

*Survey of India.*  
GENERAL REPORT,  
1914-15.

From 1st October 1914  
To 30th September 1915.

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PREPARED UNDER THE DIRECTION OF  
COLONEL SIR S. G. BARRARD, K.C.S.I., R.E., F.R.S.,  
SURVEYOR GENERAL OF INDIA.

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## INDEX MAPS (bound at end of Report).

1. Modern surveys and publication, Northern Circle.
2. " " " " Southern "
3. " " " " Eastern "
4. Publication of modern one-inch series, Northern Circle.
5. " " " " Southern "
6. " " " " Eastern "
7. " provisional editions of one-inch series, Northern Circle.
8. " " " " Eastern "
9. " modern half-inch series for India.
10. " " quarter-inch " "
11. " 'India and Adjacent Countries' series, scale  $\frac{1}{1,000,000}$ .
12. " Indian sheets of "La Carte Internationale du Monde," scale  $\frac{1}{1,000,000}$ .
13. " 'Southern Asia' series, scale  $\frac{1}{2,000,000}$ .
14. Progress of the Great Trigonometrical Survey.

# Survey of India.

## GENERAL REPORT,

1914—15.

From 1st October 1914

To 30th September 1915.

### PART 1.—GENERAL REMARKS.

# Survey of India.

## GENERAL REPORT,

1913—14.

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### ERRATUM.

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*Page 15, para. 41, line 5—*

For "150 feet to 1-inch" *read* "1,150 inches to one inch".

in the three circles, while the remaining eleven indexes show the progress in publication of the various series of maps appertaining to the scheme, and also the main framework of triangulation on which the Survey of India is based.

4. Table IV on page 32 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications apart from maps, may be found in the Annual "Records of the Survey of India"; and lists of new maps are published quarterly by the department, as well as in the monthly "Notes of the Survey of India".

5. Progress in the Trigonometrical Branch can only be assessed by a study of the "Records of the Survey of India" and the special publications issued at Dehra Dūn. The General Report can attempt little more than a brief abstract of the *locale* and nature of the different operations.

**6. Notable Events of the Survey year were as follows:—**

- (a) Owing to the war 33 Imperial Officers have been reverted temporarily to military duty and the services of 19 officers of the Provincial Service have been accepted by the Military Department during the year.
  - (b) Owing to the shortage of officers the field work of the whole department was considerably curtailed.
  - (c) A Survey detachment under an Imperial Officer accompanied the field-force in Mesopotamia and was subsequently reinforced by two more Imperial Officers and four Provincial Officers.
  - (d) The Map Record and Issue Office has been overhauled and it is hoped that the changes introduced will expedite and simplify the business of this office.
  - (e) The Government of India sanctioned in March 1915 the addition of a *new Tactical Map of India on the half-inch scale* to the topographical programme and good progress has already been made in the compilation of this map from available material.
  - (f) *Cavaliere de Filippi's expedition* has been brought to a successful conclusion.
  - (g) The detachment with the *Turco-Persian Frontier Commission* having completed its work returned to India.
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## II.—ADMINISTRATION AND PERSONNEL.

7. The cost of the department for the financial year ending 31st March 1915 was Rs. 33,84,535 against an estimated cost of Rs. 38,12,550.

8. Colonel Sir S. G. Burrard, K.C.S.I., R.E., F.R.S., administered the department throughout the year, having been granted an extension of service during the period of the war.

9. In the *Imperial Service*, Major F. C. Hirst, I.A., was permanently transferred under the Government of Bengal from 1st February 1914. Lieutenant H. M. McKay, R.E., was killed in action in France on the 13th November 1914. Lieutenant-Colonel R. T. Crichton, C.I.E., I.A., who was on deputation under Bengal reverted to the department from 24th November 1914 and Mr. J. deGraaff Hunter, M.A., who had hitherto held a special appointment was transferred to the cadre of the Imperial Service from 24th January 1915. During the year 33 officers temporarily reverted to military duty on account of the war.

In the *Provincial Service* there were 4 losses; Mr. V. D. B. Collins was killed in action in France, Mr. C. S. Littlewood died, Mr. J. P. Barker retired and Mr. E. J. H. Hanby resigned. Of the seconded officers Messrs. P. Beechy and N. Bedford retired and Messrs. C. A. O'Donel, P. F. Delaney and I. Newton were permanently transferred under the Bengal Government and Mr. O. E. C. Judd under the Assam Administration. Six officers of the Provincial Service were temporarily on deputation to military duty. Three officers received commissions in the Army while on leave in England and 10 officers received commissions in the Indian Army Reserve of Officers.

The total strength of the department at the close of the Survey year was 52 Imperial Officers, 124 Provincial Officers and 41 Upper Subordinates, besides specialists, clerks, lower subordinates and menials; but the number of officers of the first two services actually employed in the department were 19 Imperial Officers and 105 Provincial Officers, the remainder being on military duty.

10. The Computing Office has been made into an executive charge and will take its place amongst the other executive charges of the department.

11. The following Honours were conferred on members of the department during the year:—

<i>To be C.I.E.—</i>	Lieutenant-Colonel C. H. D. Ryder, D.S.O., R.E.
<i>Military Cross.—</i>	Captain F. P. Nosworthy, R.E.
<i>Distinguished Conduct Medal.—</i>	Messrs. E. C. O'Sullivan and A. J. A. Drake.
<i>Silver Medal from the Royal Geographical Society of Italy.—</i>	Major H. Wood, R.E., and Messrs. Jamna Prasad and Shib Lal.

12. The following table shows the distribution of officers during the year; the names of officers absent on long leave throughout the year or on deputation with Local Governments are omitted. Several names occur more than once on account of transfers from one office to another.

TABLE I—DISPOSITION OF OFFICERS, 1914-15.

SURVEYOR GENERAL OF INDIA—Colonel Sir Sidney G. Burrard, K.C.S.I., B.E., F.R.S.				
	<i>Imperial Officers.</i>	<i>Provincial Officers.</i>	<i>Upper Subordinates.</i>	<i>Lower Subordinates, &amp;c.</i>
Surveyor General's Office.	Major C. P. Gunter, B.E.			
No. 6 Drawing Office, Simla.	Lieut.-Colonel C. L. Robertson, C.M.G., B.E. Major H. H. Turner, B.E.	Mr. A. B. Hunter " A. A. Graham " W. H. Strong		*6 European Draftsmen. 25 Indian Draftsmen and Clerks. 4 Printers. 6 Surveyors, &c.
Basrah Survey	Lieut.-Colonel F. W. Pirrie, I.A.			
SUPERINTENDENT. MAP (Major W. M. Coldstream, B.E., up to 23rd September 1915. PUBLICATION— (Lieut.-Colonel C. H. D. Ryder, C.I.E., D.S.O., B.E., from 24th September 1915.				
	<i>Imperial Officers.</i>	<i>Provincial Officers.</i>	<i>Upper Subordinates.</i>	<i>Lower Subordinates, &amp;c.</i>
Map Publication Office, Calcutta.		Mr. M. Gastaud		
No. 1 Drawing Office, Map Record and Issue Office and Engraving Office, Calcutta.	Major H. L. Crosthwait, B.E. Captain H. J. Couchman, B.E.	T. W. Babonau " W. Skilling " J. H. S. Wilson " P. Williams " M. C. Petters " Jagdamba Prasad " C. C. Byrne " A. C. Bose " P. Simpson " P. N. Sur " E. J. H. Hanby		
Photo.-Litho. Office, Calcutta.	Major H. McC. Cowie, B.E. Capt. S. W. S. Hamilton, B.E.			
Mathematical Instrument Office, Calcutta.	Mr. T. A. Ferrier			
SUPERINTENDENT. NORTHERN CIRCLE—Colonel W. J. Bythell, B.E.				
	<i>Imperial Officers.</i>	<i>Provincial Officers.</i>	<i>Upper Subordinates.</i>	<i>Lower Subordinates, &amp;c.</i>
No. 3 Drawing Office, Mussoorie.		Mr. H. W. Biggie " J. A. Freeman " M. C. Petters		42 Clerks, Surveyors and Draftsmen, &c.
No. 1 Party, Kashmir.	Lt.-Col. C. H. D. Ryder, C.I.E., D.S.O., B.E.	Mr. F. B. Powell " G. J. S. Rae " H. H. B. Hanby " M. C. Petters " P. A. T. Kenny " D. K. Rennick " R. C. Hanson " W. J. B. Miller " E. J. H. Hanby	Mr. Natha Singh, B.S. " Nanak Chand Puri, B.A. " Hamid Gul	33 Surveyors, &c.
No. 2 Party, Punjab.		Mr. B. R. Hughes " F. B. Powell " Kanak Singh " R. E. Sanbelle " J. H. Johnson " J. A. Calvert	Mr. Chuni Lal Kapur " Lakshmi Dutt Joshi	40 Surveyors, &c.
No. 3 Party, United Provinces.	Captain F. F. Hunter, I.A. Captain F. B. Scott, I.A.	Mr. H. H. B. Hanby " E. J. Biggie " E. B. West " H. F. Hughes " G. E. R. Cooper " Moqimuddin	Mr. Mahomed Lutf Ali " Muhammad Husain	55 Surveyors, &c.
No. 4 Party, United Provinces.	Major L. C. Thuillier, I.A. Captain R. Foster, I.A.	Mr. H. W. Biggie " E. J. Biggie " H. P. D. Morton " J. C. C. Lears " Duni Chand Puri	Mr. Mohammad Husain Khan	47 Surveyors, &c.
No. 20 Party, Meerut, Dehra Dun, Saharanpur (Remount Depot), Hapur, Bahawalpur (Remount Depot), Santa Cruz, Kalka, Peshawar, Bannu, Jalandhar, Ludhiana, Samawal and Bakhal.		Mr. A. Ewing " F. C. Saint	Mr. Dharmu	27 Surveyors, &c.
Riverain Detachment, Punjab.		Mr. Maya Das Puri, B.S.	Mr. Paras Ram " Vidya Dhor Chopra	83 Surveyors, &c. 9 Naib Tahsildars, Kanungoes, &c.
Simla Survey Detachment, Simla.		Mr. C. E. C. French " W. H. Strong " O. D. Jackson	Mr. Chuni Lal Kapur " Paras Ram " Inam Din	14 Surveyors, &c.

\* Includes Army Section under Major C. J. Arbery.



TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1914-15.

SUPERINTENDENT, SOUTHERN CIRCLE)		Colonel T. F. B. Renny-Tailyour, C.S.I., R.F.				
	<i>Imperial Officers.</i>	<i>Provincial Officers.</i>	<i>Upper Subordinates.</i>	<i>Lower Subordinates, &amp;c.</i>		
<b>No. 4 Drawing Office, Bangalore.</b>		Mr. J. H. Nichol .....	Mr. B. V. Narayana Rao .....	39 Draftsmen, &c.		
		.. F. P. Walsh				
		.. P. R. Anderson				
<i>Training Section, Bangalore.</i>		Mr. W. M. Gorman .....	Mr. Hari Ram Chandra Jogalekar	15 Pupils.		
		.. S. S. McA'P. Fielding	.. E. N. Natesan, B.A.	} <i>Under training.</i>		
			.. Pulin Behari Roy		} * Resigned 1st June 1915.	
			.. Jitendra Mohan Mukerji			
			.. J. Sripati *			
<b>No. 5 Party, Central Provinces and Berar.</b>	Captain E. C. Baker, R.E. .... Lieutenant R. S. Wahab, I.A.	Mr. J. O'B. Donaghey .....	Mr. Ekmath Battu .....	32 Surveyors, &c.		
		.. F. C. Pilcher	.. Damodar Kadilkur			
		.. Munshi Lal, B.A.				
		.. C. O. Picard				
		.. A. V. Dickson				
<b>No. 6 Party, Berar, Bombay and Hyderabad.</b>	Lieut.-Col. F. W. Pirrie, I.A. ... Major L. C. Thuillier, I.A. Captain K. W. Pye, R.E.	Mr. P. R. Anderson .....	Mr. Ram Narayan Hastir	31 Surveyors, &c.		
		.. E. A. Meyer				
		.. Haji Abdul Rahim, K.B.				
		.. F. R. Kitchen				
		.. R. B. Gildea				
		.. J. C. St. C. Pollett				
		.. K. S. Gopalachari, B.A.				
		.. J. O'C. Fitzpatrick				
<b>No. 7 Party, Madras, Mysore and Pondicherry.</b>	Lieut.-Col. F. W. Pirrie, I.A. ... Captain J. D. Campbell, R.E.	Mr. W. M. Gorman .....	Mr. Abdul Hakk, K.S. ....	29 Surveyors, &c.		
		.. C. S. Littlewood (Died 16th August 1915).	.. Kodandera Mandanna			
		.. V. W. Morton	.. H. Narasimhamurti Rao			
		.. C. West				
		.. H. H. P. Butterfield				
		.. J. C. St. C. Pollett				
		.. N. S. Hariham Iyer				
<b>No. 8 Party, Madras.</b>	Major L. C. Thuillier, I.A. ... Major C. M. Browne, D.S.O., R.E.	Mr. W. F. E. Adams .....	Mr. Amantara Dhoodiba .....	36 Surveyors, &c.		
		.. S. F. Norman	.. Mandhre, R.S.			
		.. J. H. Williams	.. K. Narayanaswami Chetti			
		.. P. Kenney	.. P. S. Venguswami			
		.. M. Mahadeva Mudaliar, M.A.				
<b>SUPERINTENDENT EASTERN CIRCLE—</b>	{ Lieut.-Colonel C. L. Robertson, C.M.G., R.E., till 23rd November 1914. Lieut.-Colonel R. T. Crichton, C.I.E., I.A., from 24th November 1914.					
	<i>Imperial Officers.</i>	<i>Provincial Officers.</i>	<i>Upper Subordinates.</i>	<i>Lower Subordinates, &amp;c.</i>		
<b>No. 5 Drawing Office, Shillong.</b>		Mr. P. J. Barrington .....		22 Surveyors, Draftsmen, &c.		
		.. J. P. Barker, Retired March 2nd, 1915.				
<b>No. 9 Party, Bengal.</b>	Lieut.-Colonel C. L. Robertson, C. M. G., R.E.	Mr. J. Smith .....	Mr. Dalbir Rai .....	23 Surveyors, &c., 1 Soldier Surveyor.		
		.. Dhani Ram Verma	.. Ram Singh.			
		.. B. C. Newland				
		.. L. B. Fitz-Gibbon				
		.. A. K. Mitra				
		.. V. P. Wainright				
		.. W. P. Hales				
		.. D. N. Banerjee, B.A.				
<b>No. 10 Party, Upper Burma.</b>	Major E. T. Rich, R.E. ....	Mr. J. Smith .....	Mr. Hayat Muhammad, K.S. ...	22 Surveyors, &c., 4 Soldier Surveyors.		
		.. W. G. Jarbo	.. Maung Kyaw Nyein			
		.. H. B. Simons	.. Dharendra Nath Saha			
		.. V. W. Morton	.. Ram Prasad			
		.. Asmat-Ullah Khan, K.S.				
		.. C. B. Sexton				
		.. A. F. Murphy				
<b>No. 11 Party, Upper Burma.</b>	Captain L. G. Crosthwait, I.A. ....	Mr. J. O. Greiff .....	Mr. Lachman Daji Jadu, K.B. ...	32 Surveyors, Draftsmen, &c.		
		.. Asmat-Ullah Khan, K.S.				
		.. A. M. Talati, L.C.E.				
		.. F. E. R. Calvert				
		.. A. J. Booth				
		.. R. M. Wyatt				
<b>No. 12 Party, Assam.</b>	Lieut.-Colonel A. Meurs, I.A. ....	Mr. W. Skilling .....	Mr. Nanak Chand Puri, B.A. ...	35 Surveyors, &c., 7 Soldier Surveyors.		
		.. Pramadarangan Ray, R.S.				
		.. E. M. Kenny				
		.. P. C. Mitra, B. A.				
		.. H. H. Creed				
<b>Andamans Detachment.</b>		Mr. E. Claudius .....		8 Surveyors.		

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1914-15.

SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY—		Lient.-Colonel G. P. Lenox-Conyngham, R.E.		
	Imperial Officers.	Provincial Officers.	Upper Subordinates.	Lower Subordinates &c.
Trigonometrical Survey Office, Dehra Dun.	Mr. J. deGraaff Hunter, M.A.	Mr. H. A. Charrier " Hanuman Prasad	Mr. Sarat Kumar Mukerji	
Training School, Under training.	Captain W. E. Perry, R.E.		Mr. Jugal Behari Lal " Amir Abdul Salam " Matlub Ahmad " Girija Sonker Bagchi " Daulat Ram Vohra " Amulya Churau Ghosh " Ghulam Hasau " Ishwar Singh Beri* " Jagdeesh Prasad Vastav " Manzur Ali Taba Tabae* " Gopal Lal Mitra " Pratul Chandra Sen " Gupta	Under training. * Discharged 30th April 1915.
No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Major G. A. Beazeley, R.E.	Mr. J. Smith " O. C. Ollenbach " H. C. W. Stotesbury " O. N. Pashong " Abdul Karim " O. D. Jackson	Mr. Ram Singh, R.S. " Jamna Prasad " Shib Lal	
No. 13 Party, (Astronomical).	Lient.-Colonel G. P. Lenox- Conyngham R.E.			3 Computers, &c.
No. 14 Party, (Pendulums).	Major E. A. Tandy, R.E.		Mr. Satish Chandra Mukharji	3 Computers, &c.
No. 15 Party, (Triangulation).	Major E. A. Tandy, R.E.	Mr. L. Williams " G. A. Norman " B. T. Wyatt " A. J. Moore		19 Computers, &c.
No. 16 Party, (Total).		Mr. Syed Anlad Hosseini, K.B. " Syed Zille Hasnain " D. H. Luxa		20 Computers, &c.
No. 17 Party, (Levelling).		Mr. H. G. Shaw " D. H. Luxa " J. McCracken " T. F. Kitchen " M. S. Ganesa Aiyar " Jiya Lal Sahgal " N. N. Chuckerbutty	Mr. Karuna Kumar Das, B.A.	11 Computers, &c.
No. 18 Party, (Magnetic).		Mr. E. C. J. Bond " H. P. D. Morton " Rama Prasad Ray, B.A. " N. R. Mazumdar " Raj Bahadur Mathur, B.A.	Mr. Bidhu Bhusan Shome	18 Recorders, &c.
No. 19 Party, (Base Line).	Captain W. E. Perry, R.E.			1 Computer.
Exploration In Chinese Turkistan with Cav. Filippo de Filippi.	Major H. Wood, R.E.		Mr. Jamna Prasad	1 Surveyor
In Central Asia with Sir Aurel Stein			Mr. Lal Singh, B.B.	1 Surveyor.

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**PART 2.—FIELD WORK.****I.—TOPOGRAPHICAL SURVEYS.**

13. The two following tables show respectively the progress of the topographical programme assigned to the department in 1905, and the out-turns and costs of different parties during the year under report. They are followed by brief descriptions of the work of each topographical party.

In 1913, the Secretary of State sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas of India. This will greatly reduce the area of survey on the one-inch scale and consequently accelerate the rate of progress of topographical surveys shewn in Table II below. In order to give a better idea of what work actually lies before the department, it may be remarked that of the area remaining for survey about 620,000 square miles are likely to be surveyed on the half-inch or smaller scale.

**Table II.—Progress of Topographical Surveys since 1905.**

Survey year.	Scales of Survey.	Northern	Southern	Eastern	TOTALS.
		Circle.	Circle.	Circle.	
		<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>
1905-06 ...	Mostly 2-inch and 1-inch	6,278	1,660	10,322	18,260
1906-07 ...	ditto ...	7,519	7,666	8,659	23,844
1907-08 ...	ditto ...	14,530	9,256	12,431	36,217
1908-09 ...	ditto ...	18,624	12,526	11,542	42,692
1909-10 ...	Mostly 1-inch ...	23,838	12,532	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	23,852	9,115	10,654	43,621
1912-13 ...	Mostly 1-inch and $\frac{1}{2}$ -inch	28,192	13,349	11,836	53,377
1913-14 ...	ditto ...	25,052	15,844	14,890	55,786
1914-15 ...	ditto ...	12,334	19,286	5,056	36,676
<b>Total Areas completed to date ...</b>		<b>187,742</b>	<b>114,405</b>	<b>104,344</b>	<b>406,491</b>
<b>Approximate areas for the whole topographical programme.</b>		<b>750,000</b>	<b>542,800</b>	<b>528,800</b>	<b>1,821,600</b>
<b>Approximate areas remaining for survey.</b>		<b>562,258</b>	<b>428,395</b>	<b>424,456</b>	<b>1,415,109</b>

NOTE.—The figures of the Northern Circle for the years 1905-07, 1908-09 and 1912-14 have been altered since the publication of the General Report for the year 1913-14.

Table III.—OUT-TURNS and COSTS of Topographical Surveys, 1914-15.

PARTY and LOCALITY.		OUT-TURNS.		TOTAL COSTS.		REMARKS.
Character of ground.	Scale and type of Survey.	Areas on each Scale.	Totals on all Scales.	Survey and Mapping.	Cost-rates.	
		Sq. miles.		Rs.	Cost-rates.	NORTHERN CIRCLE.
				Rs.	Rs.	
<b>No. 1 Party—Kashmir.</b>						* Excludes Rs. 1,730 cost of move of Perso-Baloch Detachment. This Detachment was abolished and no work was done.
Mountainous and wooded	... 1-inch Survey ...	2,195	2,445	88,322	36.1	
Very high Himalayas	... 1/2-inch Survey ...	250				
<b>No. 2 Party—Punjab.</b>						† Includes Rs. 3,084 on account of pay, &c. of Establishment of No. 4 Party employed on mapping in No. 1 Party.
Plains, irrigated and non-irrigated	1-inch Survey ...	844	3,394	71,500	21.1	
Plains, sand hills and rocky outcrops	1-inch Revision Survey ...	2,550				
<b>No. 3 Party—United Provinces.</b>						‡ Includes Rs. 95-10-8 and 7,849-0-3 cost of work on Kumana and Ramnagar Forests respectively debitable to the Forest Departments concerned.
Plains and wooded hills	... 1-inch Resurvey ...	1,359	3,028	85,998	28.4	
Open and wooded plains	... 1-inch Revision Survey ...	1,669				
<b>No. 4 Party—United Provinces and Nepal.</b>						§ Excludes Rs. 3,084 on account of pay, &c. of establishment employed on mapping in No. 1 Party.
Plains wooded	... 1-inch Resurvey ...	3,467	3,467	66,354	19.1	
<b>TOTALS, NORTHERN CIRCLE:—</b>				12,334 sq. m.	Rs. 3,12,174	Cost-rate 25.3
		Sq. miles.		Rs.	Cost-rates.	SOUTHERN CIRCLE.
				Rs.	Rs.	
<b>No. 5 Party—Central Provinces and Berar.</b>						}
Intricate hills, open undulating plateau and cultivated plains.	1-inch Survey ...	3,070	4,435	79,761	18.0	
Forest-clad hills	1-inch Revision Survey ...	1,357				
Ditto	2-inch Survey ...	8				
<b>No. 6 Party—Berar, Bombay and Hyderabad.</b>						}
Varied, mostly undulating	1/2-inch Survey ...	5,096	7,640	95,885	12.6	
Intricate hills, rough country	1-inch Survey ...	2,261				
Open plains and undulating	1-inch Revision Survey ...	261				
Intricate, with thin forest	2-inch Survey ...	22				
<b>No. 7 Party—Madras, Mysore and Pondicherry.</b>						}
Rocky hills and cultivated plains	1-inch Survey ...	2,921	5,423	88,193	16.3	
Undulating plateau	1-inch Revision Survey ...	1,929				
Rocky hills, partly wooded	1-inch Supplementary Survey ...	134				
Low hills and open plains	2-inch Survey ...	439				
<b>No. 8 Party—Madras.</b>						}
High forest-clad hills	1-inch Survey ...	1,280	1,788	1,11,521	62.4	
Undulating enclosed coast country	1 1/2-inch Survey ...	508				
<b>TOTALS, SOUTHERN CIRCLE:—</b>				19,286 sq. m.	Rs. 3,75,360	Cost-rate 19.5
		Sq. miles.		Rs.	Cost-rates.	EASTERN CIRCLE.
				Rs.	Rs.	
<b>No. 9 Party—Bengal.</b>						} No detail survey was undertaken by this party during the year.
<b>No. 10 Party—Upper Burma.</b>						
Mostly hilly and thickly wooded	1-inch Survey ...	1,833	2,068	1,24,659 (a)	49.8	
Ditto ditto	1-inch Revision Survey ...	57				
Ditto ditto	2-inch Survey ...	178				
<b>No. 11 Party—Upper Burma.</b>						} No. 1-inch mapping was done during the year.
Hilly and densely wooded	1-inch Revision Survey ...	315	315	5,180	16.4	
<b>No. 12 Party—Assam.</b>						} (b) Includes 21 sq. miles special forest survey.
Open and high grass covered plains and densely wooded hills.	1-inch Survey ...	1,841	2,448	1,40,231 (c)	57.2	
	1-inch Supplementary Survey ...	223				
	2-inch Survey ...	353 (b)				
	4-inch Special Forest Survey ...	31				
<b>Andamans Detachment—Andaman Islands.</b>						} (d) Excluding cost of mapping, to be done by Forest Map Office.
Densely wooded hills and mangrove swamps.	2-inch Skeleton Survey (un-contoured.)	225	225	20,927 (d)	93.0	
<b>TOTALS, EASTERN CIRCLE:—</b>				5,056 sq. m.	Rs. 2,90,997	Cost-rate 57.5
<b>GRAND TOTALS:—</b>				36,676 sq. m.	Rs. 9,78,531	Cost-rate 26.6

**NORTHERN CIRCLE** (*vide index map No. 1*).

**14. No. 1 Party.**—The reduced area of survey shown in Table III is due to the curtailment of the winter programme of field work. The Party kept only one detachment in the field which worked during the late autumn and the following summer in the high Himālayas near Kiehtwār, and to the North and West of that place in Jammu State, the country varying from 3,000 feet to over 20,000 feet in altitude. Two khalasis lost their lives by accidents in climbing these heights, and difficulties of transport and of weather were considerable.

Triangulation in advance was carried on southwards to the neighbourhood of Dalhousie and is now complete down to the plains of Gurdāspur.

The bulk of the Party remained at Mussoorie throughout the year and a programme of half-inch fair mapping has been commenced by that portion of the Party which did not take the field.

**15. No. 2 Party.**—This Party surveyed a total area of 3,394 square miles on the 1-inch scale in the districts of Hissār, Karnāl, Rohtak, Delhi, Gurgaon and in the States of Jind, Pataudi and Dujāna. The country surveyed was flat except for occasional sandhills and rocky outcrops; portions only being canal irrigated.

In addition, triangulation and traversing of 1,200 square miles and 284 linear miles respectively were carried out for future half-inch detail survey in parts of Alwar and Bharatpur States.

**16. No. 3 Party.**—This Party surveyed on the 1-inch scale an area of 3,028 square miles, of which 1,359 square miles were re-survey, and 1,669 square miles revision survey.

All the work lay in the United Provinces and embraced parts of the following districts, Bijnor, Sahāranpur, Dehra Dūn, Garhwāl, Muzaffarnagar, Meerut, Naini Tal, Bareilly, Pilibhit, and Shāhjahānpur.

With the exception of a small area of the Siwālik hills in Sahāranpur and Dehra Dūn districts, and a part of the Kumaun hills, east of the Ganges river facing Hardwār, the country surveyed was flat; forest-clad areas were encountered along the foot hills, also in the Tarāi tahsil of Naini Tal district, and in parts of Pilibhit.

**17. No. 4 Party.**—This Party surveyed an area of 3,467 square miles of re-survey on the scale of 1 inch to 1 mile in the districts of Bāra Bankī, Fyzābād, Sultānpur, Partābgarh, Jaunpur, Azamgarh and Basti. The area consists of plains of which the greater portion is highly cultivated and covered with orchards, mango trees being in abundance. It is well-wooded but there is no forest, though scrub jungle occurs in many places. The principal rivers that run through portions of the area that came under survey are the Gogrā and the Gumti.

**18. Recess Work.**—The whole of the area surveyed this year by the Northern Circle will have been fair-drawn by the parties before they take the field next season.

**19.** The work of the following party and detachments, also belonging to this Circle, is reported on pages 15 to 17. *No. 20 Party (Cantonment)*—*Punjab Riverain detachment and Simla Survey detachment.*

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**SOUTHERN CIRCLE** (*vide index map No. 2*).

**20. No. 5 Party.**—This Party surveyed an area of 4,435 square miles in the Hoshangābād, Nimār, Betul and Wardhā districts of the Central Provinces and in the Amraoti and Akola districts of Berār, triangulated an area of 3,506 square miles in the Nimār district of the Central Provinces,

in the Buldāna, Amraoti and Akola districts of Berār, in the East Khandesh district of Bombay and in the Indore State of Central India, and traversed 42 linear miles in the Buldāna and Akola districts of Berār. The nature of the country surveyed varies considerably and consists of forest-clad hills of the Sātpurā and Gāwilgarh ranges, undulating and cultivated portions of the Sātpurā plateau and highly cultivated plains of Berār.

**21. No. 6 Party.**—This Party surveyed an area of 7,640 square miles in the Buldāna district of Berār, in the East Khandesh and Ahmadnagar districts of Bombay and in the Aurangābād, Parbhani and Bhir districts of Hyderabad, and triangulated an area of 7,335 square miles in the Bhir, Osmanābād, Nānder, Bidar and Nizāmābād (Indūr) districts of Hyderabad. The country surveyed is of a varied nature, consisting to the north of intricate hills and to the south of broad undulating valleys and cultivated lands broken by rocky ridges with occasional high and rocky flat topped hills. More than two-thirds of the area under survey is in Hyderabad and was mostly surveyed on the  $\frac{1}{4}$ -inch scale.

**22. No. 7 Party.**—This Party surveyed an area of 5,423 square miles in the North Arcot, South Arcot and Chingleput districts of Madras, in the Kolār, Mysore, Tumkūr and Bangalore districts of Mysore and in the French settlement of Pondicherry, and triangulated an area of 2,309 square miles in the Chittoor, Chingleput, Cuddapah, North Arcot and Nellore districts of Madras. The country consists of forest-clad hills mostly reserved forests, lower rocky hills covered with scrub or devoid of vegetation, open cultivated plains with detached rocky knolls and rocky outcrop and the open undulating plateau land of Mysore.

**23. No. 8 Party.**—This Party surveyed an area of 1,788 square miles in the Tinnevely district and the Travancore State of Madras, triangulated an area of 1,366 square miles in the Tinnevely district, and traversed 144 linear miles in the Travancore State. The country surveyed is very varied in character and extends from the densely inhabited and intricate country along the coast to the high range of mountains separating the Travancore State from the Tinnevely district, most of the high ground is forest-clad, uninhabited and difficult of access. The survey was laborious and entailed considerable hardships on the members of the party.

**24. Recess Work.**—The whole of the area surveyed this year by the Southern Circle will have been fair-drawn by the parties before they take the field next season.

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#### EASTERN CIRCLE (*vide* index map No. 3).

**25. No. 9 Party.**—No. 9 Party traversed an area of 2,870 square miles in the Burdwān, Nadiā and Murshidābād districts, in which 1,244 linear miles of theodolite traverse in advance of detailed topographical survey were completed. The country is absolutely flat and thickly populated particularly along the banks of the large streams, but very low-lying and consequently malarious. Communication was easy by means of carts, but some difficulty was experienced in procuring them as the people were not always ready to hire them except at monthly rates. The traversing was based on the stations of the Calcutta Meridional Series of the Great Trigonometrical Survey. No detail survey was undertaken owing to the curtailment of the field programme. The Party with the exception of one traverse camp was consequently employed on half-inch mapping at Shillong.

**26. No. 10 Party.**—No. 10 Party surveyed an area of 2,068 square miles in the Kathā, Myitkyinā and Putao districts of Upper Burma including 400 square miles of country beyond the Burma-China Frontier and in unadministered territory. 3,320 square miles were triangulated in the Myitkyinā and Putao districts and 164 linear miles of forest boundary surveys were completed. The country surveyed varied from the low lying Kaukkwe valley in the Kathā district which was less than 500 feet above sea level, to the high hills along the Burma-China Frontier, some of which were over 13,000 feet high and covered with snow during the winter months. Both plains and hills were thickly wooded and it was difficult to obtain views of the surrounding country except where ground had been cleared for cultivation.

**27. No. 11 Party.**—No. 11 Party was employed on half-inch mapping, only a small section of the party was employed in the neighbourhood of Maymyo, on the revision survey, on the 1-inch scale of 315 square miles and on the traversing of 195 linear miles of forest boundaries, for special forest surveys.

**28. No. 12 Party.**—No. 12 Party surveyed an area of 2,448 square miles on all scales in the Sibsāgar, Darrang, Nowgong and Lakhimpur districts of Assam and carried out 858 linear miles of traversing. Of the above area, 353 square miles comprised a 2-inch scale survey of reserved forests and 31 square miles of special 4-inch forest survey. The country under survey consists partly of the alluvial plains of the Brahmaputra valley and partly of the Mikir Hills which rise to an elevation of nearly 4,500 feet and are almost entirely covered with dense forest growth. A considerable portion of the plains is under tea and paddy cultivation interspersed with large tracts of tree and high grass jungle; most of the latter area is flooded during the rainy season and is swampy and much cut up by "bils" and streams.

**29. Recess Work.**—The whole of the area surveyed this year in this circle will have been fair-drawn by the parties before they take the field next season with the exception of seven sheets of No. 10 Party of which the fair-drawing is well advanced and will be completed later on.

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## II.—FOREST SURVEYS.

30. During the year 1914-15, the forest surveys have, as usual, been carried out by the topographical parties of the Survey of India. In the majority of cases, the surveys were executed on the scale of 2 inches to the mile but in some few instances, the work was done on the 1-inch scale. A considerable extent of forest boundaries was also surveyed on the scale of 4 inches to the mile.

## NORTHERN CIRCLE.

31. No forest surveys were carried out in this Circle during the year under report but certain areas have been traversed and triangulated for a special survey on behalf of the Forest Department, in the Rāmnagar and Nainī Tal divisions.

## SOUTHERN CIRCLE.

32. **Central Provinces** (*Berār Forest Circle*).—The survey on the 4-inch scale of an area of  $3\frac{1}{2}$  square miles which had been left over from the previous programme, in the Dadgaon and Gumi reserves of the Buldāna division, was taken up by No. 6 Party, and in addition, small areas of B and C class forests, aggregating 3 square miles, were surveyed on the 2-inch scale. Theodolite traverses, amounting to  $50\frac{3}{4}$  linear miles, were also run round the boundaries of these blocks and were plotted on the 4-inch scale. These surveys completed the forest areas in the Buldāna division falling within the programme of No. 6 Party.

In the course of its ordinary operations, No. 5 Party surveyed an area of  $7\frac{1}{2}$  square miles of Narnāla block in the Akola division on the 2-inch scale. No new theodolite boundary traverses were executed in this division but the survey was carried out by plane-table traverses and interpolation based on points trigonometrically fixed.

33. **Madras Presidency**.—Ten reserved forests, comprising a total area of  $51\frac{1}{2}$  square miles, were surveyed on the 2-inch scale by No. 7 Party during the year. Five of these forests are situated in the North Arcot district and the remainder in the Chingleput district. As a sufficiency of suitable surrounding points was available, the survey was carried out chiefly by interpolation but this had to be supplemented by plane-table traversing in parts; it was found impossible, owing to the flat nature of the country, to fix any conspicuous points. During the progress of survey, all the reserves were checked with the Government notifications and the boundary pillars with their numbers entered where they existed.

34. **Bombay Presidency**.—In the East Khāndesh district, three forest blocks, comprising an area of 10 square miles, were surveyed by No. 6 Party on the 2-inch scale and their boundaries, amounting to 27 linear miles, were rigorously traversed by theodolite and plotted on the 4-inch scale.

## EASTERN CIRCLE.

35. **Upper Burma**. (*Northern Forest Circle*).—No. 10 Party surveyed the Namkwin, Teinlon and parts of the Nantan and Nanyinkha reserves in the Myitkyinā division, and the Loimaw and parts of the Mannaw, Nanhin, Mawhun and Mohnyin reserves in the Kathā division, amounting to 176 square miles, on the 2-inch scale. In addition to these surveys,

164 linear miles of boundary survey on the 4-inch scale, were completed round the Maingnaung, Naminun, Namma, Nanyinkha and Indawgyi reserves of the Myitkyinā division and round the Nankobin and Namaw reserves of the Mansi division.

**Upper Burma.** (*Southern Forest Circle*).—No. 11 Party completed theodolite traverses, totalling 195 linear miles, round the boundaries of forest reserves Baw, Baw Extension, Zibingyi-Tonbo, Kywetnapa and Nyaungdauk in the Mandalay Division. The Baw and Baw Extension forest reserves are for special survey, on the 4-inch scale.

**36. Assam.**—No. 12 Party carried out, in the course of ordinary topographical operations, the survey on the 2-inch scale, of the Mikir Hills, Kaliāni, Panbāri, Upper and Lower Daigurung, Nāambar (part) and Dayāng (part) reserves embracing an area of 332 square miles. In addition, the balance of the Kāziranga reserved forest, a game sanctuary, was surveyed on the 1-inch scale, the Forest Department being of the opinion that this scale would meet their requirements. The special survey of the Upper Dihing reserve was completed, comprising areas of 21 and 31 square miles, surveyed respectively on the 2-inch and 4-inch scales; the cost of this work has been exclusively borne by the Forest Department.

**37. Andaman Islands.**—During the year under report, special forest surveys were continued by a detachment consisting of 8 surveyors under the superintendence of a Provincial Officer of the Survey of India and a detailed skeleton survey on the scale of 2 inches=1 mile, was made of 225 square miles in the island of Baratang and parts of Middle and South Andaman Islands. In addition, 93 linear miles of traversing were run.

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## III.—CANTONMENT AND LARGE-SCALE SURVEYS.

**38. No. 20 Party (Cantonment).**—During the year under report, the Party was employed on the survey of Meerut, Dehra Dūn, Landour, Sahāranpur and Hāpur (Bābūgarh) Remount Depôts on scale 16 inches to a mile; and of the bazars of Meerut and Dehra Dūn on scale 64 inches to a mile. The triangulation and traversing of Peshāwar, Jullundur, Bannu, Kālka, Sanāwar, and Bakloh have been completed in advance for season 1915-16. Also during the year Santa Cruz was retraversed to prepare a table of bearings and distances of boundary pillars. A survey of the proposed pipe-line for new Delhi was done for the Military Works Department, and the Guide Map of Mussoorie and Landour brought up to date.

Twenty-one fair maps have been sent for publication, eight fair maps have been completed and are being sent for publication, twenty-four sheets of Meerut are in hand and are nearly completed, and nine sheets of Dehra Dūn and Landour which have just been surveyed will be drawn and sent for publication in March 1916.

The programme for the ensuing year is the survey of Peshāwar, Upper Drosh, Lower Drosh, Chitrāl, Simla Lines, Kālka, Sanāwar, Bakloh, Jullundur, Fort Lockhart, Hangu, Thal and Bannu and the triangulation and traversing in advance of Nimach, Rāwalpindi, Upper and Lower Topa, Jhelum, Siālkot and Chaman.

## Out-turn and cost-rates of Cantonment Surveys, 1914-15.

Cantonments.	Scales.	Out-turn Acres.	Total cost. Rs.	Cost-rates per acre. Survey and mapping. Rs.	REMARKS.
Meerut, Sahāranpur Remount Depôt, Hāpur (Bābūgarh) Remount Depôt, Landour and Dehra Dūn ...	16"=1 Mile	19,260	41,206'57	2'14	Cantonment Bazars.
Meerut and Dehra Dūn ...	64"=1 Mile	318	4,694'82	14'76	
		19,578	45,901'39		

## Alphabetical List of Cantonments surveyed in the new style up to 1914-15.

- (1) Dehra Dūn Cantonment, Scale 16 inches = 1 mile.
- (2) Guna do. do. do.
- (3) Hāpur Remount Depôt do. do.
- (4) Kamptee Cantonment do. do.
- (5) Landour do. do. do.
- (6) Meerut do. do. do.
- (7) Quetta do. do. do. Surveyed by No. 4 Party.
- (8) Quetta Civil Station do. do. Surveyed by No. 4 Party.
- (9) Rājkot Cantonment do. do.
- (10) Sahāranpur Remount Depôt do. do.
- (11) Saugor Cantonment do. do.

**39. Punjab Riverain Detachment.**—The detachment continued the work of traversing and laying out bases in the areas under water action of the Sutlej, Rāvi, and Chenāb rivers in the districts of Jullundur, Siālkot and Gujrāt. It also demarcated rectangles with permanent mark stones on the banks of the Chenāb river (districts Gujrāt and Gujranwāla). These rectangles are to serve as bases for future survey and demarcation of boundaries in the bed of the river. A small area of similar work was also done at the request of the Settlement Officer along the river Rāvi in the Siālkot district. The work has been completed and plotted, and traces are being supplied to the Settlement Officers concerned.

**40.** *The Kāngra special survey* was started at the end of October 1914 in the Kāngra *tahsil* in continuation of last year's programme under similar conditions as existed during the previous season. In order to reduce the cost no boundaries were enlarged from the topographical maps in the snowy portions and tracts covered with forest reserves, except 2 miles disputed State boundary falling in 3 "*masāvis*" between Chamba and Nūrpur *tahsil*. 3,464 linear and 494 square miles were traversed and triangulated.

**41.** Under orders of the Punjab Government, the *Simla Settlement Survey* was started early in November 1914 in the Bharauli tract of the Simla district. During January 1915 the Simla Survey proper was commenced, where, in addition to the ordinary work 272 stations (239 boundary pillars and 33 stones) with heights, were picked up for the Simla detachment. After completing the Simla *tahsil* the Kot Khai *tahsil* was taken up during May 1915. As the work here was urgently required by the Settlement authorities it was continued during the whole of summer. In all 1,106 linear and 53 square miles were traversed and triangulated.

**42.** With a view to prepare a correct map on the same basis as that of the Kāngra Settlement and thus to avoid future boundary disputes, the survey of the *Kāngra trunk road* was undertaken during February 1915 at the request of the Executive Engineer, Provincial Division, Kāngra. Off-sets were taken on traverse lines to various boundary turnings and pillars and after applying the necessary corrections to distances measured along the road, for elevation or depression, the results were plotted on the scale 200 feet to an inch. Portions of the road facing 16 important bazars were plotted on the scale 50 feet to an inch. The plots were then tested on the ground in various places by the camp officer. Theodolite stations traversed for the Settlement Survey were generally utilized and in addition 418 fresh points covering 34 linear miles were laid out. In all 39 miles of the road were surveyed. Plots were prepared and traces are being submitted to the Executive Engineer.

**43.** As required by the Deputy Commissioner, Lahore, a small area of 719 acres was traversed and surveyed on the scale 12 inches to a mile to check the boundaries of grass land in the *Lahore Cantonment*.

**44.** 32 stations covering 29 linear miles were redemarcated in the *Khushab Thal* (sandy area) at the request of the Settlement Officer, Shāhpur. The cost was debited to the Settlement Officer.

**45. Simla Survey Detachment.**—The detachment remained at Simla, and continued the survey of the station.

During the year the following work was also undertaken:—surveys of a spur near Sanjauli, an extension of the Simla area, a map of the forest lands in Koti State, and several plans (with information such as, spirit levelled heights, sectional drawings, areas, &c.) required to illustrate proposals for the improvement of the station.

The mapping of 10, out of 31 sheets of the Simla survey, is well advanced. The plans of the Simla extension and Sanjauli-spur will be ready in October.

The Koti State forest map has been sent for publication.

There remains for completion:—(a) 2·3 square miles of the Simla survey with the drawing of 21 sheets and (b) a proposed plan of 5·3 square miles of country required to illustrate a boundary dispute between Patiala and Koti States.

It is estimated that these will be completed by March 1916.

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## IV.—TRIGONOMETRICAL SURVEYS.

## GEODETIC OPERATIONS.

**46. No. 13 Party.—Astronomical Latitudes.**—It had been intended to carry out a series of observations at stations of the Gurwani and Gora Series of the Principal Triangulation, between Latitudes  $24^{\circ}$  and  $27^{\circ}$  and on the meridians of  $82^{\circ}$  and  $83^{\circ}$  East Longitude. The object of these observations was to amplify our general knowledge of the deflection of the plumb line over the plains of India; there was no special problem in view.

The outbreak of war removed the officer who would have undertaken this work and no astronomical work was done. The establishment of the party was employed at Head Quarters chiefly on the preparation of Triangulation data for publication in pamphlet form.

The marking of the Longitude Stations by means of suitably inscribed slabs was taken up, as it had been found that several of these stations were in danger of being lost sight of.

**47. No. 14 Party.—Pendulum Observations.**—The programme that it had been intended to carry out comprised:—

(i) Observations at 8 stations in the neighbourhood of Bombay, selected with a view to the further investigation of the large difference between the force of gravity at Colaba and that at Alibāg which had been observed during the season 1913-14.

(ii) Observations at as many stations as possible in the plains of the Punjab, in order to investigate the theory that alluvial deposits depress the denser rocks of the earth's crust on which they rest and so give rise to a diminution in the force of gravity. The low values of gravity in the Ganges Valley have been attributed to this action and it is therefore desirable to ascertain whether similar low values will be obtained in other areas of equal alluvial deposition.

As no officer was available owing to the outbreak of war no observations were made.

The personnel of the party was employed partly at Head Quarters and partly on the delimitation of the boundary between the Pilibhit district and Nepāl. A report on this work will be found on pages 23 and 24 under the heading "Miscellaneous".

**48. No. 15 Party.—Triangulation.**—The following series of Principal and Secondary Triangulation were carried out:—

## (a).—PRINCIPAL TRIANGULATION.

*The Chittagong Series.*—This is a new Principal Series to connect the Burma Coast Series and the Manipur Meridional Series. It emanates from a side of the former about 30 miles East, North-East of Chittagong and traverses parts of the Chittagong Hill Tracts, the South Lushai Hills and the Chin Hills. Altogether 10 new stations were built, covering about 115 miles of difficult country. The series was satisfactorily laid out but the final connection was not quite completed and an additional station will have to be built to secure this when the observations are taken up.

## (b).—SECONDARY TRIANGULATION.

*Ashta Series.*—The connection of this series with the Karachi Longitudinal Series was completed and proved satisfactory.

*Middle Godāvāri Series.*—This series, which connects the Great Arc and the Jabalpur Meridional Series, was laid out and built in the season 1911-12 under the name of the Bhīr Series. Observations at 18 stations were completed. The connection with the Jabalpur Meridional Series proved very satisfactory.

*The Cāchār Series.*—This series was designed to connect the Assam Valley Series with the Cāchār Branch of the Eastern Frontier or Shillong Series, and was undertaken at a time when the closing discrepancy of the Nāgā Hills Series and the Manipur Longitudinal Series was believed to be due either to some error or to earthquake movement. Subsequent investigation has shown that the discrepancy is largely due to the fact that the Burma triangulation is unadjusted and is in slightly different terms from the Indian triangulation. The Nāgā Hills Series links these triangulations, and the circuit which it forms has no unduly large closing errors. The final connection with the Assam Valley Series could not be completed owing to unfavourable weather.

*The Kōkīmā Series.*—This series, which connects the Nāgā Hills Series with the Cāchār and Jaintiā Hill Series, was commenced last season when the first six stations were observed. The remaining stations were observed at and the connection completed.

## PARTICULARS OF TRIANGULATION DURING 1914-15.

	PRINCIPAL.	SECONDARY.			
	Chittagong.	Ashta.	Middle Godavari.	Cachar.	Kohima.
Number of Stations observed at ...	.....	9	18	12	8
"    "    newly built ...	10	5	13	10	.....
Length of triangulation completed in miles		39	137	55	67
"    "    remaining to be done		.....	.....	30	.....
Area of triangulation in square miles ...		426	1,990	747	576
Number of triangles observed ...		7	18	9	9
"    Astronomical Azimuths observed		.....	.....	.....	.....
Maximum triangular error ...	NOT OBSERVED.	3"30	3"67	2"88	3"7
Average " " ...		2"18	1"25	1"53	1"6
Mean closing error in latitude ...		0"28	0"07		0"21
"    "    longitude ...		0"25	0"10		0"21
"    "    height ...		2'1 ft.	1'8 ft.	No connection.	7'7 ft.
"    "    azimuth ...		4"08	1"6		9"6
"    "    log side (unit being the seventh place of decimal) ...		246	47		418
Theodolite used ...		T. & S. 8-inch Mier. No. 1311.	T. & S. 8-inch Mier. No. 1311.	T. & S. 12-inch Mier. No. III.	T. Cooke & Sons. 8-inch Mier. No. 10163

49. No. 16 Party.—Tidal Operations.—Observations were taken by means of self-registering tide-gauges throughout the year, at the stations given 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	86	*Small tide gauge working.
2. Karachi ...	1868 ...	1880	*13	
	1881 ...	Still working	35	
3. Bombay (Apollo Bandar)	1878 ...	"	87	
4. Bombay (Prince's Dock)	1888 ...	"	27	
5. Madras ...	1880 ...	1890	10	
	Restarted 1895	Still working	20	
6. Kidderpore ...	1881 ...	"	84	
7. Rangoon ...	1880 ...	"	95	
	1880 ...	1886	6	
8. Moulmein ...	Restarted 1909	Still working	6	
	1880 ...	"	85	

In addition to the above, the actual records of high and low water at Bhaunagar, Akyab and Chittagong were obtained from tide-pole readings taken during day-light by the Port Officers concerned. Tidal diagrams registered by a small river-gauge at Chittagong were supplied by the Port Officer in the earlier part of the year but the record of these diagrams was not found to be wholly satisfactory and hence they were discontinued after May 1914.

All the tidal observatories now working were inspected during the year and the tidal registrations have, on the whole, been satisfactory.

At the request of the Chief Commissioner of Port Blair the tidal observatory at that station has been shifted to a new site about 90 feet towards the south, to meet local requirements.

During the coming year tidal observations will be continued at the nine observatories now working.

50. In the following table are given the annual and decadal percentages of errors in the predicted times and heights of high and low water at all the stations where observations have been taken:—

PERCENTAGE OF ERRORS IN PREDICTED TIMES AND HEIGHTS.

YEAR.	AT OPEN COAST STATIONS.					AT RIVERAIN STATIONS.								
	Number of stations.	IN TIME.		IN HEIGHT.			Number of stations.	IN TIME.		IN HEIGHT.				
		Within 15 minutes of actuals.		Within 8 inches of actuals.	Within $\frac{1}{15}$ of mean range at springs.			Within 15 minutes of actuals.		Within 8 inches of actuals.	Within $\frac{1}{15}$ of mean range at springs.			
		H.W.—L.W.	H.W.—L.W.	H.W.—L.W.	H.W.—L.W.	H.W.—L.W.		H.W.—L.W.	H.W.—L.W.	H.W.—L.W.	H.W.—L.W.			
1905	7	82	79	96	95	96	97	2	52	62	72	57	94	92
1906	6	85	81	96	97	94	95	2	59	53	74	64	92	95
1907	6	84	83	98	98	98	99	2	58	47	78	60	96	90
1908	6	84	84	98	97	99	99	2	58	52	77	60	97	92
1909	6	85	86	97	97	97	98	3	61	59	69	65	93	92
1910	6	81	83	98	98	95	96	3	57	52	63	71	89	94
1911	6	84	84	98	99	97	98	3	65	51	68	66	90	90
1912	6	82	82	97	98	97	98	4	70	58	74	62	94	91
1913	6	88	82	97	97	98	99	4	68	55	70	58	94	88
1914	6	77	79	96	97	98	98	3	75	66	71	55	92	84
Average of ten years	...	83	82	97	97	97	98	...	62	56	72	62	93	91



**51. No. 17 Party.—Levelling.**—Three detachments were employed on the new system of “fore and back double levelling” during the past season.

**52. No. 1 Levelling Detachment** was employed (a) on *new levelling* from Bareilly to Hāthras along the road, (b) on *new levelling* from Multān to Bahāwalpur by road, (c) on a *revision* of the old line Meerut-Morādābād-Bareilly along the main road.

The outturn amounted to 342 miles. The heights of 3 Principal Stations of the Great Trigonometrical Survey, and of 474 Secondary Bench-marks were determined.

(a) The line Bareilly-Hāthras completes the circuits:—

- (i) Bareilly-Hāthras-Meerut-Bareilly, 346 miles in length, closing with an error of  $-0.064$  of a foot.
- (ii) Bareilly-Hāthras-Agra-Cawnpore-Lucknow-Bareilly; 513 miles in length, closing with an error of  $+0.202$  of a foot.

(b) The line Multān-Bahāwalpur completes the circuits:—

- (i) Multān-Bahāwalpur-Ferozepore-Lahore-Sargodha-Multān; 299 miles in length.
- (ii) Multān-Bahāwalpur-Murghai-Khemwālā-Multān; 640 miles in length.

The closing errors were respectively  $-0.309$  and  $+0.195$  of a foot.

**53. No. 2 Levelling Detachment** was employed on *new levelling* from Benares to Barākar along the Grand Trunk Road (part of the Benares-Howrah line), with branch lines from Barūn to Belsar along the Patna Canal, and from Bankipore to Bihta.

The outturn amounted to 352 miles. The heights of 4 Primary and 325 Secondary Bench-marks were determined, including 2 Principal Stations of the Great Trigonometrical Survey.

**54. No. 3 Levelling Detachment** was employed (a) on a *revision* of the line from Bellary to Gooty by road, (b) on *new levelling* from Raichūr to Bāgalkot by road, (c) on *new levelling* from Bāgalkot to Bijāpur along the main road.

(b) The line Raichūr to Bāgalkot closes the circuit Raichūr-Bāgalkot-Belgaum-Hubli-Bellary-Guntakal-Raichūr, 519 miles in length, with a closing error of  $+0.620$  of a foot.

The outturn amounted to 253 miles. The heights of 8 Primary and 155 Secondary Bench-marks were determined.

**55.** In addition to the above about 50 miles of single levelling were carried out in the *Island of Bombay*, at the request of the Local Government in order to provide heights of sufficient bench-marks for the control of the large scale survey of the Island which is still in progress.

**56. No. 19 Party.—Base Line Operations.**—During the year under report electric power became available in Dehra Dūn and the wiring of the Comparator rooms was done. The public supply is a three-phase alternating current at 380 Volts pressure, as a continuous current at 100 Volts is necessary for the motors, heater, &c. of the comparators, a motor generator was erected to effect the transformation. The comparators are now ready but owing to the diminution of the strength of the department in consequence of the reversion of so many officers to military duty there is no present prospect of any Base Line work being undertaken.

**MAGNETIC SURVEY.**

**57. No. 18 Party.—Magnetic.**—Two detachments were employed throughout the field season, and a third detachment was sent out towards the end of the season for two months to assist in completing the season's programme which comprised observations to determine the values of the magnetic elements at 73 repeat stations in India and Burma, as well as the inspection of three magnetic observatories and observations for the comparison of the instruments at each of the observatories.

On the recommendation of the Committee presided over by Dr. G. T. Walker, which was appointed in 1914 to discuss the position of the magnetic survey, the repeat stations were marked this season in a permanent manner by suitable concrete pillars and were handed over for preservation to the care of the local authorities, so that there should be no doubt in future as to their exact position. These stations will henceforward be visited at intervals of about 5 years, for the accurate determination of the secular changes of the magnetic elements.

The officer in charge was employed during the field season, with the assistance of the Head Quarters staff of the party, in carrying on the work of the final reduction of the field observations of Horizontal Force to the selected epoch, and in the revision of the preliminary values of Declination from the additional data accumulated during the past few years.

**58.** The Magnetic Observatory at Barrackpore was closed on the 26th of April. This observatory was built in July 1903. Self recording instruments showing the Declination and the Intensity of the Horizontal Force were installed in August of the same year, and one for recording the Vertical Force in April 1907. These instruments have been in operation up to the 25th of April 1915.

Dr. Walker's Committee came to the conclusion that the four observatories at Dehra Dūn, Alibāg, Kodaikānal and Toungoo were sufficient for recording the course of terrestrial magnetism in India, and recommended that the Barrackpore observatory should be closed as soon as a complete set of permanently marked field stations, scattered over the country, had been established and observations at all of them had been made. These observations, at the 73 repeat stations alluded to above, were finished at the end of April 1915 and the observatory has accordingly been closed.

**59.** *Work during recess season.*—The computation of the field observations of 1914-15 and the reduction and tabulation of the magnetic elements for the four survey base stations (Dehra Dūn, Barrackpore, Kodaikānal and Toungoo) for 1914 have been completed; the mean values of these elements for the year 1914 derived from all days, excluding those of great disturbances, are given in the table below.

The reduction of the field observations of Horizontal Force and Declination to the selected epoch is in progress.

**Mean values of the Magnetic Elements at Observatories in 1914.**

Observatory.	Latitude & Longitude.	Dip.	Declination.	Horizontal Force.	Vertical Force.
	" " "	" "	" "	C. G. S.	C. G. S.
Dehra Dūn ...	{ 30 19 19 N 78 3 19 E }	N 44 22·9	E 2 18·8	0·33165	0·32458
Barrackpore ...	{ 22 46 29 N 88 21 39 E }	N 30 58·9	E 0 32·2	0·37403	0·22459
Toungoo ...	{ 18 55 45 N 96 27 3 E }	N 23 6·1	E 0 2·6	0·38983	0 16628
Kodaikānal ...	{ 10 13 50 N 77 27 46 E }	N 4 11·2	W 1 17·1	0·37571	0·02750

## V.—GEOGRAPHICAL SURVEYS &amp; EXPLORATION.

**60. Cavaliere de Filippi's Expedition to the Karakoram.—**

The expedition brought its operations to a close in the autumn of 1914. Major Wood went to Europe with Cav. de Filippi and reached Rome in December 1914. The two surveyors with the expedition did not accompany it beyond Kashgar, but spent the winter partly in Kashgar and partly in Yarkand and returned to India *via* Gilgit in the spring of 1915.

The computations of the observations and the drawing of maps is being carried out at Dehra Dūn. A preliminary rough map was prepared by Major Wood while in Rome and a photograph of this has been received in Dehra Dūn. A general description and map of the expedition may be found in the "Geographical Journal" for August 1915. It embraces an area of 9,100 square miles on the quarter-inch scale.

**61. Sir Aurel Stein's Archæological Expedition in Central**

**Asia.**—The expedition after a very extensive tour reached Kashgar in June. The two surveyors lent by the Survey of India, Rai Bahadur Lal Singh and Muhammad Yakub Khan, were to return thence to India as soon as the work of making traces and copies, as a security against accidental loss, had been completed. They had not reached India at the close of the year under report. The total area of survey completed by the surveyors under Sir Aurel Stein during the several years he has been exploring in Central Asia now amounts to about 150,000 square miles on the quarter-inch scale.

**62. Turco-Persian Frontier Commission.**—A detachment under Lieut.-Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E., accompanied this Frontier Commission, which worked from the head of the Persian Gulf to Mount Ararat. Triangulation was carried out by Major H. M. Cowie, R.E., over the greater part of the frontier, an area of 7,500 square miles being surveyed by the detachment, and 227 pillars erected. Fair maps, 35 in number, comprising nearly the whole frontier 1,180 miles in length, have been published. The whole frontier was demarcated except a small portion near Kotour; work commenced in December 1913 and closed in October 1914.

## VI.—MISCELLANEOUS.

**63. Boundary between Nepāl and the United Provinces.—**

At the request of the Government of the United Provinces the work of laying out the boundary between Nepāl and the Pilibhīt district was undertaken. Major E. A. Tandy, R.E., was in charge of the work and had under him a detachment made up from several field parties.

The simplification of the existing boundary, so as to convert it into a line consisting of a series of straight links, except where it follows some definite and permanent natural feature, was a matter of some difficulty; an alignment was, however, finally discovered which was accepted as equitable by both sides, and a careful traverse was then executed which puts on permanent record the position of the pillars which define the straight links.

This part of the boundary has long been a source of trouble as disputes with regard to its position have frequently arisen and have been difficult to settle. The new demarcation will, it is hoped, put an end to this state of things.

In 1912-13 the boundary between Nepāl and the Naini Tāl district was demarcated, so that now the whole of the old boundary line along the Sārdā river, which had given so much trouble, has been revised and improved.

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## PART 3.—OFFICE WORK.

### I.—HEAD QUARTER OFFICES.

#### MAP PUBLICATION OFFICE (*vide* Index maps at end).

64. The classes of maps for the publication of which the Head Quarter Offices are responsible, may be enumerated as follows:—

- (a)—Topographical maps on the scale of 1 inch to 1 mile.
- (b)—Topographical maps on the scale of  $\frac{1}{2}$  inch to 1 mile.
- (c)—Topographical maps on the scale of  $\frac{1}{4}$  inch to 1 mile.
- (d)—Geographical maps on the one-millionth scale (about 1 inch to 16 miles).
- (e)—Geographical maps on the two-millionth scale (about 1 inch to 32 miles).
- (f)—General maps on small scales.
- (g)—Special maps.

The first duty of the offices is to publish the one-inch, half-inch and quarter-inch maps prepared by the field parties and Circle drawing offices from the results of the topographical surveys now in progress.

65. (a) **Topographical maps on the scale of 1 inch to 1 mile.**—During the year 207 sheets have been received for publication and 154 have been published. The corresponding figures for the previous year were 176 and 158 respectively. The output would have been larger if the machines had not been so fully occupied in complying with military requirements.

Putting aside the sheets surveyed in Kashmir where the season of field survey differed from that in other parts of India, the one-inch maps of all areas surveyed up to 30th September 1913 have been published with the exception of 2 sheets. Of the sheets surveyed up to 30th September 1914 very few have been published.

Index maps Nos. 4—6 at the end of this report show the progress made in the publication of the modern one-inch sheets and the table below gives the annual output of sheets since the modern topographical surveys were begun:—

Year.	NUMBER OF 1-INCH SHEETS PUBLISHED.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1905-06	...	...	...	...
1906-07	4	1	...	5
1907-08	16	15	22	53
1908-09	35	39	68	142
1909-10	72	41	69	182
1910-11	51	39	25	115
1911-12	68	33	58	159
1912-13	104	60	58	222
1913-14	71	38	49	158
1914-15	97	48	9	154
Total Published	518	314	358	1,190
Approximate number of 1-inch sheets in India	2,160	2,067	2,101	6,328
Approximate number remaining for publication.*	1,642	1,753	1,743	5,138

\* These figures include a large number of sheets, about 2,400, in deserts, at high altitudes and in other thinly populated tracts of which maps on so large a scale as 1 inch to the mile are unlikely to be required.

The general style of the one-inch maps is unchanged, but as opportunity arises owing to printing of new editions, sheets thus republished are hill shaded.

In addition to the output of modern one-inch sheets mentioned above, 42 sheets prepared from modern revenue surveys have been received for publication, and 55 published as preliminary editions pending their topographical revision at some future date (*vide* Index maps No. 7 and No. 8); 62 special editions of modern one-inch sheets have been published at the request of Local Governments to show village boundaries.

To maintain stocks or to give effect to important changes due to the development of communications, 12 modern one-inch sheets and 47 old style sheets on various scales have been reprinted.

**66. (b) Topographical Maps on the scale of  $\frac{1}{2}$  inch to 1 mile.** (*Vide* Index map No. 9).—In addition to the areas which are being surveyed and mapped on the  $\frac{1}{2}$ -inch scale, of which one sheet has been published, it has been decided to publish half-inch maps of all those areas already published on the 1-inch scale. Sixteen such sheets have been received for publication but none have so far been published. When a new style of map is commenced there are inevitable delays before the work gets well started but a large outturn in the publication of these sheets is expected in 1915-16.

**67. (c) The map of India on the scale of  $\frac{1}{4}$  inch to 1 mile.** (*Vide* Index map No. 10).—This map is prepared in "degree sheets" which include  $1^{\circ} \times 1^{\circ}$ , or the area covered by 16 one-inch sheets.

The following table shows the progress made in publication:—

Years of Publication.	NUMBER OF DEGREE SHEETS PUBLISHED.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
1911-12 ... ..	2	1	4	7
1912-13 ... ..	3	1	1	5
1913-14 ... ..	4	3	2	9
1914-15 ... ..	1	3	3	7
Totals ... ..	10	8	7	25
Approximate number of degree sheets in India ... ..	170	140	140	450

NOTE.—The figures for 1911-12 do not agree with those in previous reports owing to the inclusion of three sheets previously classified as "Provisional."

Pending the preparation of the new degree sheets from modern surveys, 46 degree sheets have been published during the year as Provisional Issues; these have been prepared from the maps of old surveys and have therefore not been included in Index map No. 10. 137 Atlas sheets and 17 District maps on the same scale ( $\frac{1}{4}$ -inch to 1 mile) have been reprinted.

**68. (d) Geographical Maps on the one-millionth scale,** (about 16 miles to 1 inch). (*Vide* Index map No. 11).—During the year 5 sheets of this series were published and the remainder should be completed in about two years. All the sheets published this year are contoured and printed with hypsometrical layers, the colouring used differing somewhat from that on the "International Series", with more satisfactory results.

The engraving of several of these sheets is in hand, but reproduction by heliozincography has of late years so much improved that it is doubtful whether, except in the lettering, the engraved maps are sufficiently superior to justify the time and expense spent in engraving them.

The publication of the heliozincographed edition of sheet 47 is of special interest as it covers the same ground as International Series, No. 43-E and a comparison can be made of the relative advantages of the two series.

**69. La Carte Internationale du Monde au 1,000,000'.**—(*Vide* Index map No. 12). A full description of the genesis of this series was given in the General Report for 1913-14.

No sheets have been published this year, but two are at press and several in an advanced stage.

Owing to the war, no further meetings of the International Committee have been held.

**70. (e) Geographical Maps on the two-millionth scales** (about 32 miles to 1 inch). (*Vide* Index map No. 13).—No further sheets of this series were published during the year but two are at press and the drawing of two others well in hand.

**71. (f) General Maps on small scales.**—The Political Edition of the Map of India and Adjacent Countries, scale 32 miles to 1 inch, in 12 sheets, is at press and will shortly be published; the layered editions of this map having been published last year.

The annual edition of the Railway Administration Map of India, scale 64 miles to one inch, shewing information up to the 30th June 1915 was published in August.

**72. (g) Special maps.**—Many special maps, &c., have been prepared for the various departments of Governments, both Local and Imperial, and for the General Staff including maps for Artillery Practice Camps.

**73.** During the year the *machine presses* in the Photo.-Litho. Office were employed in the following proportion, 44% departmental, 34% extra-departmental and 22% for the Military Department.

**74.** The total number of maps issued during the year shows a large increase with a small increase in the total value.

**75. Map Record and Issue Office.**—During the past year the face value of maps received from the various printing offices amounted to Rs. 3,82,246, of this sum Rs. 14,083 represents the value of maps printed in the Engraving Office, and Rs. 53,033 of those which were received from the Dehra Dūn Offices.

Details of the numbers and classes of maps published during the year and their value is given in Table IV on page 32.

The total number of maps issued from the Office during the year was 425,008 of an aggregate value of Rs. 1,78,958.

The details are as follows:—

	Government Officials.	India Office.	Depart- mental Issues.	Private Indivi- duals.	Map Agents.	Totals for 1914-15.	Totals for 1913-14.
No. of maps	303,680	3,950	88,937	24,073	4,368	425,008	359,917
Value Rs.	95,600	5,257	53,382	19,309	5,410	1,78,958	1,77,546

**76. No. 1 (Head Quarter) Drawing Office.** The office was employed in the compilation and drawing of the helio editions of maps of India and Adjacent Countries. Four sheets on the one-millionth scale were completed during the year and five are in hand. Two sheets of the Southern Asia Series, two-millionth scale, were sent to press, while two other sheets are well advanced.

During the year under report seven patterns were prepared for the engraved edition of the one-millionth India and Adjacent Countries Series and three for the one-millionth International Series. The compilation of material to be utilized for an engraved map of India on the four-millionth scale which will embrace the area covered by the 32-mile map of India, is in progress.

Fifty-four sheets on various scales were stump-shaded during the year.

A *special map of West Germany* in two sheets on the scale of 1 inch to 6 miles was prepared. These two sheets were later reduced by photography to a scale of 1 inch to 8 miles and have been published as one sheet.

Two maps of the *new half-inch series* were completed during the year; of nine others in various stages of completion four are expected to be sent to press by December 1915.

The *Mapping and Reprint Sections* prepared 33 quarter-inch (degree) sheets based on old Atlas sheets. These degree sheets are classed as "Provisional Issues" and printed in black. They have been brought up to date as regards railways and roads from material supplied from extra-departmental sources. They will be superseded eventually by modern degree sheets in colours when the areas comprising them came under revision survey. The originals of sixty-three maps on various scales have been corrected and brought up to date to supply reprints. In addition a large number of maps drawn in circle offices and field parties have passed through the section for minor corrections.

Under the head of *Extra-departmental work* which was undertaken may be mentioned the Bassein and Henzada maps for district gazetteers, Postal maps of Bengal and Assam and Bihār and Orissa, Telegraph and Railway maps for India and a special manoeuvre map of Chotā Nāgpur.

The primary duty of the *Office Copy Section* is to maintain a complete record of all alterations and additions to published maps which may be brought to notice. In addition to miscellaneous work on a large number of sheets, new canals, railways, main roads and changes of boundaries notified by district authorities were inserted on 2,187 maps.

**77. Engraving Office.**—During the year the engraving of five sheets for four-colour printing of the one-millionth India and Adjacent Countries series was completed; also 1 Degree sheet together with 1 International map were finished. Two one-millionth and 2 International maps are almost ready for press.

Eleven new maps were taken in hand and are now in various stages, namely, 4 one-millionth sheets, 6 International maps and 1 Degree sheet. The engraving of the new four-millionth map of India, which is to replace the present 64-mile map has also been begun. The system now adopted is to engrave a separate plate for each colour which, when proper precautions are taken, gives remarkably good registration results.

The periodic correction of the plates of engraved maps has been continued. In this connection it was found necessary to completely re-engage a considerable area on the 32-mile map of India north of Sadiyā where recent explorations had brought to light large changes in the course of the Brahmaputra and the drainage system connected with it. A new feature of the 5th edition of this map, now under publication, will be the approximate indication of the area under perpetual snow in the Himalayas and Tibet.



During the year a considerable number of Commission Forms and Certificates have been engraved and printed in colours for the Army Department.

Among the miscellaneous work carried out may be mentioned the engraving and printing of different kinds of section paper for statistical purposes, scales of various kinds and dies for the ornamentation of maps.

In the *Copper-plate-printing section* of this Office 30,872 impressions were pulled. Of these 9,002 were for extra-departmental orders, 1,475 Commission Forms and 7,547 photogravure prints.

Two new motor driven printing presses were installed during the year, one of which is specially suitable for printing photogravures. In the *Electro-typing and steel facing Section* 370 plates were treated.

**78. Photo-Litho. Office.**—At the commencement of the Survey year there were seven machine and fourteen hand presses in use. These were supplemented by an eighth machine press, a Double Demy, in April, 1915 and by a ninth, a Quad Crown, in June. Both these new machines were supplied by Messrs. Mann & Co. Amongst the older machines were two which were incapable of giving consistently precise registration and were not very suitable for work involving more than one colour or printing. It was to make good the weakness of the machine room in this respect that the new machines were obtained.

Except for short periods of a few days, when first one and, later, a second machine were forced to be idle on account of motor defects, all the presses were run continuously during the year.

The *Litho. Branch* of the Office has, so far, been but little affected by war conditions.

In the *Photo. Branch* no change of material has occurred during the year. The most important modification of procedure, rendered necessary by the war, has been the substitution of pyroxilin collodion for the celloidin-pyroxilin collodion used formerly. Some difficulty was experienced, at first, in reducing to a reasonable figure the percentage of waste products, when making up the pyroxilin collodion. Success in this respect was, however, soon attained and no troubles resulted from this change of collodion which was introduced at the beginning of June 1915.

Though the office has had to undertake a large amount of printing for the General Staff and has not, at the same time, made corresponding decreases in the quantity of other extra-departmental work accepted for reproduction, the outturn in departmental maps has been, thanks to the increase of machine power, higher than in either of the two preceding years. Column 5 of Table A. gives the actual figures for the three years.

Both departmental and extra-departmental work being taken into account, the total number of impressions pulled in the litho. machine presses was 1,987,591 producing 730,917 finished copies. The figures just given do not include the number of proof impressions pulled in the hand presses nor the sheets of paper polished in the machines before printing.

The total number of impressions pulled in machine presses and hand presses together is, as will be seen in Table B, column 2, rather lower than that of last year. This is due to the fact that for a great deal of the work for the General Staff and for reprints the printing orders have been small, so that the time spent in making machine preparations, preliminary to printing, stands in high proportion to that occupied by actual printing.

During the year, 154 new modern style *one-inch standard sheets* in colours were published and 12 were reprinted. Of the provisional edition, 8 sheets were printed in black and brown and 47 in black only. The total number of one-inch sheets printed during the year is, thus, 209.

Of quarter-inch maps in colours, 18 new *degree sheets* were published while 85 were reprinted either in colour or in black only.

Seven new *one-millionth sheets* were published in colours and 3 reprinted.

The *Photo. Branch* has received, during the year, the originals of 327 and the colour patterns of 241 maps to be printed in colours.

The *Negative Section* has dealt with 4,435 negatives and the *Retouching Section* with 4,711. These figures show increases of 888 and 1,008 over those of the preceding year.

The *Helio and Vandyke Sections* turned out 6,736 plates, 1,716 more than in 1913-14.

The *Process Engraving Section* pulled 65,732 half-tone impressions, of which 11,250 were from departmental blocks. From line blocks prepared by the section 1,491,403 impressions were pulled, only 400 of which were for the department. These figures are higher than those of 1913-14 by 30,022 in the case of half-tone impressions and by 616,403 in that of those from line blocks.

#### Out-turn of Photo.-Litho. Office during 1914-15.

TABLE A.

1	2	3	4	5	6	7
Year.	Cost of office.	Value of out-turn at cost-rates.	Recovered in cash or by book-debit.	NUMBER OF MAPS PRINTED.		
				Departmental.	Other than Departmental.	Total.
	Rs.	Rs.	Rs.			
1912-13	1,61,699	2,39,940	27,214	574	1,999	2,573
1913-14	1,67,801	2,40,721	33,468	491	1,975	2,466
<b>1914-15</b>	<b>1,55,515</b>	<b>2,81,146</b>	<b>36,847</b>	<b>597</b>	<b>2,168</b>	<b>2,765</b>

TABLE B.

1	2	3	4	5	6	7
Year.	Number of impressions pulled in Litho. Branch	Number of half-tone impressions pulled.	Number of line-block impressions pulled.	TYPE SECTION OUTTURN.		
				Pages or items published.	Copies printed.	Impressions pulled.
1912-13	1,966,458	51,370	530,280	8,408	1,343,465	2,608,591
1913-14	2,286,845	35,710	875,000	6,403	1,203,242	2,132,159
<b>1914-15</b>	<b>2,100,103</b>	<b>65,732</b>	<b>1,491,403</b>	<b>6,987</b>	<b>1,317,298</b>	<b>2,122,811</b>

The figures for 1912-13 and 1913-14 in columns 5, 6 and 7 of the Table A above, differ from those given in the General Report for 1913-14 as, this year, account has been taken only of finished maps received from the machines. In former years, proofs and blue prints turned out by hand presses were included.

**79. Mathematical Instrument Office.**—During the year from 1st April 1914 to 31st March 1915, there was a continued increase in the demands made on this office (*vide* item No. 1 in para. 2) as well as in the value of work done (*vide* item No. 2 in para. 2), and there was respectively a profit of Rs. 38,366, and Rs. 22,012, against Rs. 33,571 and Rs. 10,346 in the year 1913-14.

2. Below are given the usual comparative figures for the last 3 years :—

	1912-13.	1913-14.	1914-15.
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	2,81,315	4,07,802	<b>4,16,642</b>
2. Value of repairs to instruments received for repairs and returned in a serviceable condition.	64,452	56,418	<b>66,793</b>
3. Value of instruments received from Government Officers when no longer required.	57,267	69,806	<b>50,924</b>
4. Book value of the stock of instruments, &c., in Serviceable Stores.	6,45,081	4,73,470	<b>5,06,865</b>
5. Book value of the stock of instruments, &c., in Repairable Stores.	72,452	67,299	<b>62,347</b>
6. Total value of work done in the Workshop ...	2,15,328	2,40,752	<b>2,44,054</b>
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	71,188	93,991	<b>87,421</b>
8. Value of instruments purchased locally ...	6,206	9,060	<b>9,792</b>
9. Value of instruments and materials obtained from England through the Director General of Stores.	57,647	89,213	<b>2,78,380</b>
10. Average No. of employés and their pay ...	No. 301 } Rs. 68,625 }	No. 300 } Rs. 76,734 }	No. 317 } Rs. 80,917 }

3. During the year the stock of all the three stores, (the Serviceable, the Repairable and the Material Stores), was twice taken and the discrepancies noticed have been adjusted.

Table IV.—Departmental Publications, Calcutta, 1914-15.

*Note.*—For special publications at Dabru Dun, *vide*, pages 31 to 37.

Class of Maps.	Scale.	NUMBER OF DIFFERENT MAPS OF EACH CLASS RECEIVED.		Number of copies printed.	Value.
		New Publications.	New Editions and Reprints.		
<b>GEOGRAPHICAL MAPS.</b>					<i>Rs.</i>
Maps of India	Various	.....	1	2,706	4,059
Southern Asia Series	1:2,000,000	.....	.....	.....	.....
India and Adjacent Countries	1:1,000,000	2	11	8,476	8,476
Do. (International Series)	1:1,000,000	.....	.....	.....	.....
<b>TOPOGRAPHICAL MAPS.</b>					
<i>DEGREE SHEET SERIES.</i>					
Modern	1 $\frac{1}{2}$ -4 miles	39	57	94,809	93,284
Preliminary and Provisional	Do.	.....	.....	.....	.....
From Atlas Material	Do.	46	39	18,641	18,641
<i>HALF-INCH SERIES.</i>					
Modern	1 $\frac{1}{2}$ -2 miles	1	.....	490	490
<i>ONE-INCH SERIES.</i>					
Modern	1 $\frac{1}{2}$ -1 mile	154	12	81,853	80,179
Do. (Preliminary Editions)	Do.	55	.....	27,200	26,200
Do. (Village Boundary Editions)	Do.	.....	62	7,200	14,400
Old Style Sheets	{ 1 $\frac{1}{2}$ -1 mile & 1 $\frac{1}{2}$ -4 miles }	.....	47	14,687	21,883
<b>MISCELLANEOUS.</b>					
<i>Atlas of India Series</i>	1 $\frac{1}{2}$ -4 miles	.....	137	16,400	16,566
<i>Provincial Maps</i>	Various	2	1	2,200	3,212
<i>District Maps</i>	1 $\frac{1}{2}$ -4 miles	.....	17	5,157	4,970
<i>Administration Report Maps</i>	{ 1 $\frac{1}{2}$ -8 miles to 1 $\frac{1}{2}$ -16 miles }	.....	27	3,437	1,292
<i>Plans of Cities and Contourments</i>	Various	5	271	4,854	11,311
<i>Index Maps</i>	Do.	3	54	36,390	9,099
<i>Miscellaneous Maps</i>	Do.	193	49	291,019	68,184
<b>Totals for 1914-15</b>	.....	<b>500</b>	<b>785</b>	<b>615,519</b>	<b>3,82,246</b>
Corresponding totals for 1913-14	.....	728	153	574,101	3,26,077

**LETTERPRESS.**

1. Catalogue of Maps published by the Survey of India corrected to 1st January 1915. *Price Rs. 1.*
2. Circular Orders (Administrative) issued from 1st January 1909 to 31st December 1913.
3. Government of India Orders issued from 1st January 1909 to 31st December 1913.
4. General Report 1913-14. *Price Rs. 2.*

## II.—DEHRA DŪN OFFICES.

## COMPUTING AND TECHNICAL OFFICES.

**80. Computing Office.**—A new and much shortened method for the adjustment of triangulation nets has been devised. This has been already applied to the closing of the Baluchistān triangulation and the larger work of the Burma triangulation has been begun. A single triangle of the Manipur Meridional series has to be reobserved and this prevented further progress with the adjustment during the year 1914-15. The necessary observations will shortly be made. The work of adjusting the Burma triangulation was previously regarded as of such magnitude that it could not well be taken up until the triangulation was finally completed, which might mean a delay of ten years. On the other hand the data of the triangulation could not be published until some adjustment had been effected. The new method will give values which may be published without further delay. In this connection values of  $M$ , a criterion of the accuracy of the position of triangulated points, have been computed for all geodetic series.

A great effort was begun in March to ensure the publication of the 900 triangulation pamphlets in reasonable time. The past year has been considered a favourable opportunity for this and for the adjustment mentioned above, as a number of computers of the several field parties became available for part of the season owing to the cutting down of field programmes. Data for 45 pamphlets have been compiled and compared during the year; but the rate of progress has now reached 12 per month and it is hoped that this will soon be increased to 20 including the printing and binding.

Some heavy computations in connection with the change from the Everest spheroid of reference to the most recent (or any subsequent) spheroid have been made. The results will appear in Professional Paper No. 16, now in the press.

Computations of dynamic and orthometric heights of nine lines of levelling, *viz*:—Rawalpindi to Murree, Srinagar to Islāmābād, Akhaura to Dacca and Faridpur, Pāchuria to Porādaha, Comilla to Chittagong, Faridpur to Barisāl, Meerut to Delhi, Thazi to Prome, and Elephant Point to Pyinmanā and Thazi, have been accomplished.

The transit time observations made in connection with the wireless longitude determinations have all been reduced.

Data from original records were supplied to 29 departmental and non-departmental officers, and a large number of requisitions for Professional forms was attended to.

It has been decided to revise the Auxiliary Tables and to stereotype all the tables. With the old arrangement it has been difficult to keep these tables up to date, as, on account of the labour of composing, a large edition was printed on each occasion; when all the tables are stereotyped a much smaller edition will suffice and arrangements for adding new tables will accordingly be easier. A start has been made with the map graticule tables which had got into a state of some confusion. Five figure tables of log sines, cosines, tangents and cotangents have been arranged and prepared in a new form.

Additional racks have been, and are still being, provided by the workshop. It is hoped that the records and stock, which are constantly increasing, will soon be adequately stored and indexed. This has been hitherto physically impossible owing to lack of space and rack accommodation.

The binding of Departmental Paper No. 7, of Volume VI of the Records, and of several Levelling and Triangulation pamphlets was completed, and that of Professional Paper 15 and of Volume VIII of the Records, in two parts, is in the hands of the binders.

**81. Type Printing Office.**—The following publications have been printed during the year :—

- (1) Departmental Paper No. 7. The Bar Comparisons of 1907 and 1908, *By Major H. M. Corrie, R.E.*—39 pages.
- (2) Addendum to Heights of Bench Marks in sheet 43.—55 pages.
- (3) Records of the Survey of India, Volume VIII, in two parts :—  
Part I.—Explorations in Tibet and neighbouring regions.—214 pages.  
Part II.—Explorations in Tibet and neighbouring regions.—198 pages.
- (4) List of Survey of India publications as revised and re-arranged by Major E.A. Tandy, R.E.—9 pages.
- (5) Five figure Logarithmic tables of log sines, cosines, tangents and cotangents.—12 pages\*.
- (6) 20 Triangulation Pamphlets.

Professional Paper 16 “The Earth's Axes and Triangulation” is in press (printed to page 68) and the composing and stereotyping of the graticule tables have been begun.

**82. Special Operations.**—The trestle alluded to in last year's report has been satisfactorily completed. The largest type of theodolite can now be raised for observation purposes to a height of 65 feet above ground level, and its stability is such that the probable error of observation is not more than 50% greater than if it were placed on a solid masonry foundation. A description is given in Volume VII of the Records.

An instrument for calculating the attractive effect of topography on plumbline deflection has been designed by Mr. deGraaff Hunter and is now under construction. It is only necessary to run the pointer round the contour on a map and the effect in the meridian and the prime vertical can be read off on two drums. This will render possible the analysis of the earth's crustal density in much greater detail than could be attempted previously on account of the enormous labour of calculation involved.

Experiments have been made with an optical arrangement which in some cases may replace the heliotrope and the use of lamps and lampmen for triangulation. The arrangement has also a possible use in connection with secret signalling from aeroplanes and is now being considered by the Aeroplane Committee of the Board of Invention and Research, London.

A simple instrument for plotting points with given coordinates on maps has been designed and made.

**83. Workshop.**—The facilities of the workshop have been considerably increased by the acquisition of a small electric motor. Lack of space and general poorness of accommodation still cramp the work very much, and it is urgently necessary that new buildings for workshops should be erected.

**84. Observatories.**—Meteorological observations have been continued as in last year.

The Omori Seismograph has been in regular use and a list of the earthquakes recorded will appear in the Records, Volume IX. It has been noticed that about 50% of the earthquakes recorded in three years occur in, or very close to, March or April.

Photographs of the sun have been taken on 333 days, the sun being obscured by clouds on the remaining days.

\* Stereotyped.

The services of Lieutenant K. Mason, R.E. were lent for about one month, during which time he did most of the erecting of the new base line apparatus. The actual completion of the work has since been effected.

**85. Preservation of Trigonometrical Stations.**—1,079 stations were repaired by district officers at a cost of Rs. 5,475-3-11.

Out of 351 districts from which reports are annually due 24 failed to make returns.

**86. No. 2 (Dehra) Drawing Office.**—During the year the office was organised in sections to deal with:—

- (a)—Cantonment maps;
- (b)—Triangulation charts;
- (c)—Geographical maps on the one-millionth, two-millionth and four-millionth scales;
- (d)—Topographical maps on the half-inch scale;
- (e)—Miscellaneous subjects.

The Map Record Section was also re-organised; the maps and originals are being re-arranged and catalogues prepared.

The following is a summary of the work of the office during the year 1914-15:—

Class of map.	Sheets sent for publication.	Remaining in hand.
Map of Tibet, with altitude layers and with snowy areas in white, $\frac{1}{2.5 \text{ Million}}$ scale ... ..	4	
Geographical maps, $\frac{1}{M}$ scale ... ..	1	9 (a)
Miscellaneous Geographical maps on various scales ...	2	
Index chart to the Great Trigonometrical Survey of India, $\frac{1}{3 \text{ Million}}$ scale, in 4 sections ... ..		4
Miscellaneous Extra Departmental maps and plans ...	5	12
Miscellaneous Scientific diagrams and charts ...	14	4
Preliminary degree triangulation charts ...	10	44
Final do. do. ... ..	11	
Miscellaneous Triangulation charts ... ..	34 (b)	
$\frac{1}{2}$ -inch Standard sheets ... ..	2	12
Cantonment maps ... ..	52 Cantonments (c) 198 Sheets.	15 Cantonments 76 Sheets.
Explorers' maps ... ..	10	10
Miscellaneous Departmental publications ... ..	7	

(a) Includes 2 for the  $\frac{1}{2 \text{ Million}}$  series by reduction, (b) includes 32 skeleton degree triangulation charts, (c) completed and stored.

(a) The systematic correction of the *Cantonment maps* from material supplied by the Military Works Services, which was begun in August 1914, has been continued. The work has proved heavier than had been expected but will probably be considerably less in subsequent years than it has been during the first year. If this does not prove to be the case the present strength of the section will have to be increased, and—a more difficult matter—more accommodation will have to be found for it.

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(d) *Half-inch sheets compiled from one-inch maps.* During this year 2 sheets have been fair-drawn and submitted for publication and 12 are in hand. Proofs of 1 sheet have been received for colouring and examination but have not yet been completed.

(e) *Map of Tibet on the scale of  $\frac{1}{2,500,000}$ .*—The preliminary edition of this, in four sheets, has been published; this is the most important piece of layer printing that this office has undertaken. The layer system is severely tested in this map as it includes not only the highest mountains in the world but also an area to the south of Turfan which is 330 feet below the mean level of the sea. Areas which are generally snow-clad are shown in white with green-blue form-lines to indicate their configuration. An improved edition is in contemplation and will be taken up as soon as time can be found.

**87. Photozinc. Office.**—During the year the work undertaken comprised:—Forest maps; Cantonment maps; Triangulation charts; Levelling Charts; The Tibet map in four sections, with layers; Two layered maps illustrating the Pendulum operations; Degree Sheets drawn in No. 6 Drawing Office; Provisional Degree Sheets; Plan of the site of the new Capital at Delhi. A good deal of extra work was thrown on the office owing to the heavy demands made by the Chief of the General Staff for maps for war purposes.

It has been found necessary to indent for a second machine press as the work of the office is steadily increasing, the table below shows the increase during the last three years:—

Year.	No. of Subjects.	No. of Negatives.	No. of Pulls.	Chocolate and Cyanotype prints.
1912-13	1,973	1,909	236,766	1,039
1913-14	2,046	2,376	244,140	1,695
1914-15	1,898	2,267	345,520	663

It is to be remarked that up to 1912 the work consisted almost entirely of printing in black; this can be done more rapidly than colour work which demands accurate registration, work prior to 1912 has therefore not been shewn here for purposes of comparison.

**88. Forest Map Office.**—The total number of maps issued, both to officials and the public, during the year, amounted to 17,955, which is an increase of 11,514 over last year's total. The gross face value of these maps was Rs. 34,116, and the net amount realised from sales was Rs. 6,864. Of this amount, Rs. 6,524 was recovered by book-debit and Rs. 340 by cash from sales to private individuals and trading companies. The total sum realised from sales in the previous year was Rs. 2,348, so that in actual sales, there has been an increase of Rs. 4,516, during the year under review. The number of maps and field sections received for storage during the year was 16,408, besides 210 computation volumes, angle books and traverse field-books, and 95 traverse charts and plot sheets.

The following table shows, in abstract form, the work dealt with by the office :—

Class of map.	NUMBER OF SHEETS.		
	In hand.	Drawn and sent for publication.	Published.
1-inch, 2-inch and 4-inch maps of Forest Surveys	321	52	42
Special maps of India	...	10	8
Provincial, Divisional and District Forest maps	40	5	10
Working Plans and Miscellaneous maps	24	20	13
TOTALS	385	87	73

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

**89. No. 3 Drawing Office (Northern Circle).**—During the year 120 one-inch sheets previously surveyed and drawn by parties were dealt with and submitted for publication; 12 other fair sheets, not included in the above number, were also sent to press, *i.e.*, 3 on the half-inch scale, drawn in No. 2 Party's office and 9 prepared in the Drawing Office comprising 2 sheets on the quarter-inch scale fair drawn, 3 sheets on the one-inch scale fair drawing completed to margin, and 4 sheets on the one-inch scale received from the Superintendent, Map Publication and brought up to date.

The proofs and colour patterns of 142 sheets including 34 arrears from last season, and 108 out of the 116 received from the Superintendent, Map Publication of this season's return, were examined and sent to press.

*Half-inch sheets compiled from one-inch maps.*—During the year 3 sheets have been fair drawn and submitted for publication leaving the fair drawing of 28 in hand and that of 19 sheets of which the component one-inch sheets had been published, not yet commenced.

*Quarter-inch sheets compiled from one-inch or half-inch maps.*—Press order has been given for sheet 34 N and the colour guides of sheet 43 D have been asked for; the fair drawing of 6 sheets is in hand and that of 3 sheets of which the component one-inch or half-inch sheets had been published, is not yet commenced.

12 sheets (hill and outline) of the Turco-Persian Frontier were also fair drawn this year in this Drawing Office.

**90. No. 4 Drawing Office (Southern Circle).**—During the year 53 one-inch and 3 half-inch sheets, which had been previously surveyed and drawn by parties, were finally examined and submitted for publication. At the end of the year every sheet, the survey of which was completed during previous years, had been submitted.

*Half-inch sheets compiled from one-inch maps.*—11 sheets were drawn and submitted for publication. At the end of the year 7 sheets were in hand and 46 sheets, of which the component one-inch sheets had been published, had not been commenced.

*Quarter-inch sheets compiled from one-inch or half-inch maps.*—One sheet was drawn and submitted for publication. At the end of the year 3 sheets were in hand and 3 sheets, of which the component one-inch or half-inch sheets had been published, had not been commenced.

Six preliminary one-inch sheets were redrawn and submitted for publication.

The colouring, examination, &c. of 78 proofs and the hill shading of 51 sheets were undertaken.

A number of pupils were instructed in drawing. Considerable assistance was given to parties to enable them to complete their drawing during the recess season.

The Photo-Zinco. Section undertook the photographic and zincographic work required in the circle. 10 soldier surveyors, &c. were put through a course of training.

**91. No. 5 Drawing Office (Eastern Circle).**—During the year 43 one-inch sheets and 6 half-inch sheets previously surveyed and drawn by parties were dealt with; all of the one-inch sheets and one of the half-inch sheets were examined and submitted for publication. In addition to the above 1 one-inch sheet No. 79  $\frac{1}{12}$  was compiled from settlement surveys and submitted for publication together with 1 one-inch sheet which was in arrears from last year.

Proofs of 42 sheets were received and 39 were examined and sent to press.

At the end of the year every sheet, the survey of which was completed during previous years, had been submitted.

*Half-inch sheets compiled from one-inch maps.*—During the year 6 sheets have been fair drawn and 1 sheet submitted for publication leaving 29 sheets in hand of which 20 are nearing completion.

*Quarter-inch sheets compiled from one-inch or half-inch maps.*—During the year the drawing of 6 sheets has been completed while 2 sheets have been submitted for publication, 5 sheets are under examination and will be submitted shortly and the drawing of 17 sheets is nearing completion. Two proofs have been received for colouration, &c., of which one has been sent to press together with two proofs of previous years.

One degree sheet (94 G), a large portion of which was surveyed on the quarter-inch scale, has been fair mapped, is now under examination and will be submitted for publication shortly.

Three degree triangulation charts have been examined and submitted to the Superintendent of the Trigonometrical Survey.

**92. No. 6 (Simla) Drawing Office.**—As during the previous year this office was organized in 2 sections.

The *Army Section* has dealt with the preparation and reproduction of maps and plans for the use of the Army in India while the *Survey Section* has been employed on the preparation of trans-frontier maps on the one-millionth, quarter-inch and half-inch scales.

Most of the work of the *Survey Section* has consisted in redrawing in modern style, and sometimes to a reduced scale, the maps already existing, with the incorporation of such additional information of recent date as may have been available.

**93. Bihār and Orissa Drawing Office.**—(*Imperial Standard Mapping Section*). Owing to the removal of the Bihār and Orissa Drawing Office to Patna the Imperial Mapping Section was placed under the direction of the Director of Surveys, Bengal and Assam, from 1st October 1914. The office submitted the fair mapping for publication of 48 preliminary one-inch sheets of Bihār and Orissa covering an area of 11,277 square miles appertaining to the following districts:—

Monghyr, Shāhābād, Patna, Gayā, Palāmau, Hazāribāgh, Rānchī, Mānbhūm and Singhbhūm.

Four other sheets have also been completed and will shortly be sent for publication; 39 sheets are in hand and 12 sheets of the Province remain to be compiled.

For Bengal 3 sheets are nearly ready and 36 sheets are in hand.

An experiment was made to compile a sheet from cadastral detail as mapped on the four-inch Thana maps; it is hoped that the experiment will be successful and that it will lead to the reduction of arrears.

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## PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

**94. Northern Circle.**—*The Punjab Riverain Detachment* of the Northern Circle was exclusively employed as in previous years on local surveys in the Punjab. The detail of the work is shown on page 16.

*No. 20 Party (Cantonment).*—This Party continued the detail survey of the Cantonments shown on page 15.

*Simla Survey Detachment* continued its survey work in the Simla Municipality, for details see pages 16 and 17.

*The Khetran-Laghari boundary* between the Punjab and Baluchistān was demarcated by Captain R. Foster, I.A., of No. 4 Party at a cost of Rs. 1,316-11-3 which was paid for in equal shares by the two Governments concerned.

**95. Eastern Circle.**—Lieut.-Colonel Crichton, C.I.E., wrote a comprehensive note on the subject of Revenue Surveys for the information of the Chinese Government who are contemplating the introduction of Land Settlement and Surveys on a modern basis in their country.

**96. General.**—Two Provincial officers have been lent to the Bombay Government for the *Bombay City Survey*.

Various *Forest Surveys* and forest maps were carried out as usual for the Forest Department; for details see pages 13, 14 and 37.

A portion of the *Nepāl-Pilibhit boundary* has been re-aligned and surveyed by a detachment, the details of the work are at pages 23 and 24.

**97. Map Publication Offices.**—During the year numerous maps, plans, and illustrations were reproduced for many Government departments and offices, less than half of the work of the Photo.-Litho. Office being of a purely departmental nature. The reproduction of such work can be undertaken without interfering with the normal work of the department so long as the maps, &c. are submitted in a state suitable for reproduction and do not require to be redrawn.

No. 1 (Head Quarter) Drawing Office prepared amongst others the Bassein and Henzada maps for District Gazetteers, Postal maps of Bengal, Assam, and Bihār and Orissa, Telegraph and Railway maps for India, as well as several manœuvre maps; a considerable number of Commission forms and Certificates were also engraved.

**98. Mathematical Instrument Office.**—Since the outbreak of war this office has undertaken the manufacture of many 9-inch and 3-inch heliographs (444). It has also issued and repaired many other military instruments such as telescopes, binoculars, rangefinders, &c. Overtime has been worked to the extreme limit that the workmen could stand, and a certain amount of civil work has been set aside in order to meet the demands made by Military Departments.

The office as usual supplied and repaired instruments for every Government department in India.

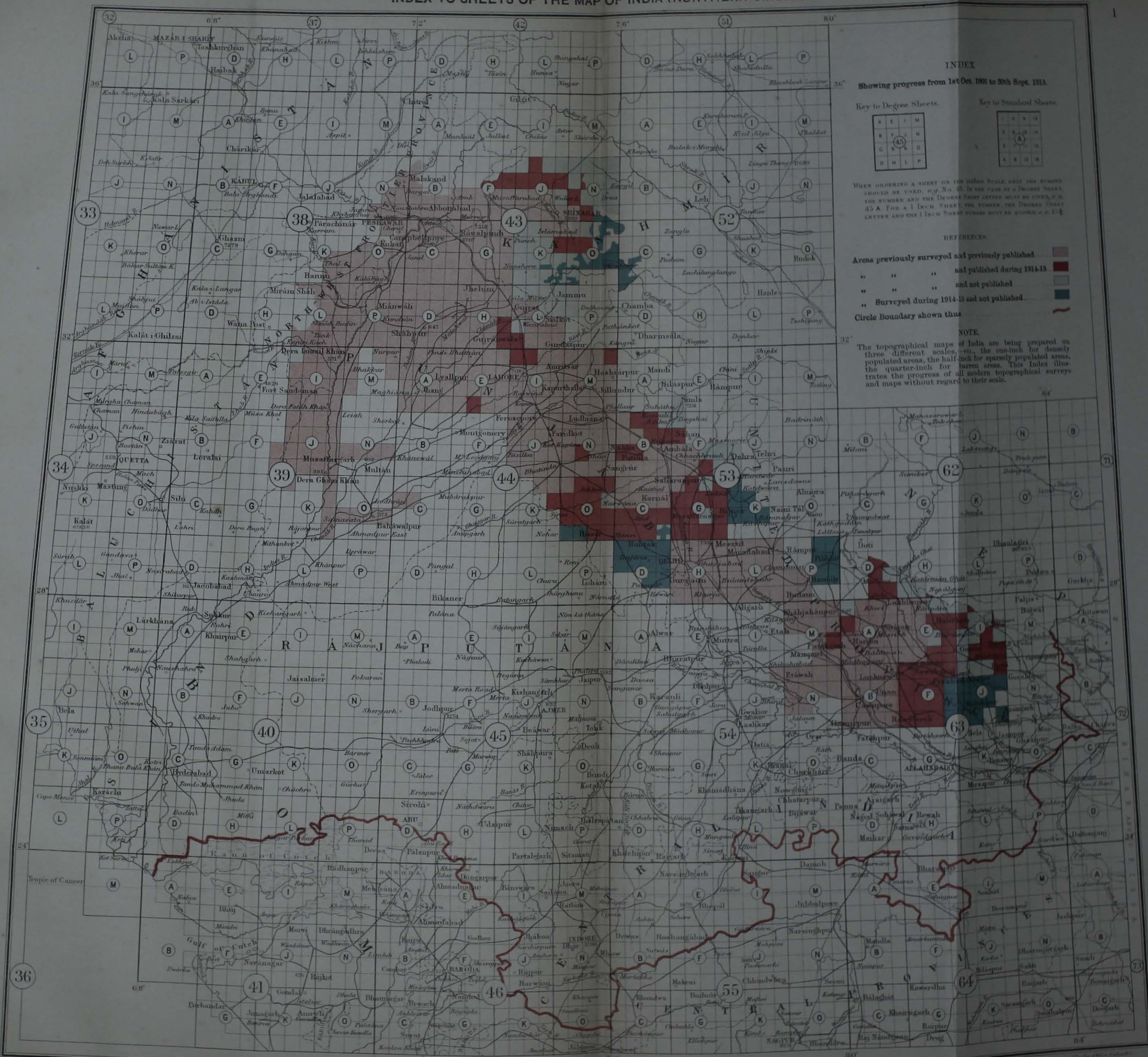
**99. Dehra Dūn Offices.**—During the year a large number of maps, &c., were reproduced for other Government departments and offices while the Computing Office also complied with requisitions for data.

## LIST OF INDEX MAPS.

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1. Modern surveys and publication, Northern Circle.
2. " " " " Southern "
3. " " " " Eastern "
4. Publication of modern one-inch series, Northern Circle.
5. " " " " Southern Circle.
6. " " " " Eastern "
7. " " provisional editions of one-inch series, Northern Circle.
8. " " " " Eastern "
9. " " modern half-inch series for India.
10. " " " quarter-inch " "
11. " " 'India and Adjacent Countries' series, scale  $\frac{1}{1,000,000}$ .
12. " " Indian sheets of "La Carte Internationale du monde." scale  $\frac{1}{1,000,000}$ .
13. " " 'Southern Asia' series, scale  $\frac{1}{2,000,000}$ .
14. Progress of the Great Trigonometrical Survey.





INDEX

Showing progress from 1st Oct. 1905 to 30th Sept. 1915.

Key to Degree Sheets.

Key to Standard Sheets.



When ordering a sheet on the Indian Scale, only the number should be used, e.g. No. 45 in the case of a Degree Sheet, the number and the Degree Sheet letter must be given, e.g. 45 A. For a 1 Inch Sheet the number, the Degree Sheet letter and the 1 Inch Sheet letter must be given, e.g. 45 A B.

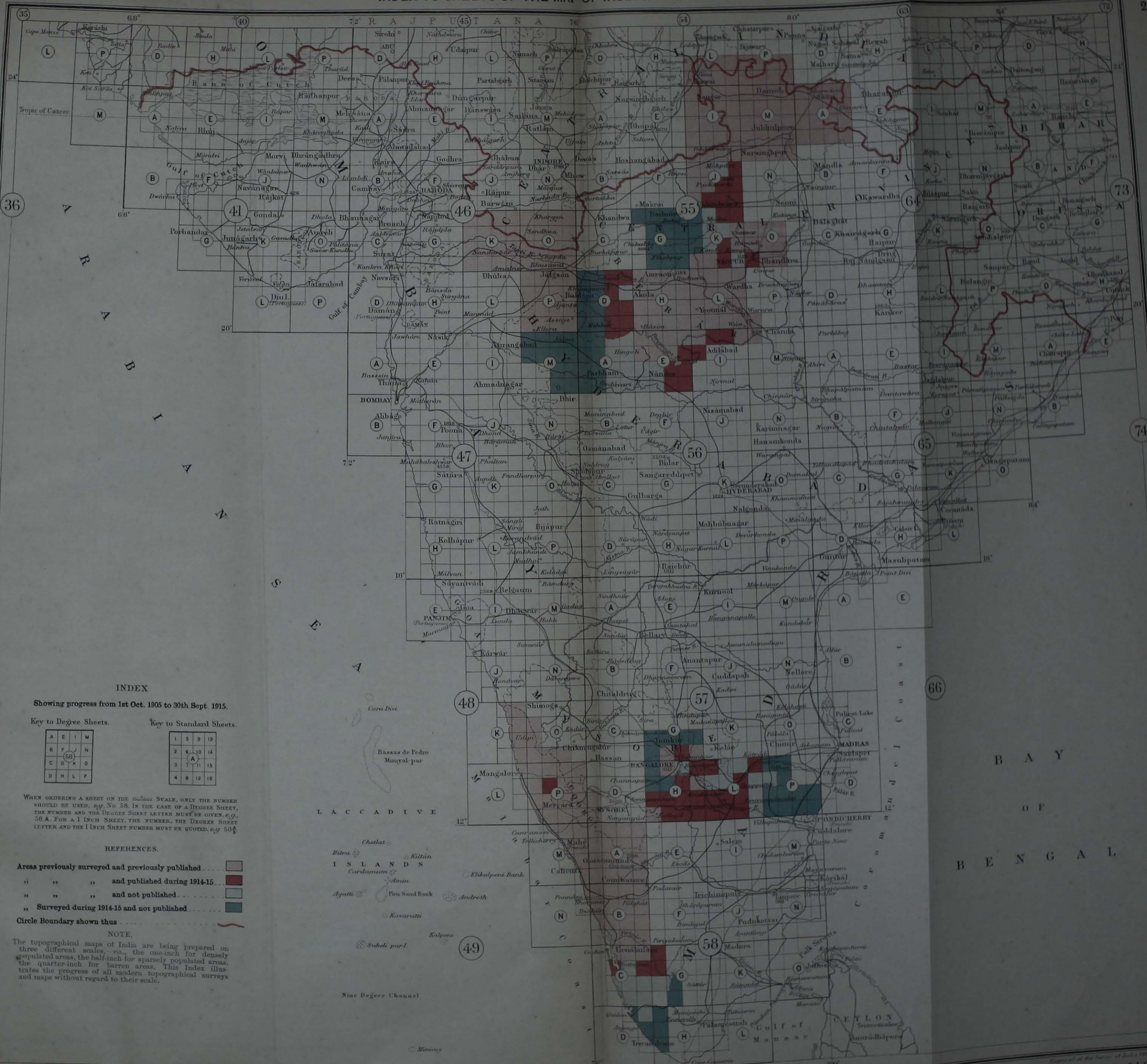
REFERENCES.

- Areas previously surveyed and previously published
- " " " and published during 1914-15
- " " " and not published
- " " " surveyed during 1914-15 and not published
- Circle Boundary shown thus

NOTE.

The topographical maps of India are being prepared on three different scales, viz. the one-inch for densely populated areas, the half-inch for sparsely populated areas, the quarter-inch for barren areas. This Index illustrates the progress of all modern topographical surveys and maps without regard to their scale.





INDEX

Showing progress from 1st Oct. 1905 to 30th Sept. 1915.

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 *one-inch* SCALE, ONLY THE NUMBER SHOULD BE USED, *eg.* No 58. IN THE CASE OF A DEGREE SHEET, THE NUMBER AND THE DEGREE SHEET LETTER MUST BE GIVEN, *eg.* 58 A. FOR A 1/2 INCH SHEET, THE NUMBER, THE DEGREE SHEET LETTER AND THE 1/2 INCH SHEET NUMBER MUST BE QUOTED, *eg.* 58 A 1/2.

REFERENCES.

- Areas previously surveyed and previously published . . . . .
- " " " and published during 1914-15 . . . . .
- " " " and not published . . . . .
- " Surveyed during 1914-15 and not published . . . . .

NOTE.

The topographical maps of India are being prepared on three different scales, *viz.*, the one-inch for densely populated areas, the half-inch for sparsely populated areas, the quarter-inch for barren areas. This Index illustrates the progress of all modern topographical surveys and maps without regard to their scale.



INDEX TO SHEETS OF THE MAP OF INDIA (EASTERN CIRCLE).



INDEX  
Showing progress from 1st Oct. 1905 to 30th Sept. 1915

Key to Degree Sheets

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

Key to Standard Sheets

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

WHEN ORDERING A SHEET OF THE INDEX MAPS, ONLY THE NUMBER SHOULD BE USED, e.g. No. 84. IN THE CASE OF A DEGREE SHEET, THE NUMBER AND THE DEGREE SHEET LETTER MUST BE USED, e.g. 84 A. FOR A 1 INCH SHEET, THE NUMBER, THE DEGREE SHEET LETTER AND THE 1 INCH SHEET NUMBER MUST BE USED, e.g. 84 A 1.

- REFERENCES.
- Areas previously surveyed and previously published
  - and published during 1914-15
  - and not published
  - Surveyed during 1914-15 and not published
  - Circle Boundary shown thus

NOTE.  
The topographical maps of India are being prepared on three different scales, viz., the one-inch for densely populated areas, the half-inch for sparsely populated areas, the quarter-inch for barren areas. This Index illustrates the progress of all modern topographical surveys and maps without regard to their scale.





INDEX

Showing progress from 1st Oct. 1905 to 30th Sept. 1913.

Key to Degree Sheets.



Key to Standard Sheets.



WHEN ORDERING A SHEET ON THE INDEX STATE ONLY THE NUMBER SHOULD BE GIVEN. FOR NO. 43 IN THE CASE OF A DEGREE SHEET, THE NUMBER AND THE DEGREE SHEET LETTER MUST BE GIVEN, e.g. 43 A. FOR A 1 INCH SHEET STATE THE NUMBER, THE DEGREE SHEET LETTER AND THE 1 INCH SHEET NUMBER MUST BE GIVEN, e.g. 43 A.

REFERENCES.

- Areas previously published
- " published during 1914-15
- Circle Boundary shown thus





INDEX

Showing progress from 1st Oct. 1905 to 30th Sept. 1915.

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	15

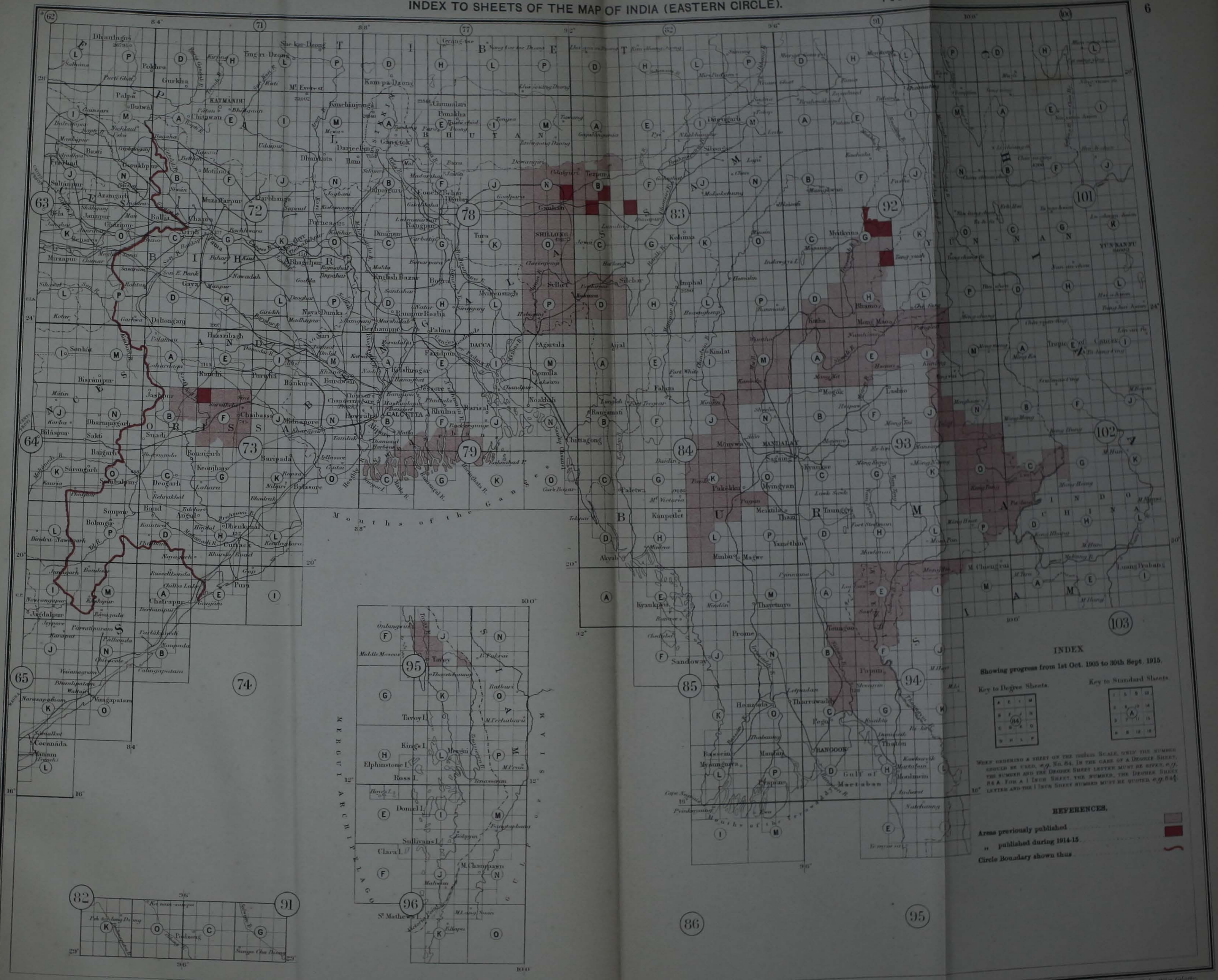
When ordering a sheet on the *Indian* Scale, only the number should be used, e.g. No 58. In the case of a Degree Sheet, the number and the Degree Sheet letter must be given, e.g. 58 A. For a 1 Inch Sheet, the number, the Degree Sheet letter and the 1 Inch Sheet number must be quoted, e.g. 58 A.

REFERENCES.

- Areas previously published
- „ published during 1914-15
- Circle Boundary shown thus



INDEX TO SHEETS OF THE MAP OF INDIA (EASTERN CIRCLE).



**INDEX**  
Showing progress from 1st Oct. 1905 to 30th Sept. 1915.

Key to Degree Sheets:

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

Key to Standard Sheets:

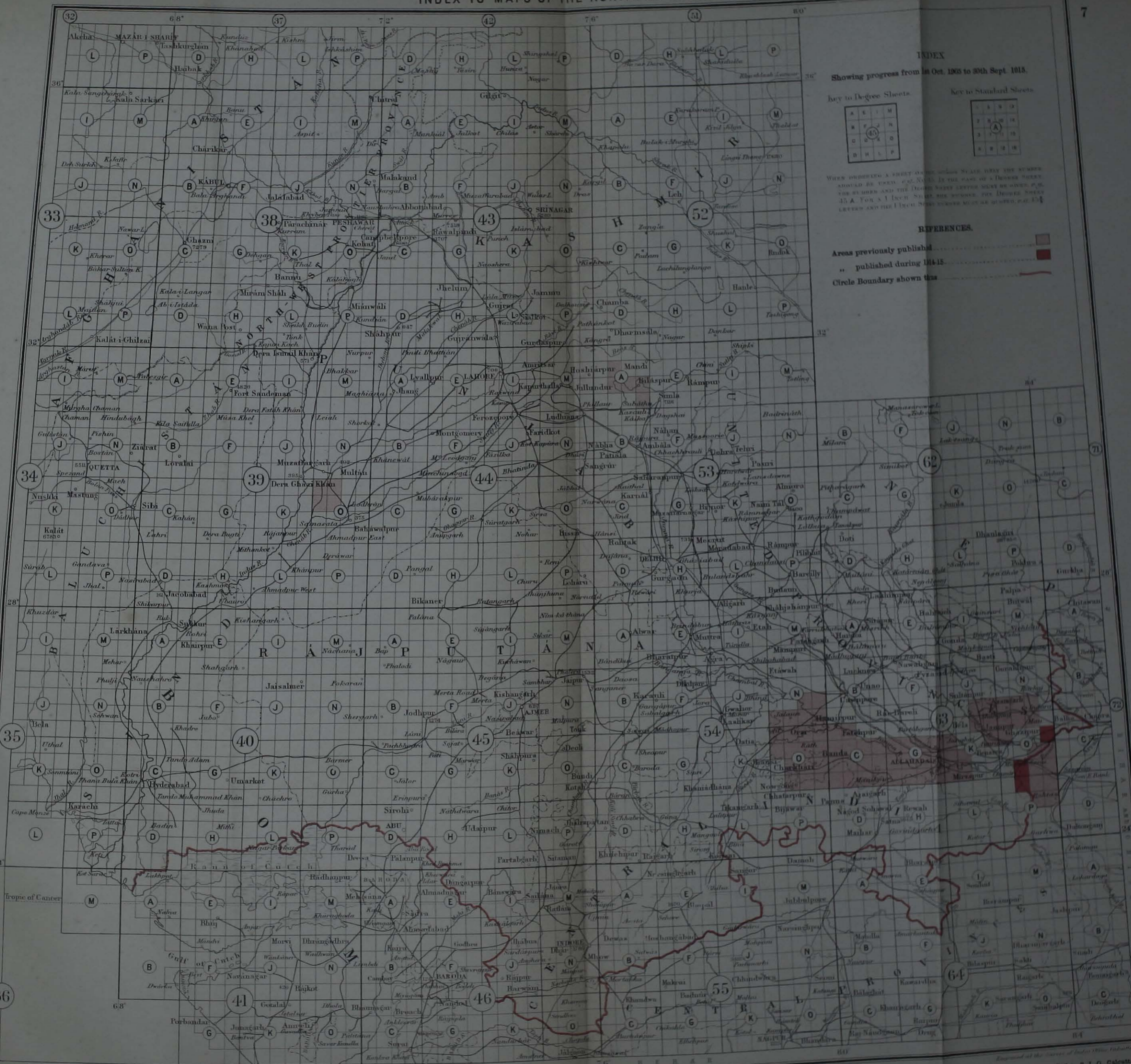
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

When ordering a sheet of the Indian Scale, only the number which is used, e.g. No. 84. In the case of a Degree Sheet, the number and the Degree Sheet letter must be given, e.g. 84 A. For a 1 inch sheet, the number, the Degree Sheet letter and the 1 inch sheet number must be quoted, e.g. 84 A 1.

**REFERENCES.**

- Areas previously published
- published during 1914-15
- Circle Boundary shown thus





INDEX  
Showing progress from 1st Oct. 1865 to 30th Sept. 1875.

Key to Degree Sheets



Key to Standard Sheets

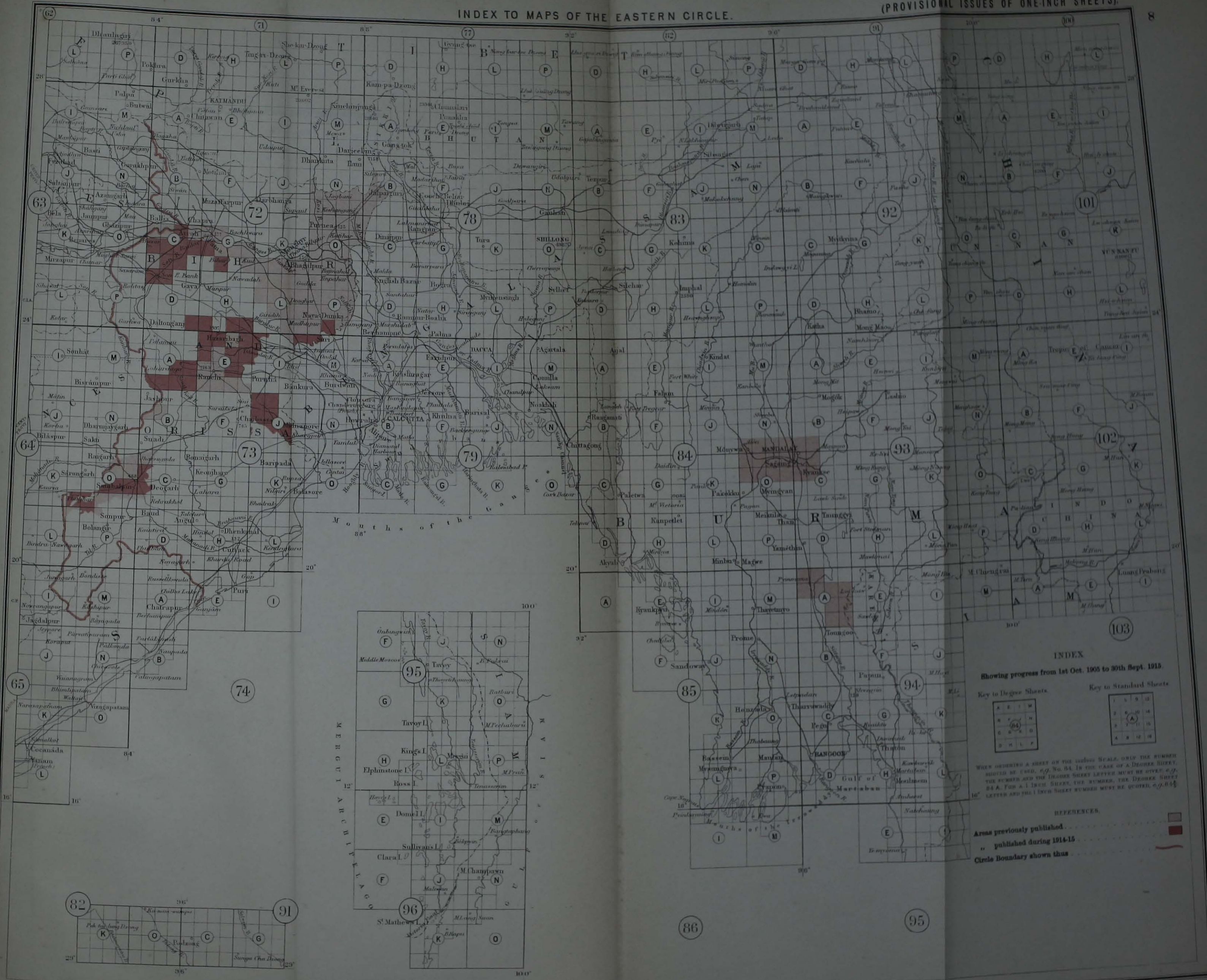


When published a sheet of the Northern Circle may be taken as a degree sheet if the number and the degree sheet letter are given, e.g. 45 A. For a 1 inch scale the number, the degree sheet letter and the Circle Sheet number must be given, e.g. 45 A.

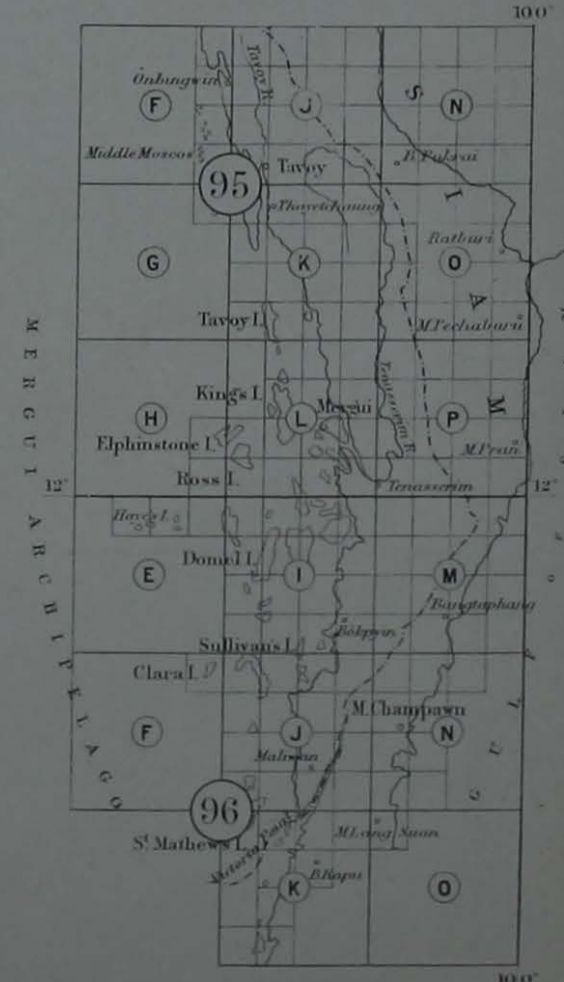
REFERENCES.

- Areas previously published
- published during 1874-75
- Circle Boundary shown this





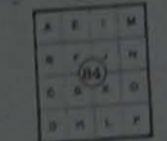
Months of the



INDEX

Showing progress from 1st Oct. 1905 to 30th Sept. 1915

Key to Degree Sheets.



Key to Standard Sheets.



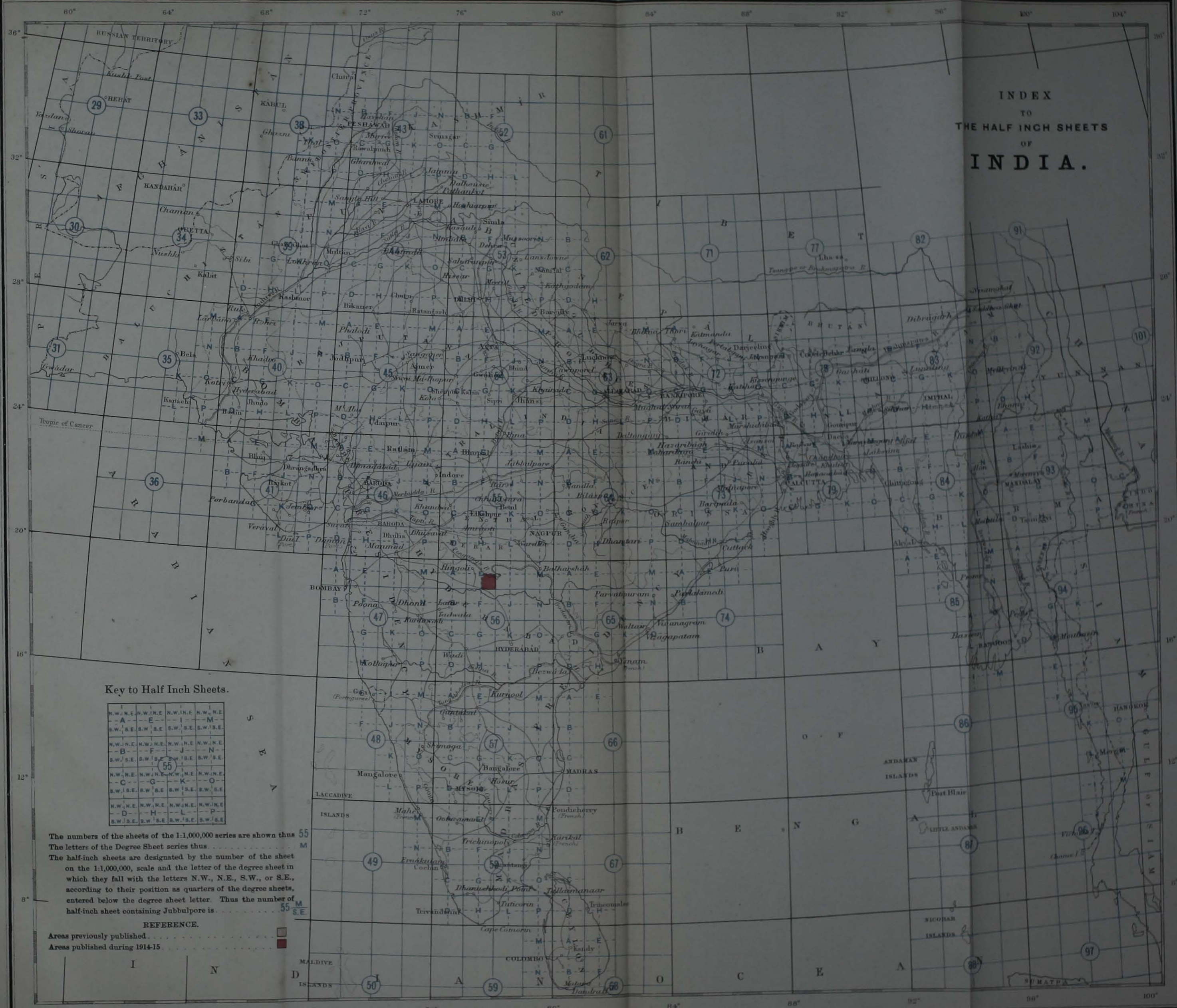
When ordering a sheet on the double scale, only the number should be used, e.g. No. 84 in the case of a Degree Sheet. The number and the Degree Sheet letter must be given, e.g. 84 A. For a 1-inch sheet, the number, the Degree Sheet letter and the 1-inch sheet number must be quoted, e.g. 84 A 10.

REFERENCES.

- Area previously published. . . . .
- published during 1914-15. . . . .
- Circle Boundary shown thus . . . . .



INDEX  
TO  
THE HALF INCH SHEETS  
OF  
INDIA.



Key to Half Inch Sheets.

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

The numbers of the sheets of the 1:1,000,000 series are shown thus 55  
 The letters of the Degree Sheet series thus M  
 The half-inch sheets are designated by the number of the sheet on the 1:1,000,000 scale and the letter of the degree sheet in which they fall with the letters N.W., N.E., S.W., or S.E., according to their position as quarters of the degree sheets, entered below the degree sheet letter. Thus the number of half-inch sheet containing Jubbulpore is 55 M S.E.

REFERENCE.

Areas previously published.   
 Areas published during 1914-15.



# INDEX TO THE DEGREE SHEETS OF INDIA.

[On the Scale of 1 Inch to 4 Miles.]



### Key to Degree Sheets.

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

The numbers of the sheets of the 1:1,000,000 series are shown thus

REFERENCES.

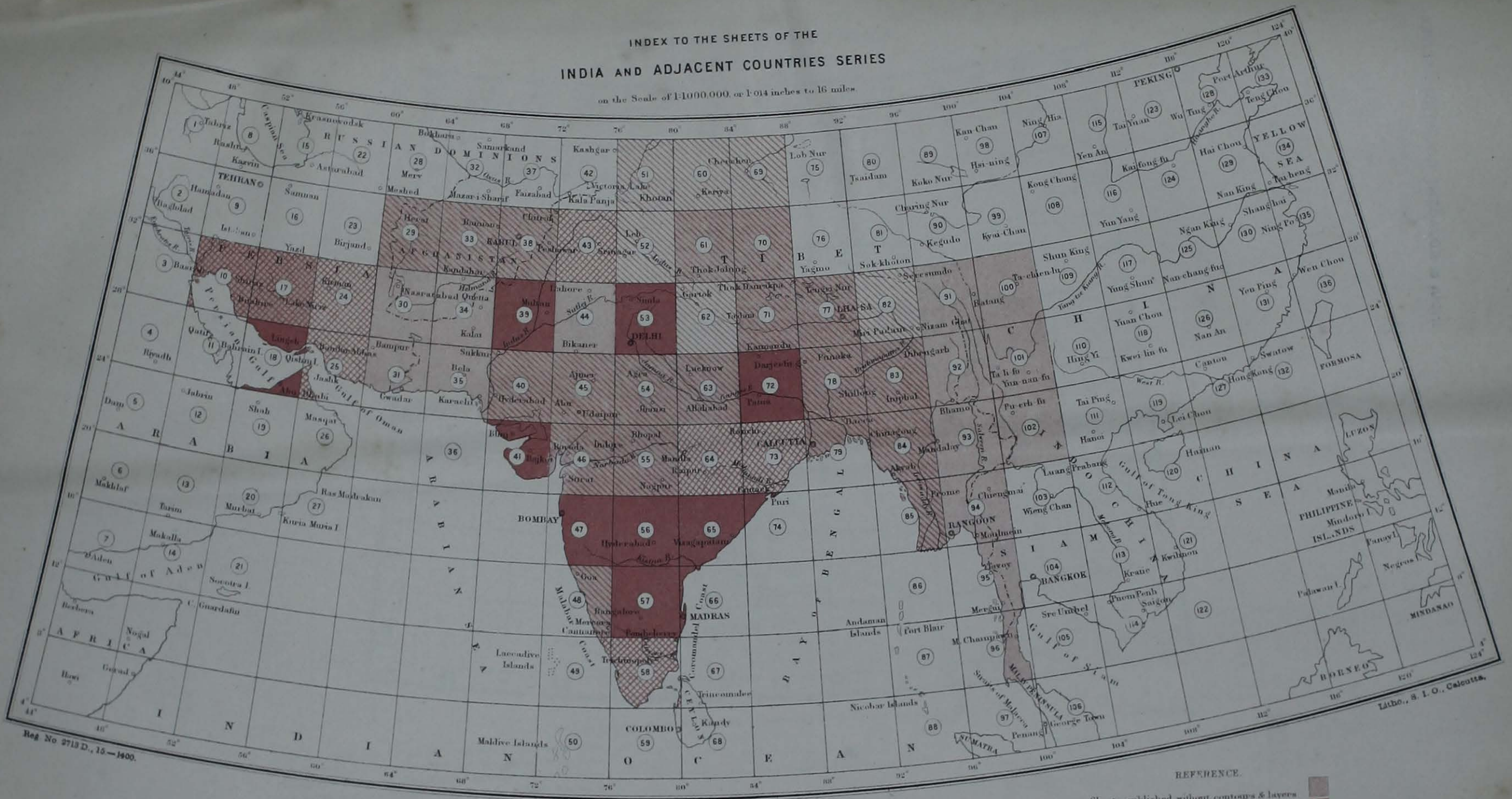
Sheets previously published   
 " published during 1914-15

NOTE.— Sheets published from old material or from atlas sheets have not been shown.



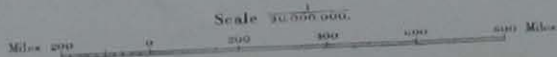
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on the Scale of 1:1,000,000, or 1:134 inches to 16 miles



Reg No 2713 D., 15-1900.

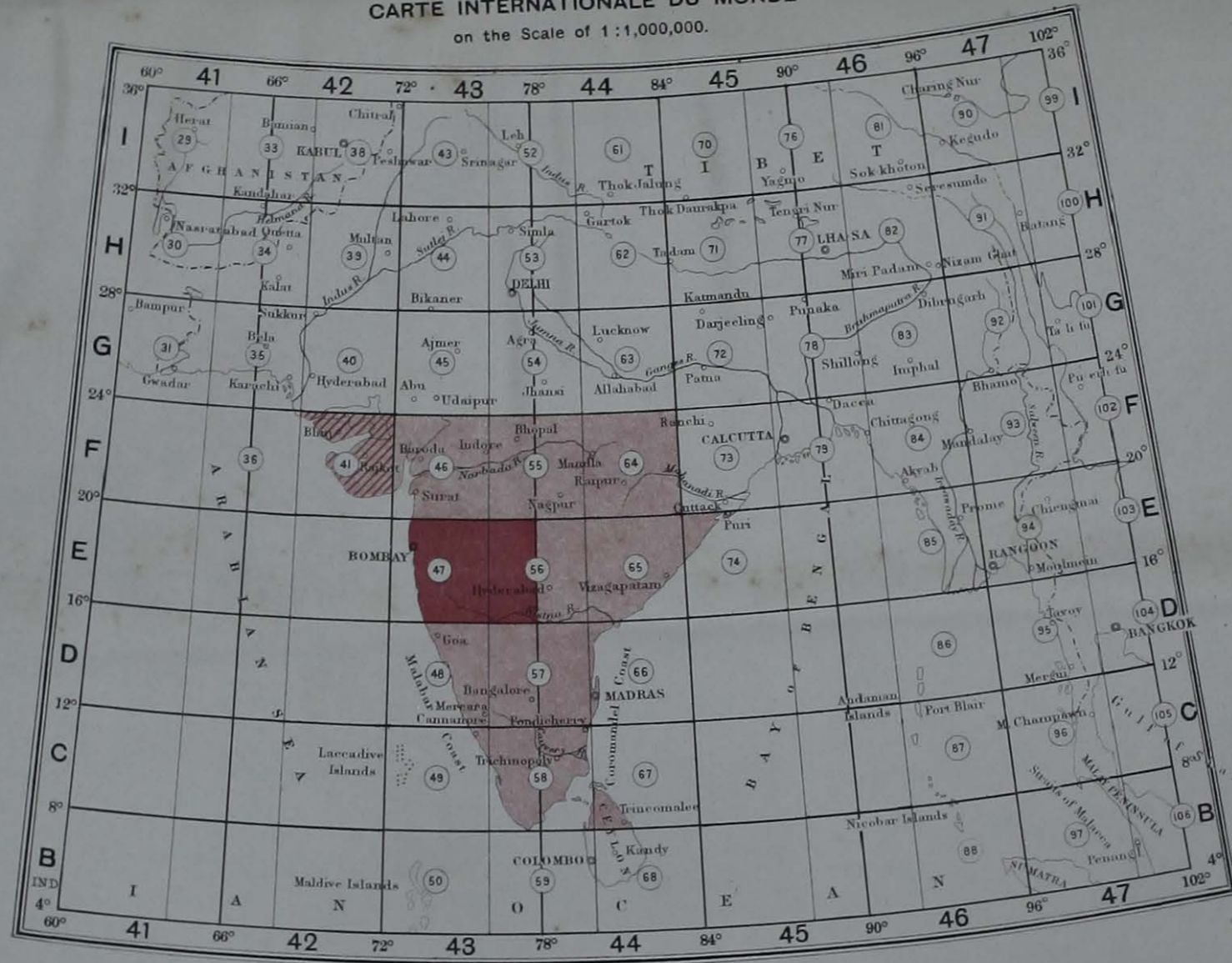
Published under the direction of Colonel Sir S. G. Burrard K.C.S.I., R.E., F.R.S., Surveyor General of India.  
1915



REFERENCE.	
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" " with contours & layers	(Dark red box)
" under publication "	(Cross-hatched box)
" in hand "	(Diagonal line box)



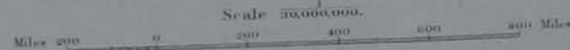
INDEX TO THE SHEETS OF THE  
**CARTE INTERNATIONALE DU MONDE**  
 on the Scale of 1:1,000,000.



Published under the direction of Colonel Sir S. G. Burrard, K.C.S.I., R.E., F.R.S., Surveyor General of India.  
 1915.

The thick lines show the margins of the sheets of the International Map of the World, Scale 1:1,000,000. Each sheet is designated by the letter N (Northern hemisphere), followed by the marginal letter, and number corresponding to its position, e.g., the sheet which includes Bombay is N.E.-43.

The figures in circles are the numbers of the sheets of the India and Adjacent Countries Series on the Scale of 1:1,000,000.



REFERENCE

- Sheets published
- " under publication
- " in hand

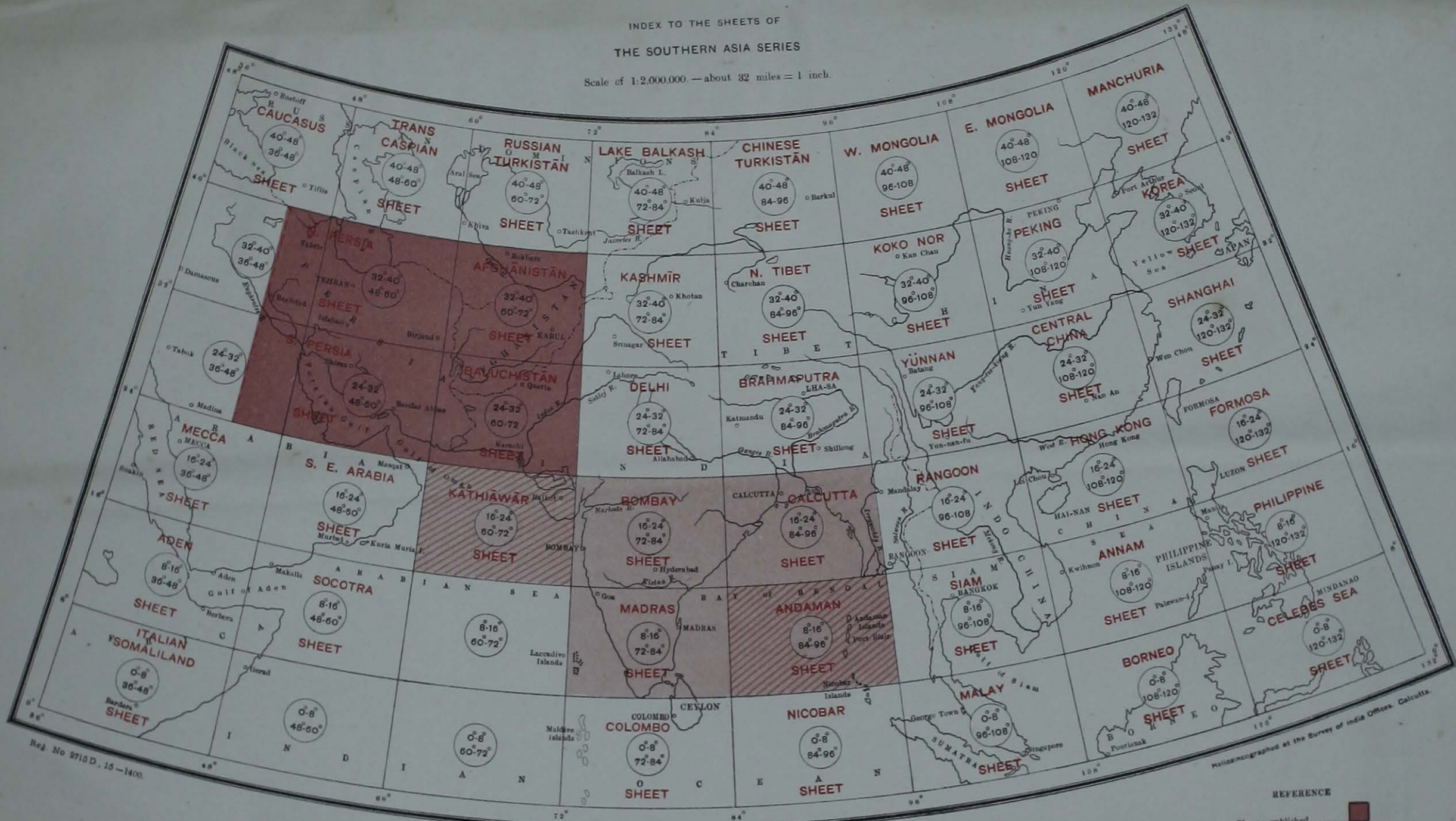


Litho., S. I. O., Calcutta



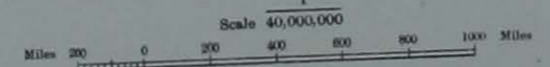
INDEX TO THE SHEETS OF  
THE SOUTHERN ASIA SERIES

Scale of 1:2,000,000.—about 32 miles = 1 inch.



Reg. No 2715 D. 15-1400.

Published under the direction of Colonel Sir S. G. Barrard, K.C.S.I., R.E., F.R.S., Surveyor General of India.



Heliocographed at the Survey of India Office, Calcutta.

REFERENCE  
 Sheets published .....  
 " under publication .....  
 " in hand .....

*Survey of India.*  
GENERAL REPORT,  
1914-15.

From 1st October 1914  
To 30th September 1915.

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PREPARED UNDER THE DIRECTION OF  
COLONEL SIR S. G. BARRARD, K.C.S.I., R.E., F.R.S.,  
SURVEYOR GENERAL OF INDIA.

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PRINTED AT THE PHOTO-LITHO. OFFICE, SURVEY OF INDIA,  
CALCUTTA,  
1916.