„ 0 31	0·3942	
1243	Mi-tan	5	16 0 10	98 26 30	16 40	„ 0 34	0·3938	
1244	Kyôndo	6	16 35 50	98 3 50	17 55	„ 0 35	0·3929	
1245	Mya-wadi	7	16 41 20	98 29 50	18 8	„ 0 35	0·3926	
1246	Amherst	8	16 4 50	97 34 0	16 38	„ 0 29	0·3932	
1247	Anin	9	15 39 40	97 44 0	15 41	„ 0 26	0·3936	
1248	Ye	10	15 14 40	97 51 10	14 52	„ 0 31	0·3948	
1249	Mvitta	2	14 10 50	98 29 50	12 29	„ 0 31	0·3925	
1250	Gônnyin Seik	3	13 41 20	98 18 50	11 21	„ 0 27	0·3953	
1251	Malee	4	13 6 50	98 19 40	10 12	„ 0 31	0·3975	
1252	Kan-hmaw	3	11 48 20	98 33 20	7 4	„ 0 21	0·3964	
1253	Bôkpyin	4	11 16 40	98 49 30	5 48	„ 0 23	0·3970	
1254	Victoria Point	1	9 59 30	98 35 20	2 46	„ 0 20	0·3970	
1255	Tenasserim	1	12 5 40	99 3 30	7 43	„ 0 29	0·3972	
1256	Srínagar	...	34 4 17	74 49 1	49 18	„ 2 54	0·3101	Communicated by Mr. D. C. Sowers of the Carnegie Institution of Terrestrial Magnetism.
1257	Sonamarg	...	34 18 45	75 18 51	49 30	„ 3 55	0·3107	
1258	Múlbekh	...	34 23 2	76 21 29	49 30	„ 3 49	0·3154	
1259	Leh	...	34 9 30	77 34 15	49 24	„ 3 34	0·3123	
1260	Panamik	...	34 47 0	77 33 40	50 9	„ 3 53	0·3101	
1261	Kigil Langar	...	35 12 0	78 0 55	50 51	„ 3 59	0·3081	

Abstract showing approximate magnetic values at stations observed at by No. 26 Party during season 1908-09—concld.

REOBSERVED FIELD STATIONS.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
20	Asolai	1	26 42 10	72 15 50	37 46	E 0 13	0·3395	H. is derived from Mean M° throughout.
21	Phalodi	5	27 7 40	72 21 50	38 20	„ 2 4	0·3409	
21A	„ (a)	„	27 7 30	72 21 20	38 15	„ 2 1	0·3415	
71	Lahore	8	31 35 50	74 18 50	45 59	„ 2 58	0·3210	
124	Bíkaner	3	28 0 40	73 18 50	39 58	„ 2 6	0·3389	
139	Viramgám	13	23 8 10	72 3 30	31 19	„ 1 7	0·3565	
157	(Panth) Píplia	1	24 12 20	75 0 40	32 28	„ 1 19	0·3589	
158	Nímbahera	3	24 37 20	74 41 40	34 30	„ 1 38	0·3526	
172	Dhond	3	18 28 0	74 35 10	22 20	„ 0 18	0·3686	
207	Hirur	4	13 35 50	75 58 10	11 26	W 0 34	0·3790	
217	Kolhápur	2	16 41 50	74 14 10	18 15	E 0 18	0·3733	
223	Manmád	2	20 14 40	74 26 20	25 29	„ 0 58	0·3654	
260	Kavas	6	25 52 20	71 31 40	35 59	„ 2 7	0·3457	
327	Tuticorin	1	8 48 10	78 9 0	0 7	W 1 20	0·3807	
387	Betragunta	7	14 48 40	79 57 20	14 13	„ 0 57	0·3807	
413	Hardikot, G.T.S.	7	26 57 30	71 51 0	39 10	E 3 6	0·3378	
486	Daltonganj	3	24 2 0	84 4 30	32 54	„ 1 18	0·3665	
544	Bárán	5	25 5 30	76 30 30	35 18	„ 1 27	0·3527	
556	Bárwáha	2	22 15 20	76 1 30	29 40	„ 0 58	0·3631	
590	Anjhi	9	27 38 20	79 59 20	39 26	„ 1 53	0·3469	
598	Kathgodam	1	29 15 20	79 32 50	42 8	„ 2 24	0·3381	
621	Bistán	9	21 41 50	75 40 10	27 54	„ 0 59	0·3758	
622	Khal Ghát	10	22 8 50	75 27 10	33 11	„ 1 54	0·3375	
623	Dhár	11	22 36 0	75 18 30	30 2	„ 0 42	0·3670	
836	Parbatipur	3	25 39 10	88 55 10	36 19	„ 1 22	0·3629	
860	Lumding	6	25 44 50	93 10 40	36 21	„ 1 16	0·3669	

Repeat Stations.

Serial No.	Name of Station.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
		° ′ ″	° ′ ″	° ′	° ′	C. G. S.	
I	Udaipur	24 35 33	73 41 57	34 4	E 1 24	0·3527	H. is derived from Mean M° throughout.
II	Karáchi	24 49 50	67 2 2	34 23	„ 1 42	0·3453	
III	Quetta	30 11 52	67 0 20	43 12	„ 3 1	0·3230	
IV	Baháwalpur	29 23 27	71 40 37	42 14	„ 2 51	0·3316	
V	Ráwalpindi	33 35 16	73 3 6	48 21	„ 3 45	0·3116	
VI	Bharatpur	27 13 27	77 29 28	38 52	„ 1 58	0·3454	
VII	Bangalore	12 59 35	77 35 58	9 57	W 0 41	0·3816	
VIII	Dhárwár	15 27 26	74 59 35	15 31	„ 0 16	0·3758	
IX	Porbandar	21 38 20	69 37 6	28 57	E 1 13	0·3598	
X	Fyzabad	26 47 27	82 7 40	38 1	„ 1 45	0·3535	
XI	Sambalpur	21 28 3	83 58 24	27 58	„ 0 46	0·3733	
XII	Waltair	17 42 57	83 19 1	21 20	„ 0 10	0·3785	
XIII	Darjeeling	26 59 49	88 16 39	38 25	„ 1 32	0·3570	
XIV	Gaya	24 46 30	84 58 54	34 23	„ 1 7	0·3665	
XV	Secunderábád	17 27 11	78 29 16	20 14	„ 0 15	0·3794	
XVI	Bhusával	21 2 46	75 47 18	27 5	„ 0 50	0·3678	
XVII	Jubbulpore	23 8 57	79 56 44	31 11	„ 1 0	0·3641	
XVIII	Tavoy	14 4 50	98 12 30	12 16	„ 0 28	0·3960	
XIX	Lashio	22 56 47	97 44 40	31 18	„ 0 43	0·3766	
XX	Akyab	20 7 53	92 53 18	25 31	„ 0 42	0·3839	
XXI	Silchar or Cáchár	24 49 43	92 47 21	34 44	„ 1 8	0·3694	
XXII	Dibrugarh	27 29 24	94 55 40	39 31	„ 1 15	0·3587	
XXIII	Port Blair	11 39 10	92 43 13	6 18	W 0 8	0·3954	

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

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

The Survey numbers refer to the published chart, thus No. $\frac{44}{3}$ 3 denotes No. 3 station, the spherical co-ordinates of whose centre are 26° North Latitude and 76° East Longitude.

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

TOPOGRAPHICAL SURVEYS.

NORTHERN CIRCLE.

No. 9 Party (*vide* Index Map of Northern Circle facing page 46).

135. The party continued the work on which it was employed during the preceding season in Dera Gházi Khán district of the Punjab and also extended its operations into the Punjab districts of Miánwáli and Muzaffargarh and also into the Dera Ismail Khán district.

Personnel.

Imperial Officers:

Captain G. A. Beazeley, R.E., in charge from 1st May to 30th September 1909.
Lieutenant E. C. Baker, R.E., in charge from 1st October 1908 to 30th April 1909.
Lieutenant F. J. M. King, R.E.

Provincial Officers:

Messrs. J. A. Freeman, H. C. W. Stotesbury, F. W. Marten, D. K. Rennick, R. C. Hanson, H. W. McDonald and F. J. Grice.

Subordinate Establishment:

26 Surveyors, 6 Draftsmen, 3 Soldier-Surveyors, 2 Computers, 2 Clerks, 1 Store-keeper and 1 Hospital Assistant.

136. This work consisted of 1 inch=1 mile topographical surveys based in the hills on last season's triangulation, and in the plains on traverses executed by No. 1 Party about 30 years ago. Some supplementary traversing and triangulation was needed. In the plains, lines of levels were run to provide heights, but these sheets were not contoured.

137. The field office opened at Leiah on the North Western Railway on the 27th of October 1908 and closed at Dera Ismail Khán on April 8th, 1909. A small section under Lieutenant King, R.E., remained out till the end of the month, to complete some additional work which had been included in the programme at the end of the field season.

138. The resurvey comprised the whole of standard sheets $39\frac{I}{2,3,4,6,7,8,10,11,12,14,15,16}$, $39\frac{J}{1,5,13,14}$ and part of $39\frac{M}{2,3}$. The revision survey comprised the remainder of $39\frac{M}{2,3}$.

139. The character of the ground was varied. Sheets $39\frac{I}{2,3,4,6,7}$, $39\frac{J}{1,5}$ consisted of very broken, hilly, inhospitable country, rising from 800 feet above sea level in the east to 11,000 feet in the west. The remaining area lay on either bank of the Indus, and was flat and sandy, and, except for a strip along the river bank on either side, was extremely dry.

140. The operations were somewhat disturbed in the north-western portion of the work, which fell in Shiráni country. Mr. H. W. McDonald, a young provincial officer, was murdered by fanatics, and surveyor Yakub Ali and two *khalásis* killed, and one *khalási* and one camelman wounded by raiders. This did not, however, prevent the completion of the sanctioned programme.

141. The outturn and cost-rates of the party were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		₹	
Triangulation, 1-inch scale	309	11·3	
Traversing	52 (*a*)	34·9	(*a*) Linear miles.
Levelling	115 (*a*)	27·5	
Mapping	...	9·8	
Detail Survey.			
Re-survey, 1-inch scale	4,313	17·2	
Revision 1-inch ,,	285	14·1	
Total Detail Survey	4,598		

142. The total cost of the party for the year under report was R1,30,298.

143. During the recess the fair mapping of the following sheets was completed and sent in for publication :—

39 $\frac{I}{6, 7, 10, 11, 12, 14, 15}$. The remaining sheets, *i.e.*, 39 $\frac{I}{4, 8, 16}$, 39 $\frac{M}{2}$, 39 $\frac{J}{1, 5, 13, 14}$ are nearing completion. Triangulation charts in degree sheets 34 I. and 34 J. are in progress.

144. The health of the party was only fair, as the district was full of fever, which interfered somewhat with the work.

145. The party offices were inspected by the Surveyor General during July 1909.

NORTHERN CIRCLE.

No. 12 Party (*vide* Index Map of Northern Circle facing page 46).

146. The party continued the work on which it was employed last year in the Peshâwar, Hazâra and Attock districts.

Personnel.

Imperial Officers :

Brevet-Major E. T. Rich, R.E., in charge up to 20th May 1909.
Lieutenant E. C. Baker, R.E., in charge from 21st May 1909.
Lieutenant S. W. S. Hamilton, R.E., and Captain L. C. Thuillier, I.A.

Provincial Officers :

Messrs. F. H. Grant, H. H. P. Butterfield, F. E. R. Calvert, Rahmatullah, Dhani Ram and Abdul Karim.

Subordinate Establishment :

20 Surveyors (Permanent and Temporary), 3 Soldier-Surveyors, 2 Writers, 1 Computer and 1 Store-keeper.

147. The field office opened at Peshâwar on the 22nd of October 1908 and closed at Râwalpindi on 21st May 1909. One section was left behind to complete the work in the higher hills, and remained in the field until July 29th.

148. The country surveyed in the Peshâwar and Attock districts consisted mostly of rich alluvial cultivated lands broken up by ravines, the average ground level being about 1,000 feet above sea level. In the Hazâra district the hills rose to nearly 10,000 feet, and the survey included most of the well-known stations in the Murree hills.

149. The outturn and cost-rates of the party were as follows :—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		R	
Mapping	...	2·4	
Detail Survey.			
Original survey, 1-inch scale .	953	13·9	
" " 2-inch " .	1,359	42·5	
Forest revision survey, 4-inch scale	70	6·2	
Total Detail Survey .	2,382		

The 1-inch work comprised the whole of standard sheets 43 $\frac{F}{3, 4, 7, 8}$, exclusive of the amount of 4-inch Forest revision survey, all of which fell in these sheets. It also included a small portion of work in 38 $\frac{N}{11}$. The 2-inch work comprised standard sheets 43 $\frac{C}{5}$, 43 $\frac{B}{12, 15, 16}$ and parts of 43 $\frac{B}{7, 8, 11}$, to complete the compilation of these sheets.

150. The total cost of the party for the year under report was R84,012.

151. During recess the following standard sheets surveyed during the year, namely, 43 $\frac{C}{5}$, 43 $\frac{B}{7, 8, 11, 12}$ were drawn and sheet 38 $\frac{N}{11}$ was completed to margin. The following sheets previously surveyed were also drawn and submitted for publication :— 38 $\frac{N}{8, 12, 16}$, 38 $\frac{O}{13}$ and 43 $\frac{B}{4}$. A special $\frac{1}{2}$-inch map was also drawn, and the whole of these maps were forwarded to the Superintendent, Northern Circle, for submission to the Map Publication Office.

152. The health of the party was good.

153. The party was inspected in the field by the Surveyor General during March, and by the Superintendent, Northern Circle, in December, February and March. The recess office was inspected by the Surveyor General in July, and by the Superintendent, Northern Circle, frequently throughout the recess season.

154. The programme for next year consists of the detail and revision survey on the 1-inch scale of 19 standard sheets, namely, 39 $\frac{M}{9, 13, 14}$ and all of sheet 44 A.

NORTHERN CIRCLE.

NO. 14 PARTY (*vide* INDEX MAP OF NORTHERN CIRCLE FACING PAGE 46).

155. The head-quarters of the party remained at Ráwalpindi throughout the field season. The area under survey lay in the Attock, Ráwalpindi, and Jhelum districts of the Punjab, while the triangulation extended into Kashmir. The country under survey was of an open, undulating nature without any high hills; it was, however, intersected by many deep ravines and by broken ground.

Personnel.

Imperial Officers:

Lieutenant O. H. B. Trenchard, R.E., in charge from 1st October 1908 to 15th June 1909. Major C. H. D. Ryder, D.S.O., R.E., attached from 7th to 15th June 1909, and in charge from 16th June 1909. Lieutenant A. A. Chase, R.E., from 1st July 1909.

Provincial Officers:

Messrs. T. W. Babonau, H. H. B. Hanby, H. B. Simons, C. West, A. B. Hunter, W. J. B. Miller, A. G. Wiseman and W. P. Hales.

Subordinate Establishment:

46 Surveyors, etc.

156. Operations in the field commenced at the end of October and the members of the party returned to recess quarters at Mussooree on various dates between the middle of April and middle of May.

157. The party was divided into three camps under Messrs. Babonau, Hanby and Miller, and the following sheets were completed:—

43 $\frac{C}{4}$ (partly surveyed last year) and 43 $\frac{C}{6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}$. Messrs. C. West and A. B. Hunter triangulated for the scale of 1 inch = 1 mile, the remaining portion of 43 G and sheet 43 $\frac{H}{13}$, sheets 43 $\frac{G}{4, 8}$ having already been triangulated and 43 $\frac{G}{12}$ surveyed by the Training Party. Mr. West, assisted by Surveyor Ram Singh, triangulated for the scale of 2 inches = 1 mile, sheets 43 $\frac{C}{12, 16}$ and southern halves of 43 $\frac{C}{11, 15}$. This latter work was computed in the field and used for this season's topography. Mr. F. C. Pilcher was attached to this party for convenience of supervision, but his results have been included in No. 18 Party's report, as he properly belonged to that party.

158. The following table shows in detail the outturn with cost-rates for the year under report, and for purposes of comparison those of the preceding year are also given:—

Description of Survey.	Outturn, sq. miles.		Cost-rate per sq. mile.	
	1907-08.	1908-09.	1907-08.	1908-09.
			R	R
Triangulation, 1-inch scale	...	3,760	...	4·2
„ 2-inch „	1,365	750	7·2	4·1
Mapping	2,738	3,750	7·7	7·6
DETAIL SURVEY.				
Original survey, 2-inch scale	2,103	2,830	30·5	20·2

159. The total cost of the party for the year under report was R1,10,538.

160. The following 11 sheets (surveyed and drawn on the scale of 2 inches = 1 mile for reduction to the scale of 1 inch = 1 mile), constituting the arrears

of last year, were sent in for publication at the commencement of recess, *i.e.* sheets 38 $\frac{O}{2, 6, 8, 10, 11, 12, 14, 15, 16}$ and 43 $\frac{C}{2, 3}$.

161. All the sheets surveyed during the year under report will be sent in before the close of recess, *viz.*, sheets 43 $\frac{C}{4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16}$.

Three sheets surveyed by the Training Party were handed over to No. 14 Party to be drawn. Of these, 43 $\frac{H}{5}$ has been submitted for publication, and the other two, 43 $\frac{G}{12}$ and 43 $\frac{H}{9}$, are complete but await a boundary reference.

162. The health of the party was on the whole fair, but at the commencement of the field season fever was very prevalent. Mr. Wiseman died from injuries received in a railway accident near Dehra Dún while returning to recess. By his death the party has lost a promising young officer.

163. The party was inspected by the Superintendent, Northern Circle, twice during the field season and repeatedly during recess, and by the Surveyor General during recess.

164. The programme for next field season provides for the survey on the scale of 1 inch = 1 mile of sheets 43 $\frac{H}{1, 13}$, and of the whole of 43 G, except 43 $\frac{G}{12}$ already surveyed.

NORTHERN CIRCLE.

No. 18 Party (*vide* Index Map of Northern Circle facing page 46).

165. The head-quarter office of the party opened at Dera Ismail Khán on the 9th November and was transferred to Miánwáli on the 18th February 1909. Field work was, however, commenced during October; a traverse section and an advance party working in Dera Ismail Khán district, the Bári Doáb section at Montgomery and the Riverain section at Lahore.

Personnel.

Imperial Officers:

Captain E. A. Tandy, R.E., in charge till 16th August, and Captain L. C. Thuillier, I.A., in charge from 17th August 1909.

Provincial Officers:

Messrs. J. G. S. Rae, H. W. Biggie, C. E. C. French, J. R. Newland, F. C. Pilcher, H. T. Hughes, Maya Das Puri and Abdul Aziz.

Subordinate Establishment:

26 Surveyors, 19 Traversers, 19 Draftsmen, 19 Computers, 3 Clerks, 1 Store-keeper, 1 Hospital Assistant and 475 Menials.

166. To begin with, surveyors were concentrated on sheets 39 $\frac{I}{5, 9}$, 38 $\frac{P}{1, 2}$ and the trans-Indus portions of 38 $\frac{P}{5, 6, 7}$, in three camps, under Messrs. Biggie, French and Newland, while Mr. Pilcher was employed on triangulation in the Salt Range under the orders of the Officer in charge No. 14 Party.

On the completion of sheets 39 $\frac{I}{5, 9}$ the surveyors were drafted to new ground in sheets 38 $\frac{P}{5, 6, 7, 8, 9}$ and 39 $\frac{M}{1}$.

Under these arrangements all sections were able to finish their work fairly simultaneously; and, before the end of April, Mr. French with a few of the best draftsmen closed work earlier and proceeded to Mussooree to project the fair sheets and put on them the margins, headings, footnotes, etc., and this resulted in a considerable saving of time during recess.

167. The outturn and cost-rates of the party were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		R	
Triangulation, 2-inch scale .	1,800	3·6	
Traversing	2,642 (*a*)	...	(*a*) Linear miles.
Detail Survey.			
Original survey, 1-inch scale .	1,500	12·4	
„ „ 2-inch „ .	945	33·7	
Total Detail Survey .	2,445		

The rates] for the two scales of survey are not fairly comparable, as some of the 2-inch work was very difficult, while the 1-inch work was easy survey in the Thal desert and mostly without contours.

The average monthly outturn per surveyor on the 1-inch scale was 34·2 square miles, and on the 2-inch it was 17·8 square miles.

168. The total cost of the party for the year under report was R1,29,760.

169. The fair mapping of all complete sheets was finished and submitted by the end of the recess.

170. During October and early in November the advance detachments suffered much from fever arising from the recent heavy rains. Later and throughout the actual field season the health of the party was good.

171. The Superintendent, Northern Circle, inspected the party in the field in the Dera Ismail Khán district in December and at Miánwáli in February and March and frequently during recess. The Surveyor General inspected the party in the field in March and during recess in July 1909.

172. The programme for next season consists of the 2-inch survey of sheets 38 $\frac{P}{14, 15}$ and 43 $\frac{D}{1, 2, 5, 6}$ and of the northern halves of 43 $\frac{D}{3, 7}$, covering part of the Salt Range and of the 1-inch survey of sheets 38 $\frac{P}{10, 11, 12, 13, 16}$ and 43 $\frac{D}{4, 8}$ and of the southern halves of 43 $\frac{D}{3, 7}$. Triangulation will be carried out in sheets 43 $\frac{D}{9, 10, 13, 14}$.

173. *Bári Doáb Traverse.*—The traversing and fixing of base lines over the Bári Doáb desert area was finished during the year. Some of the old traverse framework to which all this new work was attached had been unsatisfactorily closed, and caused a good deal of distortion in parts of the new work, and this became in places so very bad that the officer in charge had during the previous recess reviewed the whole situation with a view to distributing the closing errors more satisfactorily over the whole area. This was done, and it was accordingly decided that base-lines must be slightly shifted over a large part of the area to make them correspond to the newly assigned positions, and this work of "alteration" was additional to that mentioned above. A small extension to the west was effected for the Irrigation Department, which they wished to be pushed through rapidly, but the advance party sent for the purpose early in October suffered badly from fever, and the work was greatly impeded during the early part of the season from this cause. Later in the season it was discovered that the corrections had been wrongly applied in the field, and it became necessary to move all the pillars again. Extra men were employed, but even then the work was not completed till the end of May.

174. *Riverain Section.*—This section continued to have its head-quarters at Lahore under Mr. Maya Das Puri. This was a most important year as regards this work, as during it special arrangements were made for utilising the riverain maps and assisting settlement officers in getting all difficulties cleared up on the ground. This work, which was commenced in Gurdáspur district last year, was this season carried out under improved arrangements; a definite scheme was drawn up and accepted by the Settlement Commissioner for still further expediting and cheapening the work of future settlements, and a small selected settlement staff was given a special training for the purpose. Acknowledgments are due to Mr. F. W. Kennaway, the Settlement Officer of Gurdáspur, for the courtesy and patience with which he assisted this section in getting over the preliminary difficulties connected with the first attempt at this work.

The programme for next season consists of:—(1) Traversing along Sutlej river in Ludhiána district and base-line laying in Jullundur and Hoshiárpur districts. (2) Traversing the Beás river in Amritsar and base-line laying in Kapúrthala State. (3) Traversing the Rávi river in districts Amritsar and Siálkot. (4) Main traverses in the Sutlej, Beás, Rávi, Chenáb and Jhelum rivers.

175. *Punjab Traverse.*—Mr. J. de Graaff Hunter, M.A., was specially attached to the party towards the close of last recess reason to overhaul all the traverse data of the Punjab, to study traverse methods and to advise the riverain and other detachments as to the best way of improving their framework. He was also incidentally looking after a special experimental traverse which No. 24 Party was carrying out with Yáderin wires in the Punjab. For these purposes he established his head-quarters in the office of the riverain section at Lahore and was given a special staff of a few computers.

The rates for the two scales of survey are not fairly comparable, as some of the 2-inch work was very difficult, while the 1-inch work was easy survey in the Thal desert and mostly without contours.

The average monthly outturn per surveyor on the 1-inch scale was 34·2 square miles, and on the 2-inch it was 17·8 square miles.

168. The total cost of the party for the year under report was R1,29,760.

169. The fair mapping of all complete sheets was finished and submitted by the end of the recess.

170. During October and early in November the advance detachments suffered much from fever arising from the recent heavy rains. Later and throughout the actual field season the health of the party was good.

171. The Superintendent, Northern Circle, inspected the party in the field in the Dera Ismail Khán district in December and at Miánwáli in February and March and frequently during recess. The Surveyor General inspected the party in the field in March and during recess in July 1909.

172. The programme for next season consists of the 2-inch survey of sheets 38 $\frac{P}{14, 15}$ and 43 $\frac{D}{1, 2, 5, 6}$ and of the northern halves of 43 $\frac{D}{3, 7}$, covering part of the Salt Range and of the 1-inch survey of sheets 38 $\frac{P}{10, 11, 12, 13, 16}$ and 43 $\frac{D}{4, 8}$ and of the southern halves of 43 $\frac{D}{3, 7}$. Triangulation will be carried out in sheets 43 $\frac{D}{9, 10, 13, 14}$.

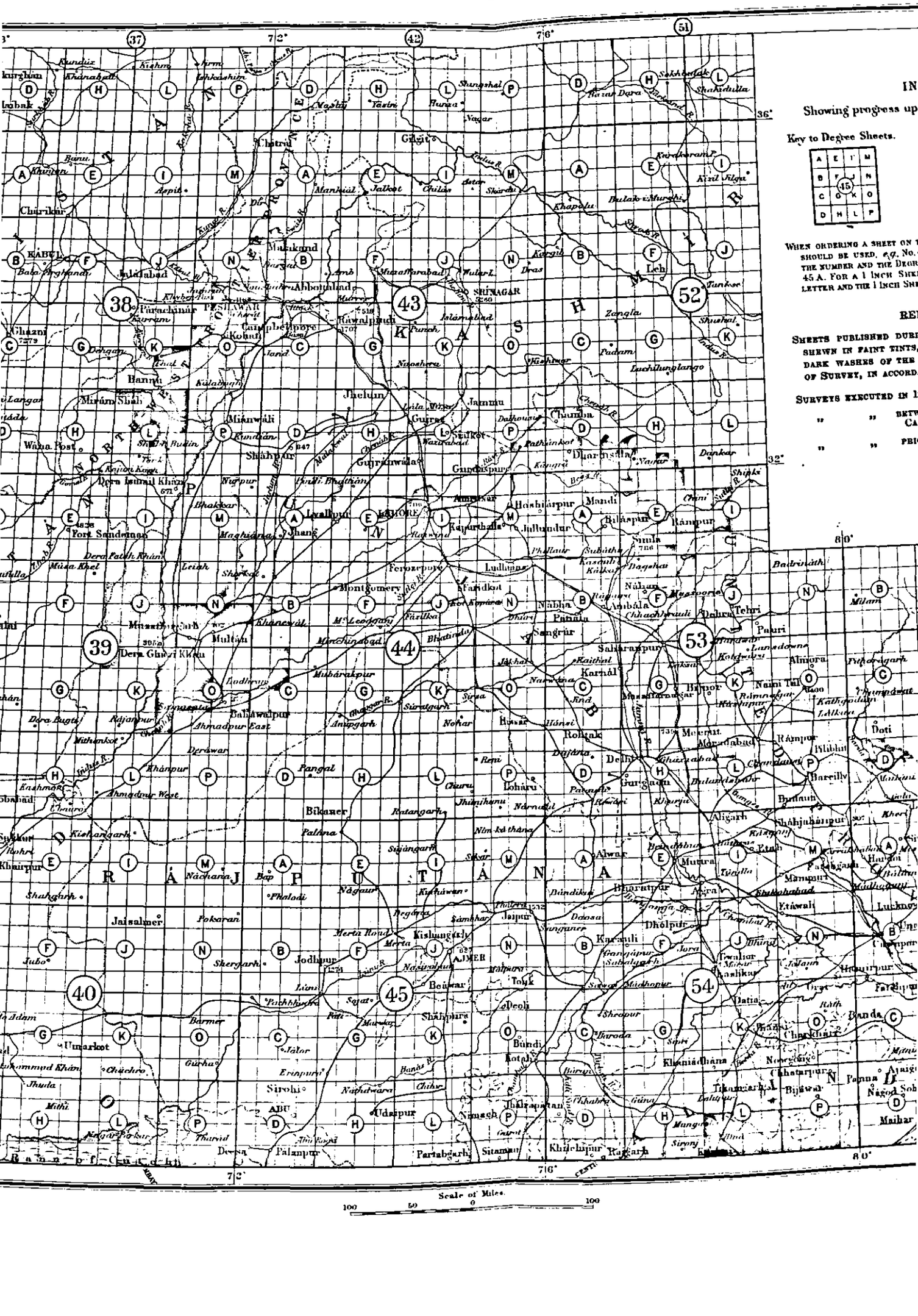
173. *Bári Doáb Traverse.*—The traversing and fixing of base lines over the Bári Doáb desert area was finished during the year. Some of the old traverse framework to which all this new work was attached had been unsatisfactorily closed, and caused a good deal of distortion in parts of the new work, and this became in places so very bad that the officer in charge had during the previous recess reviewed the whole situation with a view to distributing the closing errors more satisfactorily over the whole area. This was done, and it was accordingly decided that base-lines must be slightly shifted over a large part of the area to make them correspond to the newly assigned positions, and this work of "alteration" was additional to that mentioned above. A small extension to the west was effected for the Irrigation Department, which they wished to be pushed through rapidly, but the advance party sent for the purpose early in October suffered badly from fever, and the work was greatly impeded during the early part of the season from this cause. Later in the season it was discovered that the corrections had been wrongly applied in the field, and it became necessary to move all the pillars again. Extra men were employed, but even then the work was not completed till the end of May.

174. *Riverain Section.*—This section continued to have its head-quarters at Lahore under Mr. Maya Das Puri. This was a most important year as regards this work, as during it special arrangements were made for utilising the riverain maps and assisting settlement officers in getting all difficulties cleared up on the ground. This work, which was commenced in Gurdáspur district last year, was this season carried out under improved arrangements; a definite scheme was drawn up and accepted by the Settlement Commissioner for still further expediting and cheapening the work of future settlements, and a small selected settlement staff was given a special training for the purpose. Acknowledgments are due to Mr. F. W. Kennaway, the Settlement Officer of Gurdáspur, for the courtesy and patience with which he assisted this section in getting over the preliminary difficulties connected with the first attempt at this work.

The programme for next season consists of:—(1) Traversing along Sutlej river in Ludhiána district and base-line laying in Jullundur and Hoshiárpur districts. (2) Traversing the Beás river in Amritsar and base-line laying in Kapúrthala State. (3) Traversing the Rávi river in districts Amritsar and Siálkot. (4) Main traverses in the Sutlej, Beás, Rávi, Chenáb and Jhelum rivers.

175. *Punjab Traverse.*—Mr. J. de Graaff Hunter, M.A., was specially attached to the party towards the close of last recess reason to overhaul all the traverse data of the Punjab, to study traverse methods and to advise the riverain and other detachments as to the best way of improving their framework. He was also incidentally looking after a special experimental traverse which No. 24 Party was carrying out with Yáderin wires in the Punjab. For these purposes he established his head-quarters in the office of the riverain section at Lahore and was given a special staff of a few computers.

INDEX TO MAPS OF THE NORTHERN CIRCLE.



He made some very interesting researches into the nature and possibilities of the projection adopted by the department in connection with rectangular co-ordinates, and has devised some labour-saving methods for computations. He further studied the possibilities of traverse work and helped the riverain section to make some most valuable experiments in connection with a system of executing traverse work of a higher degree of accuracy, but involving no prohibitive increase of cost, which we propose to adopt in future for important main traverses. It is hoped that Mr. Hunter may shortly find time to embody the whole of the results of this work in a special paper. He also classified and examined the state of the traverse framework and prepared diagrammatic charts for a large part of the Punjab, but unfortunately his rather sudden transfer to Kashmir at the end of April left this work unfinished. It is hoped that Lieutenant MacLeod may be able to complete it during the coming year.

SOUTHERN CIRCLE.

CENTRAL PROVINCES AND CENTRAL INDIA AGENCY.

No. 1 Party (*vide* Index Map of Southern Circle facing page 54).

176. The sphere of this party's operations lay in the Jubbulpore, Mandla, Saugor, Damoh and Narsinghpur districts of the Central Provinces, and in the Rewah State of the Central India Agency. The work was in continuation of, and of the same nature as, that carried on in the previous year, with the exception that a certain amount of the revision survey was undertaken on the 1-inch scale.

Personnel.

Imperial Officers:

Lieutenant K. W. Pye, R.E., in charge up to 12th June 1909.
Lieutenant M. N. MacLeod, R.E., in charge from 13th June to 27th September 1909.
Major C. L. Robertson, C.M.G., R.E., in charge from 28th September 1909.

Provincial Officers:

Messrs. F. S. Bell, F. P. Walsh, W. Skilling, C. Litchfield, B. M. Berrill, R. E. Saubolle, J. G. D. Vander-Beek and Munshi Lal.

Subordinate Establishment:

38 Surveyors, etc.

177. Field work was commenced on the 1st November 1908, and closed on the 20th April 1909, when the programme was completed, with the exception of a portion of sheet $64\frac{A}{14}$. The recess office opened at Poona on the 25th April 1909.

178. The country surveyed was of a varied nature. In the eastern portion of the work it was undulating and open, while in the south and west, particularly in the Rewah State, hilly country prevailed, much broken up by ravines and covered with jungle. About one-third of the area surveyed was so densely wooded as to preclude survey by plane-table fixings, and much hindered the triangulation.

The area surveyed lay in sheets $55\frac{M}{1, 2, 3, 5, 9 \text{ (part)}}$, $55\frac{N}{5}$, $64\frac{A}{1, 5, 9, 10, 13, 14 \text{ (part)}}$ and also a portion of $55\frac{I}{10}$. Some 240 miles of topographical traversing was done in the jungles where it was found impossible to triangulate.

179. The outturn and cost-rates of the party were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		₹	
Triangulation	3,099	7·7	
Fair mapping . . .	3,272	6·1	
Detail Survey.			
Original survey, 1-inch scale . .	436	26·3	
,, ,, 2-inch ,, . .	41	6·6	
Revision ,, 1-inch ,, . .	951	13·0	
,, ,, 2-inch ,, . .	1,716	12·0	
Total Detail Survey .	3,144		

The average monthly outturn per surveyor for each class of work was as follows:—

Original survey, 1 inch =1 mile —14·4 square miles with 16 fixings and 4 heights per square mile.

Original survey, 2 inches =1 mile —16 square miles with 10 fixings and 5 heights per square mile.

Revision survey, 2 inches =1 mile —18·6 square miles with 10 fixings and 5 heights per square mile.

Revision survey, 1 inch =1 mile —19·9 square miles with 11 fixings and 6 heights per square mile.

Triangulation—150 square miles.

Topographical traversing—31·5 linear miles with 4 stations per mile.

Three officers were employed throughout the year for instructional purposes on the 1-inch original survey work, which partly accounts for the high rate.

180. The total cost of the party for the year under report was ₹91,793.

181. With the exception of slight difficulties entirely due to a misunderstanding experienced at the beginning of the season in the Rewah State, there has been no reason again to complain of the attitude of the local authorities, and everywhere the necessary help and assistance was afforded and relations were friendly.

182. The fair mapping of the following sheets has been undertaken during the recess. On the scale of 2 inches=1 mile—sheets $55\frac{M}{1,5,9}$, and $55\frac{N}{5}$. On the scale of $1\frac{1}{2}$ inches=1 mile—sheets $55\frac{I}{10}$, $55\frac{M}{2,3}$ and $64\frac{A}{1,5,9,10,13}$. It is hoped that all these will be completed and submitted for publication at the end of the recess. In addition, sheets $54\frac{P}{4,7,8,12,16}$, and $55\frac{M}{13}$, mostly mapped in the previous recess, were completed and submitted for publication.

183. The triangulation computations have not been entirely worked out; but more than sufficient points for the plane-tables required at the beginning of the season are available, and the remainder will be computed during the field season. Pending the completion of the triangulation no charts have been undertaken.

184. There was a good deal of sickness at the beginning of the field season, chiefly from malaria.

185. The party was inspected in recess during August 1909 by the Surveyor General, and in the field during January and in recess during August by the Superintendent, Southern Circle.

186. The programme of work for next field season consists of triangulation of sheets $55\frac{I}{2,3,4,7,8}$ and $55\frac{J}{1,2,3,5,6,7,9,10,11,13,14,15}$, about 4,120 square miles in all. The topographical survey will consist of original survey on the 1-inch scale in the Rewah portion, with recontouring of the Jubbulpore portions, falling in sheets $64\frac{A}{4,8,11,12,15,16}$, while $64\frac{A}{14}$ will be completed. Sheets $55\frac{I}{14,15,16}$ and $55\frac{M}{4,6,7,8}$ will be recontoured on the scale of $1\frac{1}{2}$ inches=1 mile. The old work has been found in previous seasons to be so accurate that practically no revision is required, and this work in future will generally be confined to recontouring. In addition to the above, if time permits, supplementary work will be done in sheets $55\frac{I}{9,13}$, $55\frac{M}{10,11,12,14,15,16}$, $55\frac{N}{9,13}$ and $64\frac{A}{2,3,6,7}$, which have been published in the old style and on the old graticule from comparatively recent surveys with a view to their being redrawn and published in the new style as early as possible.

CENTRAL PROVINCES AND BERÁR.

No. 2 Party (*vide* Index Map of Southern Circle facing page 54).

187. The party has been employed, during the year under report, in continuing the survey of Berár on the 1-inch and 2-inch scales as an ordinary topographical party, instead of being a training party as in previous years. Divided into four topographical camps, the party took the field at Badnera on the 26th October, the head-quarters being subsequently moved to Amraoti, when the camps had moved to their respective districts. The native *personnel* was rather a mixed one, being made up of men transferred from other parties, and of new hands. The large majority of the surveyors were practically untrained, more than half of the men being in their first field season. Fortunately, however, the greater part of the area undertaken was easy to survey, and not only was the programme accomplished, but two additional standard sheets had been completed when the party returned to recess quarters, which opened at Poona on the 3rd May. The advance triangulation was however much delayed both by the lack of officers with experience of triangulation, and by accidents or illness which befell those who were successively entrusted with this important work, and it was not until the beginning of June that a sufficient area for a portion of next season's detail work was completed. This will be supplemented by sending an officer to triangulate the remaining area a month before the surveyors take the field. In addition to the ordinary programme, a network of tertiary triangulation was extended from sides of the Great Arc series over the whole of sheet 55 L, as the work of the previous year had disclosed accumulated errors of too great magnitude to allow of extension without careful checking.

Personnel.

Imperial Officers:

Captain H. Wood, R.E., in charge, Lieutenant J. A. Field, R.E.

Provincial Officers:

Messrs. A. Ewing, C. G. Lee, Amar Singh, P. Kennegy, E. A. Meyer, F. C. Saint, R. B. Gildea and C. B. Sexton.

Subordinate Establishment:

27 Surveyors, 3 Pupils and 4 Soldier-Surveyors, 4 Clerks, etc.

188. The country surveyed presented much variety. That lying in sheet 55 H. consisted of the broken ground leading down from the Basim plateau to the low undulating plains through which the Púrna river flows. This country with its black cotton soil is very fertile and highly cultivated, and presented no difficulties for the surveyor other than arose from the height and density of the *jowari* crops which form the staple food supply of the people. The approaches to the plateau, on the other hand, were stony and rocky, intricate to survey, and overrun with a poor forest growth. The ground surveyed in sheet 55 L was the eastern end of the Yeotmál plateau sloping down to the Wardha river plains below, but the slope was more gradual and less cut up than on the other scene of operations. There was, however, much more dense forest on the plateau and slopes which presented difficulties to the surveyors, but the work in the plains was most easy.

189. The area surveyed lay in sheets $55\ \frac{H}{1, 2, 3\ (part), 5, 6}$ and $55\ \frac{L}{2, 3, 4, 6, 7}$.

190. The outturn and cost-rates of the party were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		R	
Triangulation	2,229	11·4	
Skeleton forest boundary survey, 4-inch scale.	461	5·8	
Fair mapping	2,688	8·4	
Detail Survey.			
Original survey, 1-inch scale	2,448	15·2	
„ „ 2-inch „	240	55·0	
Total Detail Survey	2,688		

The average monthly outturn of detail survey per surveyor was as follows:—

Original survey 1 inch =1 mile —20·8 square miles with 16 fixings and 3 heights per square mile.

Original survey 2 inches =1 mile —7 square miles with 49 fixings and 13 heights per square mile.

Triangulation was carried on under such exceptional circumstances that no reliable average outturn can be given.

191. The total cost of the party for the year under report was R1,02,703.

192. With the exception of an unprovoked assault by the people of Kalamb on Mr. Ewing, for which the assailants were tried, convicted and sentenced by the civil authorities, the relations with the villagers were friendly, and the district officials afforded every assistance.

193. The fair mapping of all the sheets surveyed was practically finished during the recess, and sheets 55 $\frac{H}{1, 2, 3, 5, 6}$ and 55 $\frac{L}{2, 3, 4, 6}$ will very shortly be submitted, while 55 $\frac{L}{7}$ will be forwarded later on during the field season. A triangulation chart of sheet 55 H has also been nearly completed, but the insertion of the extra detail on the 2-inch Forest editions of the 1-inch sheets published last year could not be undertaken for lack of competent draftsmen.

194. The health of the party was on the whole good. One *khalási* died of cholera, and one was killed by a bear, while Mr. Saint and a surveyor, both of whom were engaged on triangulation, had to be sent on sick leave during the field season.

195. The Surveyor General inspected the party at Poona during the recess accompanied by the Superintendent, Southern Circle, who also inspected the party during the field season.

196. The programme for next year comprises the detail survey of sheets 55 $\frac{L}{8, 9, 10, 11, 12, 13, 14, 15, 16}$, 55 $\frac{P}{4}$, 56 $\frac{I}{13}$ and 56 $\frac{M}{1}$, while sheets 55 $\frac{P}{4}$, 56 $\frac{E}{1, 2, 5, 6, 9, 10, 11, 13, 14, 15}$, and 56 $\frac{I}{1, 2, 3, 5, 9, 13}$, and 56 $\frac{M}{1}$ are to be triangulated.

BOMBAY PRESIDENCY, CENTRAL INDIA AGENCY, AND HYDERÁBÁD.

NO. 17 PARTY (*vide* INDEX MAP OF SOUTHERN CIRCLE FACING PAGE 54).

Personnel.

Imperial Officers:

Lieutenant S. W. S. Hamilton, R.E., in charge from 26th October 1908 to 30th September 1909.

Lieutenant A. H. Gwyn, I.A., from 10th November 1908.

Provincial Officers:

Mr. S. F. Norman (Senior), in charge, from 1st to 25th October 1908.

Messrs. J. H. S. Wilson, P. R. Anderson, J. R. Newland, A. K. Mitra, F. B. Kitchen, B. F. Cooper, C. O. Picard, P. C. Mitra, E. J. Hanby and A. J. Booth.

Subordinate Establishment:

34 Surveyors, 3 Clerks, etc.

197. The work carried on by this party was of the same nature, and in continuation of that of the previous season. The northern portion of the area surveyed lay in the Indore and Barwáni States of the Central India Agency while in the south, the east and west Khándesh districts of the Bombay Presidency formed the scene of operations. Triangulation was carried on mainly in the Aurangabad district of the Hyderábád State.

198. Mr. S. F. Norman did not take the field, and on the completion of some examination work proceeded on combined leave from 17th December 1908, preparatory to retirement on 8th August 1909, after 35 years' service, the last twenty of which were passed in this party. Mr. Cooper tendered his resignation, which was accepted, from 1st May 1909.

199. The party, divided up into 5 camps, took the field on the 12th November 1908 at Nardhana, whence the head-quarters were on the 21st November moved to Fort Sendhwa, Indore. The field season lasted until the end of April, when the programme was completed, with the exception of sheet 46 $\frac{O}{15}$, which it was found could not be finished in reasonable time. The recess office opened at Poona on 5th May 1909.

200. The season's operations comprised:—

(1) Revision survey on scale 1 inch=1 mile of sheets 46 $\frac{K}{9, 13}$ and 46 $\frac{O}{1, 5, 6, 9, 10, 13, 14}$ and parts of 46 $\frac{O}{2, 7, 11}$, amounting to 2,985 square miles.

(2) Resurvey on scale 2 inches=1 mile of 603 square miles of reserved forest area previously surveyed on the 1-inch scale falling in sheets 43 $\frac{O}{3}$ and sheets 46 $\frac{O}{2, 7, 11}$.

(3) Boundary skeleton surveys on the scale 4 inches=1 mile of all reserved forest areas falling in sheets 46 $\frac{O}{2, 3, 7, 11}$ pertaining to the Shirpur, Chopda and Yával ranges of the Sátpurás, amounting to 205 linear miles.

(4) Triangulation of about 2,100 square miles falling in sheets 46 $\frac{P}{6, 10, 14 \text{ (part)}}$ and 46 $\frac{P}{3, 4, 7, 8, 11, 12, 15, 16}$.

201. The scene of the detail survey operations was situated midway between the Narbada and Tapti rivers. The watershed of these rivers is the Sátpurá range, which rises to an elevation of two and three thousand feet above mean sea-level, and forms the southern boundary of the Indore State.

In the south these Sátpurás break off into high ranges, the one running along the south of Indore State, the other bounding the plains of the Tapti valley. The whole of this portion of the East and West Khándesh districts is mountainous and rugged, and covered with trees and long grass. Villages are few and far between, water is scarce, transport difficult to obtain, and, with the exception of the Bombay-Agra road which passes on the west edge of the work, and of a main road which runs through the centre along the Aner river, communications are extremely bad.

These remarks apply equally to the southern portion of the Indore State, where the Bombay-Agra road, running north and south, is the only efficient means of communication, while the country in the Barwáni State is even more difficult.

In the northern portion of the work in Indore State near the valley of the Narbada river, the country is well populated and fertile, communications are good and water plentiful.

202. Local labour was largely employed both on account of the scarcity of experienced *khalásis* and owing to its inherent advantages. But it is not safe to count on more than one-third of the menial staff being thus obtained. While such men are invaluable as guides and for obtaining supplies, they will not turn out to work early, and will rarely proceed beyond their village limits.

203. The outturn and cost-rates of the party were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
Triangulation . . 1-inch scale	2,100	5·2	
Skeleton boundary survey, 4-inch „	205 (*a*)	5·2	(*a*) Linear miles.
Fair mapping . . 1½-inch „	3,588	5·2	
DETAIL SURVEY.			
Revision survey . . 1-inch scale	2,985	13·9	
Re-survey . . . 2-inch „	603	19·1	
TOTAL DETAIL SURVEY .	3,588		

The detail surveys were tested throughout by *in situ* fixings, as the nature of the country, except in a very few cases, did not admit of chain *partal*. The monthly averages per surveyor for revision and re-survey were as follows:—

Revision on scale of 1-inch=1 mile, 23·5 square miles with 10 fixings and 4 heights per square mile.

Re-survey on scale of 2 inches=1 mile, 11·7 square miles with 27 fixings and 6 heights per square mile.

204. The total cost of the party for the year under report was ₹93,509, which includes an expenditure of ₹10,363 on publication charges and the completion of the 4-inch Forest Maps surveyed in 1905-06.

205. The area under re-survey on scale of 2 inches=1 mile embraced 394 square miles of reserved forest, and was distributed as under:—

Taluka.	District.	Area in square miles.
Shirpur	West Khándesh	133
Chopda	East „	163
Yával	„ „	98
	TOTAL	394

While the skeleton forest boundary survey, amounting to 205 linear miles, was apportioned as below:—

Taluka.	District.	Linear miles.
Shirpur	West Khándesh	96
Chopda	East „	77
Yával	„ „	32
	TOTAL	205

206. The fair mapping made good progress during the year. In October 1908 there were 45 Forest survey sheets in arrears and 5 sheets of current topographical work on a scale of 2 inches=1 mile to be completed and examined. For dealing with these, a small drawing establishment was left in recess when the party took the field. Of the forest sheets, 23 were practically finished, and were examined and despatched for publication early in the year under report. The fair drawing and examination of the five sheets remaining incomplete at the end of last year (sheets 46 $\frac{K}{1, 2, 5, 6, 14}$) were completed by the end of January, when they also were sent in for publication. The remaining 22 sheets of forest survey arrears have now been completed, and will be submitted before the party takes the field. The drawing of the 13 standard sheets of the current season's survey is well in hand, and sheets 46 $\frac{O}{1, 2, 5, 6, 9, 10, 13, 14}$ and 46 $\frac{K}{13}$ should be completed about the end of October 1909, while the remaining 4 sheets 46 $\frac{O}{3, 7, 11}$ and 46 $\frac{K}{9}$ should be ready about a month later.

207. The drawing of additional detail on the 2-inch sheets for the Forest Department has not yet been taken in hand.

208. All computations have been completed up to date. The triangulation charts of sheets 46 K and O are not quite ready for submission.

209. Mr. Sheffield, of the Federated Malay States survey, was attached to the party for training in practical field work at the commencement of the season, and was employed on plane-table surveying for about 2 months, when he was transferred to the Burma Circle to complete his course.

210. On the whole the health of the party was excellent throughout the year. Three *khalásis* died.

211. The party was inspected by the Surveyor General at Poona during July 1909, and by the Superintendent, Southern Circle, during the same month, as well as at the end of January.

212. The programme for next season comprises:—

(*a*) Detail survey on scale 1 inch=1 mile in sheets 46 $\frac{P}{4, 7, 8, 11, 12, 15, 16}$ and parts of sheets 46 $\frac{P}{3, 6, 10, 14}$, amounting to 2,550 square miles.

(*b*) Revision survey on the scale 1 inch=1 mile in sheets 46 $\frac{P}{1, 2, 5, 9, 13}$ and parts of sheets 46 $\frac{P}{3, 6, 10, 14}$ and 46 $\frac{O}{15}$, amounting to 1,750 square miles.

(*c*) Re-survey on the scale 2 inches=1 mile of reserved forest areas in sheets 46 $\frac{O}{15}$ and 46 $\frac{P}{9, 10, 13, 14}$, amounting to about 390 square miles.

(*d*) Boundary traverse of such forests in sheets 46 $\frac{O}{15}$ and 46 $\frac{P}{9, 10, 13, 14}$ as are surveyed under (*c*) above.

(*e*) Triangulation in sheets 55 $\frac{D}{1, 4, 5, 8, 9, 12, 13, 14, 16}$ and 56 $\frac{A}{1, 5, 9, 13}$ and to complete triangulation in sheets 55 $\frac{D}{2, 3, 6, 7, 10, 11, 15}$, amounting in all to about 5,600 square miles.

MADRAS.

NO. 19 PARTY (*vide* INDEX MAP OF SOUTHERN CIRCLE FACING PAGE 54).

213. The party left its recess quarters at Bangalore in November 1908 and returned there in June 1909, giving a full field season of six-and-a-half months.

Personnel.

Imperial Officers:

Major C. W. H. Symonds, I.A., in charge from 16th October 1908 to 27th June 1909.

Lieutenant C. G. Lewis, R.E., in charge from 1st to 16th October 1908 and from 28th June to 30th September 1909.

Provincial Officers:

Messrs. J. Smith, W. F. E. Adams, E. J. Biggie, W. H. Strong, A. J. Fraser, J. St. C. Pollet, Mahadeva Mudaliar, Balaji Dhondiba and M. S. Ganesa Aiyar.

Subordinate Establishment:

26 Surveyors, 3 Traversers, 2 Writers and 1 Hospital Assistant.

214. The outturn and cost-rates of the party are given in the following table:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		℟	
Triangulation	5,850	3·1	
Traversing	30(*a*)	40·3	(*a*) Linear miles.
DETAIL SURVEY.			
Original survey, 1-inch scale	713	25·1	Including mapping.
„ „ 2-inch „	1,065	62·4	
Revision, „ 1-inch „	770	15·0	
TOTAL DETAIL SURVEY	2,548		

Owing to four Sub-Assistant Superintendents on probation having been attached to the party for instruction, and to the heavy cost of transport and labour in the Nílgiris, the cost-rates are high. The average monthly outturn per surveyor on the 1-inch scale was 28·92 square miles, on the 2-inch it was 8·51 square miles, and on the 1-inch revision was 44·60 square miles.

215. The total cost of the party for the year under report was ℟1,16,386.

216. The programme of the party for the year under report consisted of the survey of standard sheets 49 $\frac{N}{13, 14}$, 58 $\frac{A}{8, 9, 10, 11, 12, 13, 14, 15, 16}$, 58 $\frac{B}{9, 13}$ and the completion of sheet 58 $\frac{A}{7}$. It was found early in the season that this programme could not be completed and it was decided to abandon the survey of sheets 58 $\frac{B}{9, 13}$, and, owing to the early break of the monsoon, sheets 58 $\frac{A}{11, 12, 15, 16}$ were unfinished. The thickly populated coastal tract, also the Nílgiris district, more than half the area of which consists of forest reserves, and the forests of the Malabar district were surveyed on the 2-inch scale, while the remaining area was surveyed on the 1-inch scale.

217. As was anticipated, the old Mysore maps proved extremely accurate, and, generally speaking, the only corrections required were the actual changes in village sites, limits of cultivation, etc. In Coimbatore district the 4-inch forest survey was utilized for supplementary survey on the 1-inch scale.

218. Of the country topographically surveyed, the coastal tract comprised in sheets 49 $\frac{N}{13, 14}$ presents the same features as were encountered in previous seasons, *i.e.*, a densely populated area extending up to the foot of the *ghats*, in

which each habitation was separately surveyed and mapped. The average number of huts over the whole of this area is 150 to the square mile, while along a narrow belt parallel to the coast there are as many as 400 to the square mile. The Nílgiri plateau, consisting mainly of open downs, is an ideal country for the plane-tabler, though the work was rendered tedious by the large number of forest reserves (some 450) and by the extraordinary intricacy of their boundaries; but it was on the *ghat* slopes that the surveyors met with the greatest difficulty; here, except in the vicinity of coffee estates, there were no roads, the jungle was extremely dense, and the climate trying, especially at the foot of the hills. In April, the early rains commenced, and the greater part of May was lost owing to the unusual amount of rain and to mists which, rising daily from the plains, by 10 A.M. completely enveloped the upper hills. It is due mainly to these causes and to sickness among the surveyors that 5 sheets remained incompletely surveyed.

219. The following maps will be submitted for publication before the end of the year:—

Sheets 49 $\frac{M}{14}$, 49 $\frac{N}{13, 14}$, drawn on the 2-inch scale, and sheets 58 $\frac{A}{8, 9, 10, 13}$, drawn on the 1½-inch scale.

220. The triangulation of sheets 58 B and 58 C was completed, and that of 58 D and 58 H in Cochin and Travancore States was commenced; the computations have been completed during recess. Triangulation charts 49 M, 49 N and 58 A will be submitted for publication.

221. The boundaries of forest reserves in South Malabar were traversed by theodolite, but in The Nílgiris this was not deemed necessary.

222. In the plains the health of the party was good, but in the Wynaad and in the malarious Attapádi and Silent valleys the surveyors suffered from very severe attacks of fever, and even those who worked in The Nílgiris did not escape. One surveyor and three *khalásis* died during the year.

223. The party was inspected during recess by the Surveyor General and by the Superintendent in charge, Burma Surveys.

224. The programme for next season consists of the survey of sheets 58 $\frac{B}{1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 14, 15}$, and the completion of sheets 58 $\frac{A}{11, 12, 15, 16}$, mostly on the 1-inch scale, in the Malabar and Coimbatore districts and in the Cochin and Travancore States. The densely populated areas on the coast and a few forest reserves in South Malabar will be surveyed on the 2-inch scale. The triangulation of the south of the peninsula, west of latitude 77° 30′, will be completed.

MADRAS.

COORG DETACHMENT (*vide* INDEX MAP OF SOUTHERN CIRCLE FACING PAGE 54).

225. The detachment was formed at Bangalore on the 1st November 1908 for the purpose of commencing survey operations in Coorg. It proceeded to the field on the 8th November 1908 and returned to Bangalore in the end of June 1909.

Personnel.

Provincial Officers:

Mr. R. Waller-Senior, in charge and Mr. E. Claudius.

Subordinate Establishment:

11 Surveyors and 1 Writer.

226. The outturn and cost-rates were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		₹	
Triangulation	2,565	6·9	
DETAIL SURVEY.			
Original survey, 2-inch scale . .	558	36·9	

The average monthly outturn per surveyor was 7·6 square miles.

227. The total cost of the detachment for the year under report was ₹36,681.

228. The programme of the detachment consisted of advance triangulation for No. 3 Party in the Malabar and South Canara districts and in Coorg and of the detail survey of sheets $48\frac{P}{11, 15}$. In spite of the triangulators remaining out in the field until well on in the rains, the triangulation could not be completed. The detail survey was completed, with the exception of 22 square miles, which will be surveyed by No. 3 Party early next season.

229. The area topographically surveyed lay chiefly in Coorg but also comprised small portions of Mysore State and of the South Canara district. The country is thickly wooded and consequently the progress of the work was slow; the early break of the monsoon was another adverse feature of this field season.

230. Sheet $48\frac{P}{15}$ was drawn on the $1\frac{1}{2}$-inch scale for reduction to the 1-inch scale; it will be completed in the Circle drawing office and will be submitted for publication before the end of the year. The triangulation was connected with the Madras Longitudinal and the Mangalore Meridional series.

231. Mr. Sheffield, an officer of the Survey Department of the Federated Malay States, was attached to the department for a few weeks in April 1909 for instruction.

232. The health of the party throughout the year was good.

233. The detachment was inspected in the field by the Deputy Surveyor General and in recess by the Surveyor General and by the Superintendent in charge, Burma Surveys.

234. The detachment will be disbanded on the 31st October 1909, and will be absorbed in No. 3 Party, which will continue work in the Madras Presidency to the north of latitude 12°.

EASTERN CIRCLE (BURMA).

BURMA.

NO. 3 PARTY (*vide* INDEX MAP OF EASTERN CIRCLE FACING PAGE 62).

235. The recess office closed in Bangalore on the 2nd November 1908 and re-opened there again on the 1st June 1909, giving an average of six months' actual work in the field for the whole party.

Personnel.

Imperial Officer:

Captain C. P. Gunter, R.E., in charge.

Provincial Officers:

Messrs. W. M. Gorman, J. O'B. Donaghey, W. E. S. Swiney and H. D. W. Stotesbury.

Subordinate Establishment:

23 Surveyors, 1 Draftsman, 2 Writers and 1 Hospital Assistant.

236. The outturn and cost-rates of the party for the year under report were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
DETAIL SURVEY.		₹	
Original survey, 1-inch scale . .	1,095	39·5 (*a*)	(*a*) Including mapping.
„ „ 2-inch „ . .	39 (*b*)	96·2 (*a*)	(*b*) Forest reserves.
Supplementary survey, 1-inch scale .	1,486	27·0 (*a*)	
Revision survey (Forests), 1-inch scale .	411	20·0 (*a*)	
TOTAL DETAIL SURVEY .	3,031		

The average monthly outturn per surveyor for supplementary survey on the 1-inch scale was 28 square miles, on the 1-inch survey it was 20 square miles, on the 2-inch survey 8 square miles, and on the 1-inch revision survey 41 square miles.

237. The total cost of the party for the year under report was R96,892.

238. The country proved very difficult to survey. Almost the whole area had to be rigidly traversed, and this accounts for the poor outturn. As there was no triangulation done by the party this season, the whole of the charges for supervision have been debited to survey: this accounts for the unusually high cost-rates. If the share of supervision, which is usually borne by the triangulation, be deducted from the cost of survey, the cost-rates work out to much the same as those of last year.

239. The programme, which was completed, consisted of the survey of sheets 84 $\frac{J}{9, 10, 11, 12, 13, 14, 15, 16}$ and 84 $\frac{K}{9, 13, 14}$ comprising parts of the Upper and Lower Chindwin, the Pakôkku and the Shwebo districts.

240. The area under survey was again of a very varied character. In the north, the Chindwin river forces its way in a very tortuous manner through rugged forest-clad country, much cut up by streams and very difficult to survey. The country rises gradually in the west to the hills of the Mahudaung range, about 2,000 feet above sea-level. In the south is a highly cultivated plain, interspersed with small scattered areas of undulating hills covered with open jungle; the cultivation consists mostly of "*Juar*," which grew very high this year, and for two months greatly impeded the progress of the work. Three of the interesting extinct volcanoes known locally as "*Twins*" on the west of the Chindwin river in the Lower Chindwin districts occur in this area. There is a lake of sulphurous water in each crater, and the water level, when measured in April, was found to be some 170 feet below the height of the surrounding country and about 30 feet above the level of the nearest water in the Chindwin river.

241. The whole area surveyed was mapped on the 1½-inch scale for photographic reduction to the 1-inch scale and will be shortly submitted for publication. The mapping of the party again shows an improvement both in quantity and quality.

242. Surveyor Pertab Singh was deputed to accompany Colonel Lumsden, C.B., on an expedition into the Mishmi country, north of Assam; he completed the survey of 250 square miles of hitherto unmapped country on the ¼-inch scale.

243. The health of the party was very good throughout the field season and recess.

244. The party was inspected in the field by the Deputy Surveyor General and in recess by the Surveyor General and on several occasions by the Superintendent in charge Burma Surveys.

245. The work of the party will in future lie in Southern India. Its programme for 1909-10 consists of 3,950 square miles of triangulation for 1-inch survey in the South Canara, Salem and Coimbatore districts of Madras and of 2,550 square miles of 1-inch survey and 390 square miles of 2-inch forest survey in sheets 48 $\frac{P}{3, 4, 7, 8, 10, 11, 12, 13, 14, 15, 16}$ and 57 $\frac{D}{3, 4}$, including portions of the Mysore State, Coorg Province and of the South Canara and Malabar districts of Madras.

UPPER BURMA.

No. 10 Party (*vide* Index Map of Eastern Circle facing page 62).

246. The party left its recess quarters at Bangalore on the 18th November 1908, and commenced field work early in December; field work was closed in the end of May 1909, and the party proceeded for recess duties to Maymyo, where, along with No. 11 Party, it occupied an office which has been placed at the disposal of the department by the Government of Burma.

Personnel.

Imperial Officers:

Captain A. A. McHarg, R.E., in charge from 1st October to 25th October 1908.

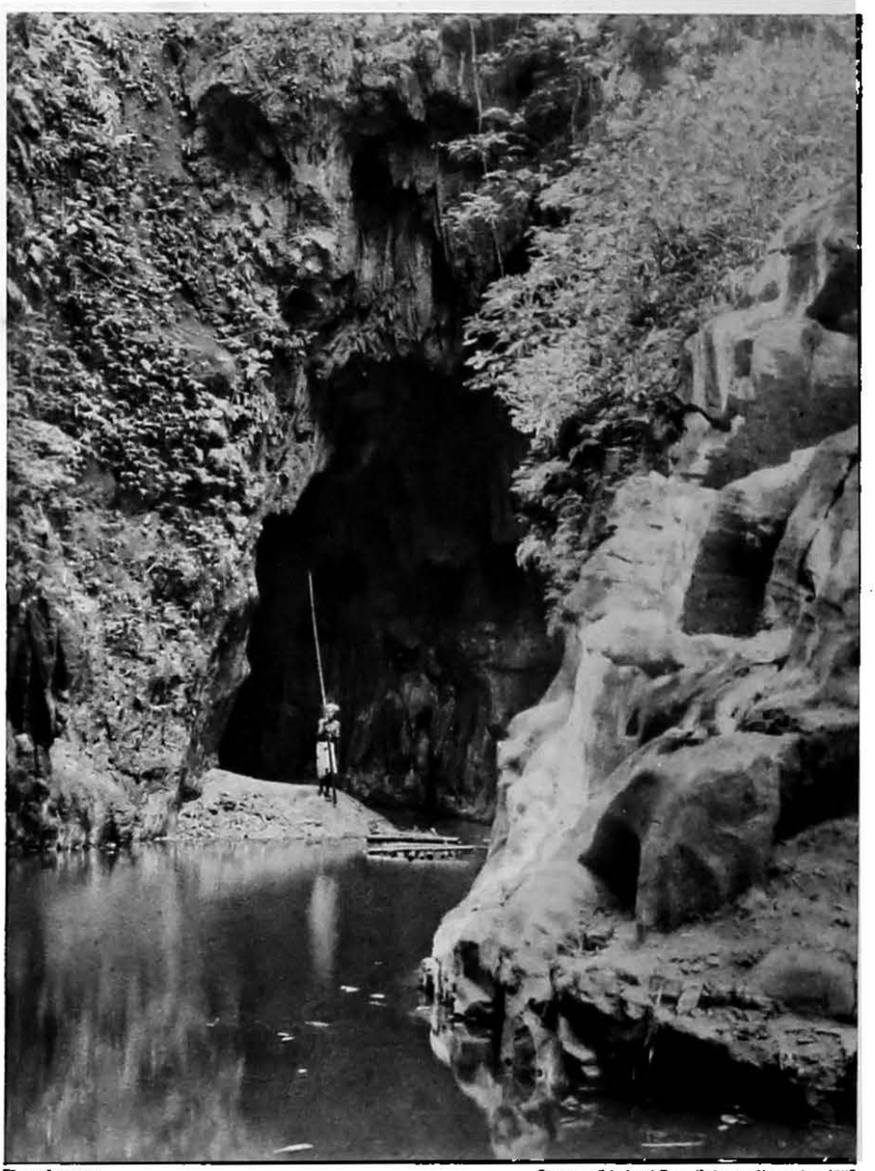
Captain L. G. Crosthwait, I.A., in charge from 26th October 1908 to 30th September 1909.

Provincial Officers:

Messrs. W. G. Jarbo, E. M. Kenny, Asmat-Ullah Khan and Abdul Rahim, K. S.

Subordinate Establishment:

25 Surveyors, 2 Soldier-Surveyors, 3 Traversers, 1 Draftsman, 1 Computer, 2 Writers and 1 Hospital Assistant.



Photogravure. Survey of India Offices, Calcutta, November 1909.

THE SACRED CAVE AT ALAUNGDAW

LOWER CHINDWIN DISTRICT (BURMA)

Enlarged from a photograph by Captain C. P. Gunter R.E.

247. The outturn and cost-rates of the party were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		℟	
Triangulation	1,686	7·8	
Traversing	226(*a*)	28·8 (*a*)	(*a*) Linear miles.
Detail Survey.			
Original survey, 1-inch scale . .	1,684	31·6	Including fair mapping.
Original survey, 2-inch „ . .	291	54·1	
Revision survey, 1-inch „ . .	829	29·4	
Total Detail Survey .	2,804		

The average monthly outturn per surveyor was 30·9 square miles for 1-inch original survey, 45·9 for 1-inch revision survey, and 10·6 for 2-inch original survey.

The revision survey consisted of the revision of forest areas which had been previously surveyed on the 4-inch scale; it was carried out on blue print reductions of the original maps; the detail was found good, but the contouring had to be done afresh.

The cost-rates of the revision survey were rather high owing to the necessity for heavy jungle clearing.

248. The total cost of the party for the year under report was R1,13,577.

249. The programme of the party consisted of the completion of sheets $84\frac{M}{1,5,9}$ which had been left unfinished the previous season, and the survey of sheets $93\frac{A}{9,10,11,12,13,14,15,16}$ on the 1-inch scale, and the 2-inch survey of all forest reserves not previously surveyed occurring in the programme, as well as the special survey of the Mosit reserve situated in sheets 92 D and 92 H; also advance triangulation and traversing in sheet 92 H. The programme was completed.

250. The area under survey lay chiefly in the Möngmit State and the height above sea-level ranged from 330 feet in the Shweli valley to over 6,000 feet in the south near the Ruby Mines. Except in the Shweli, the country is sparsely inhabited.

251. Mr. E. W. Hedgeland, of the Federated Malay States survey, was attached to the party for the field season for the purpose of studying the methods of work of the Survey of India.

252. Sheets $93\frac{A}{9,10,11,12,13,14,15,16}$ were drawn in the party on the 1½-inch scale and will be submitted shortly for publication. Sheets $84\frac{M}{1,5,9}$ are being drawn in the Burma drawing office. All computations have been completed.

253. No rain fell from November till April, and during this period the health of the party, in spite of the bad reputation of the Shweli valley, was good. After the rains commenced and well on into the recess the party suffered a good deal from fever. Three *khálasis* died during the year.

254. The party was inspected in the field by the Deputy Surveyor General and in recess by the Superintendent in charge Burma Surveys.

255. The programme for next season consists of the triangulation of sheet 92 D and the completion of 92 H, up to the Chinese frontier, and the 1-inch original survey of sheets $92\frac{L}{4,8,12,16}$, $93\frac{E}{3,6,7,9,10,11,13,14,15}$ and $93\frac{I}{1,5,9}$.

SHAN STATES, BURMA.

NO. 11 PARTY (*vide* INDEX MAP OF EASTERN CIRCLE FACING PAGE 62).

256. The party left its recess quarters at Maymyo early in November 1908 and re-assembled there in the middle of June 1909. Much time was occupied in the long journey to and from the frontier and the actual time spent on survey work in the field did not amount to much more than four-and-a-half months.

Personnel.

Imperial Officer:

Captain R. H. Phillimore, R.E., in charge.

Provincial Officers:

Messrs. O. D. Smart, Jagdamba Prasad, S. S. M. Fielding, V. W. Morton, T. P. Dewar and A. A. Graham.

Subordinate Establishment:

33 Surveyors, etc.

257. The outturn and cost-rates were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		₹	
Triangulation	1,220	6·3	
DETAIL SURVEY.			
Original survey, 1-inch scale . .	3,674	36·3	Including mapping.

The average daily outturn per surveyor was 1·54 square miles. The original detail survey was on the 1-inch scale with contours at 100 feet vertical intervals.

258. The total cost of the party for the year under report was ₹1,40,506.

259. The programme consisted of the completion of the detail survey of the Southern Shan States included in sheets $93\frac{N}{4, 8, 12, 16}$, $93\frac{O}{1, 2, 5, 6, 9, 10, 13, 14}$, $102\frac{C}{1, 2, 3, 6, 7, 11, 14, 15}$ and $102\frac{G}{2, 3}$, up to the frontiers of China and French Indo-China, and triangulation in the Salween valley for next year's detail survey. With the exception of sheets $93\frac{N}{4}$, $93\frac{O}{1, 2}$, the programme was completed.

260. The area surveyed was situated in the north of the Kengtung State and lay for nearly 200 miles along the Chinese frontier; it included the most easterly corner of the Indian Empire well, to the east of longitude 101° East. The country was well populated by Shans and other hill tribes, and footpaths and mule tracks were frequent. The hills were steep, and though many of the ranges rose to over 8,000 feet, some of the valleys were less than 2,000 feet above sea-level. Though rough and mountainous, the country was comparatively easy to survey, the hill features being bold and not heavily wooded.

261. Escorts were provided for all members of the party, as the country surveyed is seldom visited by travellers other than Shan and Chinese traders, who sell salt to the inhabitants, buying cotton and opium from them in return. The villagers were found most friendly and hospitable, and no difficulty was experienced in obtaining supplies and labour.

262. The area surveyed was mapped on the 1½-inch scale in 19 sheets, *viz.*, $93\frac{N}{8, 12, 16}$, $93\frac{O}{5, 6, 9, 10, 13, 14}$, $102\frac{C}{1, 2, 3, 6, 7, 11, 14, 15}$, and $102\frac{G}{2, 3}$. Seven of these sheets, *viz.*, $93\frac{N}{16}$, $102\frac{C}{1, 6, 7, 14, 15}$ and $102\frac{G}{3}$, will be submitted before the party leaves recess quarters, and the remainder will be completed by April 1910 by a small drawing section, which will be attached to the Burma drawing office for the purpose. The triangulation done in the field was computed in recess and the results were satisfactory.

263. The health of the party was fairly good; the work lay in the most mountainous parts of the Shan States, and in the dry season the climate was perfect. The return journey, however, owing to early rains in May and June, proved most trying.

264. The party was inspected in recess by the Superintendent in charge, Burma surveys.

265. The programme for the next season consists of the completion of the survey on the 1-inch scale of Kengtung and part of the Northern Shan States lying to the south of latitude 23°15′ and east of longitude 98°, excluding the Wa States, which it is not considered advisable to enter at present for survey purposes. Triangulation will be carried out in sheets 93 I, 93 J and 93 N.

EASTERN BENGAL AND ASSAM.

NO. 20 PARTY (*vide* INDEX MAP OF EASTERN CIRCLE FACING PAGE 62).

266. Field work was commenced in the middle of November 1908, and closed early in May 1909 giving a field season of rather less than six months. The recess quarters of the party were at Bangalore, but arrangements have been made to move them to Shillong in 1910.

Personnel.

Imperial Officer:

Major A. Mears, I.A., in charge.

Provincial Officers:

Messrs. P. F. Prunty, C. C. Byrne, Pramadaranjan Ray, J. H. Williams, Amjad Ali and L. Williams.

Subordinate Establishment:

32 Surveyors, 3 Traversers, 2 Draftsmen, 2 Computers, 2 Writers and 1 Hospital Assistant.

267. The outturn and cost-rates were as follows:—

Description of Survey.	Outturn, sq. miles.	Cost-rate per sq. mile.	Remarks.
		₹	
Triangulation	680	37·6	Cost-rates include fair mapping.
Traversing	119 (*a*)	40·8	(*a*) Linear miles.
DETAIL SURVEY.			
Original survey, 1-inch scale	398 (*b*)	26·4	(*b*) Mainly forest clad hills.
„ „ 2-inch „	660 (*c*)	27·9	(*c*) Flat open country.
„ „ 2-inch „	400 (*d*)	99·6	(*d*) Forest clad hills.
Revision survey, 1-inch „	123 (*b*)	28·4	
Supplementary survey, 2-inch scale.	452 (*e*)	43·1	(*e*) Open country and low bamboo clad hills.
TOTAL DETAIL SURVEY	2,033		

The average monthly outturn per surveyor on the 1-inch scale was 21·6 square miles; on the 2-inch scale for original survey in open plains it was 24·5 square miles, for forest covered hills 7·0 square miles, and for supplementary survey 12·6 square miles.

The principal reason for the very slow progress of the work in the forest areas of Cáchár and the Lushai Hills was the extraordinarily dense nature of the jungle growth, quite the worst so far experienced by the party. Large blocks of bamboo forest in the supplementary area account for the small outturn in this class of survey.

268. The total expenditure of the party for the year under report amounted to ₹1,22,215.

269. The programme of the party consisted of the survey of sheets 78 $\frac{P}{9, 10}$ and the completion of 78 $\frac{P}{13, 15}$ on the 2-inch scale and of 78 $\frac{P}{12, 16}$ on the 1-inch scale, also the survey of 83 $\frac{D}{10, 11, 14, 15}$, which consisted to a great extent of forest re-survey on the 2-inch scale. The survey of sheet 78 P was completed, but it was found impossible owing to early rains and to the difficult nature of the country to finish any of the four sheets allotted to the party in sheet 83 D.

270. The supplementary survey was carried out on blue print reductions on the 16-inch cadastral maps of seasons 1894 to 1896. The detail in the cultivated areas was found to be accurate, but the village sites require re-survey. In the large blocks of low bamboo clad "*tilas*" the survey might be classed as original work, the cadastral sheets showing practically no details in these areas. The revision survey was done on blue print reductions of the 2-inch survey executed by Colonel Woodthorpe and Major Badgley in 1881-83. The quality of the old survey was found to be excellent, except as regards the contouring, which had to be re-done.

271. The area under topographical survey embraced portions of districts Sylhet and Cáchár, of the Lushai Hills and of the Hill Tippera State. The greater portion of the country in districts Sylhet and Cáchár was flat, open, thickly populated and closely cultivated. The general level of this country only averages 50 to 60 feet above mean sea-level, and the whole area is covered with a network of streams, *bils* and swamps; and the villages are almost invariably situated along the rivers and streams, the banks of which are, as a rule, slightly above the general level of the country. The country surveyed in the Lushai Hills and in Hill Tippera was hilly and nearly entirely covered with almost impenetrable bamboo, cane and tree forest. Supplies were plentiful in Sylhet and Cáchár, but labour was difficult to obtain, while in the Lushai Hills and the Hill Tippera State these conditions were reversed.

272. The following six sheets will be submitted very shortly for publication:—78 $\frac{P}{9, 10, 12, 13, 15, 16}$, while sheets 83 $\frac{D}{10, 14, 15}$ have been partly drawn, and it is hoped that they will be completed before next recess.

273. The triangulation was based on the Eastern Frontier G. T. series. All computations have been completed, and the results are good. The small amount of traversing done was only carried out with the view of supplying additional points for the detail survey in the low densely wooded valleys, where it was impossible to employ triangulation.

274. The health of the party was fair in the open country until the month of April, when heavy rain caused a good deal of sickness. One surveyor was invalided at the commencement of the season. Six *khalásis* died in the field, one of whom succumbed to injuries received from a tiger. The beast made repeated and determined attacks on the combined camp of two surveyors, three men being mauled before it was finally driven off. The work, in consequence of this animal's presence, had to be stopped in its immediate neighbourhood for the remainder of the season.

275. The party was inspected by the Surveyor General and the Superintendent in charge, Burma Surveys, during the recess months.

276. The programme for 1909-10 comprises the completion of standard sheets 83 $\frac{D}{1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 14, 15}$ on the 1-inch and 2-inch scales, the latter scale being only employed for the survey of forest reserves, and also the triangulation and traversing of degree sheet 78 O.

CANTONMENT SURVEYS.

No. 1 Section.

277. During the season under report this section was employed on the survey of the cantonments in portions of the Ráwalpindi, Lahore, Meerut and Lucknow divisions. Mr. E. G. Little, a retired officer of the Provincial service, continued in charge throughout the season, while Mr. F. C. Saint was attached for duty from the 17th October to the 31st December 1908.

278. The survey of the following cantonments was completed on the scale of 16 inches = one mile, while the bazaars of four were surveyed on a scale of 64 inches = one mile:—Landour, the seven gallies (namely:—Baragali, Kálábágh, Ghora Dhaka and Khanaspur, Changlagali, Khayragali and Barian), Barrackpore, Dum-Dum, Jalápáhár, Ichhápur, Fort William, Shillong, Alipore, Attock and the newly added portions of Jhelum. The triangulation of Dharamsála and traversing of Lucknow were nearly completed, and portions added since last survey to the Nowshera and Meerut cantonments are in hand.

279. The maps of the following cantonments only were submitted for publication:—Landour, Ránikhet, Naini Tál and Alipore. Those of the following cantonments with their bazaars were also sent in:—Sitápur, Delhi, Benares, Mardán, Abbottábád, Dinapore, Bannu, Nowshera and of the Nowshera Cavalry Cantonment surveyed by this section. The following arrears of the late No. 3 section were also drawn and submitted, namely, the cantonments with bazaars of Belgaum, Saint Thomas Mount, Wellington and Bangalore. Altogether 106 sheets in all have been sent in by this section, an outturn considerably in excess of that of the three previous years, and the work of the section is now more or less up to date. The sheets of Nowshera and Nowshera new cavalry cantonments have, however, been returned to be kept in abeyance till certain additions and alterations intended in these cantonments have been made, and can be mapped, and the maps of Barrackpore and Dum-Dum, though ready, are detained owing to some changes contemplated in the bazaar boundaries.

280. The areas surveyed during the season and the cost-rates were:—

	Acres.	Rupees per acre.
Triangulation	1,369	0·91
Traversing	12,594	0·65
Original survey on 16-inch scale	7,556	1·51
„ „ on 64-inch „	136	2·60
Mapping on 16-inch scale	37,118	0·13
„ on 64-inch „	757	2·44

The average outturn per working day was—

Traversing 7 angles and 48 chains—

Detail survey on 16-inch scale	8·6 acres.
„ „ on 64-inch „	1 acre.

281. The total cost for this section for the year under report was ₹27,901.

282. The head-quarters of the section was moved to Dum-Dum from Ráwalpindi at the end of November 1908, where it remained until September 1909, when it again moved to Lucknow. These expensive moves have enhanced the cost of the section.

283. The section was inspected frequently during the season by the Superintendent, Southern Circle.

284. The programme proposed for the next field season is the survey of the Lucknow and Dharamsála cantonments as well as of the added portions of Meerut and Nowshera cantonments. On completion of this, the section will be disbanded and arrears of drawing will be transferred for completion to the office of the Superintendent, Northern Circle.

No. 2 Section.

285. This section remained in charge of Mr. L. Pocock, a retired officer of the Provincial service, throughout the year under report, and was engaged on the completion on the contouring in Jubbulpore and Pachmarhi, and on the detail survey of the 49 bazaars of the Secunderábád-Bolárum cantonment, on the large scale of 1 inch=50 feet, which has also been finished. No contouring has been done in these bazaars, but numerous heights have been marked on the maps. The theodolite traversing for work on the 16-inch and 64-inch scales was started in the cantonments and bazaars of Mandalay and of Maymyo in Burma, and the Secunderábád cantonment boundary (about 32 miles in length, with about 150 pillars) was also traversed to determine the distance between the pillars and the bearing from pillar to pillar. The traverse work at Maymyo was much retarded by wet weather.

286. The maps of four cantonments, *viz.*, of Mhow, Sehore, Jubbulpore and Pachmarhi, in all 99 sheets, have been drawn, completed and forwarded to the Trigonometrical office for publication. Eleven sheets of the bazaars of Secunderábád have also been sent for publication.

287. The areas surveyed during the season and the cost-rates were :—

	Acres.	Rupees per acre.
Traversing	2,949	1·75
Original survey on 16-inch scale	157	1·4
„ „ on 50-feet = 1-inch	1,818	7·9
Contouring on 16-inch scale	2,352	0·3
Mapping on 16-inch scale	13,218	0·5

The average outturn per working day was :—

Detail survey on 50 feet = 1 inch . . . . . 0·83 acres.

288. The total cost for this section for the year under report was R23,970.

289. The Superintendent, Southern Circle, inspected the section at Secunderábád in August 1909.

290. During next season the survey of the cantonments of Mandalay and Maymyo, on the scale of 16 inches = 1 mile, and of the three bazaars of the Mandalay cantonment, on the scale of 64-inches = 1 mile, will be undertaken, and it is hoped to complete this work by the 31st March 1910, when the section will be disbanded and arrears of mapping transferred to the Burma Circle. A large amount of the necessary preliminary traverse has been completed, and the detail work will be started in both cantonments early in October 1909, when the head-quarters of the section will move to Maymyo. The area of the two cantonments is about 11 square miles, and that of the bazaars of Mandalay about 304 acres. A great deal of the Maymyo cantonment is covered with forest.

Summary of the Outturn of work of the Field Parties during the year 1908-09.

TOPOGRAPHICAL SURVEYS.

Scale of Survey, Inches = 1 mile.	Number of Party.	*Locale* of Operations.	Triangulation.											Traverse.					Detail Survey.				
							Minor.			Tertiary.			Intersected Points.										
			Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Stations fixed.	Triangular error in seconds.	Error *per* mile in feet.	Stations fixed.	Triangular error in seconds.	Error *per* mile in feet.	Number of points fixed.	Error *per* mile in feet.	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error *per* station in seconds.	Linear error *per* mile.	Area in square miles.	Plane-table fixings *per* square mile.	Linear miles of test lines.	Number of "*in situ*" test fixings.	Linear miles of Forest boundary traverse.
1	1	Central Provinces and Central India Agency.	6	3,099	6·0	6·0	56	8·0	0·2	12	8·0	(*d*)	(*d*)	(*d*)	...	240	999	8·3	...	951(*b*) 436(*c*)	16 11	150	714	...
	2	Central Provinces and Berár	6	2,229	6·0	6·0	32	7·8	0·2	49	10·9	0·2	300	0·5	...	...	...	...	...	2,448(*c*)	16	468	915	461
	3	Upper Burma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,095(*c*) 1,480(*a*) 411(*b*)	18	498	669	...
	9	Northern Circle	6	309	4·3	5·5	...	...	...	5	5·2	2·7	55	7·2	...	52	150	...	...	4,313(*c*) 285(*b*)	11	514	302	...
	10	Upper Burma	6	1,686	6·9	6·9	5	4·0	0·1	35	6·0	0·2	200	0·3	...	226	4,062	0·1	1·7	1,684(*c*) 829(*b*)	12	260	530	...
	11	Shan States	...	1,220	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3,671(*c*)	...	...	537	...
	12	Northern Circle	6	1,200	1·9	1·9	11	7·3	0·1	18	6·8	0·2	599	0·4	...	...	...	...	...	953(*c*)	17	...	...	...
	14	,, ,,	6	3,760	7·0	7·0	...	...	...	29	10·7	0·2	292	0·7	...	...	...	...	...	...	...	...	...	...
	17	Bombay Presidency, Central India Agency and Hyderábád.	6	2,100	3·0	3·0	77	10·0	0·7	...	...	...	675	0·9	...	...	...	...	...	2,985(*b*)	10	...	860	...
	18	Northern Circle	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,500(*g*)	13	...	210	...
	19	Madras Presidency	6	5,850	6·2	6·2	22	5·5	0·1	78	6·0	0·1	858	0·4	...	30	833	1·5	1·0	713(*c*) 770(*b*)	22	2	238	...
	20	Eastern Bengal and Assam	6	680	4·8	4·8	...	...	...	37	14·2	0·4	111	0·7	...	119	804	4·8	2·1	399(*c*) 173(*b*)	23	124	128	...
		Special Surveys	...	8,302	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3,478	...	...	...	...
																		Total		28,531				
2	1	Central Provinces and Central India Agency.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,716(*b*) 41(*c*)	10 10	60	91	...
	2	Central Provinces and Berár	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	219(*c*)	49	63	283	...
	3	Upper Burma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	39(*c*)	145	6	9	...
	10	,, ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	291(*c*)	75	42	73	...
	12	Northern Circle	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,359(*c*)	19	...	...	...
	14	,, ,,	6	750	6·7	6·7	...	...	...	11	7·6	0·1	260	0·4	...	...	...	...	...	2,830(*c*)	26	806	...	...
	17	Bombay Presidency, Central India Agency and Hyderábád.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	603(*c*)	27	134	556	...
	18	Northern Circle	6	1,800	3·3	3·3	...	...	...	40	7·4	2·0	506	0·6	...	2,642	...	...	...	945(*g*)	25	...	223	...
	19	Madras Presidency	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,065(*c*)	43	1	329	...
	20	Eastern Bengal and Assam	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,060(*c*) 452(*a*)	40	362	441	...
		Coorg	6	2,565	4·7	4·7	35	22·8	0·1	56	14·2	0·2	483	0·8	...	...	...	...	...	558(*c*)	5	45	130	...
		Special Surveys	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,800	...	...	...	...
																		Total		12,999				
4	2	Central Provinces and Berár	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	461(*f*)	...	25	70	...
	12	Northern Circle	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	70	...	...	...	...
	17	Bombay Presidency, Central India Agency and Hyderábád.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	205(*f*)	...	22	...	205
																		Total		70				
		Grand Total		35,550														Grand Total		42,600				

(*a*) Supplementary survey.
(*b*) Revision survey.
(*c*) Resurvey.
(*d*) Computations incomplete.
(*e*) Original survey.
(*f*) Linear miles.
(*g*) New survey.

SPECIAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Spirit Levelling Operations.		Traversing.			Detail Survey.	
			Miles levelled over.	Trigonometrical stations connected with.	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Area in square miles.	Linear miles of test lines.
...	25	Tidal and levelling	1,085	3	...	...	...	...	...
16	Detachment	Cantonment Section No. I. . .	...	...	20·0	250	2,597	11·8	51·9
64		Punjab, United Provinces, Bengal and Assam.	...	...				0·2	
16	"	Cantonment Section No. II . .	...	...	4·6	87	1,714	0·3	0·9
105·6		Central Provinces, Hyderábád and Burma.						2·8	67·6
4	3	Mishmi Country	...	...	...	...	...	250	...

Statement showing the cost-rates of work executed by the Field Parties during the year 1908-09.

Number of Party.	Name and *locale* of field operations.	Cost-rate per square mile.						Total cost for survey year ending 30th September 1909.
		Triangulation.	Traversing.	Detail survey and preparation of maps on scales of			Fair Mapping.	
				1"	2"	4"		
	Topographical Surveys.	R	R	R	R	R	R	R
1	Central Provinces and Central India Agency.	7·7	13·4	26·3(*h*) 13·0(*a*)	6·6(*h*) 12·0(*a*)	...	6·1	91,793
2	Central Provinces and Berár .	11·4	...	15·2(*h*)	55·0(*h*)	5·8(*f*)	8·4	1,02,703
3	Upper Burma . . .	...	...	39·5(*d*)(*c*) 27·0(*g*)(*c*) 20·0(*a*)(*c*)	96·2(*c*)	...	...	96,892
9	Northern Circle . . .	11·3	34·9	17·2(*b*) 14·1(*a*)	...	...	9·8	1,30,298
10	Upper Burma . . .	7·8	28·8	31·5(*d*)(*c*) 29·4(*a*)(*c*)	54·1(*c*)(*d*)	...	...	1,13,577
11	Shan States	6·3	...	36·3(*d*)(*c*)	...	...	...	1,40,506
12	Northern Circle . . .	...	...	13·9(*d*)	42·5(*d*)	6·2(*a*)	2·4	84,012
14	„ „ . . .	4·1 4·2	...	...	20·2(*h*)	...	7·6	1,10,538
17	Bombay Presidency and Central India Agency and Hyderábád.	5·2	...	13·9(*a*)	19·1(*b*)	5·2(*f*)	5·2	93,509
18	Northern Circle (Dera Ismail Khán).	3·6	9·3(*e*) 13·5(*e*) 24·0(*e*)	12·4(*c*)(*h*)	33·7(*c*)(*h*)	...	...	1,29,760
	„ „ (Punjab Rivers)							
	„ „ (Bári Doáb) .							
19	Madras Presidency . . .	3·1	40·3	26·1(*d*)(*c*) 15·0(*b*)(*c*)	62·4(*d*)(*c*)	...	...	1,16,386
20	Eastern Bengal and Assam .	37·6	40·8	26·4(*d*)(*c*) 28·4(*a*)(*c*)	55·0(*d*)(*c*) 43·1(*g*)(*c*)	...	...	1,22,215
	Coorg Detachment . . .	6·9	...	...	36·9(*d*)(*c*)	...	...	36,681
	Total .	...	...	...	...	...	...	13,68,870

(*a*) Revision Survey.
(*b*) Resurvey.
(*c*) Inclusive of mapping.
(*d*) Original Survey.
(*e*) Rate per linear mile.
(*f*) Boundary Survey.
(*g*) Supplementary Survey.
(*h*) New Survey.

Cantonment Surveys.

Number of Party.	Nature of field operations.	Cost-rate *per* acre.						Total cost of party inclusive of charges for instruments for Local Governments.
		Traverse.	Detail survey.			Mapping.		
			16″	64″	105·6″ or 50′=1 inch.	16″	64″	
		₹	₹	₹	₹	₹	₹	₹
Detachment.	Cantonment Section, No. I.	0·7	1·5	2·6	...	0·1	2·4	27,901
„	Cantonment Section, No. II.	1·8	1·4	...	7·9	6·5	...	23,970

CALCUTTA : PRINTED BY SUPDT. GOVT. PRINTING, INDIA, 8, HASTINGS STREET.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1908-09

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E., A.D.C.

SURVEYOR GENERAL OF INDIA

CALCUTTA

SUPERINTENDENT GOVERNMENT PRINTING, INDIA

1910

Price Two Rupees or Three Shillings

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1908-09

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E., A.D.C.

SURVEYOR GENERAL OF INDIA

CALCUTTA

SUPERINTENDENT GOVERNMENT PRINTING, INDIA

1910

Price Two Rupees or Three Shillings