

# GENERAL REPORT

ON THE

## OPERATIONS

OF THE

# Survey of India,

DURING THE SURVEY YEAR

1909-10.

---

PREPARED UNDER THE DIRECTION OF

COLONEL S. G. BURRARD, R.E., F.R.S.,

OFFG. SURVEYOR GENERAL OF INDIA.



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CALCUTTA,

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Rupees or Three Shillings.

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1909-10.

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DURING THE SURVEY YEAR

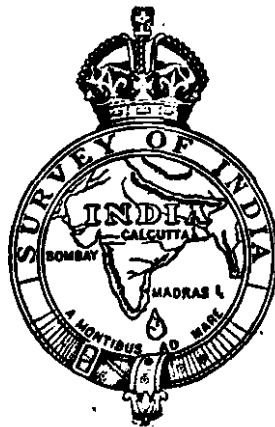
1909-10.

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CALCUTTA,

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# CONTENTS.

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## PART I. ADMINISTRATION.

	PAGE.
Administration ... ..	1 to 6

---

## PART II. SURVEY WORK IN THE FIELD.

### TOPOGRAPHICAL SURVEYS.

	PAGE.
Northern Circle ... ..	7
Southern Circle ... ..	7
Eastern Circle ... ..	8
Index Maps for Surveys ... .. facing	11

### FOREST SURVEYS.

Northern Circle ... ..	11
Southern Circle ... ..	11
Eastern Circle ... ..	12

### TRIGONOMETRICAL SURVEYS.

Triangulation ... ..	12
Levelling Operations ... ..	14
Astronomical Latitudes ... ..	15
Pendulum Operations ... ..	15
Magnetic Survey ... ..	16
Tidal Operations ... ..	16
Index Map for Trigonometrical Surveys ... .. facing	18

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## PART III. OFFICE WORK.

### HEADQUARTERS OFFICES.

	PAGE.
Map Publication Office ... ..	19
Drawing and Engraving Offices ... ..	20
Photo.-Litho. Office ... ..	21
Map Record and Issue Office ... ..	22
Mathematical Instrument Office ... ..	23

### DEHRA DUN OFFICES.

Special Operations ... ..	24
Computing Section ... ..	24
Drawing Section ... ..	25
Photo.-Zinco. Section ... ..	25
Forest Map Office ... ..	25

### CIRCLE AND LOCAL DRAWING OFFICES.

Northern Circle ... ..	26
Southern Circle ... ..	26
Eastern Circle ... ..	26
Bengal ... ..	27
United Provinces ... ..	27
Index maps for publication ... .. following	27

# GENERAL REPORT

ON THE

## Operations of the Survey of India

DURING THE SURVEY YEAR

1909-1910.

### PART I.

#### ADMINISTRATION.

1. This report deals with the operations of the Survey of India for the year ending 30th September 1910.

2. Orders were received during the year sanctioning the scheme for the re-organisation of the department, and laying down a time scale of pay, combined with charge allowances, for military officers.

The re-organisation provides for (i) three topographical circles, called the Northern, Southern and Eastern respectively, each under a Superintendent; (ii) twelve topographical parties, four to each circle; (iii) six trigonometrical parties, under the Superintendent, Trigonometrical Surveys; (iv) one Superintendent in charge of the Map Publication Office at Headquarters, with two officers under him in charge of the Photo.-Litho. and Drawing Offices respectively.

3. In pursuance of this scheme India has been divided into three circles, to which areas have been apportioned as found most convenient for topographical purposes, and parties have been re-numbered from 1 to 18, of which Nos. 1 to 12 are topographical, and 13 to 18 trigonometrical and geodetic. This has involved the amalgamation of old Nos. 2 and 17 parties to form new No. 6 Party, the absorption of the Quetta Party in No. 9 Party which retains its old number, and the formation of a new party in the trigonometrical branch.

Parties will be referred to by their new numbers throughout this report.

4. In August 1910 a committee was appointed by the Government of India to consider the grievances of officers of the Old Provincial Service and to report as to how far such grievances are real and require a remedy.

5. Four probationary Sub-Assistant Superintendents and two probationary Upper Subordinates of the Survey of India, and three probationary Assistant Superintendents of the Burma Land Records Department, were put through a course of training at Dehra Dún during the year, while eleven probationary Upper Subordinates of the Survey of India were attached to various circle and party offices for training.

6. The cost of the department for the survey year ending 30th September 1910 was Rs. 33,50,953, while that for the financial year ending 31st March 1910 was Rs. 32,55,495, against an estimated cost for the year 1910-11 of Rs. 34,98,720. The actual expenditure on topographical surveys for the survey year amounted to Rs. 19,02,964 against Rs. 16,51,677 for the previous year.

7. The distribution of officers in the various offices and parties throughout the year is shown in the following list:—

**DISPOSITION OF OFFICERS,  
1909-1910.**

Circle.	Administrative Officer.	Party or Office.	Locality.	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinate Establishment.	REMARKS.
MAP PUBLICATION.	The Hon'ble Colonel F. B. Longe, C.B., R.E., A.D.C., Surveyor General of India.	.....	Calcutta	.....	.....	.....	.....	
		Surveyor General's Office.	Calcutta	Colonel T. F. B. Renny-Tailyour, R.E., Major H. L. Crosthwait, R.E., Major G. P. Lenox-Conyngham, R.E., Captain R. H. Thomas, R.E.	.....	.....	.....	
		Mathematical Instrument Office.	Calcutta	Major J. M. Burn, R.E., Major H. L. Crosthwait, R.E., Major G. P. Lenox-Conyngham, R.E., Captain R. H. Thomas, R.E.	.....	.....	.....	
		Map Publication Office.	Calcutta	.....	Mr. M. Gastaud	.....	.....	Special establishments.
		Drawing Office	Calcutta	Captain M. O'C. Tandy, R.E.	Messrs. C. A. Norman, P. J. Barrington, A. B. Smart, J. O. Groiff, Jagdamba Prasad, P. L. Causley, J. R. Newland, P. Simpson, P. N. Sur. J. Hickie, (re-employed).	.....	.....	
		Photo.-Litho. Office.	Calcutta	Lieut. O. H. B. Trenchard, R.E., Lieut. K. W. Pye, R.E.	.....	.....	.....	
		Map Record and Issue Office.	Calcutta	Captain M. O'C. Tandy, R.E.	.....	.....	.....	
		Engraving Office	Calcutta	Captain M. O'C. Tandy, R.E.	.....	Mr. E. G. Hardinge (Bengal Drawing Office, Imperial Section).	.....	.....



NORTHERN.

Bt.-Colonel W. J. Bythell,  
R.E., *Supdt., Northern  
Circle.*

Northern Circle Drawing Office.	Mussooree ...	.....	Messrs. G. P. Tate, B. R. Hughes, M. C. Potters, J. Marten, (re-employed).	Husain Buksh, K. S.	59 Clerks, Drafts- men, &c.	
No. 1 Party ...	N. W. F. Pro- vince, Punjab and Kashmir.	Major C. H. D. Ryder, R.E., Lieut. J. D. Campbell, R.E., Lieut. A. A. Chase, R.E.	Messrs. T. W. Babonau, H. H. B. Hanby, H. B. Simons, R. C. Hanson, W. J. B. Miller, W. P. Hales.	Natha Singh, R.S., Mahindar Singh, Mhd. Husain Khan.	35 Surveyors, &c.	
No. 2 Party ...	Baluchistan ...	Major F. W. Pirrie, I.A., Lieut. F. J. M. King, R.E., Lieut. C. M. Thompson, I.A.	Messrs. F. B. Powell, H. C. H. Cooper, Subadar Kanak Singh, Messrs. E. C. O'Sullivan, G. E. R. Cooper, F. Byrne.	Sher Jung, K.B., Lal Singh, R. B.	47 Surveyors, &c.	
No. 3 Party ...	Punjab ...	Captain A. A. McHarg, R.E., Captain E. C. Baker, R.E.	Messrs. J. A. Freeman, B. M. Berrill, B. C. Newland, F. H. Grant, H. P. Butterfield, F. E. R. Calvert, Babu Jiya Lal.	Mhd. Lutf Ali ...	34 Surveyors, &c.	
No. 4 Party (including Punjab Riverain Detachment)	Punjab ...	Captain L. C. Thuillier, I.A., Captain M. N. Macleod, R.E.	Messrs. G. J. S. Rae, H. W. Biggie, C. E. C. French, Maya Das Puri, A. B. Hunter, F. C. Pilcher, Abdul Aziz, M. H. T. Hughes.	Vidya Nath Suri	101 Surveyors, &c.	No. 1 Canton- ment Section was absorbed in this party.
No. 9 Party ...	Baluchistan ...	Major G. A. Beazeley, R.E., Lieut. C. M. Thompson, I.A.	Messrs. W. J. Newland, P. A. T. Kenny, H. C. Stotesbury, D. K. Rennick, J. McCracken, A. J. A. Drake, F. J. Grice.	Gopal Singh, R. B., Dalbir Rai.	49 Surveyors, &c.	Temporarily in <i>Northern Circle.</i>
U. P. Drawing Office.	Mussooree ...	.....	Mr. J. M. Kennedy	M. Kennedy ...	18 Draftsmen, &c.	
Simla Drawing Office.	Simla ...	Lieut. J. D. Campbell, R.E., Lieut. P. G. Huddleston, R.E.	Mr. H. T. Hughes	.....	12 Draftsmen, &c.	This office was placed under direct adminis- trative control of the S. G. from 1st April 1910.
Southern Circle Drawing Office.	Bangalore ...	.....	Messrs. A. Ewing, J. Smith	B. P. Muthanna, K. Mandanna.	13 Surveyors, &c.	
No. 5 Party ...	Central Provinces	Major C. L. Robertson, C.M.G., R.E., Lieut. C. F. Nation, R.E.	Messrs. F. P. Walsh, W. Skilling, C. West, R. E. Saubolle, Babu Munshi Lal.	.....	38 Surveyors, &c.	

Colonel T. F. B. Renny-  
Tailleur, R.E., up to 17th  
October 1909 and from  
1st March 1910, Lieut-  
Colonel J. M. Fleming,  
I.A., from 18th October,  
1909 to 28th February  
1910, *Superintendents,  
Southern Circle.*

SOUTHERN.

ADMINISTRATION.

Circle.	Administrative Officer.	Party or Office.	Locality.	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinate Establishment.	REMARKS.	
SOUTHERN.	Colonel T. F. B. Renny-Tailyour, R.E., up to 17th October 1909 and from 1st March 1910, Lieut.-Colonel J. M. Fleming, I.A., from 18th October 1909 to 28th February 1910, <i>Superintendents, Southern Circle.</i>	No. 6 Party ...	Bombay and Berar.	Captain H. L. Crosthwait, R.E., Captain H. Wood, R.E., Lieut. S. W. S. Hamilton, R.E., Lieut. K. W. Pye, R.E., Lieut. J. A. Field, R.E.	Messrs. A. Ewing, C. G. Lee, Amar Sing, J. H. S. Wilson, P. R. Anderson, J. R. Newland, E. A. Meyer, A. K. Mitra, F. B. Kitchen, C. O. Picard, P. C. Mitra, F. C. Saint, E. J. Hanby, R. B. Gildea, C. B. Sexton, A. J. Booth, R. M. Wyatt.	R. V. Joshi, Dharman.	68 Surveyors, &c.	Old Nos. 2 & 17 Parties amalgamated to form this party on 1st March 1910.	
		No. 7 Party ...	Madras, Mysore and Coorg.	Capt. C. P. Gunter, R.E., Lieut. S. W. S. Hamilton, R.E., Lieut. A. H. Gwyn, I.A.	Messrs. R. Waller-Senior, W. M. Gorman, J. O'B. Donaghey, W. E. S. Swiney, H. D. W. Stotesbury, J. C. Pollett.	Ekunath Battu, Abdul Hakk.	28 Surveyors, &c.	The former Coorg detachment was absorbed in this party.	
		No. 8 Party ...	Madras ...	Capt. C. M. Browne, D. S. O., R.E., Lieut. S. W. S. Hamilton, R.E., Lieut. C. G. Lewis, R.E.	Messrs. J. Smith, W. F. E. Adams, E. J. Biggie, S. F. Norman, M. Mahadeva Mudaliar, Balaji Dhondiba, M. S. Ganesa Aiyar, A. J. Fraser.	Anantarao Dhondiba.	30 Surveyors, &c.		
		Eastern Circle Drawing Office.	Bangalore ...	.....	Messrs. H. C. H. Cooper, T. Shaw (re-employed).	B. C. H. Collins, Raghubar Datt Thaplyal, Matindra Ranjan Mazumdar, Balmokand.	42 Draftsmen, &c.		
		No. 9 Party temporarily in Northern Circle.							
		No. 10 Party ...	Northern Shan States.	Capt. L. G. Crosthwait, I.A.	Messrs. O. D. Smart, F. S. Bell, C. S. Littlewood, W. C. Jarbo, E. Claudius, Asmat-Ullah Khan, E. M. Kenny, Abdul Rahim, K.S., W. H. Strong.	Lachman Daji Jadu, R.S.	37 Surveyors, &c.	Including No. 2 Cantonment Section absorbed in this party and a Land Records Training Section.	
EASTERN.	Lieut.-Col. P. J. Gordon, I.A., <i>Superintendent, Eastern Circle.</i>	No. 11 Party ...	Northern Shan States.	Capt. R. H. Phillimore, R.E., Capt. E. C. Baker, R.E.	Messrs. Jagdamba Prasad, S. S. M. Fielding, V. W. Morton, T. P. Dewar, A. A. Graham, J. G. Vander-Beek, H. St. J. Kenny.	Hayat Muhammad.	23 Surveyors, &c.		
		No. 12 Party ...	Eastern Bengal and Assam.	Major A. Mears, I.A., Lieut. G. F. T. Oakes, R.E.	Messrs. C. C. Byrne, Pramadarajan Ray, J. H. Williams, Amjad Ali, L. Williams, J. O'C. Fitzpatrick.	.....	40 Surveyors, &c.		

TRIGONOMETRICAL SURVEYS.

Col. S. G. Burrard, R.E.,  
F.R.S., *Superintendent,*  
*Trigonometrical Surveys.*

Trigonometrical Surveys Office.	Dehra Dún ...	J. Eccles, Esq., M.A., Lieut. F. B. Scott, I.A., Lieut. W. E. Perry, R.E., Lieut. C. F. Nation, R.E., Lieut. R. S. Wahab, I.A.	Messrs. J. P. Barker, J. H. Nicol, Aulad Hossain, O. C. Ollenbach, Moqimuddin, A. J. Moore, H. H. Creed, J. A. Calvert.	Ram Singh, R. S., Karuna Kumar Das, B.A., Bidhu Bhusan Shome, Nanak Chand Puri, Ram Narain Hastir, Jugal Behari Lal.	Special estab- lishment.
No. 13 Party (Astronomical Latitudes).	Oudh ...	Capt. H. J. Couchman, R.E., Major H. L. Crosthwait, R.E.	Mr. R. Waller-Senior	.....	2 Computers, &c.
No. 14 Party (Pendulum Operations).	Central Pro- vinces.	Capt. H. M'C. Cowie, R.E.	Mr. Hanuman Prasad	.....	3 Computers, &c.
No. 15 Party (Triangulation).	Northern Balu- chistan, Kash- mir, Upper Burma.	Capt. C. M. Browne, D.S.O., R.E., Major H. H. Turner, R.E., J. deG. Hunter, Esq., M.A., Lieut. E. B. Cardow, R.E., Lieut. F. J. M. King, R.E., Lieut. H. G. Bell, R.E., Lieut. K. Mason, R.E.	Messrs. H. B. Simons, C. H. Tresham, 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.	.....	19 Computers, &c.
No. 16 Party (Tidal Operations).	Indian Ports ...	C. F. Erskine, Esq.	Mr. H. G. Shaw, Syed Zille Husnain	.....	21 Computers, &c.
No. 17 Party (Levelling).	Burma, Bengal and U. P., Punjab, Sind and Central India.	C. F. Erskine, Esq., Major J. M. Burn, R.E.	Messrs. E. H. Corridon, A. M. Talati, O. N. Pushong, D. H. Luxa, T. F. Kitchen, H. St. J. Kenny, O. D. Jackson.	.....	9 Recorders, &c.
No. 18 Party (Magnetic Survey).	India ...	Capt. R. H. Thomas, R.E., Capt. H. J. Couchman, R.E., Lieut. H. T. Morshead, R.E.	Messrs. E. C. J. Bond, H. P. D. Morton, R. P. Ray, N. R. Mazumdar, R. B. Mathur.	.....	19 Recorders, &c.
Forest Office.	Map Dehra Dún ...	Major J. M. Burn, R.E.	Mr. A. Descubes, (re-employed).	.....	.....

ADMINISTRATION.

## PART II.

### SURVEY WORK IN THE FIELD.

#### I.—TOPOGRAPHICAL SURVEYS.

##### NORTHERN CIRCLE (*vide* index map p. 11).

*No. 1 (late 14) Party.*—No. 1 Party surveyed an area of 5,100 square miles in the Abbottábád district of the North-West Frontier Province, in the Ráwalpindi, Jhelum, Gujrát and Sháhpur districts of the Punjab and in the Púñch district of Kashmir. The country surveyed was of a varied nature and included the level plains of Gujrát and Sháhpur, the broken and intersected country of Ráwalpindi and Jhelum, the Murree hills and the slopes of the Pir Panjál range of Kashmir.

*No. 3 (late 12) Party.*—No. 3 Party surveyed an area of 3,235 square miles, in the Jhang, Sháhpur, Lyallpur and Miánwáli districts of the Punjab and ran 337 linear miles of levelling. The country surveyed lay mostly in the Jhelum and Chenáb Canal colonies and was flat and open.

*No. 4 (late 18) Party.*—No. 4 Party surveyed an area 3,314 square miles in the Miánwáli, Attock and Sháhpur districts of the Punjab, triangulated 1,250 square miles, chiefly in the Salt Range, and completed 492 linear miles of traversing in the Sháhpur district, while a special detachment traversed an area of 6,000 square miles in the Lucknow, Unao, Hardoi, Sítápur, Bára Banki and Ráe Bareli districts of the United Provinces to form the basis for topographical survey which will be carried out by this party during 1910-11. The country surveyed was varied, lying partly in flat and cultivated plains, partly in the broken slopes of the Salt Range and partly in the *Thal* desert.

No. 1 Cantonment Section, which was absorbed by No. 4 Party during the year, surveyed three cantonments, namely Lucknow, Meerut and Dharm-sála, and submitted maps of the following eight for publication: (i) the seven "Galis" (Baragali, Kálábágh, Ghora Dhaka and Khanaspur, Changlagali, Khayragali and Barian) (ii) Jalápáhár (iii) Attock and Thandi Bir (iv) Jhelum (v) Fort William (vi) Dharmsála (vii) Ichhápur (viii) Shillong.

*The Punjab Riverain Detachment* which was separated from No. 4 Party on the 1st of July 1910, continued its work of traversing and laying down base lines for the future demarcation and survey of riverain boundaries, and for the general co-ordination of the cadastral surveys of the Punjab Government. 637 linear miles of main traverse and 1,650 miles of minor traverse were completed along the banks of the rivers Sutlej, Beás and Rávi and 247 base lines were laid down with permanent mark stones. 1,587 village plots of 201 villages were completed during the year and supplied to the Punjab Settlement department, and twenty sheets on the 4-inch scale were compiled.

##### SOUTHERN CIRCLE (*vide* index map p. 11).

*No. 5 (late 1) Party.*—No. 5 Party surveyed an area of 2,291 square miles in the Jubbulpore, Damoh and Mandla districts of the Central Provinces and in Rewah State, and triangulated 2,278 square miles in the Hoshangábád district and in Bhopál State. The country surveyed was for the most part hilly and wooded. The recess Headquarters of the party were transferred from Poona to Bangalore during the year.

*No. 6 Party.*—Old Nos. 2 and 17 Parties were amalgamated to form this party on 1st April 1910. The areas surveyed by the combined parties amounted to 4,982 square miles in Nágpur, Wardha and Chánja districts of the Central Provinces, in the Nánder, Sirpur Tándúr and Aurangábád districts of Hyderábád, in the Yeotmál and Buldána districts of Berár, in the East Khándesh district of Bombay and in Indore State. 5,032 square miles were triangulated and 788 linear miles of traversing for forest boundaries were completed in the same localities.

Heavily wooded, rugged hills with little water and few communications marked the country surveyed along the boundary between Indore and East Khándesh and in a small area of the Central Provinces, but otherwise the land, though containing numerous forest reserves, was fairly open and easy to survey.

*No. 7 (late 3) Party.*—Working for the first time in Southern India, No. 7 Party surveyed an area of 2,164 square miles and triangulated 1,850 square miles in the South Kanara and Malabar districts of Madras and in Mysore and Coorg.

The country varied exceedingly in character, extending from the low Malabar coast land over the Western Ghats and wooded hills of Coorg into the great plateau of Mysore, and was on the whole difficult to work in.

*No. 8 (late 19) Party.*—No. 8 Party surveyed an area of 3,095 square miles and completed 900 square miles of triangulation and 312 linear miles of traversing in Travancore and Cochin States and in the Nilgiri, Coimbatore, Malabar and Tinnevely districts of Madras. The Nilgiris and hilly portions of Malabar, Coimbatore and Cochin are covered with comparatively open jungle on the lower ground, giving way to dense, moist, evergreen forest on the upper slopes, until the high plateaux consisting of undulating open downs with clear streams of running water are reached at an elevation of about 6,000 feet. The plains of the west coast consist of paddy fields surrounded by dense groves of palms which render survey work difficult and slow.

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EASTERN CIRCLE (*vide* Index map p. 11).

*No. 10 Party.*—No. 10 Party surveyed an area 3,516 square miles in the Northern Shan States of Móngmit and North Hsenwi including 150 miles of the Burma-Yünnan frontier, and 592 square miles of country beyond the frontier were sketched in. 4,415 square miles were triangulated and 263 linear miles of traverse were completed in the Katha, Bhamo and Myitkyina districts of Upper Burma.

The country lay at a high altitude and consisted chiefly of high, sparsely wooded hills and grassy uplands in which survey was easy.

No. 2 Cantonment Section was absorbed by this party during the year and completed the survey of the Bhamo, Mandalay, Maymyo and Meiktila cantonments, while that of Rangoon was commenced, the total area amounting to 15,545 acres. 81 sheets of the maps of the Secunderábád and Bolárum Bazars surveyed in previous seasons were submitted for publication.

No. 10 Party also maintained a section for the purpose of giving practical training in cadastral survey to probationers of the Burma Land Records department who had already gone through a preliminary course of instruction at Dehra Dún. The course lasted twelve months, during which the pupils carried out traversing, 16-inch cadastral survey, 64-inch town survey and the computations, mapping and area calculations connected therewith.

*No. 11 Party.*—No. 11 Party surveyed an area of 3,997 square miles in the portions of the Shan States of North Hsenwi, South Hsenwi, Manglön and Kēng Tung lying in the vicinity of the Salween river and bounded on the east by Yünnan and the Wa States. Triangulation was completed over an area of 3,050 square miles in Mawkmai and Móngpan States and in Karenni.

The country was similar to that surveyed by No. 10 Party, consisting of bold, lightly wooded hills.

*No. 12 (late 20) Party.*—No. 12 Party Surveyed an area of 2,223 square miles in the Sylhet, Lushai Hills, Cáčár and Khási and Jaintia Hills districts of Eastern Bengal and Assam and in Hill Tippera State, and completed an area of 2,005 square miles of triangulation and 271 linear miles of traversing in the same locality. The country varied from the open cultivated plains of Sylhet to the mountainous country of the Lushai Hills and Hill Tippera, covered with the densest bamboo and evergreen forests.

The recess headquarters were transferred from Bangalore to Shillong during the year.

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# TOPOGRAPHICAL SURVEYS.

*Table shewing Outturns and Costs.*

1909-1910.

Circle.	Party.	Locality.	Character of Ground.	Type of Survey.	Scale.	Outturns.		Total Outturn of Survey on all scales.	Difference from 6,000 square miles per party.*	Total cost.	Cost rate per square mile Survey and Mapping.	REMARKS.
						Survey.	Mapping.					
						Sq. miles.	Sq. miles.	Sq. miles.	Sq. miles.	Rs.	Rs.	
N.	No. 1	N. W. F. Province, Punjab, and Kashmir	Open, hilly in parts ...	Resurvey ...	1 inch	5,100	3,570	5,100	-900	1,00,951	19.8	
N.	No. 3	Punjab	Flat, intersected by canals partly wooded.	Survey ...	1 inch	3,235	3,235	3,235	-2,765	76,928	23.8	
N.	No. 4	Punjab	{ Flat open, partly desert Hilly and intricate ...	{ Survey ... Survey ...	{ 1 inch 2 inch	{ 1,762 1,552	3,168	3,314	-2,686	† 98,694	20.7	† Excluding Rs. 35,356 on local surveys.
Totals, Northern Circle ...							9,968	11,649	-0,351	2,76,573	23.7	
S.	No. 5	Central Provinces ...	{ Hilly and wooded ... Hilly and wooded ...	{ Survey ... Survey ...	{ 1½ inch 1 inch	{ 528 1,763	1,460	2,291	-3,709	91,086	39.8	
S.	No. 6	Bombay and Berar	{ Part open, part hilly and wooded. Forest, hilly and intricate	{ Survey ... Resurvey ... Survey ... Resurvey ...	{ 1 inch 1 inch 2 inch 2 inch	{ 3,078 1,564 78 262	4,733	4,982	-1,018	1,74,999	35.1	
S.	No. 7	Madras, Mysore, and Coorg.	{ Varied ... Open ... Dense forest ...	{ Survey ... Resurvey ... Survey ...	{ 1 inch 1 inch 2 inch	{ 876 875 413	2,031	2,164	-3,836	97,032	44.9	
S.	No. 8	Madras	{ Part open, part forest ... Flat enclosed ... Forest, dense and open ...	{ Survey ... Supplementary Survey. Survey ...	{ 1 inch 1 inch 2 inch	{ 2,396 190 509	1,905	3,095	-2,905	94,378	30.5	
Totals, Southern Circle ..							10,129	12,532	-11,468	4,57,495	36.5	
E.	No. 10	Northern Shan States	Bold, lightly wooded hills	{ Survey ... Resurvey ...	{ 1 inch 1 inch	{ 3,305 211	3,000	3,516	-2,484	† 1,33,860	38.1	† Excluding Rs. 43,131 on local surveys.
E.	No. 11	Northern Shan States		{ Survey ... Survey ...	{ 1 inch 1 inch	{ 3,997 1,060	3,000	3,997	-2,003	1,41,726	35.5	
E.	No. 12	Eastern Bengal and Assam.	{ Open cultivated plains and wooded hills. Dense forest ...	{ Survey ... Resurvey ... Supplementary Survey. Survey ...	{ 1 inch 1 inch 1 inch 2 inch	{ 1,060 322 420 421	2,223	2,223	-3,777	1,38,934	62.5	
Totals, Eastern Circle ...							8,223	9,736	-8,264	4,14,520	42.6	
GRAND TOTALS ...							28,420	33,917	-26,083	11,48,588	33.9	

\* The figure 6,000 square miles from which differences are shown in column 10 is the full annual outturn per party, which it is hoped may be attained in future.  
 In order to reduce expenditure the programmes and establishments of topographical parties were cut down soon after the commencement of the field season, 1909-1910. This has adversely affected outturns and costs.

I.—TOPOGRAPHICAL SURVEYS.

11

*Table shewing progress of Topographical Surveys, 1905 to 1910.*

*Outturns in square miles.*

Survey year.	Scale.	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06 ...	1 inch and 2 inch	5,995	1,660	10,322	17,977
1906-07 ...	do.	7,277	7,666	8,659	23,602
1907-08 ...	do.	14,530	9,256	12,431	36,217
1908-09 ...	do.	17,957	12,526	11,542	42,025
1909-10 ...	do.	23,833	12,532	9,736	46,101
Areas completed to date ...	do.	69,592	43,610	52,690	165,922
Total areas included in the topographical programme.	{ 1 inch	620,000	542,800	528,800	1,691,600
	{ ½ inch	130,000	.....	.....	130,000
Approximate areas remaining for Survey.	{ 1 inch	550,408	499,160	476,110	1,525,678
	{ ½ inch	130,000	.....	.....	130,000



## II.—FOREST SURVEYS.

The forest surveys of the year were carried out, in almost every case, by the particular topographical parties in whose spheres of operations the forests lay. The surveys were for the most part on the 2-inch scale, but some were on the 1-inch scale; forest boundary surveys on the 4-inch scale were carried over a considerable area. The revision of certain areas previously surveyed on the 4-inch scale by the old Forest Survey Branch was also effected.

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*Northern Circle.*

*Punjab.*—The forest areas, surveyed by No. 4 (late 18) Party on the 2-inch scale, fell chiefly in the Salt and Khusháb ranges of the Sháhpur district, with some small areas in the Miánwáli and Attock districts of the Sháhpur Forest division; the boundaries of most of those falling in the Salt range had been previously surveyed by the Forest Survey Branch on the 4-inch scale. The total area of forests thus surveyed in the Sháhpur district amounted to 343 square miles and in the Miánwáli and Attock districts to about 4 square miles, or a total of about 347 square miles of the Sháhpur Forest division. In addition to these an area of about 34 square miles was surveyed in the Jhelum Forest division (Attock district) on the 2-inch scale and a few forests lying in the *Thal* desert on the 1-inch scale.

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*Southern Circle.*

*Central Provinces. (Berár Circle).*—In the course of the topographical survey of Berár, No. 6 (late 2) Party surveyed on the 2-inch scale all the A, B and C class forests falling in the area under survey in the Yeotmál district, and their boundaries were rigorously traversed by theodolite and plotted on the 4-inch scale. The area surveyed on the 2-inch scale amounted to 78 square miles and the boundary traversing to 229 linear miles. In addition to these, about 191 linear miles of the boundaries of the A and B class forests lying in the area proposed for detail survey next working season were traversed in advance. C class forests were not specially surveyed before, and considerable difficulties were experienced in identifying their boundaries as the field boundary marks were in many places found missing. In two cases it was absolutely impossible to survey the boundary, as no marks of any kind existed on the ground. Steps have, however, been taken to inspect the boundary marks and renew them if found missing, and it is hoped that in the ensuing year there will be no further difficulties over this question.

*Madras Presidency.*—Forest Surveys on the 2-inch scale were carried on during the year by Nos. 7 and 8 (late 3 and 19) Parties in the following Divisions:—

In the Nilgiris 122 reserved forests of a total area of 59 square miles were surveyed. Of these 37 forests were partially done last year. In addition to this many corrections to the demarcated boundaries were entered on last year's plane-table sections. The survey of the reserved forests in the Nilgiris is now complete. In Central Coimbatore there were surveyed the Attapádi forest reserve which has recently been transferred to this division from South Malabar, and the Chenat Nair, Pulampara and Varalapadi forest reserves, comprising an area of 48 square miles. In South Coimbatore the greater part of the Anamalai forest reserve falling in sheet 58  $\frac{B}{15}$  was resurveyed on the 2-inch scale, as the old 4-inch maps were found to be extremely inaccurate. The area thus surveyed amounted to 131 square miles. In South Kanara, Sampaje, Todikana, Kiribagh, Nalkuru and Devachalla forest reserves, of a total area of 40 square miles, were surveyed. The only forest reserve which had not been previously traversed by theodolite (with the exception of the Nilgiris reserves) was the Attapádi forest, Block No. VI; it was intended to traverse this, but the boundary was not cleared in time for the traverse to be carried out, and it was abandoned. The total area surveyed in the Madras Presidency amounted to 278 square miles.

*Bombay Presidency.*—The survey of the Sâtpura reserve on the 2-inch scale which was commenced in the year 1905-06 was completed this year by No. 6 Party, and about 121 square miles were surveyed. In addition to this about 114 square miles of forests in the Bhusâwal, Jâmner and Jâlgaon talukas of the East Khândesh district were surveyed on the same scale. Boundary surveys of all these forests, amounting to 316 linear miles, were made on the 4-inch scale.

*Coorg.*—In Coorg, 20 reserved forests, of a total area of 309 square miles, were surveyed by No. 7 Party on the 2-inch scale.

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*Eastern Circle.*

*Eastern Bengal and Assam.*—The survey of the Katakhal and Sonai reserves in the Câchâr Forest division, which was commenced last year, was completed on the 2-inch scale by No. 12 (late 20) Party, and the Inner Line and Barail reserves have been mapped up to the limits of the topographical programme of the party. The officer in charge reports that the large area of dense bamboo and cane jungle, the impenetrable nature of the undergrowth and extensive swamps met with in parts, made the survey of the Câchâr forests one of the most trying and difficult pieces of work that have so far been experienced by his party, either in Burma or Assam. The area thus surveyed in the Câchâr division amounted to 293 square miles. The Langai and Shingla reserves in the Sylhet Forest division, comprising an area of 94 square miles, came under survey and were completed.

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## III.—TRIGONOMETRICAL SURVEYS.

TRIANGULATION (*vide* index map p. 18).

The work of No. 15 Party included principal, secondary and tertiary triangulation.

*(a). Principal Triangulation.*

(i).—The North Baluchistán series emanating from the side Zawa-Zibra of the Kalát longitudinal series was extended through the whole length of Northern Baluchistán and closed on the side Tounsa-Langawala of the Great Indus series.

The following is an abstract of the work done:—

Number of Principal Stations observed at	...	...	17
Number of Principal Stations newly fixed	...	...	15
Number of Principal Stations built	...	...	5
Length of triangulation completed in miles	...	...	261
Area of triangulation in square miles	...	...	6,580
Average triangular error of 24 triangles	...	...	0"-303
Number of Astronomical Azimuths observed	...	...	3

(ii).—The Kashmír series emanating from the side Nerh-Khagriána of the North-West Himalaya series was continued to latitude 34°-50' N.

The following is an abstract of the work done:—

Number of Principal Stations observed at	...	...	9
Number of Principal Stations newly fixed	...	...	7
Number of Principal Stations built	...	...	11
Length of triangulation completed in miles	...	...	90
Area of triangulation in square miles	...	...	1,600
Average triangular error of 7 triangles	...	...	0"-591
Astronomical azimuth observed	...	...	1

In addition to triangulation work, a series of comparisons was carried out to test the accuracy of mercurial barometers, aneroid barometers and hypsometers, as height measuring instruments.

The results proved that the aneroid barometers differed greatly from one another and from the mercurial barometers. The latter gave heights in defect, and the hypsometers gave heights considerably in excess of those obtained by triangulation. At 16,000 feet the excess was as much as 600 feet.

The constants employed in the formulæ by which elevations are deduced from barometric and hypsometric observations require modification.

(iii).—The Upper Irrawaddy series was commenced from the side Tangte-Lakar Bum of the Great Salween series.

The following is an abstract of the work done:—

Number of Principal Stations observed at	...	...	9
Number of Principal Stations newly fixed	...	...	4
Number of Principal Stations provisionally fixed	...	...	3
Number of secondary Stations provisionally fixed	...	...	3
Length of triangulation completed in miles	...	...	112
Area of triangulation in square miles	...	...	2,900
Average triangular error of 8 triangles	...	...	0"-381
Astronomical Azimuth observed	...	...	1

(b).—*Secondary Triangulation.*

Two secondary series, the Mawkmai and Khási Hills series, were commenced in Upper Burma and Assam respectively. The work done is shewn in the following abstracts.

The Mawkmai Series.—

Stations observed at	...	...	...	...	31
Stations fixed	...	...	...	...	36
Stations built	...	...	...	...	16
Length of triangulation completed in miles	...	...	...	...	140
Area of triangulation in square miles	...	...	...	...	1,810
Average triangular error of 25 triangles	...	...	...	...	1".99

The Khási Hills Series.—

Stations observed at	...	...	...	...	12
Stations fixed	...	...	...	...	10
Stations built	...	...	...	...	24
Length of triangulation completed in miles	...	...	...	...	41
Area of triangulation in square miles	...	...	...	...	400
Average triangular error of 10 triangles	...	...	...	...	3".17

(c).—*Tertiary Triangulation.*

Tertiary triangulation for the topographical survey of Kashmir was completed in sheets 43  $\frac{F}{11, 12, 15, 18}$  and 43  $\frac{J}{4}$  and commenced in sheets 43  $\frac{J}{5, 7, 8, 12, 16}$

LEVELLING OPERATIONS.

*No. 17 Party.*—Three detachments were employed on levelling operations during the past season.

No. 1 levelling detachment carried out revision levelling from Rangoon to Pyinmana and new levelling from Wuntho to Myitkyina, and also connected the standard bench-marks at Rangoon, Pegu, Toungoo, Mandalay, Shwebo, Meiktila, Magwe, Wuntho and Myitkyina. The outturn amounted to 465 miles.

No. 2 levelling detachment levelled the Himalayan lines from Hardwár to Lansdowne, from Bareilly *viá* Káthgodám to Naini Tál (Brewery), and from Siliguri to Tindhária, and connected the standard bench-marks at Lucknow, Patna (Bankipore), Muzaffarpur, Motihári, Bhágalpur, Purnea, Dinájpur, Burdwán, Calcutta, Balasore, Cuttack, Berhampur (Madras), Vizagapatam, Cocanáda, Bezwáda, Nellore and Rewah. The outturn was 310 miles.

No. 3 levelling detachment was employed on levelling from Lahuwáli G. T. S. *viá* Khánpur to Rohri, from Shikárpur to Jacobábád, from Páli *h.s.* to Godhra, and from Lahore to Dharmkot in the Himalayas, *viá* Patháankot and Dharmsála; it also connected the standard bench-marks at Sadikganj, Baháwalpur, Khánpur, Sukkur, Jacobábád, Hyderábád (Sind), Karáchi, Godhra, Baroda, Rájkot, Surat, Dhúlia, Mhow and Bhopál (2). The outturn amounted to 501 miles.

During the past year a scheme for increasing the number of bench-marks fixed on ground rock was introduced; 150 rock-cut bench-marks were laid down and connected by the levelling officers in the course of their operations, and of these 49 bench-marks were protected by pillars of an approved design.

30 Standard bench-marks were erected and 41 connected during the year.

## GEODETTIC SURVEY.

*(a).—Astronomical Latitudes.*

*No. 13 Party.*—No. 13 Party was employed on latitude operations in Oudh. Of the 11 stations visited 5 were situated on that portion of the Karara Meridional series which lies north of the Ganges and the remainder were on the North East Longitudinal series.

The results of the season's work are given in the following table:—

Name of Station.	Latitude.	Longitude.	Height above mean sea level.	Deflection of the plumb-line (O—C)
			<i>feet</i>	"
Sora	26 17	81 12	400	+7.56
Pariaon	25 50	81 22	346	+8.33
Parewa	26 38	81 12	380	+7.44
Utiamao	27 0	81 12	386	+4.54
Imlia	27 19	81 8	428	—1.07
Masi	27 38	81 23	406	—10.38
Dadaura	27 43	81 43	420	—14.82
Mánichauk	27 37	82 5	360	—19.23
Basadela	27 24	82 17	366	—12.53
Pathardi	27 26	82 45	320	—18.66
Ghaus	27 21	83 6	296	—16.74

An attempt was made during recess to apply to India the method which Mr. J. Hayford has used in the United States, to ascertain whether the condition known as isostasy exists. This involved the computation of the deflection of the plumb-line, due to visible masses, up to a distance of 2,534 miles from each station. The deflection was computed for 106 latitude stations and for 18 longitude stations in the prime vertical.

*(b).—Pendulum Operations.*

*No. 14 Party.*—No. 14 Party carried out pendulum operations in a tract situated between Latitudes 21° and 26° N. and Longitudes 79° and 83° E., thus extending to the east and north-east the investigations commenced in the season 1908-09 in Central India.

In the table below are shewn the stations visited and the results obtained. The usual procedure was followed in carrying out the observations, four pendulums being swung at each place, and as a rule four complete sets of night and day observations made, each set being preceded and followed by star observations for the determination of clock rate.

TABLE.

No.	Stations.	Latitude.	Longitude.	Height.	$g$	$g_0$	$g_0''$	$\gamma_0$	$g_0 - \gamma_0$	$g_0'' - \gamma_0$
		° ' "	° ' "	<i>feet.</i>	<i>cm.</i>	<i>cm.</i>	<i>cm.</i>	<i>cm.</i>	<i>cm.</i>	<i>cm.</i>
1	Rajpur	21 13 56	81 41	996	978.612	978.705	978.670	978.681	+ 0.024	— 0.011
2	Amgaon	21 21 31	80 28	1,032	.614	.710	.674	.689	+ 0.021	— 0.015
3	Biláspur	22 3 53	82 12	878	.631	.763	.733	.783	+ 0.030	0.000
4	Seoni	22 5 29	77 29	2,032	.622	.811	.744	.735	+ 0.076	+ 0.009
5	Pendra	22 46 41	82 0	1,996	.638	.824	.754	.778	+ 0.046	— 0.024
6	Jubbulpore	23 51	79 59	1,467	.719	.856	.806	.803	+ 0.053	+ 0.003
7	Umaria	23 31 37	80 54	1,499	.740	.880	.830	.827	+ 0.053	+ 0.003
8	Damoh	23 49 54	79 26	1,213	.758	.871	.829	.848	+ 0.023	— 0.019
9	Katni	23 50 25	80 26	1,254	.757	.874	.830	.848	+ 0.026	— 0.018
10	Saugor	23 51 47	78 48	1,757	.731	.895	.834	.850	+ 0.045	— 0.016
11	Maihar	24 15 38	80 43	1,161	.784	.892	.851	.877	+ 0.015	— 0.026
12	Allahábad	25 25 55	81 55	288	.943	.970	.960	.958	+ 0.012	+ 0.002

MAGNETIC SURVEY.

*No. 18 Party.*—Four detachments each under a Provincial officer were employed. Two of these re-observed at old field stations in the area lying between Latitude 16° to 19° and Longitude 73° to 78°, where the secular change in H. F. appeared to be abnormal. These detachments also surveyed a few small areas in detail. The third was employed on detail survey in Central India and the fourth took observations along the outer Himalaya from Naini Tal to Dharmasála.

The Imperial officers observed at all repeat stations with the exception of Port Blair and also at a number of old field stations. The four observatories were inspected and comparative observations taken at each, and also at Alibág.

In all 69 new stations of the preliminary survey and 71 of the detail survey were occupied, while 100 old field and 22 repeat stations were visited.

*Work during recess.*—The computation of the previous season's field work and the reduction and tabulation of the base station results for 1909 have been completed.

The mean values of the magnetic elements at the observatories in 1909 were as follows :—

Observatory.	Lat. N.	Long. E.	Declination.	Horizontal Force.	Vertical Force.	Dip.
	° ' "	° ' "	° ' "	C. G. S.	C. G. S.	° ' "
Dehra Dún ...	30 19	78 3	E.2 34.8	·33276	·31909	43 48.0
Barrackpore ...	22 46	88 22	E.1 0.7	·37300	·22099	30 38.7
Toungoo ...	18 56	96 27	E.0 30.0	·38766	·16476	23 1.5
Kodaikānal ...	10 14	77 28	W.0 50.1	·37459	·02391	3 39.1

TIDAL OPERATIONS.

*No. 16 Party.*—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	30	* Small tide-gauge working. Property of Port Trust.
2 Karáchi ...	{ 1868 1881	{ 1880 Still working	{ 13 29	
3 Bombay (Apollo Bandar) ...	1878	" "	32	
4 Bombay (Prince's Dock) ...	1888	" "	22	
5 Madras ...	{ 1880 Restarted 1895	{ 1890 Still working	{ 10 15	
6 Kidderpore ...	1881	" "	29	
7 Rangoon ...	1880	" "	30	
8 Port Blair ...	1880	" "	30	
9 Moulmein ...	{ 1880 Restarted 1909	{ 1886 Still working	{ 6 1	

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

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

In the following tables are given the annual and decadal percentages of errors in the predicted times and heights of high and low waters at open coast and riverain stations.

## PART II.

*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.
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
1909	6	85	86	97	97	97	98
Average of 10 years	...	80	75	96	95	96	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.
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	78	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
1909	3	61	59	69	65	93	92
Average of 10 years	...	57	58	73	60	93	91

# PART III.

## OFFICE WORK.

### I.—HEADQUARTER OFFICES.

#### MAP PUBLICATION (*vide* index maps p. 27).

The maps, the publication of which forms the main task of the office, may be divided into four classes.

- (a)—Small scale geographical maps.
- (b)—Geographical maps on the one-millionth scale.
- (c)—Degree sheets, *i.e.*, topographical maps on the scale of one inch to four miles, each sheet covering an area of one degree of latitude by one of longitude.
- (d)—Standard sheets, *i.e.*, topographical maps on the scale of one inch to one mile, each sheet covering an area of 15 minutes by 15 minutes.

(a)—*Small scale geographical maps.*—During the year under report the new engraved map of India on the 32-mile scale has made fair progress. It has been decided to include Tibet in this map and to complete the north eastern sheet to its margins; this step will enhance the value of the map but will retard its completion.

A new series of engraved index maps on the 32-mile scale was commenced, each index embracing an area corresponding to that of one sheet on the one-millionth scale and giving full information with regard to the survey and publication of sheets of the "degree" and "standard sheet" series that fall within it.

(b)—*Geographical maps on the one-millionth scale.*—The compilation of these maps from such information as is available has gone on continuously in the Drawing Office. Two new sheets were published and many were carried to an advanced stage; it is hoped that of the fifty sheets covering India and Burma the greater part will shortly be printed. During the year nine sheets of this series were reprinted, and at its close eleven sheets were under publication.

(c)—*Degree sheets.*—The publication of this series of maps in colours in the same style as the one inch standard series has commenced. No degree sheet of India proper based on modern surveys was published during the year; nevertheless good progress has been made.

The question of hill shading for reproduction by the half-tone process has received much attention, and the experiments made have thrown light on the nature of the difficulties to be contended with and on the means of overcoming them.

Materials for the drawing of eighteen of the degree sheets of India proper and Burma, produced by the reduction of larger scale surveys, have been supplied to the circle drawing offices during the year.

(d)—*One-inch standard sheets.*—On 30th September 1909, 268 sheets of this series had been published and 84 were in course of publication. On 30th September 1910, 476 sheets had been published and 33 were under publication. During the year therefore 208 sheets were printed, as compared with 174 during 1908-09.

The figure 476 includes 127 sheets of which the drawing is based either on cadastral survey or on topographical survey executed prior to the 1st October 1905. Of these some have been printed in colours and some in black only; they have been published as preliminary editions and are not coloured on the index maps of this report.



The following table shows the progress made in the publication of one-inch standard sheets from new topographical surveys only, during the past 5 years; see index maps at the end of this report.

Year.	STANDARD SHEETS PRINTED.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06	0	0	0	0
1906-07	4	1	0	5
1907-08	16	11	22	49
1908-09	34	26	60	120
1909-10	72	43	60	175
Total printed	126	81	142	349
Total in programme	2,160	2,067	2,101	6,328
Number remaining for publication	2,034	1,986	1,959	5,979

The office is in a position to deal with a considerably larger number of sheets and will be able to undertake all the work required when parties and circle drawing offices send in their full estimated outturn.

*Special maps.*—In addition to the above series of maps the office has dealt with a large number of special maps, of which the most important are the following:—

New railway map on the 64-mile scale (under preparation).

New railway, road, and canal map on the 32-mile scale (under preparation).

Map of the N. E. frontier of India on the 32-mile scale (nearing completion).

Postal map of Sind on the 8-mile scale (under preparation).

*Old style maps.*—Of old maps which are not likely to be superseded in the near future, 229 were prepared for reprinting by the addition of such information as was available, and of these 164 were printed.

#### DRAWING AND ENGRAVING OFFICES.

*Provisional degree sheets.*—Many years must elapse before the new degree sheets on the  $\frac{1}{4}$ -inch scale extend over India, and much inconvenience arises from the fact that the old series of maps on this scale, namely the Atlas sheets, do not conform to the new series in shape, in graticule or in area, with the result that the publication of a sheet of the new series will not wholly supersede any one Atlas sheet.

It has been decided therefore to prepare provisional degree sheets by cutting and joining the old  $\frac{1}{4}$ -inch maps in the same form as the new series. In this way, sheets of the old style will be superseded with moderate rapidity, and every new sheet prepared from modern surveys will displace completely one of the provisional maps; overlapping and confusion will thus be avoided. Experiments are being made in order to arrive at the best and most economical method of effecting this conversion, which is a matter of considerable technical difficulty.

*Stamps for symbols.*—Stamps for the printing of the various conventional symbols have for some time been wanted, and many experiments have been made in the search for a suitable method of making them. A satisfactory plan has been discovered and it is intended to provide full equipments of symbols to all parties and circle drawing offices, and so to attain to uniformity in the conventional representation of natural and artificial features.

*Hill shading.*—A variety of experiments in methods of hill shading have been carried out. An endeavour has been made to substitute the stump for the brush as it expedites the work, but it is in many respects inferior and the success of the experiment is still doubtful. The air brush, a mechanical device for spraying ink, has also been tried for certain purposes and it is hoped that it will be found of use.

The following table shows the volume of work in the office during the year.

## I.—Maps of the modern series.

Class of Map.	Number of sheets in hand.	Number completed and sent to press.
Geographical maps $\frac{1}{1,000,000}$ and smaller scales ...	99	39
1 inch = 4 miles (Degree sheets, &c.) ...	64	30
1 inch = 1 mile (Standard sheets) ...	242	208
Totals ...	405	277

## II.—Old style maps, reprints and other plans and charts.

Standard maps ...	212	164
Miscellaneous maps and charts ...	157	131
Maps for other departments ...	133	81
Totals ...	502	376

## PHOTO-LITHO. OFFICE.

*Three-colour photography.*—Perhaps the most interesting results obtained during the year are those of Mr. Taylor, Manager of the Photo. Branch, in his experiments with three-colour photography.

The rapid deterioration of colour-sensitive plates in the Indian climate has made this process both uncertain and expensive, and it has been Mr. Taylor's aim to produce a bromide of silver emulsion in collodion for coating plates, which would render them suitable to take the place of imported dry plates in this process. In this he has attained to a remarkable degree of success, and it is hoped that before long the office will be able to take up reproduction in colours as a regular branch of its business. At present this will not perhaps be much used by the Survey of India itself, but it should be of value to several other departments of Government.

The output of the printing section of the office during the last three years is shewn in the following table.

Year.	Number of impressions pulled.	Number of maps printed.		
		Departmental.	Extra-departmental.	Total.
1907-08 ...	1,563,453	891	1,175	2,066
1908-09 ...	1,506,607	2,047	726	2,773
1909-10 ...	1,574,180	2,697	1,053	3,750

The cost of the office during the year was Rs. 1,54,494, and the value of the outturn Rs. 2,13,894 including Rs. 51,586 recovered in cash or by book debit transactions. These figures compare favourably with those of the preceding year, which were: cost Rs. 1,58,643, value of outturn Rs. 1,72,234.

## MAP RECORD AND ISSUE OFFICE.

The gross face value of the maps received from the printing offices during the year amounted to Rs. 3,40,000. This sum includes Rs. 15,361 and Rs. 25,014, the values of maps printed in the Engraving Office and at Dehra Dún respectively.

The following table shows the maps printed and received and their face value.

Class of maps.	Scale.	Number of different maps of each class received.		Value.
		New publications.	Reprints.	
				Rs.
1 Geographical maps ...	Small	5	5	44,850
2 India and Adjacent Countries	1 1,000,000	2	9	4,504
3 Degree sheets ...	1 in. = 4 m.	10	2	5,650
4 Standard sheets (new style) ...	1 in. = 1 m.	205	3	1,04,305
5 Provincial maps ...	{ 1 in. = 16 m. 1 in. = 32 m. }	2	11	14,675
6 District maps ...	1 in. = 4 m.	.....	13	2,755
7 Atlas sheets ...	1 in. = 4 m.	.....	119	13,776
8 Standard sheets (old style) ...	1 in. = 1 m.	76	121	89,321
9 Administration Report maps	1 in. = 8 m.	.....	37	1,632
10 Plans of Cities and Cantonments ...	Various	25	24	21,285
11 Triangulation and traverse charts ...	Various	58	.....	1,625
12 Index maps ...	Various	54	30	17,778
13 Miscellaneous maps ...	Various	48	38	17,884
Totals ...	.....	483	412	3,40,000

The total number of printed maps issued during the year was 1,42,421, of an aggregate value of Rs. 1,24,858. The details of the sales were as follows.

Sales to	Number of maps.	Value.
		Rs.
Government Officials ...	74,469	45,929
India Office ...	5,759	7,508
Departmental issues ...	40,803	51,763
Private individuals ...	19,230	17,617
Agents ...	1,980	2,041
Totals ...	1,42,421	1,24,858

A new catalogue of maps corrected up to February 1st 1910 was published during the year.

## MATHEMATICAL INSTRUMENT OFFICE.

There has been a large falling off in the demand for new instruments and also for the manufacture and repair of instruments required to be done in the workshops. In the former case the diminution amounted to 32 per cent. and in the latter to 24 per cent. on the average values of the two previous years.

This heavy decrease in demand and the consequent increase in the value of the stock in hand, on which  $3\frac{1}{2}$  per cent. interest charges are levied, have combined to show deficits in the profit and loss accounts of the instrument store and workshops, amounting in the former case to Rs. 20,176 and in the latter to Rs. 15,270.

Good progress has been made in the manufacture of more delicate instruments, such as theodolites, levels, clinometers and all descriptions of scales and offsets; the dividing and engraving of the latter have been greatly facilitated by two new machines, an automatic dividing machine and an engraving machine, which were installed during the year.

A noteworthy piece of work was the design and manufacture of the largest adjustable plan board that has ever been made or used in India. This plan board measures 11 feet 9 inches by 10 feet 3 inches, and the whole weight is taken by a ball-thrust which makes its adjustment particularly easy. It is now in use in the studio of the Photo.-Litho. Office, in connection with the photographic reduction of combined standard sheets for the preparation of degree sheets on the  $\frac{1}{4}$ -inch scale.

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## II.—DEHRA DÚN OFFICES.

## A. SPECIAL OPERATIONS.

The erection of the base line observatory was commenced in May 1909. In accordance with instructions received from the Secretary of State, the plans were sent home for Sir David Gill's inspection. Building operations had to be temporarily suspended but were resumed on receipt of the plans from Sir David.

Approximate sites for the measurement of base lines in Burma and Baluchistán have been selected, and a complete apparatus of wires has been purchased to replace the old compensation bars.

Photographs of the sun were taken on 337 days in the year. It is hoped that on the 28 days when the sun was completely obscured, photographs of it were secured either at Greenwich or Mauritius.

## B. COMPUTING SECTION

The chief points of interest in the work of this section are as follows:—

*Geodetic work.*

During the summer of 1910 the simultaneous reduction of the levelling was completed. All closing errors of circuits were eliminated, the level net was tied to sea level at nine different ports, orthometric corrections were applied, and adjusted values for the heights of all bench-marks fixed between 1858 and 1909 were obtained. A complete account of the levelling operations of the Survey,—of the methods of observation, of the instruments and bench-marks, of the connections with sea level, of the accuracy of results,—has now been published in Volume XIX of the *Account of the Operations of the Great Trigonometrical Survey of India*.

The publication of this volume marks the close of the first half-century of levelling work in India, and provides a scientific and consistent basis for the levelling operations of the future.

*Geographical work.*

Barometric observations for height in Central Asia by Doctor Stein and clinometric observations for heights of certain Himalayan peaks by Doctor Longstaff were reduced, and the results supplied to the Drawing Office for incorporation in maps.

Computations of Captain Robinson's triangulation in Kohistán and Sind Ságar Doab during 1851—59 were partly undertaken, for incorporation in the trans-frontier degree triangulation charts.

The co-ordinates and heights of a few more peaks from Captain Wood's triangulation in Western Tibet were computed and adjusted, for incorporation in the map of Tibet.

Certain tables of the 4th edition of the Auxiliary Tables were extended to 45° N. latitude, for inclusion in a smaller edition for the use of explorers.

Synoptical Volume No. XXXV of the North East Longitudinal Series passed through the press and was issued. This volume furnishes data of points in the Himalayas from Dehra Dún to Assam, and some of the highest peaks in the world fall within its area. The new system of numbering Himalayan peaks mentioned on page 15 of the General Report for 1907-08 has been adopted in it. Mount Everest will in future be known as  $\frac{\text{Peak 37}}{72.1}$  in addition to its old name.

*Preservation of trigonometrical stations.*

695 Principal stations of the 3,598 in existence were repaired by district officers at a cost of Rs. 4,057; 15 old stations were reported as destroyed, and 25 new stations were added. Out of 333 districts from which reports are due annually, 18 failed to make returns.

C. DRAWING SECTION.

The following table shows the volume of work undertaken.

Class of map.	Number of sheets in hand.	Number of sheets drawn and sent to press.
Geodetic and scientific diagrams and charts ...	218	116
Geographical maps, $\frac{1}{M}$ and smaller scales ...	11	4
Miscellaneous indexes and plans ...	8	7
Special maps for Doctor Stein ...	94	94
Totals ...	331	221

D. PHOTO.-ZINCO. SECTION.

1,750 maps and diagrams were photographed against 1,478 in 1908-09. The number of impressions pulled was 3,02,909 against 2,67,732 in the previous year. The machine lithographic press was employed throughout the year printing the maps of Doctor Stein's exploration, cantonment and forest maps and triangulation and levelling charts.

E. FOREST MAP OFFICE.

The number of maps issued to Forest and other officials during the year was 9,662 against 7,689 issued in 1908-09, and the amount realised by sales amounted to Rs. 1,555 against Rs. 3,312 in the previous year.

The following table shows in abstract from the work dealt with by the office.

Class of map.	NUMBER OF SHEETS.		
	In hand.	Drawn and sent to press.	Published.
Standard maps of Forest Surveys ...	229	69	46
Special maps of India ...	8	8	6
Provincial, Divisional and District Forest maps ...	9	4	5
Working plans and miscellaneous maps ...	15	7	8
Totals ...	261	88	65

The space for the storage of maps in the present building is insufficient to meet the demands which will eventually be made on it, and proposals have been submitted for its extension by the erection of a new building.

### III.—CIRCLE AND LOCAL DRAWING OFFICES.

#### A. NORTHERN CIRCLE DRAWING OFFICE.

The normal main work of the office was the examination of standard sheets drawn by the various parties, the drawing and examination of sheets which the parties (either from insufficient establishment or owing to a short recess season) had been unable to undertake, the preparation of special editions of standard sheets, and the drawing of degree sheets.

The office also undertook the drawing of certain sheets of the  $\frac{1}{M}$  series and the examination of standard sheets prepared in the United Provinces Drawing office mentioned below.

The following is a summary of the special work in hand and sent to press.

Class of map.	Scale.	NUMBER OF SHEETS.	
		In hand.	Drawn and sent to press.
Map of Turkistan	1 in. = 32 m.	1	.....
India and Adjacent Countries	$\frac{1}{1,000,000}$	5	1
Degree sheets	1 in. = 4 m.	18	4
Totals	.....	24	5

#### B. SOUTHERN CIRCLE DRAWING OFFICE.

The final examination of eight standard sheets was completed and assistance was given to the Eastern Circle Drawing Office in the completion of their arrears of mapping, and to the various parties in the Southern Circle in their current mapping.

The Photo.-zinc detachment of the office was taken over from the Eastern Circle and was fully occupied with photographic and vandyke work.

#### C. EASTERN CIRCLE DRAWING OFFICE.

The following table shows the number of maps and charts in hand and sent to press during the year.

Class of map.	Scale.	NUMBER OF SHEETS.	
		In hand for drawing, completion, or examination.	Sent to press.
Standard sheets	1 in. = 1 m.	59	59
Forest editions of above	2 in. = 1 m.	9	9
Village boundary editions of standard sheets	1 in. = 1 m.	5	5
Triangulation charts	1 in. = 4 m.	12	9
Degree sheets	1 in. = 4 m.	7	3
Miscellaneous maps	1 in. = 4 m.	2	2
Standard sheets (old form)	1 in. = 1 m.	4	4
Totals	.. ..	98	91

## D. BENGAL DRAWING OFFICE.

*(Imperial Section).*

The standard mapping section of this office continued its work of compilation of standard sheets from modern cadastral surveys for publication as preliminary editions in black only.

71 standard sheets covering an area of 9,748 square miles were dealt with; of these 14 have been submitted for publication and 6 are nearly complete. One traverse chart was completed.

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E. UNITED PROVINCES DRAWING OFFICE.

This office was again employed under the Superintendent, Northern Circle, on the compilation of standard sheets in the United Provinces in both new and old styles from old cadastral surveys.

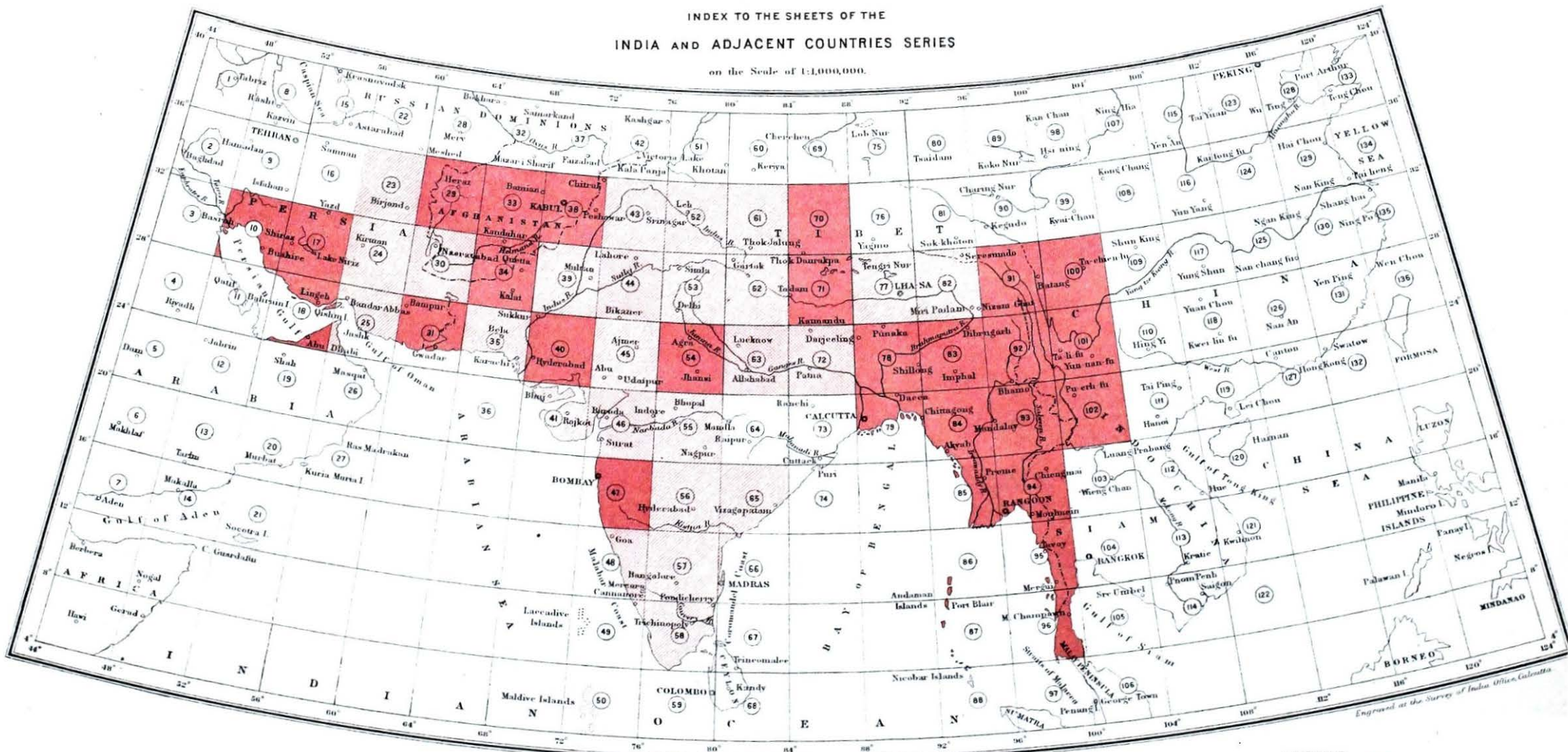
The new style sheets will be published as preliminary editions in colours, the old style sheets in black.

Twenty one sheets in the new and two in the old style were drawn and submitted for publication, and forty seven traverse charts were completed.



INDEX TO THE SHEETS OF THE  
INDIA AND ADJACENT COUNTRIES SERIES

on the Scale of 1:1,000,000.

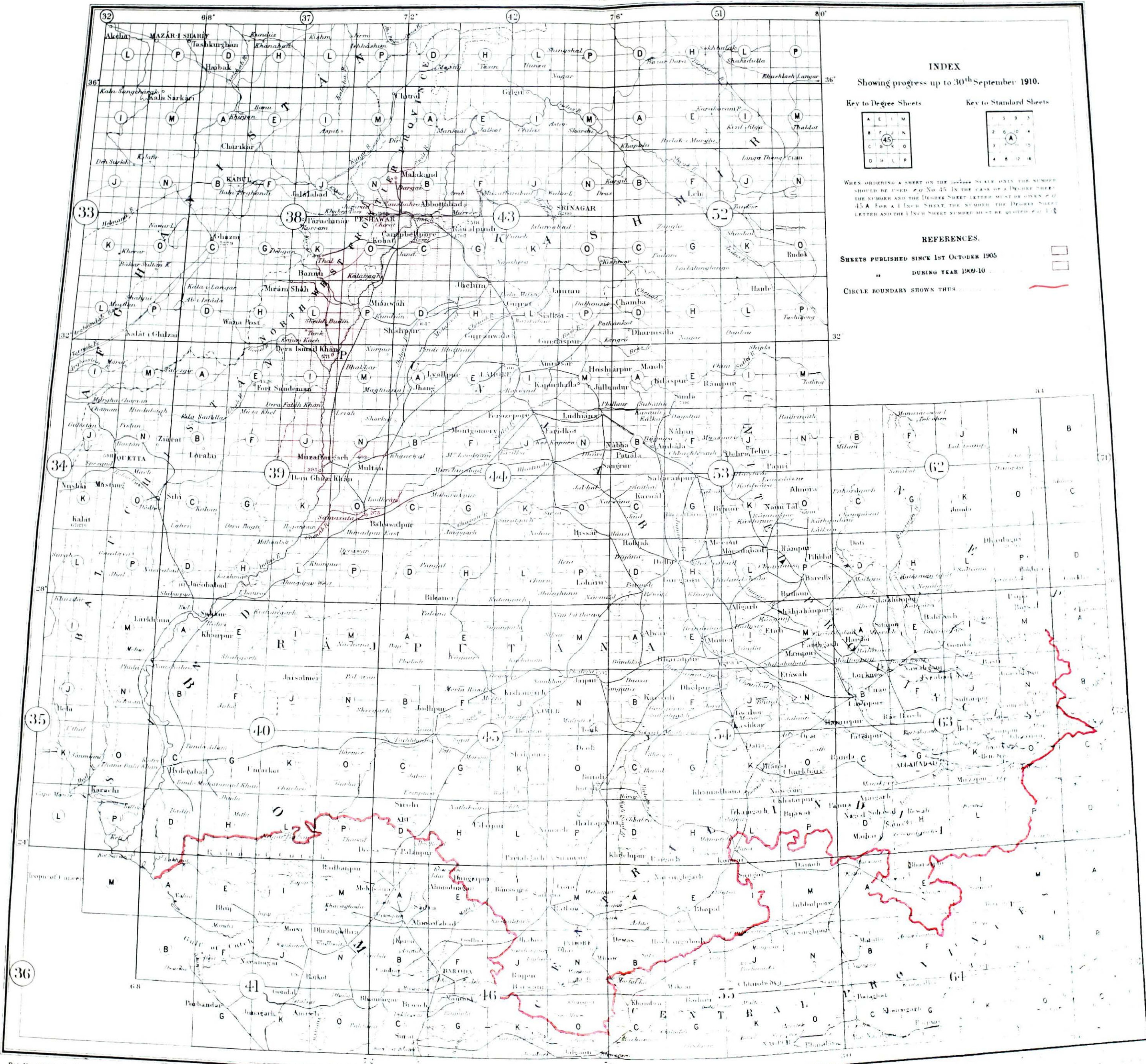


Published under the direction of The Hon'ble Colonel F. B. Lunge, R.E., A.D.C., Surveyor-General of India.  
1910.

Scale 1:1,000,000.  
Miles 0 200 400 600 800 Miles.

REFERENCE.

Sheets published   
under publication   
in hand



INDEX

Showing progress up to 30th September 1910.

Key to Degree Sheets



Key to Standard Sheets



WHEN ORDERING A SHEET ON THE 1:50,000 SCALE ONLY THE NUMBER SHOULD BE USED. IN THE CASE OF A DEGREE SHEET THE NUMBER AND THE DEGREE SHEET LETTER MUST BE GIVEN. IN THE CASE OF A 1:250,000 SHEET THE NUMBER, THE DEGREE SHEET LETTER AND THE 1:50,000 SHEET NUMBER MUST BE GIVEN.

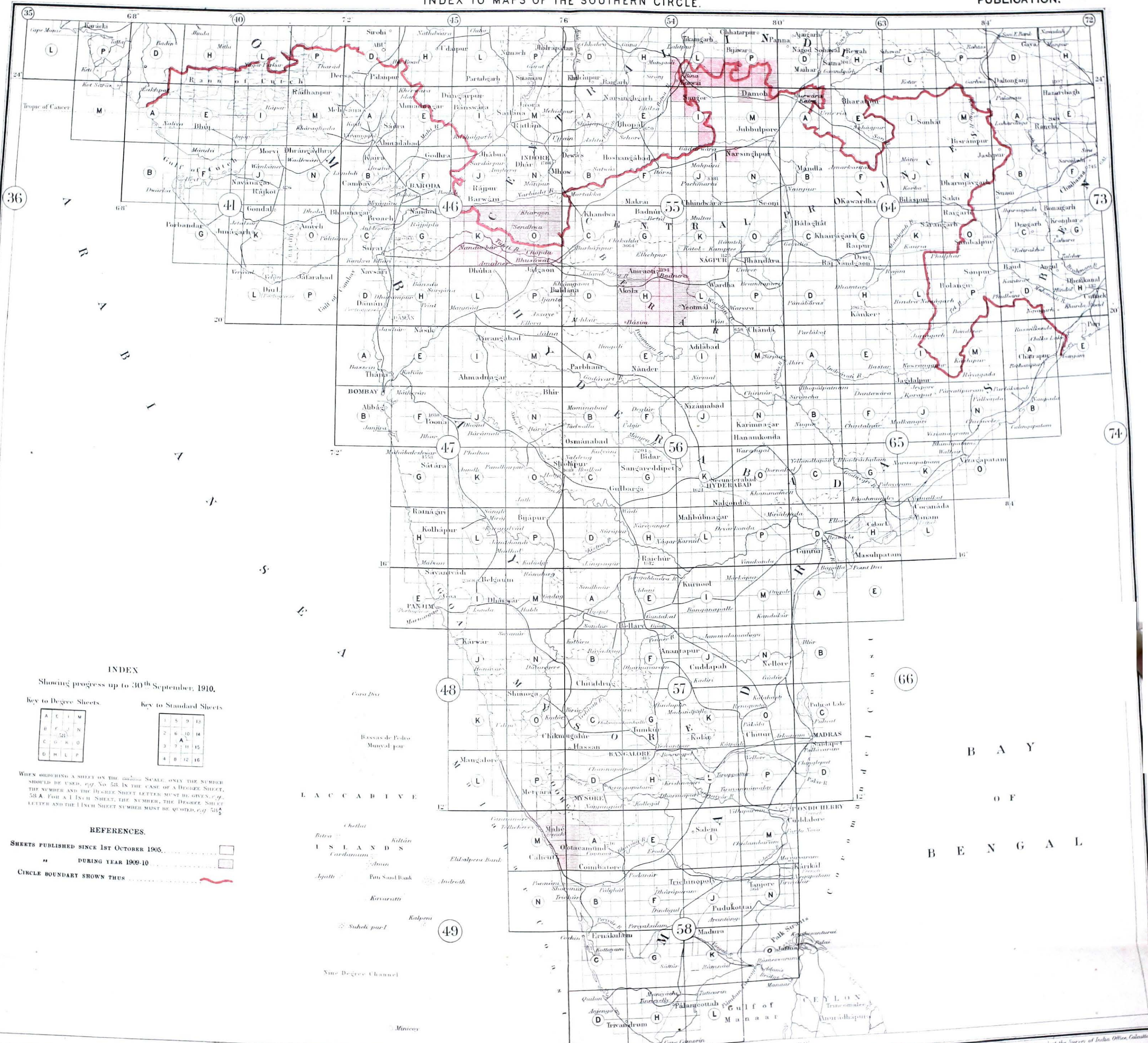
REFERENCES.

SHEETS PUBLISHED SINCE 1ST OCTOBER 1905

" DURING YEAR 1909-10

CIRCLE BOUNDARY SHOWN THIS





INDEX

Showing progress up to 30th September, 1910.

Key to Degree Sheets.

A	E	I	M
B	F	J	N
C	G	K	O
D	H	L	P

Key to Standard Sheets

1	5	9	13
2	6	10	14
3	7	11	15
4	8	12	16

When ordering a sheet on the *common* scale, only the number should be used, e.g. No. 53. In the case of a Degree Sheet, the number and the Degree Sheet letter must be given, e.g. 53 A. For a 1 Inch Sheet, the number, the Degree Sheet letter and the 1 Inch Sheet number must be quoted, e.g. 53 A 1.

REFERENCES.

- SHEETS PUBLISHED SINCE 1ST OCTOBER 1905.
- " DURING YEAR 1908-10.
- CIRCLE BOUNDARY SHOWN THUS

L A C C A D I V E

- Chetlat
- Islands: *Batra*, *Kiltan*, *Cardamum*, *Anau*
- Agath
- Putt Sand Bank
- Kavarath
- Suket par-I
- Sine Degree Channel
- Manicoy

B A Y  
O F  
B E N G A L

# GENERAL REPORT

ON THE

## OPERATIONS

OF THE

# Survey of India,

DURING THE SURVEY YEAR

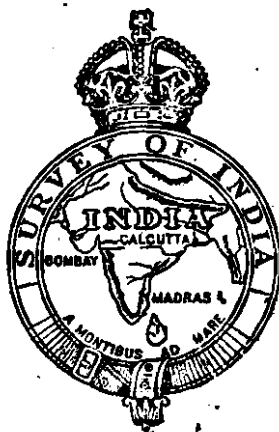
1909-10.

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PREPARED UNDER THE DIRECTION OF

COLONEL S. G. BARRARD, R.E., F.R.S.,

OFFG. SURVEYOR GENERAL OF INDIA.



Printed at the Photo.-Litho. Office, Survey of India,

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