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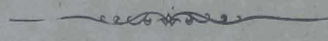
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Survey of India.

GENERAL REPORT.

1920-21.

From 1st October 1920.
To 30th September 1921.



PREPARED UNDER THE DIRECTION OF
COLONEL C. H. D. RYDER, C.I.E., D.S.O., R.E.,
SURVEYOR GENERAL OF INDIA.



PRINTED AT THE PHOTO-LITHO. OFFICE, SURVEY OF INDIA,
CALCUTTA,
1922.

Price Two Rupees or Four Shillings.

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Survey of India.

1

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CALCUTTA,

PRINTED AT THE
PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, SURVEY OF INDIA,
14, WOOD STREET,
CALCUTTA.

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(a) The LAYERED edition represents a map printed in colours with graduated layer tints of colour to show altitudes, and, shading to emphasize the hills. This edition gives prominence to the physical features.

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(a) SOUTHERN ASIA SERIES, scale 1:2,000,000 or nearly 1 inch = 32 miles, in LAYERED and POLITICAL editions, size 36 inches × 24 inches, price Rs. 3 per copy.

(b) INDIA AND ADJACENT COUNTRIES; scale 1:1,000,000 or nearly 1 inch = 16 miles, in LAYERED and POLITICAL editions, or if from old surveys, as PRELIMINARY editions; size 24 inches × 19 inches, price Re. 1-8 per copy. If printed on linen-backed paper Rs. 2-4.

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- (b) PROVINCIAL MAPS, on scales 1 inch = 16 miles and 1 inch = 32 miles.
- (c) DISTRICT MAPS, on scales 1 inch = 4 miles and 1 inch = 8 miles.
- (d) CANTONMENT AND TOWN MAPS AND OTHER MISCELLANEOUS MAPS, of various scales and prices.

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9. The prices quoted for various maps are exclusive of postage and V. P. P. charges. Any further information may be obtained free of charge from the Officer in charge, Map Record and Issue Office, 13, Wood Street, Calcutta.

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6. " " Indian sheets of "La Carte Internationale du Monde," scale $\frac{1}{1,000,000}$.
7. " " 'Southern Asia' series, scale $\frac{1}{2,000,000}$.
8. Progress of the Great Trigonometrical Survey.

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Survey of India.

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GENERAL REPORT,

1920—21.

From 1st October 1920

To 30th September 1921.

PART 1.—GENERAL REMARKS.

I.—INTRODUCTION.

1. The main parts of this report, as shown in the "Contents" on the opposite page, are *Part 2—Work of Field Parties, &c.*, summarising the operations of the field parties, grouped under appropriate headings; and *Part 3—Office Work*, which gives a brief account of the year's progress in the head-quarters and other offices. Fuller details of these operations are being published in Volume XVI of the "Records of the Survey of India."

2. An abstract showing the progress of the topographical programme assigned to the department in 1905, may be found in Table II on page 9. From this it will be seen that the out-turn of topographical survey during the current year was 39,961* square miles; and that this brings the total progress since 1905 to 580,735 square miles, leaving 1,240,865 square miles still to be done.

3. The first Index map, at the end of the report, shows the progress of this topographical programme both in survey and in publication in the three circles, while the remaining seven 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 30 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 in the monthly "Notes of the Survey of India."

5. Progress in the Trigonometrical Survey 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.

* Excludes 13½ square miles large scale survey (military) on the eight-inch scale.

6. The following events are notified:—

- (a) A fairly full programme of topographical work was carried out during the year. The area surveyed being 39,961 square miles compared with 30,464 square miles the previous year. This however does not compare it with the record years before the war, 1912-13 and 1913-14, when 53,377 and 55,786 square miles respectively were surveyed. This is due to the cessation of recruitment of surveyors, &c., during the war, and to the retention of two topographical parties in recess owing to financial stringency. The field work of the Trigonometrical Survey had to be greatly curtailed owing to shortage of officers.
- (b) The Survey detachment under Major H. T. Morshead, D.S.O., R.E., which was sent with the Mount Everest Expedition returned after completing 12,930 square miles of original survey in Tibet, 3,126 square miles of revision survey in Sikkim and 700 square miles of photo. survey near Mount Everest.
- (c) Lectures were delivered by Lieut.-Colonel C. P. Gunter, O.B.E., R.E., to the Senior Officers' Class at Belgaum and at Murree, Northern Command, on the subject of survey and mapping, and the use of aerial photography for survey purposes.
- (d) A competitive examination for admission to the Class II Service was held during the year. 19 candidates sat for examination out of whom 3 were selected.
- (e) Experimental determinations of longitude by wireless telegraphy were carried out at Dehra Dūn. The Paris "scientific" time-signals were successfully received.
- (f) The tide predicting machine has been transferred from the National Physical Laboratory at Teddington to Dehra Dūn. The future prediction and publication of tide tables for Indian ports will be carried out by the Survey of India, commencing in 1923.
- (g) There has been an increased demand on the part of the public for maps during the year.
- (h) The demand for large scale surveys of towns, &c., is continuous.
- (i) Most of the personnel employed under the Mesopotamian Administration returned to India by July 1921.

II.—ADMINISTRATION AND PERSONNEL.

7. The actual cost of the department for the financial year ending 31st March 1921 and of the two previous years is shown below:—

	1918-19.	1919-20.	1920-21.	REMARKS.
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>	
Gross actual cost	38,38,091	44,92,352	45,76,608*	* These figures are not final.
Deduct receipts and credits	18,83,964	20,65,422	14,50,650*	
Net actual charges	19,54,127	24,26,930	31,25,958*	

8. Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E., administered the department from the 17th November 1920 on return from leave. Colonel W. M. Coldstream, R.E., officiated for him during his absence on leave.

9. Of Class I officers:—Colonel Sir Gerald Lenox-Conyngham, Kt., R.E., F.R.S., Lieut.-Colonels C. L. Robertson, C.M.G., R.E., and A. Mears, I.A., and Mr. B. R. Hughes retired, and Captain H. A. Joly de Lotbinière, M.C., R.E., reverted to the Home Establishment.

Major F. F. Hunter, D.S.O., I.A., reverted from deputation to Persia and Captain R. S. Wauchope, O.B.E., I.A., from deputation to military duty.

Mr. E. C. J. Bond, V.D., was promoted from the Class II Service.

The following officers were appointed during the year:—

Captains T. M. M. Penney, R.E., H. R. C. Meade, I.A., J. K. Douglas, R.E., R. S. P. MacIvor, I.A., W. J. Norman, M.C., R.E., T. W. R. Haycraft, R.E., and G. W. Gemmell, I.A., Lieutenants G. H. Osmaston, M.C., R.E., H. A. Bazley, R.E., G. F. Heaney, R.E., and G. Bonford, R.E.

The number of officers on deputation to military duty at the end of the year is 1.

Commissary and Honorary Major C. J. Arbery, M.B.E., retired.

Mr. R. C. Malcolm was appointed as Assistant Manager, Mathematical Instrument Office.

Of Class II officers:—Messrs. F. P. Walsh and Syed Zille Hasnain, K.S., retired and Messrs. M. Gastaud and A. Ewing ceased to be re-employed. Mr. H. B. Powell who had been on deputation to Burma died.

Messrs. N. C. Puri, R.S., and E. N. Natesan were promoted from the Upper Subordinate Service.

Captain J. H. Williams reverted from deputation to military duty, and Mr. V. W. Morton, Lieutenant L. B. Fitz-Gibbon and Mr. N. C. Puri, R.S., reverted from deputation under the High Commissioner for Mesopotamia.

Mr. J. O'B. Donaghey was placed on deputation for five months under the Government of Madras.

The number of officers on deputation to military duty at the end of the year is 1.

Mr. J. B. Chorlton was appointed as Assistant Manager, Photo-Litho. Office.

In the Upper Subordinate Service, Mr. Hamid Gul, K.S., retired, 12 officers were promoted from the Lower Subordinate Service and 14 candidates were appointed on probation, one of whom resigned.

Messrs. Sher Jang, K.R., Annada Prasad Ghosh, Muhammad Hasan and Jagannath reverted from deputation to Mesopotamia.

The total strength of the department at the close of the Survey year was 62* Class I officers, 97† Class II officers and 80‡ Upper Subordinates, besides specialists, clerks, lower subordinates and menials.

10. The following honours were conferred during the year:—

<i>Companion of the Order of the Indian Empire.</i> —	Lieutenant-Colonel H. L. Crosthwait, R.E.
<i>Member of the Order of the British Empire.</i> —	Mr. P. A. T. Kenny, Extra Assistant Superintendent.
<i>Mentioned in despatches.</i> —	Lieutenant-Colonel H. L. Crosthwait, C.I.E., R.E. Captain R. S. Wauchope, O.B.E., I.A. (second time). Mr. V. W. Morton, Extra Assistant Superintendent. Mr. Muhammad Husain Khan, Sub-Assistant Superintendent. Surveyor Jalil-ul-Kadr. Surveyor Muhammad Ayub Khan. Surveyor A. Francis. Draftsman Ananta Krishna Ray.
<i>Elected a founder Fellow of the Institute of Physics.</i> —	Dr. J. deGraaff Hunter, Sc.D., M.A.
<i>Khan Sahib.</i> —	Mr. Muhammad Husain Khan, Sub-Assistant Superintendent.

Mr. J. C. St. C. Pollett, Extra Assistant Superintendent, has been granted a commission as 2nd-Lieutenant in the 6th Bangalore, Coorg and Mysore Battalion, Auxiliary Force, India.

11. The following table shows the distribution of officers during the year. The names of officers on leave, on deputation to Local Governments, on military duty or on foreign service throughout the year are omitted; the names of some of the officers on leave, military duty or on foreign service during the greater part of the year are also omitted.

* Including one officer on temporary military duty.

† Including one officer on temporary military duty, officers on foreign service and probationers but excluding officers re-employed and on deputation to Local Governments (except Mr. P. Simpson on deputation to Bihar and Orissa).

‡ Including probationers and one officer on foreign service.

TABLE I—DISPOSITION OF OFFICERS, 1920-21.

SURVEYOR GENERAL OF INDIA—		Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E. (on leave up to 16th November 1920). Colonel W. M. Coldstream, R.E., Officiating to 16th November 1920.			
		Class I Officers.	Class II Officers.	Upper Subordinates.	Lower Subordinates, &c.
Surveyor General's Office.		Major H. J. Couchman, D.S.O., M.C., R.E.			
SUPERINTENDENT, MAP PUBLICATION—		Lieut.-Colonel G. A. Benzeley, D.S.O., R.E.			
		Class I Officers.	Class II Officers.	Upper Subordinates.	Lower Subordinates, &c.
Map Publication Office, Calcutta.			Mr. M. Gastaud (re-employed). " J. Prasad, R.S.		
No. 1 Drawing Office, Map Record and Issue Office, & Engraving Office, Calcutta.		Major F. F. Hunter, D.S.O., I.A. " C. M. Thompson, I.A.	" P. Williams " J. Prasad, R.S. " Pramadarajan Ray, R.S. " Abinash Chunder Bose " C. West " Asmat-ullah Khan, K.B. " A. B. Hunter " Priya Nath Sur " F. B. Kitchen " Munsbi Lal, B.A. " H. H. P. Butterfield " Jiya Lal Sabgal		
Photo.-Litho. Office, Calcutta.		Lt.-Colonel A. A. McHarg, D.S.O., R.E. Major A. H. Gwyn, I.A.			
Mathematical Instrument Office, Calcutta.		Mr. T. A. Ferrier, C.B.E. (re-joined from leave on 7th September 1921.) " S. Woodhouse (Offg.).			
Bengal & Bihar & Orissa Drawing Office, (Imperial Standard Mapping Section).			Mr. C. West	Mr. Charu Chandra Biswas	
No. 6 Drawing Office (Simla).		Major L. G. Crosthwait, I.A.	Mr. R. E. M. Saubolle " A. J. A. Drake, D.C.M. " H. H. P. Butterfield	Mr. Sher Jang, K.B.	5 European Draftsmen. 4 Printers. 2 Clerks. 15 Indian Draftsmen. 7 Pupil Draftsmen.
SUPERINTENDENT, NORTHERN CIRCLE		Lieut.-Colonel H. L. Crosthwait, C.I.E., R.E., up to 13th December 1920. Lieut.-Colonel H. Wood, R.E., from 14th December 1920.			
		Class I Officers.	Class II Officers.	Upper Subordinates.	Lower Subordinates, &c.
No. 3 Drawing Office, Mussorie.		Mr. J. A. Freeman	Mr. A. A. Graham " Moqimuddia " H. G. Shaw (re-employed).		41 Surveyors, &c.
No. 1 Party, North-West Frontier Province, Punjab and United Provinces.		Major H. T. Morshhead, D.S.O., R.E.	Mr. P. A. T. Kenny, M.B.E. Major C. H. Tresham Mr. R. C. Hanson " A. J. A. Drake, D.C.M. " H. T. Hughes	Mr. Jamna Prasad, R.S. " Muhammad Husain Khan, R.S. " Vidya Dhar Chopra " Afraz Gul Khan " Muhammad Khan " Jit Singh Rawat " Sijawal Khan	44 Surveyors, &c.
No. 2 Party, Central India, Delhi Province, Rajputana and United Provinces.		Bt.-Lieut.-Colonel S. W. S. Hamilton, D.S.O., R.E.	Mr. C. O. Picard " Duni Chand Puri " Prafulla Kumar Ghosh, n.s. (on probation). " T. O. Throfall (on probation).	Mr. Muhammad Husain " Imam Din " Lakshmi Dutt Joshi " Daulat Ram Vohra " Narsingh Das Joshi (on probation).	48 Surveyors, &c.
No. 3 Party, United Provinces.		Bt.-Major C. G. Lewis, R.E. Captain L. H. Jackson, I.A. " E. A. Glennie, D.S.O., R.E. (on probation).	Mr. E. H. West " L. Williams " J. H. Johnson " G. E. R. Cooper	Mr. Laitan Khan, I.D.S.M.	44 Surveyors, &c.
No. 4 Party, United Provinces.		Mr. J. A. Freeman " H. H. B. Hanby " M. C. Petters Captain L. H. Jackson, I.A.			18 Surveyors, &c.
Sind-Sagar Party, Punjab.		Major R. Foster, I.A.	Mr. Dhani Ram Verma " J. C. C. Lears " Maya Das Puri, R.S. " D. N. Banerjee, L.C.E.	Mr. Chuni Lal Kapur " Nabidad Khan " Amrit Ram	10 Surveyors, &c. 27 Local Revenue staff.
No. 22 (Riverain) Party, Punjab.		Mr. H. H. B. Hanby	Mr. Dhani Ram Verma " Maya Das Puri, R.S. " Abdul Karim, B.A.	Mr. Jamna Prasad, R.S. " Ram Narayan Hastir " Vidya Dhar Chopra " Galab Singh	48 Surveyors, &c.

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1920-21.

SUPERINTENDENT, SOUTHERN CIRCLE		{ Lieut.-Colonel C. P. Gunter, O.B.E., R.E., up to 19th October 1920. Brevet-Colonel F. W. Pirrie, C.M.G., C.I.E., I.A., from 20th October 1920 to 31st January 1921. Lieut.-Colonel C. P. Gunter, O.B.E., R.E., from 1st February to 15th March 1921. Lieut.-Colonel H. H. Turner, R.E., from 16th March 1921.			
		Class I Officers.	Class II Officers.	Upper Subordinates.	Lower Subordinates, &c.
No. 4 Drawing Office, Bangalore.	Mr. J. H. Nichol " J. O'B. Donaghey			Mr. B. V. Narmyana Rao " Damodar Khadilkar	40 Draftsmen, &c.
No. 5 Party, Berar, Bombay, Central India and Central Provinces.	Major L. C. Thuillier, I.A. Captain G. Lennox, I.A. (on probation).	Mr. F. C. Pilcher " F. W. Smith " Muhammad Najam-uddin, B.A. (on probation).		Mr. P. S. Vengusvami " J. A. Cabral (on probation).	32 Surveyors, &c.
No. 6 Party, Bangalore.	Lieut.-Colonel C. P. Gunter, O.B.E., R.E. Mr. J. O'B. Donaghey	Mr. H. B. Simons " E. A. Meyer " Munshi Lal, B.A. " N. S. Hariharu Iyer " E. N. Natesan, B.A.		Mr. K. G. Mandanna	25 Surveyors, &c.
No. 7 Party, Madras.	Major J. D. Campbell, D.S.O., R.E.	Mr. F. H. Grant " A. F. Murphy " N. S. Hariharu Iyer " E. N. Natesan, B.A.		Mr. K. Narayanasvami Chetti " Damodar Khadilkar " Shib Lal " Shudi Lal Dube	34 Surveyors, &c.
No. 8 Party, Madras and Travancore State.	Lieut.-Colonel M. O'C. Tandy, D.S.O., O.B.E., R.E.	Mr. C. E. C. French " M. Mahadeva Mudaliar, M.A. " B. T. Wyatt " M. S. Ganesa Aiyar " J. C. St. C. Pollett " J. A. Culvert		Mr. H. Narasimhamurti Rao " Saikh Muhammad Sulik " Abdal Ghafur	49 Surveyors, &c.
No. 20 Party, Cantonment and Military District Lands in the 9th Division.	Mr. B. R. Hughes Captain J. K. Douglas, R.E. (on probation).	Mr. J. H. S. Wilson		Mr. Dharmu " J. M. Mukerji	31 Surveyors, &c.
Training Section	Lieut.-Colonel C. P. Gunter, O.B.E., R.E.	Mr. S. S. McA'F. Fielding " V. W. Morton " F. H. Grant	14 Probationers		23 Surveyors and Pupils.
Record Section		Mr. Haji Abdul Rabin, K.B.	Mr. Annada Prasad Ghosh		9 Computers, &c.
SUPERINTENDENT, EASTERN CIRCLE		{ Lieut.-Colonel E. T. Rich, C.I.E., R.E., up to 22nd November 1920. Colonel W. M. Coldstream, R.E., from 23rd November 1920.			
		Class I Officers.	Class II Officers.	Upper Subordinates.	Lower Subordinates, &c.
No. 5 Drawing Office, Shillong.	Mr. W. M. Gorman " M. C. Petters	Mr. E. Claudius Lieut. C. S. McInnes Captain J. O'C. Fitzpatrick		Mr. Jagdeesh Prasad Vastav " Bansi Ram	25 Surveyors, &c.
No. 9 Party, Bengal and Bihar and Orissa.	Bt.-Lieut.-Colonel B. H. Philimore, D.S.O., R.E.	Mr. E. J. Riggie " E. G. Hardinge " Amar Krishna Mitra Lieut. C. S. McInnes Mr. Bhupendra Nath Saha, M. Sc. (on probation).		Mr. Jagdeesh Prasad Vastav " Amulya Charan Ghosh " Gopal Lal Mitra " Sasadhar Mukerjee (on probation).	29 Surveyors, &c.
No. 10 Party, Upper Burma.	Lieut.-Colonel E. T. Rich, C.I.E., R.E. Captain O. Slater, M.C., R.E. (on probation).	Mr. W. G. Jarbo " G. E. R. Cooper " H. H. Creed " H. M. Critchell (on probation).		Mr. Hayat Muhammad, K.S. " Dharendra Nath Saha " Ram Prasad, R.S. " Mung Te, A.T.M.	15 Surveyors, &c.
No. 11 Party, Lower Burma.	Mr. J. O. Greiff Captain T. M. M. Penney, R.E. (on probation).	Mr. O. J. H. Hart " F. C. Saint " F. J. Grice " A. V. Dickson		Mr. Pratul Chandra Sen Gupta, B. Sc. " Khan Muhammad	31 Surveyors, &c.
No. 12 Party, Assam.	Bt.-Lieut.-Col. C. M. Browne, C.M.G., D.S.O., R.E. Major F. B. Scott, I.A.	Mr. E. M. Kenny " D. K. Hennick, M.B.E. " Prafulla Chandra Mitra, B.A.		Mr. Girija Sonker Bagchi	31 Surveyors, &c.
No. 21 (Burma Forest) Party, Upper and Lower Burma.	Mr. H. W. Biggie	Mr. S. F. Norman Lieut. L. D. Fitz-Gibbon Captain V. P. Wainright " C. B. Sexton Mr. H. M. Critchell (on probation).		Mr. Dalbir Rai " Gulam Hasan " Bhamba Ram	14 Surveyors, &c.

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1920-21.

	<i>Class I Officers.</i>	<i>Class II Officers.</i>	<i>Upper Subordinates.</i>	<i>Lower Subordinates, &c.</i>	
SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY	Major R. H. Thomas, D.S.O., R.E., up to 16th November 1920.				
	Lieut.-Colonel H. L. Crosthwait, C.I.E., R.E., from 17th November 1920 to 13th March 1921.				
	Lieut.-Colonel H. McC. Cowie, R.E., from 14th March 1921.				
	Superintendent's Office.	Major H. T. Morshend, D.S.O., R.E.	Mr. G. J. S. Rao	Mr. Lalbir Singh	
		" F. J. M. King, R.E. (<i>On probation</i>).	" Nanak Chand Puri, B.A., R.S.		
		Captain T. M. M. Penney, R.E.			
		" H. R. C. Meade, I.A.			
		" J. K. Douglas, R.E.			
		" R. S. P. MacIvor, I.A.			
		Lieut. G. H. Osmaston, M.C., R.E.			
	" H. A. Bazley, R.E.				
	Captain W. J. Norman, M.C., R.E.				
	Lieut. G. F. Heaney, R.E.				
	Captain T. W. R. Hayercraft, R.E.				
	Lieut. G. Bomford, R.E.				
	Captain G. W. Gemmell, I.A.				
Computing Office.	Dr. J. deGraaff Hunter, M.A., sc.D., F. Inst. P.	Mr. Hanuman Prasad	Mr. Sarat Kumar Mukerji	49 Computers, &c.	
No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Major F. J. M. King, R.E.	Mr. G. J. S. Rao	Mr. Ram Singh, R.S.	162 Draftsmen, &c.	
	Captain R. S. P. MacIvor, I.A. (<i>on probation</i>).	" H. P. D. Morton	" Paras Ram		
		" Rama Prasad Ray, B.A.	" Jugal Behari Lal		
		" T. F. Kitchen	" Baldeo Bhari Lal		
		" F. B. Kitchen	" Sadik Ali		
		" O. D. Jackson	" Muhammad Hasan " Kunja Behari Lal		
No. 13 Party, (Astronomical).	Captain H. E. Roome, M.C., R.E.			1 Computer, &c.	
	" G. Lennox, I.A. (<i>on probation</i>).				
No. 14 Party, (Pendulum).	Lieut.-Colonel H. McC. Cowie, R.E.			1 Clerk, &c.	
	Captain R. S. Vauchope, O.B.E., I.A.				
	" E. A. Glennie, D.S.O., R.E. (<i>on probation</i>).				
	" H. R. C. Meade, I.A. (<i>on probation</i>).				
No. 15 Party, (Triangulation).	Bt.-Major K. Mason, M.C., R.E.			7 Computers, &c.	
	" " E. O. Wheeler, M.C., R.E. (<i>on probation</i>).				
	Captain O. Slater, M.C., R.E. (<i>on probation</i>).				
No. 16 Party, (Tidal).	Mr. O. C. Ollenbach	Mr. Hanuman Prasad		20 Computers, &c.	
		" Syed Zille Husnain, K.S. " D. H. Luxa			
No. 17 Party, (Leveling).	Bt.-Major K. Mason, M.C., R.E.	Mr. O. N. Pushong	Mr. Karuna Kumar Das, B.A.	15 Computers, &c.	
		" Raj Bahadur Nathur, B.A.	" Satish Chandra Mukerjee		
		" K. S. Gopalachari, B.A.	" Pulin Behari Roy		
		" Narendra Nath Chuckerbutty, L.C.E.	" A. A. S. Matlub Ahmad		
No. 18 Party, (Magnetic).	Mr. E. C. J. Bond, v.D.	Mr. Nikunjo Ronjon Mazumdar.	Mr. Bidhu Bhusan Shome	1 Magnetic Ob- server.	
			" Hem Chandra Banerjee, B.A.	10 Computers, &c.	
No. 19 Party, (Base Line).	Major C. M. Thompson, I.A.			2 Clerks, &c.	

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PART 2.—WORK OF FIELD PARTIES, &c.

I.—TOPOGRAPHICAL SURVEYS.

12. 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 shown 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 569,800 square miles are likely to be surveyed on the half-inch or smaller scales.

Table II.—Progress of Topographical Surveys since 1905.

Survey year.	Scales of Survey.	Northern Circle.	Southern Circle.	Eastern Circle.	TOTALS.
		<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 ...	23,833	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 ½-inch	28,192	13,349	11,896	53,377
1913-14 ...	ditto ...	25,052	15,844	14,890	55,786
1914-15 ...	ditto ...	12,334	19,286	5,056	36,676
1915-16 ...	ditto ...	8,168	17,243	6,931	32,342
1916-17 ...	ditto ...	11,689	11,338	9,723	32,750
1917-18 ...	ditto ...	4,202	12,181	8,396	24,779
1918-19 ...	ditto ...	509	7,263	6,176	13,948
1919-20 ...	ditto ...	9,145	11,891	9,428	30,464
1920-21 ...	ditto ...	14,411*	14,275	11,275	39,961
Total areas completed to date ...		235,866	188,596	156,273	580,735
Approximate areas for the whole topographical programme.		750,000	542,800	528,800	1,821,600
Approximate areas remaining for survey.		514,134	354,204	372,527	1,240,865

* Excludes 13½ square miles large scale military survey on the scale of 8 inches = 1 mile.

Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1920-21.

PARTY and LOCALITY.		OUT-TURNS OF PLANE-TABLING.		COSTS OF SURVEY INCLUDING MAPPING.		REMARKS.
		Areas on each Scale of each Class.	Totals of areas on all Scales.	Total costs.	Cost-rates.	
Character of Country.	Scale and Class of Survey.	Sq. miles.		Rs.	Rs. per sq. mile.	
No. 1 Party—North-West Frontier Province, Punjab and United Provinces.						NORTHERN CIRCLE.
Wooded hills ...	Quarter-inch Revision Survey ...	159	8,400	1,78,147	21·2	
Ditto ...	Half-inch Revision Survey ...	2,365				
Ditto ...	Half-inch Original Survey ...	465				
Ditto ...	One-inch Revision Survey ...	5,052				
Ditto ...	One-inch Original Survey ...	359				
Plain, partly cultivated and partly waste land.	Large-Scale Survey ...	13½	13½	6,028	446·5	
No. 2 Party—Central India, Delhi Province, Rajputana and United Provinces.						
Cultivated plains, open with occasional isolated low rocky hills.	Half-inch Original Survey ...	1,059	4,094	87,245 (a)	21·3	
Cultivated plains, open	One-inch Resurvey ...	1,693				
Ditto ditto	One-inch Revision Survey ...	1,208				
Low rocky hills and cultivated plains.	Four-inch Revision Survey ...	134				
No. 3 Party—United Provinces.						
Densely wooded hills and plains ...	One-inch Revision Survey ...	610	1,917	1,53,408 (b)	80·0	
Densely wooded hills ...	One-inch Original Survey ...	60				
Wooded hills ...	Two-inch Original Survey ...	1,247				
TOTALS, NORTHERN CIRCLE:—				14,424½ sq. m.	Rs. 4,24,828	Cost-rate 29·4
No. 5 Party—Berar, Bombay, Central India and Central Provinces.						SOUTHERN CIRCLE.
Intricate jungle-clad hills and well wooded plains.	One-inch Original Survey ...	2,768	3,871	1,13,130	29·2	
	One-inch Revision Survey ...	1,103				
No. 6 Party—Bangalore						
No. 7 Party—Madras.						
Open, undulating country	One-inch Original Survey ...	3,383	5,243	1,20,993 (c)	24·2 (d)	
Hilly jungle-clad	Two-inch Original Survey ...	628				
Ditto	One-inch Supplementary Survey ...	440				
Ditto	Two-inch Supplementary Survey ...	65				
Open, undulating and jungle-clad hills.	One-inch Revision Survey ...	727				
No. 8 Party—Madras and Travancore State.						
Flat coastal plains and high hills	One-inch Original Survey ...	303	5,161	1,89,547 (e)	36·7	
	One-inch Supplementary Survey ...	4,810				
	Two-inch Original Survey ...	43				
	Two-inch Supplementary Survey ...	5				
TOTALS, SOUTHERN CIRCLE:—				14,275 sq. m.	Rs. 4,23,670	Cost-rate 29·7

Table III.—(Concluded).—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1920-21.

PARTY and LOCALITY. Character of Country. Scale and Class of Survey.		OUT-TURNS OF PLANE-TABLING.		COSTS OF SURVEY INCLUDING MAPPING.		REMARKS.
		Areas on each Scale of each Class.	Totals of areas on all Scales.	Total costs.	Cost-rates.	
		Sq. miles.		Rs.	Rs. per sq. mile.	
EASTERN CIRCLE.						
No. 9 Party—Bengal and Bihar and Orissa.						
Flat and cultivated plains, in parts congested with villages, in parts cut up by tidal creeks and forests.	One-inch Original Survey ...	2,115	3,000	1,71,068 (f)	57.0	(f) Excludes Rs. 16,142 for instruction of pupils.
Open undulating plains varied with rocky scrub covered hills.	One-inch Supplementary Survey	703				
Flat plains congested with well wooded villages and factories.	One and a half-inch Revision Survey.	182				
No. 10 Party—Upper Burma.						
Densely wooded hills and plains ...	Half-inch Original Survey ...	3,843	3,843	2,32,417	60.5	
No. 11 Party—Lower Burma.						
Intricate hills and low ground with mangrove swamp and densely wooded.	One-inch Original Survey ...	1,494	1,494	2,27,805 (g)	152.5	(g) Includes cost of Maymyo Drawing office and excludes Rs. 30,144 on account of cost of Forest boundary traverse and triangulation in connection therewith.
No. 12 Party—Assam.						
Hills mostly covered with forest and high grass, valleys densely wooded.	Half-inch Original Survey ...	2,633	2,766	1,64,089	59.3	
Hills and plains densely wooded ...	Two-inch Original Survey ...	133				
No. 21 (Burma Forest) Party—Upper Burma.						
Wooded hills ...	... Two-inch Original Survey ...	103	172	1,39,533	811.2	
Ditto ...	... Four-inch Original Survey ...	69				
TOTALS, EASTERN CIRCLE:—				11,275 sq. m.	Rs. 9,34,912	Cost-rate 82.9
GRAND TOTALS:—				39,974½ sq. m.	Rs. 17,83,410	Cost-rate 44.6

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

13. No. 1 Party.—This party surveyed an area of 8,400 square miles, chiefly revision survey on the one-inch and half-inch scales, and original survey on the one-inch and half-inch scales, in the Kāngra and Simla districts, Chamba, Mandi, Suket and Simla Hill States of the Punjab. The party also completed a large scale military survey of a small area in the Kohāt district of the North-West Frontier Province for a proposed cantonment.

Triangulation in advance was carried out in the Tehri-Garhwāl State of the United Provinces.

The country surveyed and triangulated lay entirely in the Himālayas and ranged from 950 feet to over 22,000 feet in altitude. Part of this was surveyed during the summer.

14. No. 2 Party.—This party surveyed an area of 4,094 square miles as follows:—897 square miles in Bharatpur State, 124 square miles in Alwar State and 1 square mile in Jaipur State, all of the Rājputāna Agency, as also 37 square miles in the Muttra district of the United Provinces, on the half-inch scale; 61 square miles in Bharatpur State and 2,840 square miles in the Agra, Muttra, Aligarh, Etah, Mainpuri and Budaun districts of the United Provinces on the one-inch scale and 134 square miles on the four-inch scale in Imperial Delhi and Vicinity (*vide* page 20).

The country surveyed on the one-inch scale consisted of open cultivated plains, except in a few places where trees were numerous, while that surveyed on the half-inch scale also consisted of open cultivated plains but included occasional isolated low rocky hills.

Traversing was also carried out in the Gwalior and Dholpur States and in Allahābād City (*vide* page 46).

15. No. 3 Party.—This party surveyed an area of 1,247 square miles on the two-inch scale and 670 square miles on the one-inch scale in Garhwāl, Almorā, and Nainī Tal districts of the United Provinces and in the Indian state of Garhwāl-Telhi and in Nepāl, triangulated an area of 1,280 square miles in Garhwāl and Almorā districts and in Nepāl, and traversed 44.2 linear miles in Nepāl. The survey of the Kumaun hills is being executed chiefly in the interests of the Forest Department (*vide* page 17). The maps will be published on the two-inch scale.

16. No. 4 Party.—This party continued in abeyance until September 1921, when preparations for taking the field were commenced.

17. Training.—22 pupil surveyors were entertained and given instruction in drawing during recess. 10 of these were discharged as unlikely to become good surveyors, 6 will take the field for training in survey, while 6 will remain in the circle office for further training in drawing. Of the pupil surveyors entertained in 1919 and 1920, 17 were promoted unclassified surveyors. 6 were discharged, and the remainder have been distributed for further training during the coming field season.

In addition 13 soldier surveyors are undergoing their first period and 7 their second period of training.

18. Recess Work.—The progress in the fair-mapping of the current season's sheets was retarded owing to the arrears remaining over from the previous year, and to the fact that No. 1 Party had a summer field season this year. It is hoped to complete all arrears by the end of next recess.

The fair-mapping of the following sheets of the current and previous season's survey remained for completion on 30th September 1921:—

Sheets on the one-inch scale ...	26
Sheets on the two-inch scale ...	16
Sheets on the half-inch scale ...	3
Town-guide maps ...	5

Of these, 12 will be submitted for publication before the end of October.

19. Records Section.—Triangulation data for 10 degree sheets were compiled. All triangulation and traverse records were re-indexed, and a report prepared showing all triangulation and traverse work in the Northern Circle area, executed prior to 1905, falling in sheets which have not been surveyed on the modern system.

20. Particulars of special work done by Nos. 2, 22 and Sind-Sāgar Parties will be found on pages 20, 46 and 47.

SOUTHERN CIRCLE (*vide* Index map No. 1).

21. No. 5 Party.—This party surveyed an area of 3,871 square miles on the one-inch scale in the north-east portion of the East Khāndesh district of Bombay, the Amraoti and Buldāna districts of Berār, the Indore State of Central India and the Makrai State and Nimār district of the Central Provinces. It also triangulated an area of 2,199 square miles in the Bhopāwar Agency, the Amjhera and Ujjain districts of Gwalior State, the States of Dewās and Indore of Central India and the north-west corner of the Nimār district of the Central Provinces. The country consists of jungle-clad hills, well wooded cultivated plains and the elevated plateau around the city of Indore.

22. No. 6 Party.—The head-quarters of the party remained at Bangalore throughout the year and completed the fair-mapping of 4,602 square miles, on various scales, of Būshire and Shirāz in Persia, Secunderābād, Bolārūm, and the Mahbūbnagar district of Hyderābād (Deccan), Kolār district of Mysore and Anantapur district of Madras.

An area of 670 square miles in the Mahbūbnagar district of Hyderābād (Deccan) was triangulated with supplementary points for the forward season's topography.

23. No. 7 Party.—This party surveyed an area of 5,243 square miles on different scales in the Guntūr, Nellore, Kurnool, Cuddapah and Anantapur districts of Madras and the Kolār and Tumkūr districts of Mysore.

The country surveyed is partly flat, open and cultivated and partly hilly and jungle-clad.

24. No. 8 Party.—This party surveyed an area of 5,161 square miles on the two-inch and one-inch scales in Rāmnād, Madura, Tanjore and Coimbatore districts of Madras and Travancore State. The area surveyed consisted chiefly of flat coastal plains irrigated by numerous tanks, but also included a portion of the Palni hills and high hills in Travancore State rising to a height of 8,841 feet at Anaimudi, the highest hill in Southern India.

25. The report on the survey of cantonments and military stations undertaken by No. 20 Party appears on page 20. See also page 47, para. 69.

26. Training Section.—The three probationers of the Upper Subordinate Service who remained under instruction from the previous year completed their course on the 31st October 1920 and were then transferred to parties. The new class of Upper Subordinates consisting of 14 probationers joined on 3rd January 1921 and were put through a short course of plane-tableing, triangulation, traversing and levelling. One probationer was allowed to resign on 3rd June 1921. Eight will be transferred to parties so as to join at the commencement of the 1921-22 field season, and the remaining five will continue training for a few months longer.

21 pupil surveyors were under training at the commencement of the year; of these 4 were discharged during the year as being unlikely to make efficient surveyors. 7 pupils were transferred to parties during the year, the remaining 10 were retained till the end of the year for further instruction.

22 new pupil surveyors were recruited between August 1920 and May 1921. During recess they have received preliminary training in drawing and plane-tableing.

27. Recess Work.—27 one-inch sheets out of 50 surveyed during the year under report were received in the circle office up to the 30th September 1921. All the remaining sheets will be fair-mapped before the close of the recess season.

There was no original half-inch survey carried out during the year.

There are no arrears of drawing from previous season's work.

28. Record Section.—This section was formed on 1st May for the purpose of dealing with triangulation and traverse data of the circle and preparing the triangulation pamphlets and charts. Nine pamphlets and charts were prepared and submitted for publication during the year.

EASTERN CIRCLE (*vide* Index map No. 1).

29. No. 9 Party.—This party surveyed an area of 3,000 square miles on the scales of $1\frac{1}{2}$ inches and 1 inch = 1 mile in the neighbourhood of Calcutta and in Bihār. Work fell in the Hooghly, Midnapore and Twenty-four Parganas districts of Bengal and the Monghyr district of Bihār.

South of Calcutta, work covered the reclaimed area of the Sundarbans in the Twenty-four Parganas district, and progress was much interfered with by tidal creeks and forests. Drinking water was bad, and the health of surveyors suffered considerably.

In Monghyr district the one-inch preliminary sheets prepared from recent cadastral surveys were found very accurate, and the supplementary survey carried out amounted to little more than the survey of the more hilly parts and the contouring of the remainder.

A large number of pupils were trained by the party during the year.

30. No. 10 Party.—This party surveyed an area of 3,843 square miles on the half-inch scale in the Putao district, in the unadministered territory of the Hukawng valley adjoining the Myitkyinā district of Upper Burma and in the tribal territory, locally known as "The Triangle", between the Mali Hka and N'mai Hka branches of the Irrawaddy. It also triangulated 3,594 square miles in advance for topographical surveys on the half-inch scale, in unadministered territory adjoining the Myitkyinā and Upper Chindwin districts. The area surveyed in the Putao district

consisted of a broken mass of hills covered with dense jungle, extending from the N'mai Hka at an altitude of 2,000 feet to the Irawaddy-Salween divide, at an average altitude of 12,000 feet, with peaks rising to nearly 14,000 feet. Almost the whole area in the Hukawng valley was covered with dense jungle and comprised a level plain crossed by numerous big streams and bounded on the north and east by high hill ranges rising in places to 11,000 feet.

31. No. 11 Party.—Survey operations were continued in Lower Burma, in the Mergui district. 1,494 square miles were surveyed on the one-inch scale and 2,012 square miles triangulated in advance for detail survey, 355 of which consisted of revision of last season's work and connection with Siamese triangulation.

The party also carried out the traversing of the boundaries of five reserved forests in the Amherst district, 275 linear miles being traversed and 1,297 square miles of triangulation being carried out in this area.

The country surveyed in the Mergui district comprised the source and upper waters of the Ngawun, the upper reaches of the Lenya river, portion of the boundary between Burma and Siam, and some coastal areas near Bokpyin. The inland area consists of dense impenetrable jungle covering deep valleys and intricate hills, rising to a height of over 3,000 feet, and the coastal areas are mangrove swamp cut up by numerous tidal creeks.

32. No. 12 Party.—This party surveyed an area of 2,766 square miles on the two-inch and half-inch scales in the districts of Nowgong, Cāchār and Khāsi and Jaintiā Hills. An area of 2,752 square miles of triangulation and 326 linear miles of traversing (covering an area of 248 square miles) was carried out in the districts of Nowgong, Sibsāgar, Nāgā Hills, Cāchār and Manipur State, in advance of detail survey.

The area surveyed in Nowgong was flat country, partly cultivated and partly covered with high grass and trees. The remaining districts consisted of partly open but mostly densely wooded hills rising to about 5,600 feet.

33. No. 21 (Burma Forest) Party.—The work done by this party is included in that shown in Forest Surveys, Eastern Circle, page 19. See also page 48, para. 72.

The area over which operations extended is hilly, ranging in altitude from 200 to 5,000 feet and covered with dense forest growth.

34. Training.—This was carried out by No. 9 Party and in the Maymyo Survey School. In addition to 1 Class II and 2 Upper Subordinate officers and 3 soldier surveyors, 6 second year and 19 first year pupils accompanied No. 9 Party to the field and 14 new pupils were entertained at the beginning of the recess season. The average out-turn of the pupils was encouraging. During the year 4 pupils were discharged and 2 soldier surveyors and 8 pupils have been drafted to parties.

At Maymyo 52 pupils, mostly Burmans, were at different times under training. Of these, 24 were discharged or resigned, after varying periods of instruction, 10 have been drafted to parties and 18 retained for further training. It is early yet to judge whether recruiting in Burma will give good results. The pupils of the Maymyo school will be employed next field season on the actual survey of Kalaw forest and of a portion of Maymyo.

35. Recess Work.—The sheets which had to be drawn by the parties of the Eastern Circle during the recess season numbered 59, including 16 'forest' sheets and 18 sheets which were in arrears from last year. By the 30th of September, 9 of the arrears sheets and 7 of the sheets surveyed

during the year were received in the Eastern Circle office. The great majority of the remainder will be despatched from parties by the close of the recess season on October 31st and special arrangements have been made to complete the mapping of the others before next recess season.

36. Record Section.—A small section for the preparation of triangulation data and charts for publication in the triangulation pamphlets was formed early in the year. It prepared 10 pamphlets and charts before it was disbanded, at the beginning of the recess season, owing to the staff being required for other work.

II.—FOREST SURVEYS.

37. Details of the topographical surveys of reserved forests executed by field parties of the Survey of India for the year under report are given below. In the majority of cases the surveys were carried out on the two-inch scale, but in special cases the four-inch and one-inch scales were used. Boundary surveys were made where required, and plots prepared on the four-inch scale.

NORTHERN CIRCLE.

38. **United Provinces. Kumaun Forest Circle.**—In the *North Garhwāl Forest Division*, 8 square miles of reserved forests were surveyed on the two-inch scale, and an area of 260 square miles (including non-forest areas) was triangulated in advance for future surveys on the two-inch scale.

In the *South Garhwāl Forest Division*, 170 square miles of reserved forests were surveyed on the two-inch scale.

In the *Central Almorā Forest Division*, 37 square miles of reserved forests were surveyed on the two-inch scale. There are four-inch uncounted maps of 14 square miles of this area. In addition an area of 180 square miles (including non-forest areas) was triangulated in advance for future surveys on the two-inch scale.

In the *East Almorā Forest Division*, 187 square miles of reserved forests were surveyed on the two-inch and 22 square miles on the one-inch scale. There are four-inch uncounted maps of the latter area. In addition an area of 840 square miles (including non-forest areas) was triangulated in advance for future surveys on the two-inch scale.

In the *Rānīkhet Forest Division*, 64 square miles of reserved forests were surveyed on the two-inch scale.

SOUTHERN CIRCLE.

39. Madras. II Forest Circle.—In the *Guntūr Forest Division*, areas of 562.50 and 34.68 square miles of the reserved forests were surveyed on the two-inch and one-inch scales respectively as follows:—

Name.				Area in square miles.
Andugulapādu	R. F.	...	...	3'06
Koppukonda	"	...	...	18'01
Nūyanipālem	"	...	...	2'19
Bollāpalli	"	...	...	94'51
Guttikonda	"	...	...	78'60
Jānapādu	"	...	...	5'20
Sitūrūmpuram	"	...	...	1'54
Konanki	"	...	...	7'95
Nemalipuri	"	...	...	16'46
Mādinapādu	"	...	...	17'71
Tangeda	"	...	...	4'87
Regulagadda	"	...	...	5'07
Vemavaram	"	...	...	3'21
Govindapuram	"	...	...	6'04
Venkatāyapālem	" (part)	...	...	9'44
Pillutla	"	...	...	4'20
Goli	"	...	...	8'86
Tumutukota	"	...	...	11'53
Pasvemula	"	...	...	35'09
Kandlagunta	"	...	...	78'82
Ganglagunta	"	...	...	31'33
Mutukūru	"	...	...	87'00
Kakirala	"	...	...	33'59
Daida	"	...	...	4'96
Gūmulapādu	"	...	...	2'10
Dūchepalle	"	...	...	1'16
			Total	562'50
Vinukonda	R. F.	...	...	12'32
Muppālla	"	...	...	4'24
Kopparam	"	...	...	1'00
Kūkutlapalle	"	...	...	0'04
Mandūdi 1	"	...	...	3'16
Mandūdi 2	"	...	...	1'68
Veludurti	"	...	...	5'68
Pāluvāyi	"	...	...	1'08
Mādugala	"	...	...	3'56
Dārvenmala	"	...	...	1'92
			Total	34'68

III Forest Circle.—In the *Nellore Forest Division*, areas of 72.38 and 29.54 square miles of the reserved forests were surveyed on the two-inch and one-inch scales respectively as follows:—

Name.				Area in square miles.
Nandanavanam	R. F. Block A. Extn. A & A, 1	...	...	28'83
Ditto	Block B.	...	...	24'97
Vedullacheruvu	R. F.	...	...	11'88
Hūjipuram	"	...	...	8'18
Kanigiri Hill	"	...	...	8'18
Musunūru	"	...	...	1'62
Peda Cherlāpalli	" (part)	...	...	1'20
Peda Alvalapādu	"	...	...	2'57
			Total	72'88

Name.				Area in square miles.
Veligonda	R. F.	...	...	15'76
Dasaripalli	...	...	...	1'22
Rāvīguntapalli	"	...	...	2'16
Inimerla	" (part)	...	...	6'46
Guvvadi	" ( " )	...	...	1'04
Totalachemvupalli	" ( " )	...	...	2'88
Total				29'54

V Forest Circle.—In the *Madura Forest Division*, an area of 48·628 square miles comprising the “Amphill Downs” Reserve was surveyed on the two-inch scale.

EASTERN CIRCLE.

40. Assam. Western Forest Circle.—In the *Cachār Forest Division*, 68 square miles of Krungming and Langting Mupā Forest Reserves were surveyed on the two-inch scale. In the *Khāsi and Jaintiā Hills Forest Division*, 48 square miles of Saipung Forest Reserve were surveyed on the two-inch scale.

Eastern Forest Circle.—In the *Nowgong Forest Division*, 17 square miles of the Rangkhang, Hojāi and Habaipur Forest Reserves were surveyed on the two-inch scale.

187 linear miles of traversing was carried out in the reserves above mentioned, of which 100 linear miles followed no well-defined natural feature.

41. Burma. Delta Forest Circle.—In the *Bassein Forest Division*, 405 square miles of triangulation and 186·3 linear miles of traversing, covering an area of 245 square miles were carried out in the Podaw, Kyeintali, Sitsayan, Shwemyindin, Kungyaung and Kyetpaung Reserves. In the two last reserves the completion of the traverse work had to be postponed because of *khedda* operations.

Tenasserim Forest Circle.—In the *Ataran Forest Division*, the boundaries of the following reserves were traversed:—Dali Reserve and Extensions, Kyaikkamaw Reserve and Extensions, Tagundaing Reserve, Kyonkawun and Moulmein Fuel Reserves. The total linear distance traversed was 274·60 miles and the approximate area covered by these reserves is 327 square miles.

In the *South Tenasserim Forest Division*, 190 square miles of the Ngawun Reserve Forest were surveyed in the course of the ordinary topographical surveys on the one-inch scale.

Northern Forest Circle.—In the *Mansi Forest Division*, an area of 68·8 square miles was surveyed on the four-inch scale including the whole of Hwelit and parts of Mode and Chaunggyibya Reserves.

Southern Forest Circle.—In the *Meiktila and Southern Shan States Forest Divisions*, areas of 45·1 and 58·2 square miles respectively were surveyed on the two-inch scale of the following reserves:—Yupadaung, Wetpyuye Ye-E and Magwe. A small portion of the Magwe Reserve was surveyed last year.

III.—CANTONMENT AND LARGE-SCALE SURVEYS.

42. No. 2 Party.—A section of this party carried out the third biennial revision on the four-inch scale of the four sheets of Delhi and Vicinity including 58 square miles in Imperial Delhi and Delhi New Cantonment and 76 square miles in the vicinity, outside Imperial limits. Only very minor changes were disclosed other than those due to building operations.

The cost-rate of the revision is Rs. 45.1 per square mile and that of the fair-maps, which will be submitted for publication early in November 1921, Rs. 15.0 per square mile.

43. No. 20 Party.—During the year under report the party completed the survey of the following cantonments and military lands on the sixteen-inch scale:—

Wellington, Wellington Sanitary area, Wellington Catchment area, Aravanghāt (Aravankadu) Cordite Factory grounds, Kārteri Cordite Factory grounds, water supply channel from Bairani stream to the Cordite Factory boundary, drinking water supply channel from Dodabetta to Cordite Factory boundary, High Tension line from Kārteri to Aravanghāt (Aravankadu), Kaity rest camp, Lovedale Estate and extension for Lawrence Memorial School, ground on which military buildings are erected at Ootacamund, Cannanore, West Hill (Calicut) and Velichi military lands.

The surveys of the following bāzārs on the sixty-four-inch scale were also completed:—St. Thomas's Mount, Poonamallee, Pallāvaram and Cannanore.

The surveys of the Bangalore Civil and Military Station on the sixteen-inch scale and of the General, Shūle, Halsūr bāzārs and Arab lines, Bangalore, on the scale of one inch = fifty feet are in progress and almost completed.

The traversing and triangulation of Deolāli for a sixteen-inch survey has been completed.

The levelling of 50.9 linear miles was undertaken in cantonments on which to base traverse heights, at a cost of Rs. 83.9 per linear mile.

The fair-mapping of the following cantonments and military lands have been completed during the year:—Secunderābād Cantonment and bāzār, Pallāvaram Cantonment and bāzār.

87 sheets have been fair-mapped and submitted to press, 61 more sheets have been completed and 83 remain to be completed.

The out-turn on the sixteen-inch scale, of original survey, was 9,111 acres and revision survey, was 5,583 acres. On the sixty-four-inch scale the out-turn of original survey was 283.5 acres. In addition 489.4 acres of original survey have been carried out on the one-inch = fifty feet scale.

The cost-rate of original detail survey on the sixteen-inch scale was Rs. 1.1 per acre and the average daily out-turn per surveyor 14.7 acres, the cost-rate of revision survey on this scale was Rs. 1.8 per acre and the daily out-turn per surveyor 12.4 acres.

The cost-rate of original survey on the sixty-four-inch scale was Rs. 7.0 per acre and the average daily out-turn per surveyor was 1.7 acres.

The cost-rate of original survey on the one inch = fifty feet scale was Rs. 28.3 per acre and the average daily out-turn per surveyor 0.55 acre.

The cost-rate of triangulation for all scales of survey was Re. 0·3 per acre.

The cost-rate of traversing for all scales was Rs. 76·0 per linear mile, the average number of stations being 9 per linear mile.

The total area fair-mapped was 23,714 acres on the sixteen-inch scale, 236 acres on the sixty-four-inch scale and 238 acres on the one inch = fifty feet scale.

The cost-rate of fair-mapping on the sixteen-inch, sixty-four-inch and one inch = fifty feet scales was Re. 0·6, Rs. 15·1 and Rs. 39·2 respectively per acre.

Alphabetical List of Cantonments and Military Stations surveyed and published in modern style, on the scales of 16 and 64 inches = 1 mile, up to the end of 1920-21.

(1) Agar	Cantonment.	(23) Jullundur	Cantonment.
(2) Aurangābād	do.	(24) Kālka	do.
(3) Bakloh	do.	(25) Kamptee	do. and Bāzār.
(4) Balūn or Thath (Dalhousie)	Camp area.	(26) Landour	do.
(5) Bannu	Cantonment.	(27) Meerut	do. and Bāzār.
(6) Chaman	do.	(28) Nasirābād	do. do.
(7) Chitrāl	Station.	(29) Nimach	do. do.
(8) Dehra Dūn	Cantonment.	(30) Peshāwar	do. do.
(9) Deoli	do.	(31) Quetta	do.
(10) Drazinda	Out Post.	(32) Quetta	Fort.
(11) Drosb	Cantonment.	(33) Quetta	Civil Station.
(12) Delhi New	do.	(34) Rājkot	Cantonment.
(13) Erinpura	do.	(35) Rāwalpindi	do.
(14) Fort Lockhart.		(36) Sahāranpur	Remount Depôt.
(15) Ghairat	Station.	(37) Sanāwar	Cantonment.
(16) Guna	Cantonment.	(38) Saugor	do.
(17) Hangu	do.	(39) Siāllkot	do.
(18) Hāpur (Bābūgarh)	Remount Depôt.	(40) Simla	Indian Infantry Lines.
(19) Hosūr	do.	(41) Sitābaldī	Fort (Nāgpur).
(20) Jandola	Out Post.	(42) Thal	Cantonment.
(21) Jatta	do.	(43) Topa	do.
(22) Jhelum	Cantonment.	(44) Zānī	Out Post.

IV.—THE TRIGONOMETRICAL SURVEY. 25

GEODETIC OPERATIONS.

44. No. 13 Party.—Astronomical, No. 14 Party.—Pendulum, No. 15 Party.—Triangulation, and No. 19 Party.—Base Line Operations.—No field operations were carried out by these four parties, the personnel being employed at the Headquarters offices of the Trigonometrical Survey, or on special duty.

45. No. 16 Party.—Tidal Operations.—Tidal registrations were carried out by means of self-registering tide-gauges during the year under report at the following stations:—

Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	REMARKS.
1. Aden	1879 ...	Still working	42	*With a small tide-gauge.
2. Karāchi	{ 1868 ...	1880	*13	
	{ 1881 ...	Still working	40	
3. Bombay (Apollo Bandar)	1878 ...	"	43	
4. Bombay (Prince's Dock)	1888 ...	"	33	
	{ 1880 ...	1890	10	
5. Madras	{ Restarted 1895	Still working	26	
6. Kidderpore	1881 ...	"	40	
7. Rangoon	1880 ...	"	41	
8. Moulmein	{ 1880 ...	1886	6	
	{ Restarted 1909	Still working	12	
9. Port Blair	1880 ...	"	41	

In addition to the above, the actual times and heights of high and low water at Bhaunagar, Chittagong and Akyab, were observed on watches and tide-poles under the orders of the Port Officers concerned, who forwarded these results monthly to this office.

Hourly readings of the height of the water, read against a tide-pole, were taken at Basrah throughout the day and night, and were supplied to this office weekly by the Director, Inland Water Transport, Mesopotamia. The observations for the year commencing 1st January 1920 were reduced by harmonic analysis, and the constants thus deduced were used in the computations of data for the Basrah tide-tables for 1922.

These data were forwarded to the Director, National Physical Laboratory, Teddington, England on the 6th January 1921, and were used for the preparation of the 1922 tide-tables with the aid of the tide-predicting machine.

The tide-tables for 1922 for Basrah were received on the 26th and 29th September 1921, and have already been despatched to the port officials requiring them.

The tide-tables for 1922 for the Indian ports have not been received as yet, but intimation was received of their having been despatched from England on the 12th August 1921. They are expected to be received in India shortly, and will be distributed to the various port officials as soon as possible after their receipt.

Tidal registrations at the nine observatories still working have been carried out satisfactorily, and will be continued during the coming year. During the past year these observatories were all inspected.

46. The following table shows the annual and decadal percentages of errors in the predicted times and heights of high and low water at the 9 stations where observations have been taken by self-registering tide-gauges:—

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 $\frac{1}{6}$ of mean range at springs.		
									H.W.—L.W.	H.W.—L.W.
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	83 82	97 97	98 99	4	68 55	70 58	94 88		
1914	6	77 79	96 97	98 98	3	75 67	71 55	92 84		
1915	6	82 82	98 98	96 96	3	76 66	73 67	94 92		
1916	6	81 82	96 97	96 99	3	81 68	73 62	98 87		
1917	6	75 72	96 98	96 97	3	78 65	69 64	92 88		
1918	6	83 82	97 97	97 96	3	76 63	66 65	90 89		
1919	6	78 75	96 97	97 98	3	74 65	70 69	98 92		
1920	6	82 81	94 97	97 98	3	76 66	64 62	89 86		
Average of ten years	...	81 80	97 98	97 98	...	74 62	70 63	92 89		

47. *Tide-predicting machine.*—This machine, which has been used for the prediction of the tides of India and the adjacent coasts since 1879, was originally erected at the observatory of the India Stores Department, London, under the control of Mr. Edward Roberts. In 1905 the instrument was transferred to the control of the Director, National Physical Laboratory, Teddington, England, under whose direction the prediction of tides for Indian ports has been completed up to the end of 1922. In 1920 it was decided that the future prediction and publication of the tide-tables for Indian ports should be carried out in India by the Survey of India, who would commence the prediction of tides for 1923. The tide-predicting machine was accordingly despatched from England, and was received in Dehra Dūn towards the end of September 1921. On being unpacked it was found to have been badly damaged in transit. Arrangements are being made to have the machine repaired, and as soon as this is completed the machine will be erected and the prediction of tides for 1923 will be commenced.

48. **No. 17 Party.—Levelling.**—Four double and one special detachments were employed during the past season on the levelling operations summarised below:—

(a) *In Bengal and Bihār, for Nadiā Rivers Scheme.*

(i) From Timpahār to Jiāganj.

(ii) From Chākdaha to Berhampore.

(iii) From Berhampore to Jayrāmpur.

(iv) From Berhampore to Jiāganj.

(v) From Porādaha *via* Nator to Rautāra.

(b) *In Bihār, for Irrigation Department.*

From Darbhāngā to Bagahā by the B. B. and C. I. Railway.

- (c) *In the United Provinces, for the Sārdā Canal Project.*
 (i) From Pilibhit to Mailāni.
 (ii) From Shāhjahānpur *viā* Mailāni. Kheri-Lakhimpur to Sitāpur.
 (iii) From Sitāpur to Lucknow with a branch line to Mādhoganj.
 (iv) From Lucknow *viā* Rāe Bareli and Sultānpur to Fyzābād.
 (v) From Sultānpur to Allahābād.
 (vi) From Shāhjahānpur to Baghauī.
 (d) *In the United Provinces.* Revision work due to loss of old bench-marks since 1867-68.
 From Bareilly to Pilibhit.
 (e) *In Bombay and Baluchistān, for the Sukkur Barrage Project.*
 From Jacobābād *viā* Sehwan to Hyderābād.

This line was levelled on the system for high precision work and forms part of line 101 of the new level net of India.

- (f) *In the United Provinces and Rājputāna, for the new level net of India. (Line 107).*
 From Muttra to Mārwar Pāli.
 (g) *In the City and environs of Lahore.* Tertiary levelling for the city sanitation scheme.

The total out-turn consisted of 685 miles of primary levelling, 1,314 miles of secondary levelling and about 75 miles of tertiary levelling.

Of this, 1,725 miles of levelling, mainly secondary, were executed at the request of Local Governments, Irrigation departments, &c.

The heights of 55 primary, 1,636 secondary and 259 tertiary bench-marks were determined.

A new hand-book on Levelling of Precision was published during the year.

MAGNETIC SURVEY.

49. No. 18 Party.—Magnetic.—The declination, horizontal force and vertical force magnetographs continued in operation throughout the year at the Dehra Dūn and Toungoo observatories, and daily absolute magnetic observations were taken regularly by the observers in charge. The observatories were visited during the field season and observations consisting of declination, horizontal force and dip were taken for the comparison of instruments. The Kodaikānal and Alibāg observatories, under the control of the Meteorological Department, were also visited by the officer in charge of the magnetic survey for the same purpose.

Observations at Repeat Stations.—Six repeat stations at even distances apart, most of them *en route* to the observatories, were selected and observed at this field season. The stations will be visited annually to take magnetic observations with the object of ascertaining in what year, during the interval of the 5-yearly observations at all repeat stations, an appreciable change in the curve of secular change is indicated, so that it may be possible to determine with greater accuracy the rate of annual change which the magnetic elements undergo in different parts of India.

Reduction of observations to epoch.—The reduction of the observations at the field and repeat stations in India, which was last year reported to be under revision, is now well in hand and will be completed about the end of the year.

Great magnetic storm.—A magnetic storm of great intensity, which seriously interrupted the working of the telegraphs in India, was recorded at the observatories from the 13th to the 17th May 1921. The magnitude of the storm was greater, and its duration three times longer, than the big storms of the 11th and 12th August 1919 and 22nd March 1920.

The Magnetic elements at observatories.—The computation and tabulation of the provisional values of dip, declination, horizontal force and vertical force for the three observatories Dehra Dūn, Toungoo, and Kodaikānal, for the year 1920, have been completed: the mean values of these elements derived from all days, excluding those of great disturbances, are given in the table below:—

MEAN VALUES OF THE MAGNETIC ELEMENTS AT OBSERVATORIES IN 1920.

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 59·9	E 1 52·0	·32951	·32949
Toungoo ...	{ 18 55 45 N } { 96 27 3 E }	N 23 7·7	W 0 23·7	·39114	·16707
Kodaikānal ...	{ 10 13 50 N } { 77 27 46 E }	N 4 36·1	W 1 49·9	·37787	·03042

PART 3.—OFFICE WORK.

I.—HEAD QUARTER OFFICES.

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

50. Brief reports of the work carried out during the year under review in the six offices administered by the Map Publication Office are given in paras. 52 to 56, 64, 65 and 76.

Work under war conditions having ceased, requisitions by the Army for maps, &c., have resumed normal proportions.

51. The classes of maps for the publication of which the Head Quarter Offices are responsible are as follows:—

- (a) Topographical maps on the one-inch scale.
- (b) Topographical maps on the half-inch scale.
- (c) Topographical maps on the quarter-inch scale.
- (d) (i) Geographical maps on the 1:1,000,000 scale (about 1 inch = 16 miles).
- (ii) La Carte Internationale du Monde on the 1:1,000,000 (about 1 inch = 16 miles).
- (e) Geographical maps on the 1:2,000,000 scale (about 1 inch = 32 miles).
- (f) General maps on the same and smaller scales.
- (g) Special maps.

The progress made in the publication of each of these classes is detailed below:—

(a) **Topographical maps on the one-inch scale.**—During the year 45 modern sheets have been published.

Index map No. 2 at the end of this report shows the progress made in the publication of the modern one-inch public sheets, and the following table gives the annual output of these sheets since the modern topographical surveys were begun:—

Years of publication.	NUMBER OF ONE-INCH SHEETS PUBLISHED.			
	Northern Circle.	Southern Circle.	Eastern Circle.	Total.
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
1915-16	85	69	50	204
1916-17	23	40	22	85
1917-18	18	12	13	43
1918-19	32	19	6	57
1919-20	15	37	52	104
1920-21	15	11	19	45
Total published	706	502	520	1,728
Probable number of one-inch sheets which will not be published owing to the area covered by them being included in the programme for survey and publication on the half-inch scale	911	564	473	1,948
Approximate number remaining for publication	535	963	1,044	2,542
Approximate number of public one-inch sheets in India	2,152	2,029	2,037	6,218

In addition to the above, preliminary editions (in colours) of 20 one-inch sheets, prepared from modern revenue surveys, have been published during the year pending their topographical revision. Also 1 provisional issue.

96 modern one-inch, 29 preliminary editions of one-inch, and 49 old style one-inch sheets have been reprinted during the year.

(b) **Topographical maps on the half-inch scale.**—Index map No. 3 at the end of this report shows the progress made in the publication of the modern half-inch public sheets. This series now forms the *tactical* map of India, having taken the place of the quarter-inch maps in this respect. It was commenced in 1914; most of the sheets published up to date are reductions from the one-inch map, but others are from direct half-inch surveys.

The following table gives the annual output of these sheets :—

Years of publication.	NUMBER OF HALF-INCH SHEETS PUBLISHED.		
	Drawn from component one-inch sheets.	Surveyed on half-inch scale.	Total.
1914-15 ... ..	...	1	1
1915-16	21	4	25
1916-17	50	6	56
1917-18	59	6	65
1918-19	26	4	30
1919-20	31	8	39
1920-21	59	2	61
Totals	246	31	277
Approximate total number of half-inch sheets in India ... ..	.....	.....	1,630

In addition to the above, a preliminary edition (in colours) of one half-inch sheet prepared from old half-inch material, has been published during the year.

3 modern public half-inch sheets have been reprinted during the year.

(c) **Topographical maps on the quarter-inch scale.**—These maps are prepared in "degree" sheets which include 1° of latitude and 1° of longitude, *i.e.*, the area covered by 16 one-inch sheets, or 4 half-inch sheets.

Index map No. 4 at the end of this report shows the progress made in the publication of the modern quarter-inch public sheets.

The following table gives the annual output of these sheets :—

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
1915-16 ... ..	...	1	4	5
1916-17	1	...	3	4
1917-18 ... ..	...	...	4	4
1918-19 ... ..	...	3	8	11
1919-20	4	...	4	8
1920-21	1	...	...	1
Totals	16	12	33	61
Approximate number of "degree" sheets in India	170	140	140	450

6 preliminary sheets in colours from comparatively modern surveys have been published and 13 are in hand.

In addition to the above, 15 modern public quarter-inch sheets have been reprinted during the year.

3 "degree" sheets have been prepared in No. 1 Drawing Office from the old engraved quarter-inch Atlas sheets brought up to date and published (in black only) as provisional issues; and 18 of such sheets which were published previously have been reprinted during the year. These "provisional" degree sheets, including those in hand, now cover the greater part of the area of India for which modern "degree" sheets are not likely to be available for some time.

(d) **Geographical Maps on the 1:1,000,000 scale.**—(i) **The "India and Adjacent Countries" Series** (*Vide* Index map No. 5).—During the year 6 new sheets of this series have been published, 4 sheets have been engraved and 23 sheets have been reprinted.

(ii) **La Carte Internationale du Monde.**—(*Vide* Index map No. 6).—A full description of the genesis of this series was given in the General Report for 1913-14; 2 sheets of this series have been published during the year. 10 sheets have been published up to date.

(e) **Geographical Maps on the 1:2,000,000 scale.**—(*Vide* Index map No. 7).—No new map of this series was published during the year. It has been decided to engrave the sheets of this map on two plates only, one for outline and one for the hill features.

(f) **General Maps on the same and smaller scales.**—The engraved plates of all these maps have been corrected and brought up to date as far as possible during the year.

(g) **Special maps.**—The annual edition of the Railway Administration map (on the scale of 1 inch = 64 miles) has been published during the year; four provincial maps and the map of India and Adjacent Countries (on the scale of 1 inch = 64 miles) have been reprinted.

Numerous special maps have also been prepared and printed for the Army, for Local Governments, Railways and for other Departments.

Most of the "Town-guide" maps, on the scale 12 inches = 1 mile, of several of the larger Indian cities, which were under preparation, have been published.

The "Town-guide" maps of Agra, Barrackpore, Dum Dum and Cawnpore were published during the year.

A map of Mount Abu on scale 1 inch = 220 feet has been published, 5 Cantonment maps were also reprinted during the year.

52. Map Record and Issue Office.—During the year under report there has been a somewhat larger demand for maps than during the previous year resulting in an increase in map issues to government officials.

The feature of this year's report is the heavy number of publications (departmental and extra-departmental) received in this office for storage and issue, *viz.*, 435,745 copies valued at Rs. 1,27,350 in excess of those received during 1919-20, involving heavy work in dealing with receipts and registration of printed maps.

To meet the demands for more up to date information in respect of the maps that are available, a new catalogue has been prepared and will be issued shortly.

Issues.—FROM MAP RECORD AND ISSUE OFFICE, 1920-21.

YEAR.		ON BOOK DEBIT (TO GOVERNMENT OFFICIALS).		ON CASH PAY- MENT (TO PRI- VATE INDIVI- DUALS AND MAP AGENTS).		FREE ISSUES (DEPARTMENTAL AND TO INDIA OFFICE).		TOTAL.	
		Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.	Number of Printed Copies.	Value Rs.
1920-21	Depart- mental.	69,280	64,884	38,585	45,934	56,661	27,905	164,526	1,38,723
	Extra- depart- mental.	1,524,588	1,41,518	98,143	13,634	163	270	1,622,894	1,55,422
	Total ...	1,593,868	2,06,402	136,728	59,568	56,824	28,175	1,787,420	2,94,145
1919-20.	Total ...	1,271,851	1,66,823	136,971	55,468	77,044	50,859	1,483,866	2,73,150
1918-19.	Total ...	2,227,010	3,87,085	101,222	47,663	37,204	32,539	2,365,436	4,67,287

Table IV.—Publications received in Map Record & Issue Office, during the year 1920-21.

A.—From the Calcutta Printing Offices, (including the Engraving Office).

Class of Maps.	Scale.	NUMBER OF DIFFERENT MAPS OF EACH CLASS RECEIVED.		Number of copies printed.	Value.
		New Publications.	Reprints and New Editions.		
DEPARTMENTAL.					
GENERAL MAPS.					Rs.
Maps of India	Various	...	2	2,594	3,920
GEOGRAPHICAL MAPS.					
Map of India	1"=32 miles	...	...	...	...
Southern Asia Series	1:2,000,000	...	...	...	...
India and Adjacent Countries Series	1:1,000,000	6	23	13,870	20,532
La Carte Internationale du Monde	1:1,000,000	2	...	600	600
TOPOGRAPHICAL MAPS.					
Quarter-inch, Modern	1"=4 miles	12	33	18,030	25,832
Do. (Provl.)	1"=4 miles	37	12	26,690	39,474
Do. (Provl.)	1"=4 miles	3	18	6,930	9,908
Half-inch, Modern	1"=2 miles	74	7	40,700	59,553
Do. (Provl.)	1"=2 miles	1	...	500	750
One-inch, Modern	1"=1 mile	45	96	77,985	1,07,326
Do. (Provl.)	1"=1 mile	20	29	24,134	35,076
Do. (Provl.)	1"=1 mile	1	...	100	150
Old Style sheets	Various	...	49	12,049	16,576
SPECIAL MAPS.					
District Maps	1"=4 miles	...	2	600	413
Administration Report Maps	1"=8 miles	...	2	100	38
Provincial Maps	Various	...	4	2,681	4,695
Plans of Cities and Cantonments	Various	5	5	7,327	15,696
Index Maps	Various	1	17	11,390	2,686
Miscellaneous Maps	Various	22	17	24,577	19,855
Total	.....	229	316	270,857	3,63,080
EXTRA-DEPARTMENTAL.					
Maps	Various	64	70	245,290	49,209
Plans and diagrams	Various	122	13	534,042	63,678
Illustrations	.....	65	4	167,743	17,594
Miscellaneous	.....	51	39	677,284	26,709
Total	.....	302	126	1,624,359	1,57,190
Grand Total	.....	531	442	1,895,216	5,20,270
B.—From the Trigonometrical Survey Office, Dehra Dūn.					
Various	.....	.....	26	4,200	6,540
C.—LETTERPRESS.					
1. Survey of India General Report, 1919-20. Price Rs. 2 or 4s.					

53. No. 1 (Head Quarters) Drawing Office.—The organization of the office remained substantially the same as last year.

The work carried out by the various sections was as follows:—

(1) *The Compilation Section.*—

(a) "La Carte Internationale du Monde au 1,000,000".—Two of the three sheets sent in for publication during 1919-20 were published during the year under report. One sheet was completed and sent for publication. Seven new sheets were taken up. Outline patterns of four of these sheets have been supplied to the Engraving Office, the remaining three sheets are in hand.

(b) The Southern Asia Series, scale 1:2,000,000.—Five sheets were reported in hand last year, two new sheets were taken up this year. Of these seven sheets, complete outline patterns for four sheets and partly complete patterns for two were supplied during the year to the Engraving Office. The outline pattern for the remaining sheet is in hand.

(c) Miscellaneous.—Originals for the following were prepared and submitted for publication:—

(i) Index chart showing limit of responsibility for mapping and survey between the War Office, Egypt and India.

(ii) Type table for topographical maps.

Print originals of the following were prepared and submitted for publication:—

(I) Index to half-inch sheets of the East Persia Party.

(II) Index to F. O. U. O. half-inch sheets for the General Report (Confidential Supplement).

(III) Index to publication of the one-inch, half-inch and quarter-inch and 1/M sheets for the Chief of the General Staff.

Patterns for the following were supplied to the Engraving Office for engraving plates:—

(1) Standard Index chart No. 92.

(2) Index to 1/2M sheets.

Patterns for the correction and reprint of the layered edition of the 32-mile map of India were prepared.

Indexes were kept up to date.

(2) *The "One-Millionth" Section.*—

(a) Of the engraved editions (original and modernized) at the end of last year there were ten sheets in hand, one new sheet was taken up during the year under report. Of these 11 sheets, complete outline and contour patterns of 7 were sent to the Engraving Office, patterns for the remaining four sheets are in hand.

(b) Helio editions.—(original). One sheet has continued in hand during the year.

(c) The original of 1 sheet has been corrected and sent to press for reprint, and four other sheets for reprint (helio edition) are in hand.

- (d) Miscellaneous.—A type table for topographical maps, card indicator scales, colour patterns for the new map catalogue, corrections to the 1/M border specimen for reprint were completed and the original engraved patterns of two sheets prepared at Dehra were corrected after examination before being sent to the Engraving Office.

(3) *The Quarter-Inch Section*.—Of the nine quarter-inch sheets (preliminary editions) shown as in hand at the end of last year, one sheet has been completed and sent to press. Two have been completed and are about to be sent to press. The fair-drawing of two sheets is well advanced and the rough compilation of the remaining four sheets is finished and under examination.

Eleven quarter-inch sheets were in hand at the beginning of the year for reprint. Of these, three (modern) sheets and five F. O. U. O. sheets were corrected to date and sent for publication, one sheet (preliminary edition) was prepared from a print original of the outline and a new contour original was drawn, the completed sheet being sent for reprint, the remaining two sheets (preliminary edition) are completed as to print original of outline, but the drawing of new contour originals is still in hand.

Five new quarter-inch sheets (preliminary edition) taken up during the year are in hand. The original of one sheet (preliminary edition) was corrected, brought up to date and sent for reprint.

In addition, boundary colour guides for two sheets and a stump-shaded original for one sheet were prepared.

(4) *The Reprint Section*.—Owing to the great increase in the reprint work and also to the heavy demands made upon the office for extra-departmental and special maps it was found necessary to divide the Mapping and Reprint Section into two sections, known as, the Reprint Section and the Mapping Section. The former deals now entirely with old style reprint work and degree sheets compiled from the Indian Atlas, and the latter with all special maps whether departmental or extra-departmental and all reprints of modern maps (*vide* sub-para. 5).

The work of the Reprint Section for the year was as follows:—

- 41 old style (15" × 30") one-inch sheets were corrected and sent for reprint; of these 6 were fragmentary but were completed to edges; 16 sheets are still in hand.
- 26 one-inch sheets were converted to modern graticule, corrected and sent for reprint as 15" × 15" sheets, of these 15 were fragmentary but were completed to edges from all available material; one sheet is still in hand.
- 21 degree sheets were compiled from the Indian Atlas and other material and sent for reprint. Of these 5 were fragmentary but were completed to edges from 1/M material. Twelve sheets remain in hand.
- 17 degree sheets, compiled from Indian Atlas material, were corrected against office copies and sent for reprint, five sheets remain in hand.
- 2 Atlas sheets were corrected against office copies and sent for reprint.

Total number of sheets sent for reprint ... 107.

 " " " remaining in hand ... 34.

The above out-turn represents a 30% increase over last year.

(5) *The Mapping Section.*—

- (a) 125 modern topographical sheets were corrected and brought up to date against office copies and sent for reprint, 2 sheets remain in hand.
- (b) The original of the 64-mile (departmental) Railway map of India was brought up to date and sent for reprint. Five other miscellaneous cases are still in hand.
- (c) Press order proof corrections have been inserted on the original fair sheets of 220 modern topographical sheets and three 1:1,000,000 scale sheets after publication, corrections to fourteen modern topographical sheets are in hand.
- (d) The fair sheets of 25 special maps on various scales have been drawn for other government departments, &c., and sent to press. These include maps for H.R.H. The Prince of Wales tour, railway, census, commercial, military and other maps.
- (e) Black prints of plane-table sections of 16 sheets were pasted together and sent to the Photo.-Litho. Office for supply to parties of blue prints for fair-drawing.
- (f) Minor corrections to 1,800 stock copies of modern maps were made by hand, for the Map Record and Issue Office.

(6) *The Office Copy Section.*—

- (a) Additions and corrections have been entered on the existing "office copies" of 2,368 published sheets; 559 "office copies" of newly published or reprinted sheets have also been prepared during the year.
- (b) The miscellaneous work of the section included questions relating to revenue survey maps, and the supply of authenticated copies of records to officials and private persons. The areas of 74 newly published one-inch and half-inch maps were checked against the Auxiliary Tables and the areas were entered in the Area-Register.

(7) *The Examining Section.*—This section is responsible for the examination of the sheets drawn by other sections in the office and also for the general scrutiny of a considerable number of sheets fair-drawn in other circles and drawing offices.

187 cases affecting 257 fair sheets have been dealt with by this section during the year. 11 cases affecting 11 fair sheets remain in hand.

In addition to the above current work, the section supplied scientific data to various officials, kept up corrections to Imperial Gazetteers, examined projections on copper of sheets in the Engraving Office, checked geographical names in various Survey of India publications, corrected press copies and prepared indexes for the same, drafted corrections to various departmental hand-books, type and conventional sign tables and border specimens; prepared diagrams illustrating professional orders and papers, and carried out much other miscellaneous work.

54. Engraving Office.—(1) *Engraving Section.*—The engravers have been chiefly employed on—

- (a) India and Adjacent Countries on the 1:1,000,000 scale.—Of the six plates remaining in hand, four have been completed

and two are nearing completion. Of six new sheets projected during the year, one is nearing completion, three are well in hand and two are projected only.

- (b) "La Carte Internationale du Monde", scale 1:1,000,000.—The two sheets completed last year have been published. Of the four sheets projected last year, one is approaching completion and the remaining three are well in hand. No new sheets were projected.
- (c) Southern Asia Series, on the 1:2,000,000 scale.—One (Colombo) taken up during the year is completed, two (Brahmaputra and Madras) which remained in hand from last year are well advanced, and three new sheets are in hand, *i.e.*, Bombay, Delhi and Calcutta, and one new sheet (N. Tibet) projected.
- (d) In addition to above, periodic corrections have been carried out on the plates of all the general maps of India on various scales. The boundary symbols of most of the 1/32-mile index sheets have been changed to make them appear more prominent, and other improvements have been engraved on 27 out of 46 indexes and 6 others are in hand. Thirteen pages of an approved copy book of different styles of lettering for use of Survey students, draftsmen, &c., have been engraved. A new large tint plate has been ruled for the Photo-Litho. Office, size 41" × 27". A new border specimen has been engraved for the Southern Asia Series, 1:2,000,000 scale, also a new index for the latter. A number of titles has been engraved for photogravure plates and several old plates that were worn out have been repaired. One district map is being brought up to date with modern graticule.
- (e) As a result of exhaustive enquiry, a graphic system of controlling the work of the office has been instituted and a full programme of work for two years ahead has been laid down, which will absorb the full capacity of the establishment.

(2) *Copper Plate Printing Section.*—32,502 impressions were pulled during the year compared with 29,040 during the previous year; 12,550 of these prints were scales and charts, 9,000 photogravures, 1,895 India Atlas sheets and 9,057 were from miscellaneous plates including prints on parchment and transfers.

The amount of extra-departmental work included in the above was 9,753 impressions or about 30 per cent. Sixty-one plates were dealt with in the Steel-facing branch.

55. Photo-Litho. Office.—The *Litho.* out-turn although apparently smaller than last year, is really better for the following reasons:—

- (i) Total number of pulls is considerably larger.
- (ii) All sheets printed during the year have had their coloured boundaries machine-printed, whereas formerly this was not the case. This implies one or more extra printings as a rule.

- (iii) During the war a large demand was made for reprints of frontier and trans-frontier sheets from standing plates, whereas practically all the reprints published during the year are similar to new sheets, that is, the originals had as far as possible been brought up to date, necessitating re-photography and a complete set of new plates.

The *Type Section* out-turn has improved considerably, chiefly on account of the longer runs per item, although the total number of items has been steadily decreasing during the last four years.

One new "Laureate" platen press was received from England for the *Process Engraving Section* towards the end of the year.

The following tables briefly summarize the record of the office for the past 3 years:—

TABLE A.

1	2	3	4	5	6
Year.	* Cost of office.	Value of out-turn at cost-rates.	NUMBER OF MAPS PRINTED.		
			Departmental.	Other than Departmental.	Total.
	<i>Rs.</i>	<i>Rs.</i>			
1918-19	2,21,218	4,54,243	637	4,203	4,840
1919-20	2,20,643	4,19,636	786	3,118	3,904
1920-21	2,70,193	4,77,839	625	2,546	3,171

* Does not include cost of chemicals, paper, &c., obtained from England.

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 OUT-TURN.		
				Pages or items published.	Copies printed.	Impressions pulled.
1918-19	4,248,913	183,413	1,151,678	5,577	1,233,211	1,829,380
1919-20	3,013,622	122,522	727,255	4,656	1,564,552	2,742,584
1920-21	3,736,999	237,976	501,265	3,429	2,034,962	3,609,532

TABLE C.
PHOTO. BRANCH.

	1918-19.	1919-20.	1920-21.
Negatives	4,190	6,658	5,786
Zinc plates	7,227	9,161	7,591
Photogravure plates	554	544	490
Half-tone blocks			
Line blocks			

56. Mathematical Instrument Office.—During the year from 1st April 1920 to 31st March 1921, there was a decrease in the demands made on this office (*vide* item 1 in para. 2), and an increase in the value of work done (*vide* item 6 in para. 2), and there was respectively a profit of Rs. 35,681 and Rs. 26,793 against a profit of Rs. 71,839 and Rs. 20,109 in 1919-20.

2. The following table shows the usual comparative figures for the last 3 years:—

	1918-19.	1919-20.	1920-21.
	<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.	7,64,795	5,54,959	4,74,911
2. Value of repairs to instruments received for repairs and returned in serviceable condition.	50,904	48,002	96,089
3. Value of instruments received from Government Officers when no longer required.	1,33,730	51,503	70,484
4. Book value of the stock of instruments, &c., in Serviceable Stores.	4,22,818	4,06,050	5,06,988
5. Book value of the stock of instruments, &c., in Repairable Stores.	1,10,554	79,057	1,07,873
6. Total value of work done in the Workshop ...	4,35,023	3,67,313	4,81,809
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	2,17,342	1,95,907	1,82,644
8. Value of instruments purchased locally ...	2,72,462	70,276	41,063
9. Value of instruments and materials obtained from England through the Director General of Stores.	67,174	1,57,694	2,98,795
10. Average No. of employees and their pay ...	No. 556 Rs. 1,63,759	No. 599 Rs. 1,28,770	No. 618 Rs. 1,77,655

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.

II.—DEHRA DŪN OFFICES.

TRIGONOMETRICAL SURVEY OFFICE.

57. Computing Office.—During the year under review the adjustment of the stations and intersected points of the following geodetic series was carried out:—

- (a) Kashmir Principal Series.
- (b) Indo-Russian connection.
- (c) Mōnghsat Secondary Series.
- (d) Mawkmai Secondary Series.
- (e) Pendant portion of the Kashmir Principal Series.
- (f) Kāgān Secondary Series.
- (g) Changchenmo Secondary Series.
- (h) Rupshu and Bārā Lācha Secondary Series.
- (i) Upper Indus Secondary Series.

The adjustment of heights of the following geodetic series was also completed during the year under review:—

- (a) Khāsi Hills Secondary Series.
- (b) Jaintiā Hills Secondary Series.
- (c) Mawkmai Secondary Series.
- (d) Mōnghsat Secondary Series.

Computations were carried out in connection with the following:—

- (a) Auxiliary Tables, Part III, 5th Edition.
- (b) The remodelling of computation forms and adapting them to paper of foolscap size.
- (c) Graticules of maps for Sir Aurel Stein and No. 2 Drawing Office.
- (d) Longitude by wireless telegraphy (Dehra Dūn).
- (e) Deflections of the plumb-line, Bouguer and Hayford corrections for pendulum stations and heights of gravity stations in Turkistān.
- (f) Meteorological results.
- (g) Regrinding of a figure in the Burma Coast Series.
- (h) The adjustment of Mr. Bond's stations in Assam (region of 1897 earthquake).
- (i) The formula for barometric heights.
- (j) The height of Mount Everest.

Final corrections were applied to latitude, longitude, azimuth, log: side, and heights of stations and intersected points of triangulation falling in some 70 Degree sheets in Burma, N.-W. Frontier and trans-frontier regions.

120 Degree triangulation pamphlets were compiled, of which 104 were also compared; 87 pamphlets were sent to and 51 pamphlets passed through the press.

The Professional forms of the department were of different sizes, which is inconvenient for storage. It has therefore been decided to convert them to foolscap size, and the opportunity has been taken to improve the arrangement of the forms where possible.

Type Printing Section.—The following publications were printed during the year:—

1. Professional Papers Nos. 18 and 19 (print and reprint).
2. Auxiliary Tables, Parts I, II (reprint) and 19 Tables of Part III (set up and partly printed).

3. Levelling pamphlets No. 54 (reprint) and No. 44 (addendum) and slips for eight levelling pamphlets.
4. Catalogue of Library Books.
5. Triangulation pamphlets covering 51 Degree sheets.

Observatories.—Meteorological observations were continued as usual. The Omori seismograph was in operation throughout the year. Tremors of violent intensity were recorded on the 17th December 1920 (epi-centre at Piang Liang, China). Photographs of the sun were taken on 320 days, the sun being obscured on the remaining days of the year.

Preservation of Triangulation Stations.—750 stations were repaired by the district officers at a cost of Rs. 5,108. Out of 359 districts from which reports were due, 13 failed to send returns.

Research.—The main heads of research were:—

- (a) Longitude by wireless signals from Paris,
- (b) Investigation of atmospheric refraction,
- (c) Adjustment of minor triangulation net-work.

A short account of progress made in these matters is given in Records of the Survey of India, Volume XVI.

58. No. 2 (Dehra) Drawing Office.—During the year under report the work of this office was carried out by six sections. The personnel of the *Field Section* was absorbed into the other sections and the section was done away with.

(1) *The Triangulation Chart and Cantonment Section.*—Deals with the fair-drawing of triangulation, levelling and index charts, and the publication, reprint and correction of cantonment plans. In addition to the ordinary work of this section, 128 miscellaneous maps, charts, and diagrams (of which 13 were fair-drawn) were dealt with and sent to press, and 158 sheets were hand-coloured.

(2) *The Compilation Section.*—Deals with the compilation and fair-mapping of geographical maps on different scales. One fair sheet on 1/M scale shown as in hand last year was completed and sent to press. Of the 10 sheets of rough compilation on 1/M scale, shown in hand last year, two sheets are being fair-mapped, and two sheets have been sent to Calcutta to be engraved, leaving a balance of 6 sheets in hand. The stump-shading for 6 sheets on different scales was taken in hand this year; two have been completed and sent to press. Of the rough compilation of sheets on the 1/2M scale, 3 were in hand at the beginning of the year and 2 more were taken up during the year; one sheet was completed, and sent to Calcutta to be engraved, leaving a balance of 4 in hand. The section has also taken up the fair-mapping of 7 half-inch sheets, which are all in hand.

(3) *The Stein Section.*—Deals with the fair-mapping of Sir Aurel Stein's explorations in Chinese Turkistan and Kansu in 1900-01, 1906-08 and 1913-15. The 14 sheets shown as in "proof in colour" stage, and the 8 sheets shown as sent to press last year, have all been published during the year. This, added to 21 sheets of this series already published, brings the total of published sheets to 43. In addition to 4 sheets in hand, two more sheets were taken up during the year; of these 5 sheets have been sent to press and one sheet is in hand.

(4) *The Half-inch Section.*—Deals with the fair-mapping of half-inch sheets. 12 sheets were in hand at the end of last year, 32 sheets were received during the year; 8 sheets have been sent to press and 36 sheets are in hand.

(5) *The Examining Section.*—Examines the majority of the important sheets drawn in this office, and instructs the pupil draftsmen in drawing, hand-printing, and the use of drawing instruments. 85 sheets on various scales were examined and disposed of during the year.

(6) *The Map Record Section.*—Deals with the storage of originals and office copies of cantonment plans, triangulation and other charts, and geographical maps, and keeps a small stock of all maps published by the department for occasional issue to the public and for departmental use. It also deals with the despatch of all sheets printed in Dehra Dūn, and with all correspondence on the subject.

The following is the summary of the work of the office during the year 1920-21 :—

Class of maps.	Balance of sheets on 1st October 1920.	Sheets received in 1920-21.	Sheets sent to press in 1920-21.	Balance of sheets in hand on 1st October 1921.	REMARKS.
Triangulation charts	11	32	25	18	
Levelling charts, scale 1/M	1	2	2	1	
Index charts to illustrate reports.	.....	4	3	1	
Cantonment plans for publication.	59	152	118	93	Corrections and additions made and sent to press.
Cantonment plans for correction.	53	8	57*	4	* Corrections carried out in both originals and office copies and stored.
Miscellaneous maps, charts and diagrams.	.....	129	128	1	
Colour guides	450†	75	158	70	† 285 sheets of Hyderabad Forests transferred to Forest Map Office and 12 sheets pending publication.
GEOGRAPHICAL MAPS.					
Fair sheets, scale 1/M	1	2	1	2	
Rough compilation, scale 1/M	10	.....	4‡	6	‡ Two sheets are being fair-drawn and 2 sheets have been sent to Calcutta for engraved edition.
Rough compilation, scale 1/2M	3	2	1	4	For engraved edition.
Stump-shading	.....	6	2	4	
Sir Aurel Stein's explorations in Chinese Turkistan and Kansu in 1900-01, 1906-08 and 1913-15, for publication on 2/M scale.	4	2	5	1	One sheet is in 'proof in colour stage'. The 14 sheets which were in 'proof in colour stage' and 8 sheets which were sent to press last year have all been published during the year under report.
Half-inch sheets	12	32	8	36	

Photo-Zinco. Section.—During the year 1920-21, the work undertaken comprised :—

- Cantonment maps.
- Indexes and Triangulation charts.
- Forest maps.
- Sir Aurel Stein's maps.
- Miscellaneous maps.
- Extra-departmental maps.

The group of 4 technical hands sent to Baghdād to re-inforce the Mesopotamian Survey Party, returned to Dehra Dūn during the year.

The following table shows the work done in the last three years :—

Years.	No. of Subjects.	No. of Negatives.	No. of Pulls.	No. of Chocolate and Bromide prints.
1918-19 ...	1,193	1,475	275,276	229
1919-20 ...	1,414	2,087	316,114	562
1920-21 ...	1,430	1,911	436,996	447

59. Forest Map Office.—The classes of work entrusted to the four technical sections of this office have been described in a previous report; the distribution of work has been continued on the same lines; and the progress made during the year under report is described below :—

(1) *The Drawing Section.*—The progress of this section is shown in the table below :—

Class of map.	In hand on 1st October 1920.*	Received during the year.	Drawn and sent for publication during the year.	In hand on 30th September 1921.	Published during the year.	Total number of copies printed.
(a) ...	82	77	106	3	110	} 30,588
(b) ...	87	99	42	94	44	
(c) ...	16	4	7	13	8	
(d) ...	12	6	14	4	24	
(e) ...	.....	7	7	.....	12
(f) ...	8	22	9	19	18	
(g) ...	50	28	73	5	62	
Total ... 1920-21.	153	243	258	138	278	
Total ... 1919-20.	192	205	211	21,823

* These figures have been revised since last year's report and are now correct.

- (a) Reprints of Forest maps on various scales.
- (b) Forest editions, on the scale of 2 inches = 1 mile, of modern one-inch maps.
- (c) Maps of Forest Circles and Divisions.
- (d) Maps to illustrate working plans, &c.
- (e) Maps and diagrams to accompany Administration Reports.
- (f) Forest maps from special surveys, mostly on the scale of 4 inches = 1 mile.
- (g) Index and miscellaneous maps.

(2) *The Portfolio Section.*—Office copies of 31 maps and colour specimens of 64 maps were prepared, corrections on 60 sheets were completed, and 2,687 sheets were coloured by hand for issue, all the office copy corrections to be made from notifications received during the year were fully carried out.

(3) *The Map Record Section.*—The number of maps, diagrams and other records, received for storage was 7,921. 6,068 maps, &c., valued at Rs. 10,265 were issued. Sales by book-transfer to government departments amounted to Rs. 3,700 for 1,982 maps, &c., these figures show a decrease of 11,948 maps and Rs. 5,459 under those for last year. Cash sales to the public amounted to Rs. 1,762 for 1,139 maps, a decrease of Rs. 1,963 under the amount realized the previous year.

(4) *The Book-Binding Section.*—This section dealt with 487 volumes for the Forest Research Institute, the value realized being Rs. 1,249, an increase of 59 volumes and Rs. 236, over the figures for last year. In addition 136 envelopes and leather cases were made and the cost, viz. Rs. 72, realized by book-transfer; 2,168 maps of various sizes were mounted on cloth for issue.

60. At the special request of the Officer in charge, Map Record and Issue Office, Calcutta, the Drawing Section prepared a complete set of Index maps showing the areas published on the two-inch and four-inch scales together with a few specimens of the maps published by this office for insertion in the new edition of the Survey of India Catalogue of Maps.

III.—CIRCLE AND LOCAL DRAWING OFFICES.

61. No. 3 Drawing Office (Northern Circle).—During the year 16 two-inch sheets out of 35 and 16 one-inch sheets out of 39 previously surveyed were fair-mapped by parties and have been submitted for publication. In addition to these, 2 one-inch sheets were re-drawn in the Circle Drawing Office and 5 half-inch sheets were brought up to date and completed to edge in No. 1 Party's office and submitted for publication.

Half-inch sheets compiled from modern one-inch and old style half-inch sheets.—34 half-inch sheets, 30 of which were drawn in the Circle Drawing Office, have been submitted for publication during the year.

Modern material available.—All half-inch sheet areas of which component one-inch sheets have been published have now been disposed of; the fair-mapping of 14 sheets being in hand in the Circle Drawing Office while that of 41 sheets has been allotted to No. 2 Drawing Office. In addition to the above, there are 26 half-inch sheet areas of which some of the component one-inch sheets, though surveyed, have not been submitted for publication.

Quarter-inch sheets compiled from modern one-inch and half-inch and old style sheets.—During the year 3 quarter-inch sheets were fair-mapped in the Circle Drawing Office and submitted for publication.

Modern material available.—There are 26 quarter-inch sheet areas of which the component one-inch or half-inch sheets have been published; of these the fair-mapping of 7 sheets is in hand. In addition to the above there are 11 quarter-inch sheet areas of which the component one-inch or two-inch sheets though surveyed have not been submitted for publication.

Special maps.—During the year the Environs map of Lahore, scale four inches = 1 mile, the Royal Artillery Practice Camp map of Kutwa-Mirzāpur survey, scale three inches = 1 mile, the Guide Map of Mount Abu survey, scale six inches = 1 mile and the Mussoorie City Map survey, scale twenty-four inches = 1 mile, were fair-mapped and submitted for publication.

The colour patterns of 7 Town-guide and Environs maps, scale twelve inches and four inches respectively = 1 mile; 4 sheets of the Delhi and Vicinity, scale four inches = 1 mile, were prepared and submitted for publication.

Hill-shaded sheets.—64 one-inch and half-inch sheets were stump-shaded and submitted for publication.

Layer guides.—Nil.

Colour patterns and press order proofs.—Press order proofs and colour patterns of 107 sheets were submitted for publication. In addition to these, the yellow and green colour patterns of 16 sheets were specially prepared and submitted during the year for future reprint purposes.

Miscellaneous.—The traverse plots of 26 *mauzas* in 44 sheets, scale sixteen and thirty-two inches = 1 mile, of the Gondā district and of 17 sheets, scale sixteen inches = 1 mile, of the Naini Area, Allahābād district, were supplied and the cost of preparation recovered from the Deputy Commissioner, Gondā, and the Chairman, Allahābād Improvement Trust, respectively.

For the purpose of reprint, the office copies of 35 one-inch sheets were corrected and submitted for publication during the year.

The fair sheets of 21 one-inch and 16 half-inch sheets were brought up to date and submitted for reprint during the year.

62. No. 4 Drawing Office (Southern Circle).—During the year, 42 one-inch sheets previously surveyed and mapped by parties were finally examined and submitted for publication. There are no arrears.

by parties were received in the drawing office. There was 1 one-inch sheet in hand from the last report, making a total of 43 sheets.

Of these, 42 sheets were submitted for publication and one one-inch sheet was returned to the party for incorporation and publication on the half-inch scale.

Half-inch sheets compiled from modern one-inch and old style sheets.—There were 33 sheets under drawing during the year, of which 15 were in hand at Maymyo and 18 in the drawing office. 22 sheets were submitted for publication, leaving 11 in hand in the drawing office.

Modern material available.—Exclusive of the sheets being drawn, there are 20 half-inch sheets in the circle, of which the component one-inch sheets have been published.

Quarter-inch sheets compiled from modern one-inch, half-inch and old style sheets.—Of the 7 quarter-inch sheets noted as in hand, and one in abeyance, in the previous report, 4 have been submitted for publication during the year, leaving 3 in hand and one in abeyance pending the completion of recent half-inch surveys for incorporation. The fair-mapping of 1 quarter-inch sheet was started during the year.

Modern material available.—There is 1 sheet, the fair-mapping of which has yet to be undertaken in the circle, of which the component half-inch sheets have been published.

Special maps.—The fair-drawing of two sheets of the Syriam-Kyauktan survey on the three-inch scale, for reproduction, was undertaken by the drawing office during the year; both sheets will shortly be submitted for publication.

Hill-shaded sheets.—42 shaded sheets were submitted for publication during the year, including the 7 in hand at the close of last year. There are no arrears.

Layer guides.—5 layer guides were submitted, including 2 in hand at the close of last year. There are no arrears.

Colour patterns and press order proofs.—Press order proofs for 52 sheets and colour patterns for 53 sheets received during the year, including 10 in hand at the close of last year, were submitted for publication. There are no arrears.

Triangulation charts and traverse data.—The section formed during the previous year for the preparation of charts and for the sorting, numbering, indexing and registering of all computation volumes and data &c., in the circle office and parties, prepared and submitted for publication 10 charts with their pamphlets and data. The preparation of 11 charts of degree sheets in Burma is in abeyance pending the preparation and publication by the Superintendent of the Trigonometrical Survey of the preliminary G. T. pamphlets.

The triangulation charts and pamphlets of 2 degree sheets, for which the preliminary pamphlets have been published, remain to be prepared when an officer is available for the work.

64. No. 6 (Simla) Drawing Office.—The *Army Section* has dealt with the preparation and printing of maps and plans for the use of the Army and other Government Departments.

The *Survey Section* has been employed on the preparation of trans-frontier maps on the one-millionth and quarter-inch scales, and incorporating additional information on those previously published.

65. Bengal and Bihâr and Orissa Drawing Office.—(Imperial Standard Mapping Section). This section has been employed as usual on (a) the compilation from modern revenue survey material and

from other maps and (b) the fair-mapping of the preliminary editions of modern one-inch sheets in colours pending their topographical revision. The sheets are completed from old material in cases where no modern work is available.

This section has now been divided into sub-sections each under a supervisor, in order to more effectively control the progress of the fair-mapping through its successive stages.

22 new sheets of Bengal and 8 new sheets of Bihār and Orissa have been fair-mapped and submitted for publication during the year.

This section has also taken up the compilation and drawing of preliminary editions of quarter-inch sheets falling in its area and 2 sheets are in hand.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

66. Northern Circle. No. 2 Party.—A section of this party commenced the traverse survey of Allahābād City for detail survey on the scale 64 inches=1 mile for the Allahābād Improvement Trust.

129 linear miles in an area of 4,128 acres were traversed and 78 plot charts prepared at a cost-rate of Rs. 61·5 per linear mile.

67. Sind Sāgar Party.—During the year under report, the party was employed on completion of the rectangulation of the Sind-Sāgar Doāb in connection with the Punjab Government Canal and Colonization project, in Miānwāli, Jhang and Muzaffargarh districts and in rectangulation in connection with the Sutlej valley project in Multān district.

Sub-division into 100-acre rectangles was carried out over the portion of the Sind-Sāgar Doāb, remaining over from previous years comprising an area of 740 square miles. 4,736 rectangles of 100 acres each were laid out and their corners marked by stones, making a final total of 50,774 100-acre rectangles over an area of 7,933·4 square miles for the whole project.

For the Sutlej valley project, sub-division into 25-acre rectangles was carried out in the Multān district in an area of 270·4 square miles. 6,922 rectangles of 25 acres each were laid out and their corners marked by stones. An area of 647·35 square miles was also triangulated for the purpose of laying down corners of 2,400-acre rectangles.

The country in the Sind-Sāgar Doāb which lies between the Indus and Jhelum and Chenāb rivers, locally known as the "Thal", is a vast tract of sand hills covered with stunted trees, sparsely populated and mostly waterless. Scattered patches of cultivation occur at rare intervals, surrounding wells, the water of which is brackish and almost undrinkable. The area of the Sutlej valley project is a flat plain, the portion bordering on the Sutlej river is thickly cultivated but, to the north, the plain is waterless and covered with dense jungle with occasional patches of sand.

In addition, a considerable amount of miscellaneous work in connection with the extension of rectangulation for the Sutlej valley project was carried out.

68. No. 22 (Riverain) Party.—The party continued the work of traversing and laying down base lines. 189 linear and 225 square miles of main circuits, and 3,373 linear and 526 square miles of minor traverse were executed, 323 theodolite stations of the former and 14,272 of the latter in 258 villages, were fixed. 368 corners of 121 squares in 375 square miles were demarcated with permanent mark-stones on both banks of the Sutlej river in Montgomery district and Bahāwalpur State, to serve as bases for future survey and demarcation of boundaries and fields in the bed of the river. 2,156 plotted and 649 boundary *masāvis* (settlement mapping sheets) on the scale of 1/2,640, and 37 four-inch sheets were traced and supplied in time to the Settlement Officers, Montgomery and Muzaffargarh. Besides these, 533 boundary *masāvis* were partly compiled on the scale of one inch = 220 feet for the next season's work, and 270 miscellaneous traces were prepared, all the traverse stations marked during the field season were plotted on 38 four-inch sheets.

The *Lahore Town Traversing* was undertaken at the request of the Sanitary Commissioner, Punjab for the large scale survey of Lahore and its environs for the purpose of sanitary improvement. It was commenced in the beginning of February 1921 and was finished in June 1921.

Three different scales viz.:—

- (i) One inch = 100 feet for Lahore Town proper and the congested areas outside the old city walls,
- (ii) Sixteen inches = 1 mile for the rest of the municipal area, and
- (iii) Six inches = 1 mile for an area one and a half miles in breadth all round the municipal limit,

were proposed by the Sanitary Commissioner. Traverse lines had to be run with due regard to the scales. It was connected with points of the Gurhagarh Meridional Series, and with the Rāvi riverain traverse executed in seasons 1912—14. In all, 6,485 theodolite stations were laid down and 644 linear miles traversed, covering an area of about 63 square miles. 234 intersected points were also fixed. Inside the town the stations were marked with 9-inch long iron nails with round flat tops of 2-inch diameter and outside the town with stones 6 inches \times 6 inches \times 10 inches with \odot engraved into the top and embedded flush with the ground. All the traverse stations and intersected points were plotted on 8 \times 8 inch sheets and 8 traces of the same were made.

Khaur Special Survey.—This was undertaken for the Attock Oil Company at their request through the Deputy Commissioner, Attock district. The work consisted in contouring at 10-foot intervals the area surveyed for them on scale 8 inches = 1 mile without contouring in season 1915-16 and surveying on the same scale, with contours at 10-foot interval, the adjacent area in the neighbourhood of Khaur village (Attock) and demarcation of the boundary of the new area for lease. The topography was based on traversing and levelling emanating from Khaur h.s. In all, 330 theodolite stations were laid out in 109.46 linear miles and 91 intersected points with heights were fixed. Level lines were run in suitable places to provide sufficient heights for the purpose of accurate contouring. In all, 43.05 linear miles were levelled and 1,235 stations were laid down and 80 bench-marks were fixed. The work was commenced in January and finished in March 1921. An area of 8 square miles was surveyed. 4 miscellaneous traces were prepared and all the traverse stations marked and intersected points were plotted on three 8-inch sheets.

Lahore "Nazul" Land Survey, on the scale of 1 inch = 40 feet, was undertaken at the request of the Deputy Commissioner, Lahore in connection with the Lahore city extension scheme. The survey was based on the traverse already done in connection with the Lahore town survey. It was commenced towards the end of August 1921. It is expected to be finished in October 1921. 33.5 acres have been surveyed.

69. Southern Circle.—The survey on the scale of one inch = fifty feet of 4 bāzārs areas within the limits of Bangalore Civil and Military Station is being carried out at the expense of the Bangalore Municipality, and the total area involved is 524 acres.

A considerable amount of traversing had to be carried out as only 10 per cent. of the old traverse stations could be found. The actual

amount of traversing carried out was 28.2 linear miles supplying 825 traverse stations, which works out at 1.6 stations per acre, the average distance between stations being 180 feet.

The number of sheets involved is 35 and the survey will be completed by the end of October 1921.

The cost-rates of this survey are shown on page 20.

At the request of the military authorities, an area of 1,121.3 acres of land adjoining Bangalore, required for a grass farm, has been surveyed on the sixteen-inch scale at a cost of Rs. 2,300.

70.—At the request of the Madras Government, Mr. J. O'B. Donaghey was placed on deputation for the settlement of the Mysore-South Kanara boundary. Representatives of the Madras Government and of the Mysore Durbar accompanied Mr. Donaghey and about 24 miles of some of the most difficult portions of the boundary were settled and a record prepared on prints of the Madras forest four-inch survey sheets. The work will be continued during the next field season.

71. Eastern Circle.—In addition to his duties in the Imperial Department, the Superintendent, as Director of Surveys, Assam held administrative charge of the Assam Survey Department, including the Assam Traverse Party, the Assam Drawing Office and Reproduction Office and the Assam Survey School; he also held administrative charge of the Maymyo Survey School under the Government of Burma.

72. No. 21 Party.—At the instance of the Government of Burma, the survey of a small length of boundary in the Southern Shan States was carried out by an officer in order to settle a dispute between two states.

73. Trigonometrical Survey.—At the request of the Punjab Government, levelling operations were carried out by No. 17 Party in Lahore City for the city sanitation scheme, (*vide* page 24). As this was a special work not properly belonging to the task of the Survey of India, its cost was defrayed by that Government.

74. Head Quarter Offices.—The total out-turn of all extra-departmental publications during the year for the Army, for Local Governments and for other government offices are given in Table A of the Photo-Litho. Office report on page 35, in the "Issues" table and in Table IV of the Map Record and Issue Office report on pages 29 and 30.

In addition to the special maps for other departments which are mentioned in para. 51 (g) on page 28, these extra-departmental publications include various operation and manœuvre maps for the Army, maps to illustrate the journals of the United Service Institution, various reports of government officials, maps for railway guides, and for posting in railway carriages, &c. The usual large numbers of weather charts for the Meteorological Department and of the photogravure and half-tone illustrations for the Archæological and other departments were also printed.

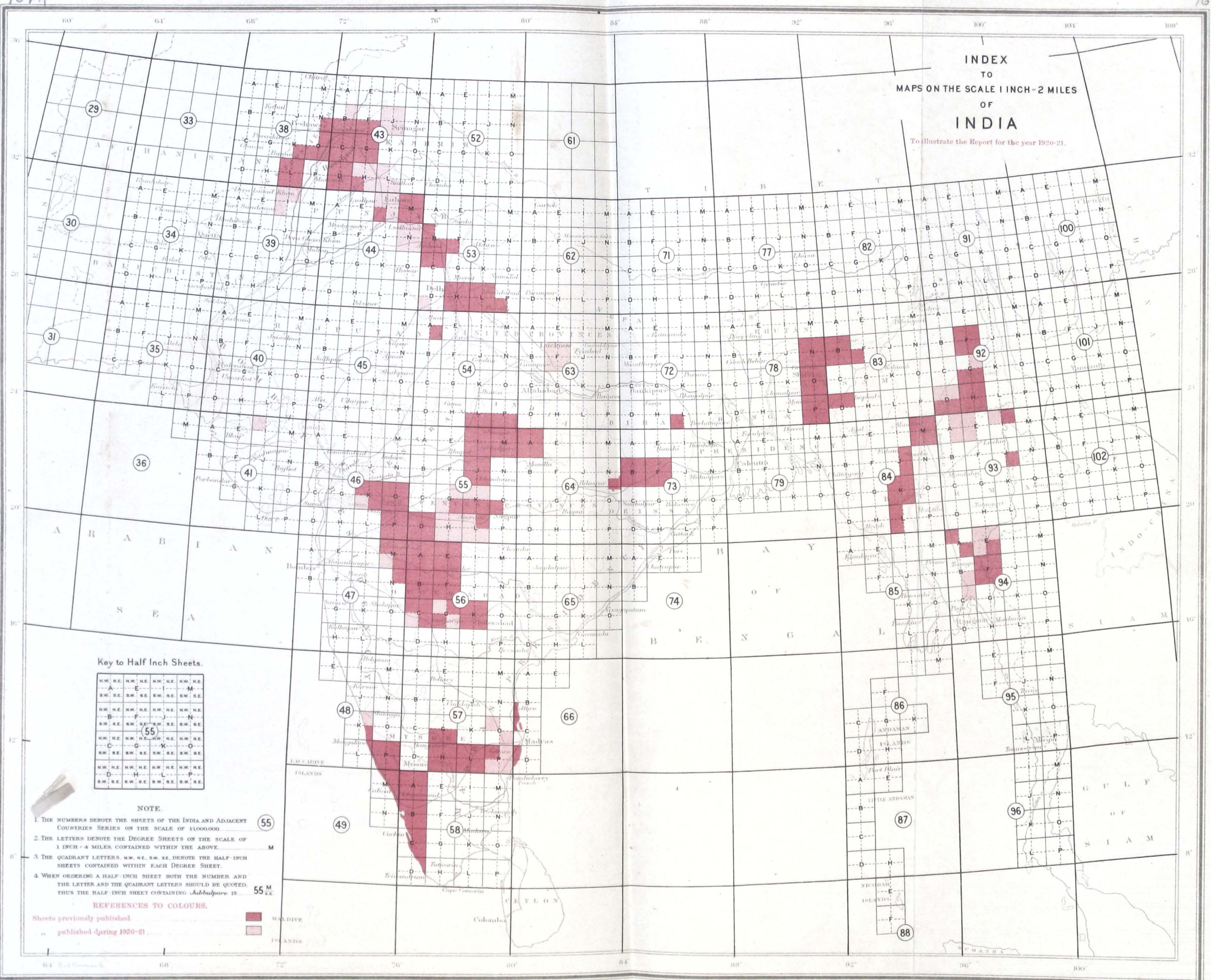
The work entailed by the preparation of originals for some of these special maps, in addition to their publication, is mentioned in the reports of No. 1 Drawing Office and of the Engraving Office on pages 31 to 34.

75. Mathematical Instrument Office.—The manufacture and repair of heliographs, prismatic compasses, scales, protractors, &c., for military departments was carried on during the year. The manufacture and repair work for civil departments are now again well up to date.

76. No. 6 (Simla) Drawing Office.—In addition to its normal work for the Army, the *Army Section* has prepared maps and plans for the Legislative, Foreign and Political, and Commerce and Industries Departments.

INDEX TO MAPS ON THE SCALE 1 INCH = 2 MILES OF INDIA

To illustrate the Report for the year 1920-21.



Key to Half Inch Sheets.

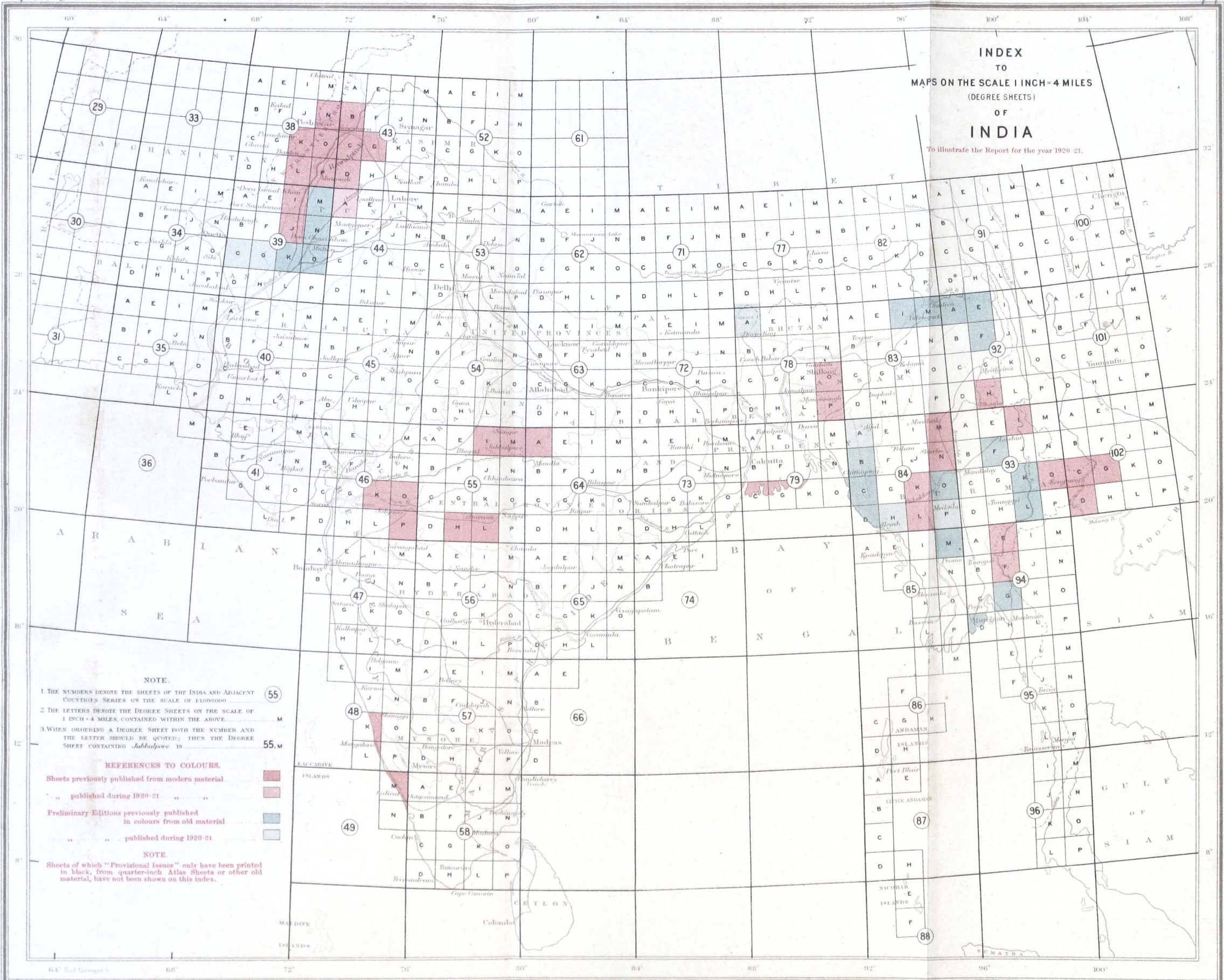
N.W.	N.E.	N.W.	N.E.	N.W.	N.E.		
A	E	I	M	A	E	I	M
S.W.	S.E.	S.W.	S.E.	S.W.	S.E.		
N.W.	N.E.	N.W.	N.E.	N.W.	N.E.		
B	F	J	N	B	F	J	N
S.W.	S.E.	S.W.	S.E.	S.W.	S.E.		
N.W.	N.E.	N.W.	N.E.	N.W.	N.E.		
C	G	K	O	C	G	K	O
S.W.	S.E.	S.W.	S.E.	S.W.	S.E.		
N.W.	N.E.	N.W.	N.E.	N.W.	N.E.		
D	H	L	P	D	H	L	P
S.W.	S.E.	S.W.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

NOTE.

1. THE NUMBERS DENOTE THE SHEETS OF THE INDIA AND ADJACENT COUNTRIES SERIES OF THE SCALE OF 1:100,000.
2. THE LETTERS DENOTE THE DEGREE SHEETS OF THE SCALE OF 1 INCH = 4 MILES, CONTAINED WITHIN THE ABOVE.
3. THE QUADRANT LETTERS, N.W., N.E., S.W., S.E., DENOTE THE HALF-INCH SHEETS CONTAINED WITHIN EACH DEGREE SHEET.
4. WHEN ORDERING A HALF-INCH SHEET BOTH THE NUMBER AND THE LETTER AND THE QUADRANT LETTERS SHOULD BE QUOTED, THUS THE HALF-INCH SHEET CONTAINING **Subulpara 55 M S.E.**

REFERENCES TO COLOURS.

- Sheets previously published ■ MALDIVES
- published during 1920-21 ■ 1st ANDER



INDEX
TO
MAPS ON THE SCALE 1 INCH = 4 MILES
(DEGREE SHEETS)
OF
INDIA
To illustrate the Report for the year 1920-21.

NOTE.

1. THE NUMBERS DENOTE THE SHEETS OF THE INDIA AND ADJACENT COUNTRIES SERIES ON THE SCALE OF 1:100,000
2. THE LETTERS DENOTE THE DEGREE SHEETS ON THE SCALE OF 1 INCH = 4 MILES, CONTAINED WITHIN THE ABOVE.
3. WHEN ORDERING A DEGREE SHEET BOTH THE NUMBER AND THE LETTER SHOULD BE QUOTED; THIS THE DEGREE SHEET CONTAINING *Jubbulpore* IS

REFERENCES TO COLOURS.

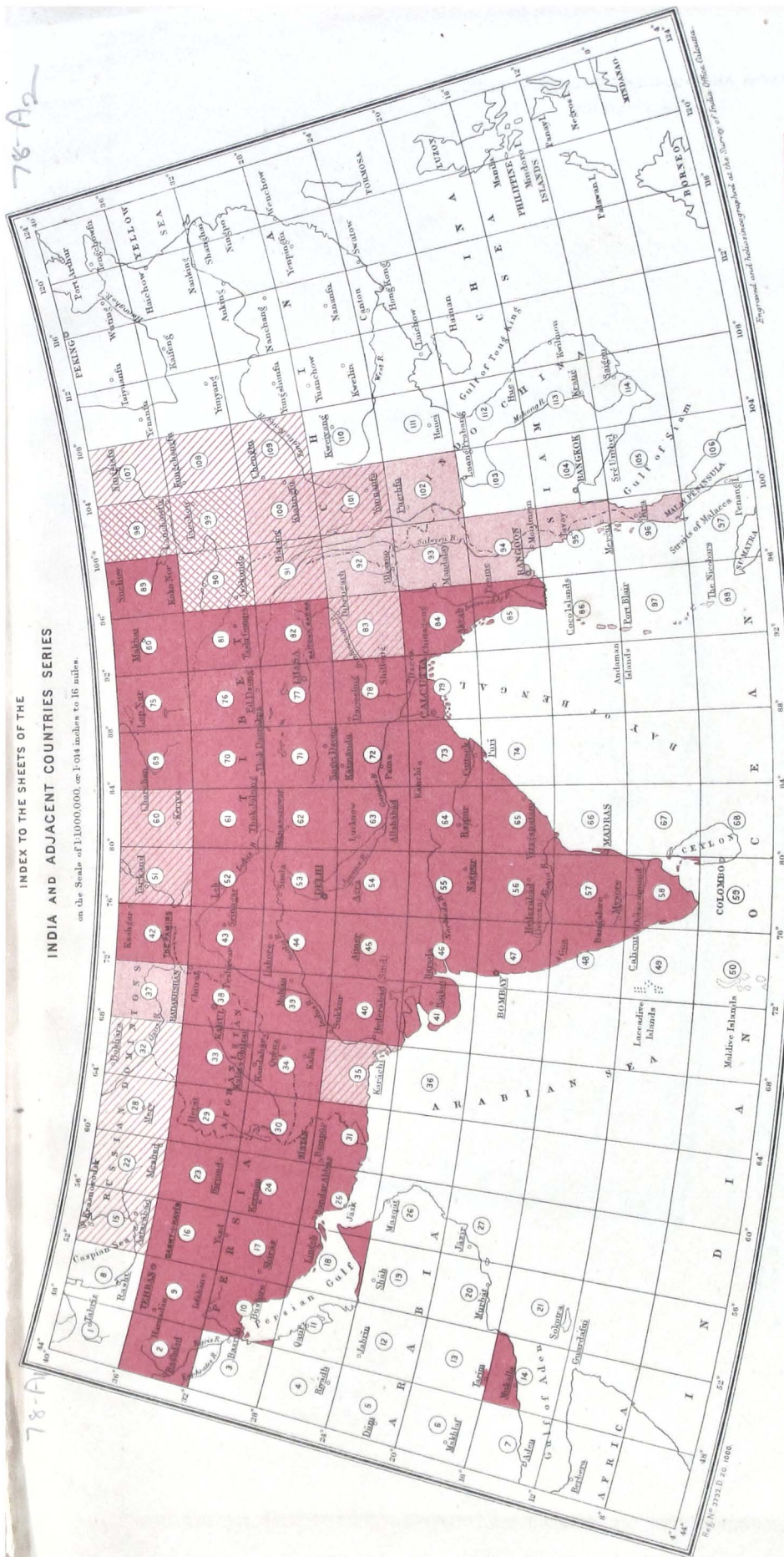
- Sheets previously published from modern material
- published during 1920-21
- Preliminary Editions previously published in colours from old material
- published during 1920-21

NOTE.

Sheets of which "Provisional Issues" only have been printed in black, from quarter-inch Atlas Sheets or other old material, have not been shown on this index.

INDEX TO THE SHEETS OF THE
INDIA AND ADJACENT COUNTRIES SERIES

on the Scale of 1:1,000,000, or 1/31 1/2 inches to 16 miles.



78-A2

78-A

REFERENCE

- To illustrate the Report for the year 1920-21.
- Shaded without contours & layers
- with contours & layers
- under publication
- in hand

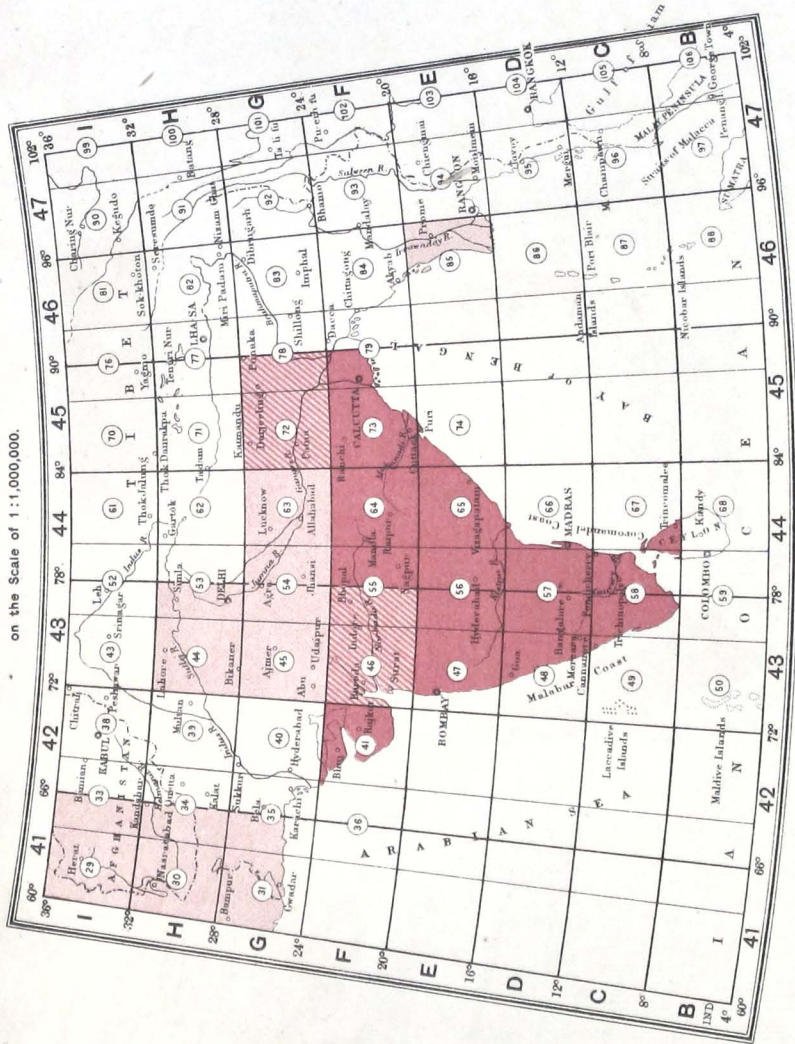
Scale 1:1,000,000.

Miles 0 200 400 600 800 Miles.

NOTE.

The names underlined on this Index are the title names of the sheets, and their numbers are shown in circles. Sheets 35 and 65, 67 and 100, are published respectively as combined sheets.

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



EXPLANATION.

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.

Miles 0 100 200 300 400 500
 Scale in kilometers 0 100 200 300 400 500

REFERENCE

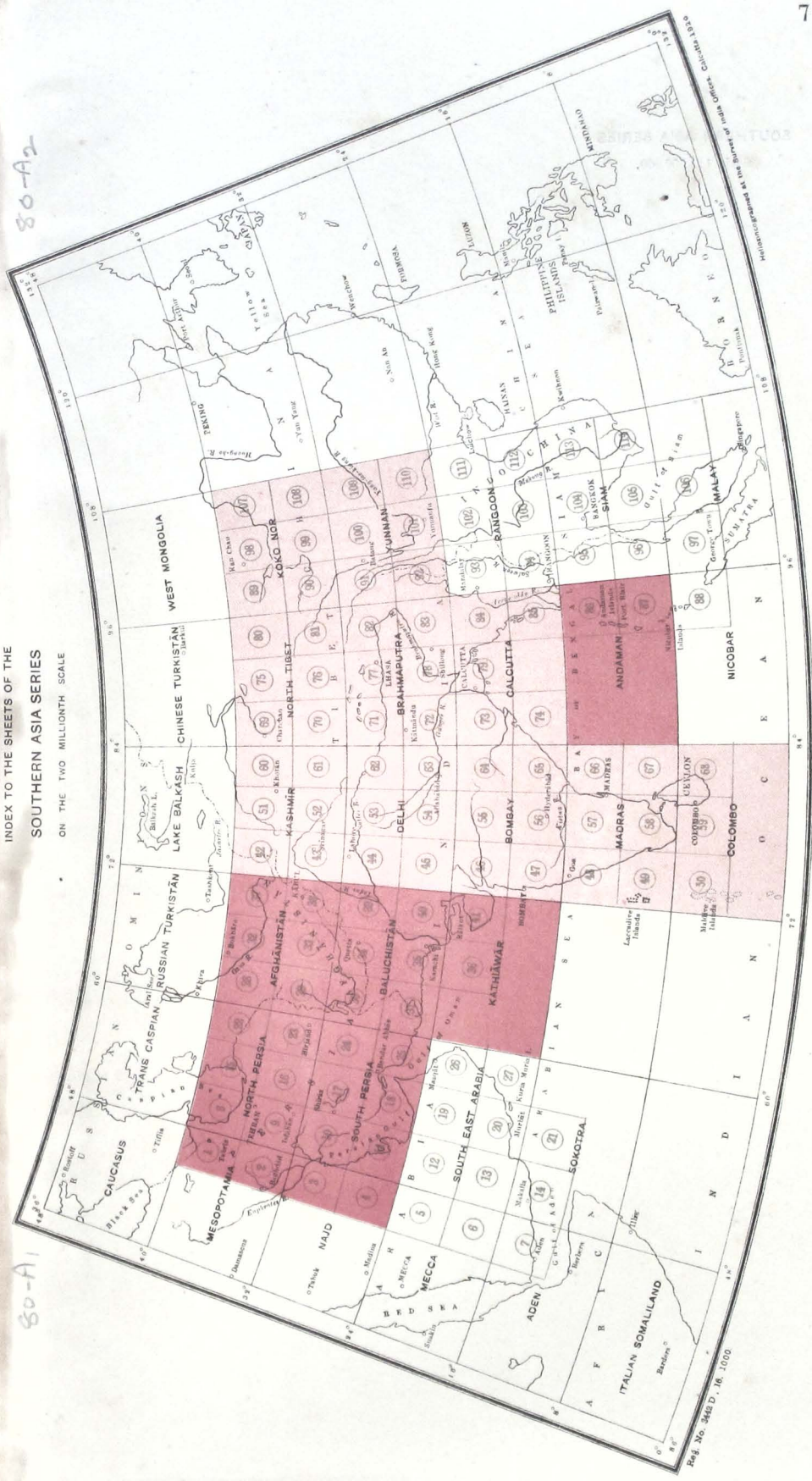
Sheets published
 " under publication
 " in hand

To illustrate the Report for the year 1920-21.

80-A2

INDEX TO THE SHEETS OF THE
SOUTHERN ASIA SERIES
ON THE TWO MILLIONTH SCALE

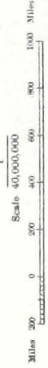
80-A1



REFERENCE

To illustrate the Report for the year 1920-21.

- Sheets published with contours & layers.
- " " " under publication
- " " " in hand



The E. portions of MESOPOTAMIA and NAJD sheets
have been published for the present as outliners to
N. & S. PERSIA sheets respectively.