

HC-45

Survey of India.
GENERAL REPORT,
1921-22.

From 1st October 1921
To 30th September 1922.



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

PRINTED AT THE PHOTO-LITHO. OFFICE, SURVEY OF INDIA,
CALCUTTA,
1923.

Price Two Rupees or Four Shillings.

HC-45

3252

JA
Survey of India.

GENERAL REPORT,

1921-22.

From 1st October 1921

To 30th September 1922.



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

PRINTED AT THE PHOTO-LITHO. OFFICE, SURVEY OF INDIA,
CALCUTTA,
1923.

2
PRINTED AT THE
PHOTOGRAPHIC AND LITHOGRAPHIC OFFICE, SURVEY OF INDIA,
14, WOOD STREET,
CALCUTTA.

NOTICE.

MAPS PUBLISHED BY THE SURVEY OF INDIA

are obtainable from the Map Record and Issue Office, 13, Wood Street, Calcutta, on the Public Service—on Cash Payment or Book-Transfer, and, for private use—on Cash Payment or V. P. P.

Forest maps are obtainable only from the Officer in charge, Forest Map Office, Dehra Dūn.

Geological maps are obtainable from the Director, Geological Survey of India, Calcutta.

The Survey of India publish maps for the greater part of SOUTHERN ASIA between the meridians of 44° and 124° East of Greenwich and between parallels 4° and 40° north latitude.

2. Surveys executed after 1905 are classed as "MODERN", those PRIOR to that date are classed as "OLD".

3. Maps are printed in two styles or editions *viz.*, LAYERED and POLITICAL:—

- (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.
- (b) The POLITICAL edition represents a map printed in colours, but without graduated layer tints. Hills are represented by contours and shading. This edition gives prominence to the Civil Divisions of India which are shown by ribands of colour along boundaries of administrative partitions.

NOTE.—When maps are printed in colours, from mixed or old surveys, the edition is styled "PRELIMINARY"; and when published in black only or with hills in brown, the edition is styled "PROVISIONAL" issue.

4. The series of Modern maps are grouped under three Divisions:—

(I) GEOGRAPHICAL, embracing —

- (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.
- (c) INTERNATIONAL MAP OF INDIA, scale 1:1,000,000 or nearly 1 inch = 16 miles, in LAYERED edition (without shading of hills), size 30 inches × 26 inches, price Re. 1-0 per copy.

(II) TOPOGRAPHICAL, comprising maps on:—

- (a) SCALE 1 INCH = 1 MILE, in the POLITICAL edition, size 24 × 19 inches, price Re. 1-8 per copy.
- (b) SCALE 1 INCH = 2 MILES, in the POLITICAL edition, size 24 × 19 inches, price Rs. 3-0 per copy.
- (c) SCALE 1 INCH = 4 MILES, in the LAYERED and POLITICAL editions, size 24 × 19 inches, price Re. 1-8 per copy, and from old surveys as PROVISIONAL issues, price Re. 1 per copy.

NOTE.—Modern Topographical maps printed on linen-backed paper are Rs. 12 extra per copy. Index charts or Key maps to the Geographical and Topographical series are obtainable gratis.

(III) GENERAL MAPS which include:—

- (a) GENERAL MAPS OF INDIA, scale 1 inch = 32 miles, in sets of 12 sheets, each sheet 25 × 32 inches, in LAYERED and POLITICAL editions, price Rs. 12 per set, and on scale 1 inch = 64 miles, POLITICAL edition only, size about 3½ feet square, at Rs. 6 the copy. Also various maps of India on the same and smaller scales and miscellaneous special maps illustrating Railways, &c.
- (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.

5. MAP CATALOGUES can be obtained at ONE RUPEE per copy.

6. Maps can be mounted on cloth and folded or mounted on rollers for hanging, &c., at an extra charge.

7. For particular purposes, copies of any map can be supplied in black or black and brown on request and at special rates.

8. Any map, chart or diagram can be reproduced if the applicant submits a suitable original drawing. Special rates exist for such work and estimates can be given on request.

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.

AGENTS FOR THE SALE OF INDIAN OFFICIAL PUBLICATIONS.

LONDON.

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

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

KEGAN PAUL, TRENCH, TRÜBNER & Co.,
68, Carter Lane, E.C.

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

HENRY S. KING & Co., 65, Cornhill, E.C.

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

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

W. THACKER & Co., 2, Creed Lane, Ludgate
Hill, E.C.

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

EDINBURGH.

OLIVER AND BOYD, Tweeddale Court.

DUBLIN.

E. PONSONBY, LTD., 116, Grafton Street.

OXFORD.

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

CAMBRIDGE.

DEIGHTON, BELL & Co., LTD., Trinity Street.

ON THE CONTINENT.

ERNEST LEROUX, Rue Bonaparte,
Paris - France.

MARTINUS NIJHOFF, The Hague - Holland.

OTTO HARRASSOWITZ, Leipzig - } Germany.
FRIEDLÄNDER & SOHN, Berlin - }

FOR MAPS ONLY.

LONDON.

EDWARD STANFORD, LTD., 12-14, Long Acre,
W.C.

INDIA.

THACKER, SPINK & Co., No. 3, Esplanade,
East, Calcutta.

NEWMAN & Co., No. 3, Old Court House
Street, Calcutta.

THE PUNJAB RELIGIOUS BOOK SOCIETY,
Lahore.

BURMAN & Co., Muzaffarpur.

THACKER & Co., LTD., Bombay.

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

HIGGINBOTHAMS, LTD., Madras.

THE CURATOR, GOVERNMENT BOOK DEPOT,
BURMA, Rangoon.

THACKER, SPINK & Co., Simla.

COCKBURN AGENCY, Srinagar, Kashmir.

7 CONTENTS.

		PAGE.
PART 1.—GENERAL REMARKS—		
	I.—Introduction	1
	II.—Administration and Personnel	8
	TABLE I.—Disposition of Officers	5
PART 2.—WORK OF FIELD PARTIES, &c.—		
I.—TOPOGRAPHICAL SURVEYS.—	TABLE II.—Progress since 1905	9
	TABLE III.—Out-turns and costs	10
	Northern Circle	13
	Southern Circle	14
	Eastern Circle	16
II.—FOREST SURVEYS.—	Northern Circle	18
	Southern Circle	18
	Eastern Circle	19
III.—CANTONMENT AND LARGE-SCALE SURVEYS.—No. 20 Party		21
	Cantonments	21
IV.—THE TRIGONOMETRICAL SURVEY.—	Astronomical Latitudes	22
	Pendulum Observations	22
	Triangulation	22
	Tidal Operations	22
	Levelling	23
	Base Lines	22
	Magnetic Survey	24
V.—GEOGRAPHICAL SURVEYS AND EXPLORATION.—		26
PART 3.—OFFICE WORK—		
I.—HEAD QUARTER OFFICES.—	Map Publication Office	27
	Map Record and Issue Office	29
	TABLE IV.—Publications during the year	31
	No. 1 Drawing Office	32
	Engraving Office	34
	Photo.-Litho. Office	35
	Mathematical Instrument Office	36
II.—DEHRA DŪN OFFICES.—	Computing Office	38
	No. 2 Drawing Office	39
	Forest Map Office	41
III.—CIRCLE AND LOCAL DRAWING OFFICES.—		48
PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS—		
46		

INDEX MAPS (bound at end of Report).

1. Modern survey and publication.
2. Publication of modern one-inch series.
3. " modern half-inch series for India.
4. " " quarter-inch " "
5. " " 'India and Adjacent Countries' series, scale $\frac{1}{1,000,000}$.
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.

Survey of India.

GENERAL REPORT,

1921—22.

From 1st October 1921

To 30th September 1922.

PART I.—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 XVIII 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 44,604* square miles; and that this brings the total progress since 1905 to 625,339 square miles, leaving 1,196,261 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 31 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 37 square miles surveyed on half-inch scale in 1920-21 and re-surveyed on one-inch scale in 1921-22, 9 square miles of eight-inch survey, and 355 square miles previously surveyed on the 1½-inch scale.

6. The following events are notified:—

- (a) A fair progress was made this year in the topographical surveys of this department, the area surveyed this year exceeding that of the previous year by 4,643 (44,604—39,961) square miles. Only one topographical party which had been in the field during the whole of the previous year remained in recess for the current year. It is hoped that with the existing strength the prewar average of over 50,000 square miles will be attained in the near future. The field work of the Trigonometrical Survey had to be considerably curtailed owing to financial reasons.
- (b) Messrs. Sher Jang, K.B., Sub-Assistant Superintendent, and Lal Singh, R.B., Sub-Assistant Superintendent (retired) were presented to H. R. H. the Prince of Wales during his visit to Dehra Dūn on the 13th March 1922.
- (c) Major H. T. Morshead, D.S.O., R.E., was permitted, while on leave, to accompany the Mount Everest Expedition of 1922.
- (d) Captain H. R. C. Meade, I.A., and Mr. Bansī Ram, Sub-Assistant Superintendent, accompanied the Political Officer, Sikkim, on a journey to Bhūtān.
- (e) A Survey detachment has been formed from the 18th October 1921 for the purpose of carrying out traverse survey in the Bhopāl State.
- (f) Officers were deputed in connection with the settlement of boundaries, *e.g.*, Mysore-South Kanara, Assam-Burma, United Provinces-Benares State.
- (g) A surveyor was deputed to Tibet with Sir H. H. Hayden.
- (h) During the solar eclipse in September 1922, observations were carried out with a view to determine whether the elements of the earth's magnetism underwent change during the obscuring of the sun.
- (i) Lieut.-Colonel G. A. Beazeley, D.S.O., R.E., taught his system of air sketching to military officers at Risalpur. He also instructed officers of the Iraq administration in air-reconnaissance and sketching.
- (j) Lectures on maps and surveys were delivered by Lieut.-Colonel C. P. Gunter, O.B.E., R.E., to Intelligence Classes at Poona and Bangalore.
- (k) A permanent executive charge was sanctioned for the Map Record and Issue Office with effect from the 11th September 1922; the number of executive charges reserved for Class II officers was thus raised from 10 to 11 (3 of which are temporary for the present).
- (l) There has been an increased demand both from the public and Government officials for maps during the year.
A branch office for the convenience of the Calcutta public has been temporarily established in No. 5, Esplanade East, for the display and sale of departmental publications.
- (m) The demand for large scale surveys of towns, &c., is continuous.

II.—ADMINISTRATION AND PERSONNEL.

7. The actual cost of the department for the financial year ending 31st March 1922 and of the two previous years is shown below:—

	1919-20.	1920-21.	1921-22.	REMARKS.
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>	
Gross actual cost	44,92,352	48,70,530	51,48,926*	* These figures are not final.
Deduct receipts and credits	20,65,422	15,52,147	17,86,351*	
Net actual charges	24,26,930	33,18,383	33,62,575*	

8. Colonel C. H. D. Ryder, C.B., C.I.E., D.S.O., R.E., administered the department throughout the year.

9. Of Class I officers:—Bt.-Colonel F. W. Pirrie, C.M.G., C.I.E., I.A., retired, the services of Colonel H. H. Turner, R.E., were replaced at the disposal of His Excellency the Commander-in-Chief in India, and Major O. H. B. Trenchard, R.E., reverted to the Home Establishment.

Major V. R. Cotter, I.A., reverted from deputation to military duty.

Mr. M. C. Petters was on deputation in connection with the settlement of United Provinces—Benares boundary from 14th to 24th March 1922. Mr. J. O'B. Donaghey was on deputation under the Government of Madras for about 2½ months. Captain H. R. C. Meade, I.A., was on deputation to accompany the Political Officer, Sikkim, on his journey through Bhutān for about 4½ months.

Lieutenants G. H. Osmaston, M.C., R.E., G. F. Heaney, R.E., and G. Bomford, R.E., have been deputed temporarily to military duty, England, to attend the Supplementary Course for R. E. officers at Chatham.

Mr. Jagdamba Prasad, R.B., was promoted temporarily from the Class II Service.

Of Class II officers:—Mr. E. G. Hardinge was placed on deputation under the Government of Assam to take over charge of duties from Mr. A. B. Smart who finally retired on the termination of his re-employment. Mr. F. C. Saint was dismissed, Mr. J. A. Calvert resigned.

Mr. W. J. Baker who had been on deputation to Burma retired on 4th September 1921. Mr. C. J. Veale was permanently transferred under the Government of the United Provinces.

Mr. V. W. Morton was on deputation under the Government of Madras for about 4 months and to military duty with the Auxiliary Force, India, for about a month.

Mr. J. C. St. C. Pollett was on deputation to military duty with the Auxiliary Force, India, for about a month.

Messrs. S. R. Kelkar, B.Sc., Muhammad Aslam Chowdhury, B.A., and C. P. E. Davenport were appointed during the year.

In the Upper Subordinate Service, Messrs. Dharmu, Dalbir Rai and Masud Khan retired, Mr. Amulya Charan Ghosh resigned, Mr. Kunja Behari Lal died, Mr. Gulab Singh has been reverted to the Lower Subordinate Service. 3 officers were promoted from the Lower Subordinate Service and 10 candidates were appointed on probation. 5 of whom resigned.

Mr. Bansī Rām was on deputation to the Assam-Burma boundary survey for three months and with the detachment formed to accompany the Political Officer, Sikkim, on his journey through Bhutān for about 4 months.

The total strength of the department at the close of the Survey year was 60* Class I officers, 96† Class II officers and 82‡ Upper Subordinates, besides specialists, clerks, lower subordinates and menials.

10. On completion of its programme in the Southern Command, No. 20 (Cantonment) Party has been placed under the administrative control of the Superintendent, Northern Circle, from the 1st April 1922.

11. The following honours and rewards were conferred during the year:—

<i>Companion of the Order of the Bath.</i> —	Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E.,
<i>Officer of the Order of the British Empire.</i> —	Mr. P. A. T. Kenny, M.B.E., Extra Assistant Superintendent.
<i>Members of the Order of the British Empire.</i> —	„ L. Williams, Extra Assistant Superintendent.
	„ G. A. Norman, Extra Assistant Superintendent.
	„ A. J. Booth, Extra Assistant Superintendent.
<i>Rai Bahadur.</i> —	„ Jagdamba Prasad, R.S., Deputy Superintendent (Temporary).
<i>Rai Sahib.</i> —	„ Hunuman Prasad, Extra Assistant Superintendent.
	„ Dhani Ram Verma, Extra Assistant Superintendent.
	„ Shib Lal, Sub-Assistant Superintendent.
<i>Khan Sahib.</i> —	„ Afraz Gul Khan, Sub-Assistant Superintendent.

Mr. Ram Prasad, R.S., Sub-Assistant Superintendent, was awarded an honorarium of Rs. 500 for skillful withdrawal of his men from the west of the Hukawng valley during Nāgā raids.

Mr. V. W. Morton, Extra Assistant Superintendent, has been granted a commission in the Auxiliary Force, India, as Lieutenant in No. 14 Battery, Royal Field and Garrison Artillery.

Mr. B. T. Wyatt, Extra Assistant Superintendent, (Bangalore Battalion), has been granted a commission as Second-Lieutenant in the Auxiliary Force.

Second-Lieutenant J. C. St. C. Pollett, Extra Assistant Superintendent, has been promoted to the rank of Lieutenant in the Auxiliary Force.

Of the 18 members of the Mussoorie Battalion of the Auxiliary Force which won the Reading Cup for shooting this year, the following seven were officers of the Survey of India:—Messrs. E. B. West, O. N. Pushong, Major C. H. Tresham, Messrs. L. Williams, A. A. Graham, C. O. Picard and H. T. Hughes, Extra Assistant Superintendents.

12. 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 followed by leave or on foreign service throughout the year are omitted.

* Including one officer temporarily promoted from the Class II Service.

† Including officers on foreign service and probationers but excluding one officer temporarily promoted to Class I Service, one officer re-employed and officers 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, 1921-22.

SURVEYOR GENERAL OF INDIA—Colonel C. H. D. Ryder, C.R., C.I.E., D.S.O., R.E.			
	<i>Class I Officers.</i>	<i>Class II Officers.</i>	<i>Upper Subordinates.</i>
Surveyor General's Office.	Lt.-Col. R. H. Thomas, D.S.O., R.E. Major H. J. Couchman, D.S.O., M.C., R.E.		<i>Lower Subordinates, &c.</i>
SUPERINTENDENT, MAP PUBLICATION—	Lient.-Colonel G. A. Beazeley, D.S.O., R.E., up to 31st October 1921.		
	Brevet-Colonel F. W. Pirrie, C.M.G., C.I.E., I.A., from 1st November 1921 to 22nd March 1922.		
	Lient.-Colonel E. A. Tandy, R.E., from 23rd March to 15th June 1922. E. T. Rich, C.I.E., R.E., from 16th June 1922.		
	<i>Class I Officers.</i>	<i>Class II Officers.</i>	<i>Upper Subordinates.</i>
Map Publication Office, Calcutta.		Mr. J. Prasad, R.B. Pranadarajan Ray, R.S.	
No. 1 Drawing Office, Map Record and Issue Office, & Engraving Office, Calcutta.	Major F. F. Hunter, D.S.O., I.A. V. R. Cotter, I.A. Mr. J. Prasad, R.B.	Mr. P. Williams Pranadarajan Ray, R.S. Abinash Chunder Bose C. West A. B. Hunter Priya Nath Sur F. B. Kitchen Munshi Lal, B.A. H. T. Hughes P. C. Mitra, B.A. Jiya Lal Sahgal	<i>Lower Subordinates, &c.</i>
Photo.-Litho. Office, Calcutta.	Lt.-Colonel A. A. McHarg, D.S.O., R.E. Major F. J. M. King, R.E.		
Mathl. Instt. Office, Calcutta.	Mr. T. A. Ferrier, C.S.E.		
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 H. H. P. Butterfield	Mr. Sher Jang, K.B. 5 European Draftsmen. 4 Printers. 2 Clerks. 17 Indian Draftsmen.
SUPERINTENDENT, } —Lient.-Colonel H. Wood, R.E. NORTHERN CIRCLE }			
	<i>Class I Officers.</i>	<i>Class II Officers.</i>	<i>Upper Subordinates.</i>
No. 3 Drawing Office, Mussoorie.	Mr. J. A. Freeman	Mr. E. B. West A. A. Graham Moqimuddin H. G. Shaw (re-employed).	<i>Lower Subordinates, &c.</i> 43 Surveyors, &c.
No. 1 Party, Punjab, Punjab States, United Provinces.	Lt. G. H. Osmaston, M.C., R.E. (on probation). G. F. Heaney, R.E. (on probation).	Mr. C. C. Byrne P. A. T. Kenny, O.B.E. A. M. Talati, L.C.E. Major C. H. Treaham Mr. R. C. Hanson A. J. A. Drake, D.C.M. H. T. Hughes O. D. Jackson	Mr. Sher Jang, K.B. Muhammad Husain Khan, R.S. Muhammad Hasan Jit Singh Rawat Sijawal Khan Latif Khan Mohammad Jamsod (on probn.) Mohammad Abdu Sattar (on probation).
No. 2 Party, Central India, Rajputana and United Provinces and Delhi Province.	Ht.-Lient.-Colonel S. W. S. Hamilton, D.S.O., R.E. Capt. L. H. Jackson, I.A. W. J. Norman, M.C., R.E. (on probation). T. W. R. Hayercraft, R.E. (on probation). Lt. G. H. Osmaston, M.C., R.E. (on probation). G. F. Heaney, R.E. (on probation).	Mr. J. McCruken, M.B.E. C. O. Picard Duni Chand Puri Prafulla Kumar Ghosh, B.Sc. (on probation).	Mr. Muhammad Husain Khan, R.S. Muhammad Husain Iman Din Afraz Gul Khan, R.S. Jagamath Narsingh Das Joshi Mohammad Jamsed (on probation). Mohammad Abdu Sattar (on probation).
No. 3 Party, United Provinces and Nepal.	Major C. G. Lewis, R.E. Captain L. H. Jackson, I.A. T. W. R. Hayercraft, R.E. (on probation).	Captain J. H. Williams Mr. E. B. West L. Williams, M.B.E. J. H. Johnson A. J. A. Drake, D.C.M.	38 Surveyors, &c.
No. 4 Party, United Provinces.	Mr. M. C. Petters	Mr. G. A. Norman, M.B.E. F. C. Saint (dismissed from 1-8-22). Moqimuddin	Mr. Chuni Lal Kapur Lakshmi Dutt Joshi Vidya Dhar Chopra Lalnan Khan, I.D.S.M. Mohabat Lal Kohli (on probn.) Narayana Chandra Ray, (on probation). Dalip Singh Gandhi (on probn.)
No. 20 Party, Cantonments and Military District Lands in the 5th, 6th and 8th Divisions.	Captain J. K. Douglas, R.E.	Mr. J. H. S. Wilson C. E. C. French F. W. Smith	Mr. Dharna (retired from 28 Surveyors, &c. 1-7-22). J. M. Mukerji
No. 22 Party, Punjab.	Mr. H. H. B. Hanby	Mr. Dhani Ram Verma, R.S.	Mr. Jamma Prasad, R.S. Ram Narayan Hastar (c) Gulab Singh, (reverted to L. S. S. from 23-9-22) (a)
No. 23 (Punjab Rect-angulation) (old Sind-Sagar) Party, Punjab.	Major R. Foster, I.A.	Mr. J. C. C. Lears C. O. Picard D. N. Banerjee, L.C.E.	Mr. Lakshmi Dutt Joshi Anrit Ram (b)
Bhopal Traverse Detachment.		Mr. Maya Das Puri, R.S.	Mr. Nabidad Khan 5 Traversors, &c. (e)

(a) Excluding 1 Supervisor on the purely temporary establishment. (c) Excluding 22 purely temporary men.
(b) Excluding 2 Supervisors on the purely temporary establishment. (d) Excluding 76 purely temporary men.
(e) Excluding 11 purely temporary men.

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1921-22.

		Colonel H. H. Turner, R.E., up to 17th April 1922. Lieut.-Colonel C. P. Gunter, O.B.E., R.E., from 18th April to 29th May 1922. Colonel H. H. Turner, R.E., from 30th May to 9th August 1922. Lieut.-Colonel C. P. Gunter, O.B.E., R.E., from 10th August 1922.			
		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. E. Claudius	Mr. B. V. Namyana Rao " Damodar Khadilkar " V. R. Ethirajulu Nayudu	43 Draftsmen, &c.	
No. 5 Party, Quarters, Central India and Central Provinces.	Major F. B. Scott, I.A. Captain G. Lennox, I.A.	Mr. J. H. S. Wilson " F. C. Pilcher " F. W. Smith " J. A. Calvert, (resigned from 12-1-22). " Muhammad Najumuddin, B.A. (on probation).	Mr. P. S. Vengusevani " Daulat Ram Vohra " J. A. Cabral " Manji Ram Sharma (on probation).	37 Surveyors, &c.	
No. 6 Party, Hyderabad.	Lieut.-Colonel C. P. Gunter, O.B.E., R.E. Captain J. K. Douglas, R.E. (on probation).	Mr. H. B. Simons " E. A. Meyer " J. G. St. C. Pollett " E. N. Natesan, B.A.	Mr. K. G. Maudanna " Daulat Ram Vohra " T. S. Narayana, B.A. (on probation).	26 Surveyors, &c.	
No. 7 Party, Madras and Hyderabad.	Major J. D. Campbell, D.S.O., R.E. Captain G. W. Gemmell, I.A. (on probation). Lieut. G. Bonford, R.E. (on probation).	Mr. F. H. Grant " A. F. Murphy " N. S. Harihar Iyer " T. O. Threlfall (on probation).	Mr. K. Narayanaswami Chetti " Shib Lal, B.S. " Shadi Lal Dube " K. B. Muthanna (on probation).	39 Surveyors, &c.	
No. 8 Party, Madras and Bombay.	Lieut.-Colonel M. O'C. Tandy, D.S.O., O.B.E., R.E. Captain J. K. Douglas, R.E. (on probation).	Mr. M. Mahadeva Mudaliar, M.A. " B. T. Wyatt " M. S. Ganesa Aiyar	Mr. H. Nursimhamurti Rao " Shaikh Muhammad Salik " Abdul Ghafur " Janam Raj Chibbar (on probation).	42 Surveyors, &c.	
Training Section		Mr. S. S. McA'F. Fielding " V. W. Morton	14 Probationers	23 Surveyors and Pupils.	
Record Section		Mr. Haji Abdul Rahim, K.B.	Mr. Annada Prasad Ghosh	5 Computers, &c.	
SUPERINTENDENT, EASTERN CIRCLE		Colonel W. M. Coldstream, R.E.			
		Class I Officers.	Class II Officers.	Upper Subordinates.	Lower Subordinates, &c.
Superintendent's Office.	Captain H. R. C. Meade, I.A. (on probation).			Mr. Bhamba Ram	
No. 5 Drawing Office, Shillong.	Mr. W. M. Gorman	Mr. E. G. Hardinge (on deputation, Assam, from 12-9-22).	Mr. Jagdeesh Prasad Vastav " Bansi Ram	28 Surveyors, &c.	
No. 9 Party, Bengal and Bihar and Orissa.	Bt.-Lieut.-Colonel R. H. Phillimore, D.S.O., R.E. Captain R. S. P. MacIvor, I.A. (on probation). Lieut. H. A. Bazley, R.E. (on probation).	Mr. E. J. Biggie " Amar Krishna Mitra Lieut. C. S. McLunes Captain J. O'C. Fitzpatrick Mr. Bhupendra Nath Saha, M.Sc. (on probation).	Mr. Jagdeesh Prasad Vastav " Gopal Lal Mitra " Sasadhar Mukerjee " Rohini Kumar Tulapatra, B.A. (on probation).	37 Surveyors, &c.	
No. 10 Party, Upper Burma.	Lieut.-Colonel E. T. Rich, C.I.F., R.E. Captain O. Slater, M.C., R.E. (on probation).	Mr. W. G. Jarbo " S. F. Norman " O. J. H. Hart " F. J. Grice " H. H. Creed	Mr. Hayat Muhammad, K.S. ... " Dharendra Nath Saha " Ram Prasad, R.S. Maung Pe, A.T.M.	26 Surveyors, &c.	
No. 11 Party, Lower Burma.	Mr. J. O. Greiff Captain T. M. M. Peoney, R.E. (on probation).	Mr. O. J. H. Hart " G. E. R. Cooper " A. V. Dickson	Mr. Pratul Chandra Sen Gupta, B.Sc. " Khan Muhammad " Akani Kumar Sen Gupta (on probation).	24 Surveyors, &c.	
No. 12 Party, Assam.	Bt.-Lieut.-Col. C. M. Browne, C.M.G., D.S.O., R.E.	Mr. E. M. Kenny " D. K. Rennick, M.B.E. " R. C. Hanson " Prafulla Chandra Mitra, D.A.	Mr. Girija Souker Bagchi " Atul Chandra Maulick (on probation). " Suresh Chandra Chatterjee, B.Sc. (on probation).	38 Surveyors, &c.	
No. 21 (Burma Forest) Party, Upper and Lower Burma.	Mr. H. W. Biggie	Mr. S. F. Norman Lieut. L. B. Fitz-Gibbon Captain V. P. Wainright " C. B. Sexton Mr. H. M. Critchell (on probation).	Mr. Dalbir Rai (retired from 1-7-22). " Ghulam Hasan	20 Surveyor, &c.	

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1921-22.

	<i>Class I Officers.</i>	<i>Class II Officers.</i>	<i>Upper Subordinates.</i>	<i>Lower Subordinates, &c.</i>	
SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY	{ Lieut.-Colonel H. McC. Cowie, R.E., up to 17th October 1921. " " E. A. Tandy, R.E., from 18th October 1921 to 10th March 1922. " " H. McC. Cowie, R.E., from 11th March to 2nd July 1922. Major L. C. Thuillier, I.A., from 3rd July to 2nd August 1922. Lieut.-Colonel H. McC. Cowie, R.E., from 3rd August 1922.				
	Superintendent's Office.	Lieut.-Colonel R. H. Thomas, D.S.O., R.E. Major W. E. Perry, M.C., R.E. (On probation). Captain H. R. C. Meade, I.A. " R. S. P. MacIvor, I.A. Lieut. G. H. Osmaston, M.C., R.E. " H. A. Bazley, R.E. " G. F. Heaucy, R.E. " G. Bomford, R.E. Captain G. W. Gemmell, I.A.	Mr. Nanak Chand Puri, B.A., B.S. (Probationers). " Srinivasa Rao Kelkar, B.Sc. " Muhammad Aslam Chowdhury, B.A. " C. P. E. Davenport.	Mr. Lalbir Singh.	
	Computing Office.	Dr. J. deGraaff Hunter, M.A., sc.D., F. Inst. P. Major C. M. Thompson, I.A. Captain E. A. Glennie, D.S.O., R.E.	Mr. Ifanuman Prasad, B.S. Mr. Sarat Kumar Mukerji	64 Computers, &c.	
	No. 2 Drawing Office and Forest Map Office, Dehra Dun.	Major L. C. Thuillier, I.A. " F. J. M. King, R.E. " W. E. Perry, M.C., R.E. Captain R. S. P. MacIvor, I.A.	Mr. H. P. D. Morton " H. B. Simons " Rama Prasad Hay, B.A. " T. P. Kitchen " O. D. Jackson " Nanak Chand Puri, B.A., B.S. " Asmat-ullah Khan, K.B.	Mr. Ran Singh, B.S. " Paras Ram " Jugal Behari Lal " Baldeo Bihari Lal " Kunja Behari Lal (died on 3rd May 1922). " Sadik Ali " Muhammad Hasan	169 Draftsmen, &c.
	No. 13 Party, (Astronomical).	Captain H. E. Roome, M.C., R.E.			2 Computers, &c.
No. 14 Party, (Pendulum).	Lieut.-Colonel H. McC. Cowie, R.E. Major W. E. Perry, M.C., R.E.			2 Computers, &c.	
No. 15 Party, (Triangulation).	Major H. T. Morshead, D.S.O., R.E. Mr. E. C. J. Bond, v.D. Bt.-Major K. Mason, M.C., R.E. " " E. O. Wheeler, M.C., R.E. Captain E. A. Glennie, D.S.O., R.E.		Mr. Muhammad Hasan	6 Computers, &c.	
No. 16 Party, (Tidal).	Major C. M. Thompson, I.A. Captain E. A. Glennie, D.S.O., R.E.	Mr. Hanuman Prasad, B.S. " D. H. Luxa		21 Computers, &c.	
No. 17 Party, (Levelling).	Major F. J. M. King, R.E. Bt.-Major K. Mason, M.C., R.E. Captain E. A. Glennie, D.S.O., R.E.	Mr. G. J. S. Rae " O. N. Pushong " Raj Bahadur Mathur, B.A. " K. S. Gopalachari, B.A. " Narendra Nath Chuckerbutty, L.C.E.	Mr. Karuna Kumar Das, B.A. " Satish Chandra Mukerjee " Pulin Belari Roy " Amir Abdul Salam Matlub Ahmad " Abdul Majid	16 Computers, &c.	
No. 18 Party, (Magnetic).	Mr. E. C. J. Bond, v.D.	Mr. Nikunjo Ronjon Mazumdar " Jiya Lal Sahgal	Mr. Bidhu Bhusan Shome " Hem Chandra Banerjee, B.A.	1 Magnetic Ob-server. 10 Computers, &c.	
No. 19 Party, (Base Line).	Major V. R. Cotter, I.A. Captain E. A. Glennie, D.S.O., R.E.			1 Clerk, &c.	

CONTENTS OF PART 2.—WORK OF FIELD PARTIES, &c.

	<i>Page.</i>
I.—TOPOGRAPHICAL SURVEYS —Table II, Progress since 1906 ...	9
Table III, Out-turns and costs ...	10
Northern Circle	13
Southern Circle	14
Eastern Circle	16
II.—FOREST SURVEYS —Northern Circle	18
Southern Circle	18
Eastern Circle	19
III.—CANTONMENT AND LARGE-SCALE SURVEYS —No. 20 Party	21
Cantonments	21
IV.—THE TRIGONOMETRICAL SURVEY —Astronomical Latitudes ...	22
Pendulum Observations ...	22
Triangulation	22
Tidal Operations	22
Levelling	23
Base Line Operations	22
Magnetic Survey	24
V.—GEOGRAPHICAL SURVEYS AND EXPLORATION—	26

PART 2.—WORK OF FIELD PARTIES, &c.

I.—TOPOGRAPHICAL SURVEYS.

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

In 1913, the Secretary of State sanctioned a scheme for the reduction of the scale of survey of certain sparsely populated areas of India. This will greatly reduce the area of survey on the one-inch scale and consequently accelerate the rate of progress of topographical surveys 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 557,000 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 4-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 ...	16,624	12,526	11,542	42,692
1909-10 ...	Mostly 1-inch ...	23,833	12,582	9,736	46,101
1910-11 ...	ditto ...	27,528	13,171	9,218	49,917
1911-12 ...	ditto ...	28,852	9,115	10,654	48,621
1912-13 ...	Mostly 1-inch and ½-inch	28,192	13,349	11,836	53,377
1913-14 ...	ditto ...	25,052	15,844	14,890	55,786
1914-15 ...	ditto ...	12,334	19,286	5,056	36,676
1915-16 ...	ditto ...	8,168	17,248	6,981	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	7,283	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
1921-22 ...	ditto ...	11,528*	21,596†	11,480	44,604
Total areas completed to date ..		247,394	210,192	167,753	625,339
Approximate areas for the whole topographical programme.		750,000	542,800	528,800	1,821,600
Approximate areas remaining for survey.		502,606	332,608	361,047	1,196,261

* Excludes 37 square miles surveyed on half-inch scale in 1920-21 and re-surveyed on one-inch scale in 1921-22, and 9 square miles of eight-inch survey.

† Excludes 365 square miles previously surveyed on the ½-inch scale.

Table III.—OUT-TURNS of PLANE-TABLING and COSTS
of Topographical Surveys, 1921-22.

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.		Nil	Nil	71,604 (a)	7.7	NORTHERN CIRCLE. (a) Cost of survey of a small area for which credit was taken in last year's report of 8,400 square miles together with cost of mapping of 9,277 square miles undertaken this year. N. B.—Last year an area of 8,400 square miles was surveyed but not mapped. Only arrears of the previous years were mapped. The total cost of surveying and mapping 8,400 square miles is Rs. 2,10,840 giving a cost-rate of Rs. 25.1 per square mile.
No. 2 Party—Central India, Rajputana and United Provinces.						
Cultivated plains, open	... Half-inch Original Survey	492	5,611	1,40,822 (b)	25.1	(b) Excludes Rs. 49,747 cost of training probationers and pupils, Rs. 4,191 debitable to the Allahabad Improvement Trust, Rs. 1,193 debitable to the Executive Engineer, Western Jaunna Canal, Rs. 666 debitable to the City Board, Mussoorie, and Rs. 3,351 debitable to the Chief Engineer, Public Works Department, Delhi. (c) Includes 37 square miles surveyed in 1920-21 on half-inch scale and resurveyed in 1921-22 on one-inch scale.
Ditto	... One-inch Resurvey	2,425				
Ditto	... One-inch Revision Survey	2,694 (c)				
No. 3 Party—United Provinces and Nepal.						
High, wooded hills	... Two-inch Original Survey	1,969	1,969	1,54,402	78.4	
No. 4 Party—United Provinces.						
Cultivated plains, congested with villages in parts.	One-inch Revision Survey	3,691	3,985	86,023 (d)	21.8	(d) Excludes Rs. 680 debitable to Benares State and U. P. Govt. and Rs. 13,994 cost of training of pupils and probationers.
Cultivated plains and densely wooded low hills.	One-inch Original Survey	294				
TOTALS, NORTHERN CIRCLE—		11,565 sq. m		Rs. 4,53,751	Cost-rate 39.2	

Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1921-22.

PARTY and LOCALITY.		OUT-TURNS OF PLANE-TABLING.		COSTS OF SURVEY INCLUDING MAPPING.		REMARKS.
		Areas on each Scale of each Class.	Total of areas on all Scales.	Total costs.	Cost-rates.	
Character of Country.	Scale and Class of Survey.	Sq. miles.		Rs.	Rs. per sq. mile.	
SOUTHERN CIRCLE.						
No. 5 Party—Gwalior, Central India and Central Provinces.						
<i>Jungle-clad hills, well wooded cultivated plains and part of the Malwa plateau.</i>	Half-inch Original Survey ...	1,646	4,679	1,38,999	29·7	(e) Includes 277-769 square miles of Indore State Forest.
	One-inch Original Survey ...	(a) 2,404				
	One-inch Supplementary Survey	615				
	Four-inch Original Forest Survey	14				
No. 6 Party—Hyderabad.						
<i>Undulating and cultivated country: wooded hills.</i>	Half-inch Original Survey ...	6,270	6,635	1,16,781	17·6	
	Half-inch Supplementary Survey	365				
No. 7 Party—Madras and Hyderabad.						
<i>Open or undulating mostly cultivated Low scrub covered hills Forest-clad hills ...</i>	One-inch Original Survey ...	8,810	6,092	1,51,016	24·7	
	Two-inch Original Survey ...	333				
	One-inch Supplementary Survey	1,949				
No. 8 Party—Madras and Bombay.						
<i>Irrigated and cultivated plains and high forest-clad hills in Madras Presidency. High hills rising to a height of 4,000 feet and open and cultivated area in Bombay Presidency.</i>	One-inch Original Survey ...	970	4,555	1,41,174	30·9	(f) Includes cost of fair-mapping and fixing scattered auxiliary heights.
	One-inch Supplementary Survey	199				
	One-inch Revision Survey ...	3,386				
TOTALS, SOUTHERN CIRCLE:— 21,961* sq. m. Rs. 5,47,970						Cost-rate 25·0

* An area of 365 square miles previously surveyed on the 1½-inch scale has been included.

Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1921-22.

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 Bihār and Orissa.						
Flat and cultivated plains, congested with villages.	One-inch Original Survey	462	3,771	1,91,180	50·7	
Open undulating plains, well populated, varied with rocky scrub covered hills.	One-inch Supplementary Survey	3,287				
Rough hills covered with Sāl forest.	Two-inch Original Survey	42				
No. 10 Party—Upper Burma.						
Densely wooded hills and plains	Half-inch Original Survey	3,168	3,168	1,74,518	55·1	
No. 11 Party—Lower Burma.						
Hills densely wooded, rocky wooded islands and sea coast and mangrove swamp.	One-inch Original Survey	1,980	2,150	1,99,029 (a)	92·6	(a) Includes cost of two-inch forest survey not chargeable to Forest Department.
Flat and hilly forest tracts	Two-inch Original Survey	170				
No. 12 Party—Assam.						
Mainly hills, partly open and partly jungle-clad and plains densely covered with jungle.	Half-inch Original Survey	883	2,199	1,80,187 (b)	81·9	(b) Excludes Rs. 108 cost of mapping four-inch forest boundary plots.
Plains and hills mainly jungle-clad.	One-inch Original Survey	1,182				
Plains densely covered with jungle	Two-inch Original Survey	184				
No. 21 (Burma Forest) Party—Upper and Lower Burma.						
Densely wooded hills and flat ground.	Two-inch Original Survey	147	163	1,52,851	999·0	
Wooded hills	Four-inch Original Survey	6				
Ditto	Two-inch Original Survey	26	39			(c) Done by Survey Training School for the party.
Ditto and town of Kalaw	Four-inch Original Survey	14				
TOTALS, EASTERN CIRCLE:—				11,480 sq. m.	Rs. 8,97,715	Cost-rate 78·2
GRAND TOTALS:—				45,006 sq. m.	Rs. 18,99,436	Cost-rate 42·2

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

14. No. 1 Party.—This party was employed on the completion of the fair-mapping left over from the previous season, comprising 33 sheets on the one-inch and 7 sheets on the half-inch scale. No detail surveys were undertaken during the year.

An area of 2,700 square miles was triangulated, in preparation for a topographical survey on the one-inch and half-inch scales. This area comprises chiefly the tribal tract, in the southern half of the Dera Ghāzi Khān district in the Punjab, but extends westward into the adjoining portion of the Marri-Bugti country in Baluchistān. It is practically tree-less, and rises from about 300 feet to about 4,500 feet above mean sea level. Water is scarce and mostly brackish and communications are few and bad.

15. No. 2 Party.—This party surveyed an area of 4,776 square miles in the Agra, Aligarh, Muttra, Etah, Mainpuri, Farrukhābād, Etāwah, Cawnpore, Jālaun and Hamirpur districts of the United Provinces, 137 square miles in Dholpur State in Rājputāna, 143 square miles in Gwalior State and 63 square miles in Baoni State in the Bundelkhand Agency in Central India on the one-inch scale, and 492 square miles in Gwalior State in Central India on the half-inch scale.

The country surveyed consists of cultivated plains, for the most part open and easy, except in a few places where trees were numerous. There was a great deal of broken ground along the banks of the Jumna and Chambal rivers. The area was devoid of hills.

Triangulation was carried out in Gwalior and Datīā States in Central India and in Bharatpur, Dholpur, Karauli and Jaipur States in Rājputāna and an area of 6,560 square miles completed in advance for detail survey on the half-inch scale.

The *traverse* of Allahābād city and Municipal areas for large scale detail survey and of demarcated areas of leased land in Imperial Delhi was completed, (*vide* page 46).

16. No. 3 Party.—This party surveyed an area of 1,969 square miles on the two-inch scale in the Garhwāl and Almorā districts of the United Provinces and in Nepāl. No triangulation was carried out. The survey of the Kumaun hills is being executed chiefly in the interests of the Forest Department (*vide* page 18). The maps are being published on the two-inch scale.

17. No. 4 Party.—This party, which had been in abeyance since 1917, surveyed an area on the one-inch scale of 3,542 square miles in the Azamgarh, Balliā, Bastī and Gorakhpur districts of the United Provinces, 149 square miles in the Champāran and Sāran districts of Bihār and Orissa and 294 square miles in Nepāl, or a total of 3,985 square miles. In addition, 58 square miles of triangulation and 133 linear miles of traversing were carried out in the Champāran district and in Nepāl to supply data for the detail survey during the current season.

The country surveyed consists mainly of well cultivated plains dotted over with lakes, marshes and numerous groves of mango trees and intersected by several rivers the principal of which are the Gogrā, Gandak and Rāpti. Towards the north-east, the country begins to undulate and the alluvial plain gives place to a broken, hilly region which forms the lower slopes of the Someswar range.

A report on the deputation in connection with the disputed boundary between Benares State and the United Provinces will be found on page 46.

18. Training.—No pupil surveyors were entertained during the year. Of those entertained in 1920 and 1921, 13 were promoted unclassified surveyors, 8 were discharged and the remainder have been distributed to the parties for further training during the coming field season.

No soldier surveyors joined for training during the year. Of the batch reported as undergoing training last year, 10 have been reverted to their regiments and, of the remainder, 4 are undergoing their 1st period and 4 their 2nd period of training, 1 having been transferred to the Unattached List.

19. Recess Work.—The fair-mapping of all the sheets of No. 2 and 4 Parties was completed before these parties left for the field. The arrears of No. 1 Party were completed except for 1 one-inch sheet which still had to be examined and 7 half-inch sheets. These latter were taken over by No. 3 Drawing Office and 6 of these will be submitted before the end of the current year.

No. 3 Party's fair-mapping is still in arrears. * The forest work of this party entails much extra work. A drawing section is remaining in Mussoorie during the ensuing field season and all arrears will be completed before the commencement of the next recess.

The fair-mapping of the following sheets of the current and previous season's survey remained for completion on 30th September 1922:—

Sheets on the one-inch scale	...	...	26
Sheets on the two-inch scale	...	...	24
Sheets on the half-inch scale	...	...	9
Town-guide map	...	...	1

Of these, 28 will be submitted for publication before the end of November 1922.

20. Record Section.—Triangulation data for 12 degree sheets were completed. This section was amalgamated with No. 3 Drawing Office from 1st August 1922.

21. Particulars of special work done by Nos. 2, 4, 20, 22 and 23 (Punjab Rectangulation) (old Sind-Sāgar) Parties and Bhopāl Traverse Detachment will be found on pages 21 and 46 to 48.

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

22. No. 5 Party.—This party surveyed an area of 4,679 square miles as follows:—2,000 square miles in the Betūl, Hoshangābād and Nimār districts of the Central Provinces, 715 square miles in Indore State and 214 square miles in Dhār State, both of the Central India Agency, on the one-inch scale; 1,299 square miles in Indore State, 97 square miles in Dewās State, 48 square miles in Dhār State, 6 square miles in Rājgarh State, 22 square miles in Jāmnia State and 54 square miles in the Mānpur pargana (British), all of the Central India Agency, 120 square miles in the Amjhera and Ujjain districts of Gwalior, on the half-inch scale; and 14 square miles of reserved forests in the Hošhangābād district of the Central Provinces on the four-inch scale.

The country surveyed consists of jungle-clad hills, well wooded cultivated plains, and part of the Mālwā plateau.

It also triangulated an area of 4,410 square miles in the Central India Agency, Gwalior and the Central Provinces.

23. No. 6 Party.—This party completed an area of 6,270 square miles of half-inch original survey and 365 square miles of half-inch supplementary survey in the Gulbarga, Raichūr and Mahbūbnagar districts of Hyderābād.

690 square miles of supplementary triangulation was carried out in the Amrābād and adjoining reserved forest areas in the Mahbūbnagar and Nalgonda districts of Hyderābād.

The country surveyed is undulating and mostly cultivated except in the wooded hills of the forest areas.

24. No. 7 Party.—This party surveyed an area of 5,950 square miles on the one-inch and two-inch scales in the Kurnool, Anantapur and Cuddapah districts of Madras, and 142 square miles on the one-inch scale in the Raichūr district of Hyderābād, and triangulated an area of 4,462 square miles in the Cuddapah, Chittoor and Anantapur districts of Madras.

The country surveyed is generally cultivated open expanses of level or undulating land, rocky scrub covered hills and the forest-clad ranges of the Nallanalaia and Erramalaia.

25. No. 8 Party.—This party surveyed 4,555 square miles on the one-inch scale. Of this area, 1,169 square miles fell in the Madura district of Madras and consisted of about equal proportions of irrigated and cultivated plains and of the high forest-clad Palni and Sirumalai hills; of the remaining 3,386 square miles, 2,626 square miles fell in the Poona, Kolāba and Sātāra districts, 663 square miles in Bhor State and 97 square miles in Phaltan State in Bombay; this area included portions of the Western Ghāts rising to a height of 4,000 feet and the more open and cultivated area to the east of the Ghāts. Poona and Kirkee were included in the area surveyed.

26. Training Section.—The section comprised five of the 1920-21 class of Upper Subordinate probationers who had been kept back for further training in plane-tableing and nine Upper Subordinate probationers recruited this year who joined in October as well as 20 pupil surveyors recruited during the year.

The preliminary training of the pupil surveyors in drawing and in plane-tableing on two and four-inch scales in the neighbourhood of Bangalore was continued up to November when the section took the field.

During the field season the 2nd year Upper Subordinates completed their training in plane-tableing and were all posted to various circles in May 1922. Of the 9 new Upper Subordinate probationers four resigned during the field season and five completed their course in plane-tableing and triangulation. Of the 20 pupil surveyors 6 resigned or were discharged as unsuitable and 14 completed their plane-tableing course.

On return to recess, 2 more pupil surveyors were allowed to resign, the remaining 12 continued their training in fair-drawing and were posted to parties in the circle in October 1922. The 5 Upper Subordinate probationers completed their training in traversing, levelling, computations and drawing and after passing a final examination in October 1922 were posted to various circles.

27. Recess Work.—21 one-inch sheets out of 50 surveyed during the year under report were received in the circle office up to the 30th September 1922. All the remaining sheets, except one which will be partly resurveyed, will be fair-mapped before the close of the recess season.

Six original half-inch sheets out of 8 surveyed during the year were received in the circle office up to the 30th September 1922. The remaining 2 sheets will be fair-mapped before the close of the recess season.

Besides the above 4 special forest maps will be completed by No. 5 Party before the close of the recess season.

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

28. Record Section.—Six triangulation pamphlets and charts were prepared and submitted during the year. Data for 8 degree sheets were compiled in pamphlet form and preserved in the section. All triangulation and traverse records were re-indexed. Data were extracted and supplied on cash payment to a private individual.

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

29. No. 9 Party.—This party surveyed an area of 3,771 square miles on the two-inch and one-inch scales in Bengal and Bihār. In Bengal the work fell in the Howrah, Midnapore, and Twenty-four Parganas districts of Bengal and in the Bhāgālpur, Monghyr and Santāl Parganas districts of Bihār.

The area surveyed in Bengal lies on both sides of the Hooghly river, and is flat, and densely populated and that surveyed in Bihār is well populated, undulating and generally open, with small areas of rocky wooded hills.

An area of 540 square miles in the neighbourhood of Patna was traversed for detail survey next season, the work falling in districts Muzaffarpur, Patna, Sāran and Shāhābād of Bihār.

An area of 1,600 square miles was triangulated in the Orissa Tributary States.

30. No. 10 Party.—This party surveyed an area of 3,168 square miles on the half-inch scale in the unadministered area lying between the Putao and Myitkyinā districts of Burma and the Lakhimpur district of Assam. Triangulation was attempted to the south-west of the area surveyed but could not be proceeded with owing to the hostility of the Nāgās. The whole area is covered with dense jungle and, except in the Hukawng, consists of steep and intricate hills rising to 8,000 feet. The Hukawng is a broad level plain crossed by numerous streams, its altitude being about 650 feet.

31. No. 11 Party.—Survey operations were continued in Lower Burma. In the Mergui district, on the mainland and in Sullivan or Lampi island and numerous small islands along the coast, 1,980 square miles were surveyed on the one-inch scale. In the Amherst district, 170 square miles of reserved forest were surveyed on the two-inch scale.

The country surveyed on the mainland consists of a densely forest-clad ridge, rising, in places, to 2,000 feet in elevation, connected in the northern portion of the area with the barrier range along the Siamese frontier and terminating at its southern extremity in the high promontory of Victoria Point. Mangrove swamps and mud flats form the coast. The numerous islands of the Archipelago are thickly wooded, with steep rocky shores, broken by occasional sandy beaches and vary in size from mere rocks to peaks of 2,000 feet.

32. No. 12 Party.—This party surveyed an area of 2,199 square miles on the two-inch, one-inch and half-inch scales in Assam, in the districts of Cāchār, Nowgong, Sibsāgar and the Nāgā Hills and in Manipur State.

An area of 3,376 square miles of triangulation and 277 linear miles of traversing (covering an area of 1,017 square miles) were carried out in the district of the Nāgā Hills, Manipur State and the Sadiyā Frontier Tract, in advance of detail survey.

The area surveyed was hilly, ranging from 400 feet to 6,000 feet, approximately; almost the whole of it was covered with dense forest.

33. No. 21 (Burma Forest) Party.—The work done by this party is included in that shown under Forest Surveys, Eastern Circle, pages 19 and 20.

The area over which operations extended is hilly, rising to 5,000 feet and covered with very dense forest growth.

34. Training.—This was carried out in No. 9 Party and in the Maymyo Survey School.

In No. 9 Party results were encouraging, an average out-turn of 68 square miles of survey being obtained from each pupil. In all, 2 military officers, 1 Upper Subordinate officer, 1 soldier surveyor and 12 pupil surveyors were under training of whom 3 pupil surveyors have been discharged as unlikely to become good surveyors.

At Maymyo results were less satisfactory. Since the school was formed in December 1920, 70 pupils, mostly Burmans, have been under training for different periods. 31 of these have been discharged as unlikely to become surveyors, 4 absconded or resigned and 6 were discharged or resigned after having been trained and drafted to parties and only 15 are sufficiently trained for ordinary field work. The experiment of recruiting Burmans to train as surveyors has not been successful and it is proposed to close the school from November 1st when the few partially trained pupils still at the school will be attached to parties to complete their training.

35. Recess Work.—The sheets which had to be drawn by the parties of the Eastern Circle during the recess season numbered 56 including 7 special forest sheets and 1 sheet in arrears from the previous year's drawing. By the 30th September, 6 of these sheets had been received in the circle office and all the remaining sheets will be received and sent for publication before the beginning of next recess season.

II.—FOREST SURVEYS.

36. Details of the topographical survey of reserved forests executed by field parties of the Survey of India during the year under report, are given below. In the majority of cases, the surveys were carried out on the scale of 2 inches to a mile, but occasionally the 4 inches and 1 inch to a mile scales were adopted. Boundary surveys were made where required, and plots prepared on the 4-inch scale.

NORTHERN CIRCLE.

37. **United Provinces. Kumaun Forest Circle.**—In the *North Garhwāl, Central Almorā, and East Almorā Forest Divisions*, reserved forest areas of 158, 22 and 361 square miles respectively, were surveyed on the 2-inch scale, thus completing the survey of reserved forests in the two latter forest divisions.

SOUTHERN CIRCLE.

38. **Central Provinces. Northern Circle.**—In the *Hoshangābād Forest Division*, the following reserved forest areas, totalling 13·764 square miles, were surveyed on the 4-inch scale:—

Name of Block or Extension.	Area in square miles.
Joga Kalan A	1·759
Bichola Extension B	0·259
" " C	0·168
Indpura " D	10·204
Lokartalai " E	0·033
" " F	0·149
" " G	0·819
" " H	0·251
Budhimai " K	0·189
Dimdadch " L	0·133
Total	13·764

39. **Madras. II Forest Circle.**—In the *South and West Kurnool Forest Division*, an area of 5·96 square miles was surveyed on the 1-inch scale in the Dudrala Reserved Forest and of 241·63 square miles on the 2-inch scale in the under-mentioned reserved forests:—

Name.	Area in square miles.
Gāddenadugu	7·53
Loddipalle	2·00
Yaparlapādu	13·38
Voddaman	1·89
Rāmāllakota	2·85
Yemboyi	4·69
Lanjabanda	6·00
" Extension	5·35
N. Dhone (part)	7·08
Rāngūpuram A and B	8·85
Carried over	59·62

Name.			Area in square miles.
	Brought forward	...	59'62
Betamcherla	...	...	14'08
Pānem	...	...	36'05
Gani	...	...	65'43
Owk and Extension (part)	...	...	41'15
Giddalore Block 1	...	...	4'95
" " 2	...	...	10'12
Yedanada	...	...	1'87
Mittapalli	...	...	4'38
Alamur	...	...	0'28
Rāmavaram	...	...	3'70
	Total	...	241'63

III Forest Circle.—In the *North and South Cuddlaph Forest Division*, a total area of 44'77 square miles was surveyed on the 2-inch scale, of the under-mentioned reserved forests:—

Name.			Area in square miles.
Dhodiyan	A	...	6'15
"	B	...	3'43
Gandikota	N	...	1'97
"	S	...	8'39
Bhanikotamale	...	...	16'50
Dotrudapalle (part)	...	...	3'58
Mahidi Kantaldimmi	...	...	3'79
Penner	...	...	0'96
	Total	...	44'77

EASTERN CIRCLE.

40. Bihār & Orissa. Bihār & Orissa Forest Circle.—In the *Santāl Parganas Forest Division*, an area of 1 square mile comprising the Kelhari closed Block was surveyed on the 1-inch scale, and areas of 2 and 40 square miles of the Balghora closed Block and the old Reserve respectively were surveyed on the 2-inch scale.

41. Assam. Western Forest Circle.—In the *Cāchār Forest Division*, an area of 96'57 square miles of the Langting Mupā Forest Reserve was surveyed on the 1-inch scale, the scale of 2 inches to the mile, on which a portion of this reserve was surveyed last year, having been reduced to 1-inch with the concurrence of the Conservator of Forests.

Eastern Forest Circle.—In the *Nowgong Forest Division*, areas of 10'25 and 15 square miles of the Lumding and Kaki Reserved Forests respectively were surveyed on the 1-inch scale, and the whole of the Dhansiri Reserve amounting to 74'14 square miles was surveyed on the 2-inch scale.

In the *Sibsāgar Forest Division*, the whole of the Rangāpahār Reserved Forest amounting to 34 square miles was surveyed on the 2-inch scale.

42. Burma. Northern Forest Circle.—In the *Mansi Forest Division*, the survey of an area of 3'8 square miles on the 4-inch scale completed the survey of the Mode Reserved Forest.

Central Forest Circle.—In the *Meiktila and Southern Shan States Forest Divisions*, areas of 26 square miles on the 2-inch and 18 square miles on the 4-inch scale were surveyed in the Kubyin and Kalaw Reserved Forests respectively. In the former reserve, 37 linear miles of its boundaries were traversed.

Tenasserim Forest Circle.—In the *West Salween Forest Division*, (New Thaton Division), 250 linear miles of the boundaries of the following reserves were traversed: Kalemataung, Martaban, Danu (fuel), Kyosein, Wetwundaung, Bilin, and Pabein.

In the *Ataran Forest Division*, areas of 64·85, 104·8, and 0·8 square miles of the Kyonkawun, Kyaikkamaw and Tagundaing Reserved Forests respectively were surveyed on the 2-inch scale.

Delta Forest Circle.—In the *Bassein Forest Division*, 47 square miles of triangulation and 299 linear miles of traversing were carried out in the Chaungtha, Mezali, Sinma, Myittaya and Thitpok Reserves, and 146·9 square miles of surveys on the 2-inch scale as follows:—

Shwemyindin Reserve	...	...	...	9·3	square miles.
Podaw	"	...	...	29·6	"
Kyeintali	"	...	...	34·3	"
Sitsayan	"	...	...	29·5	"
Chaungtha	"	...	...	26·5	"
Unclassed Forest	...	...	...	17·7	"
			Total	<u>146·9</u>	"

III.—CANTONMENT AND LARGE SCALE SURVEYS.

43. No. 20 Party.—During the year the party completed the survey of Bangalore, Deolali and Ahmadabad cantonments on the sixteen-inch scale, and in addition, a considerable area around Deolali on the six-inch scale, to illustrate proposed military extensions. The remaining portions of the bazaar areas in Bangalore were completed on the scale of one inch to fifty feet, as well as the bazaars in Deolali and Ahmadabad on the sixty-four-inch scale.

31.94 linear miles of traversing and 96.83 linear miles of levelling were completed in conjunction with these surveys at a cost of Rs. 237.66 and Rs. 18.90 per mile respectively.

The fair-mapping of the following cantonments has been completed during the year:—Pallavaram, St. Thomas's Mount, Poonamallee, Velichi and West Hill. 39 sheets have been submitted to press; of the remainder, comprising 96 sheets, 46 are nearly ready and the rest well in hand.

The out-turns and cost-rates of the several classes of survey are as follows:—

1. Sixteen-inch, original, 2,064 acres @ Rs. 4.55 per acre.
2. Sixteen-inch, revision, 3,461 acres @ Rs. 1.04 per acre.
3. Six-inch, original, 40.21 square miles @ Rs. 190.22 per square mile.
4. One inch to fifty feet, original, 65.63 acres @ Rs. 9.82 per acre.
5. Sixty-four-inch, original, 48.36 acres @ Rs. 16.29 per acre.
6. Sixty-four-inch, revision, 58.00 acres @ Rs. 13.91 per acre.

The average daily out-turns being:—

8.22, 10.15, 57.60, 0.66, 2.20, 1.41 acres, respectively.

The total areas fair-drawn, with cost-rates, are as follows:—

1. 4,636.00 acres on the sixteen-inch scale @ Rs. 3.95 per acre.
2. 20.10 square miles on the six-inch scale @ Rs. 134.57 per square mile.
3. 75.00 acres on the one inch to fifty feet scale @ Rs. 196.76 per acre.
4. 666.00 acres on the sixty-four-inch scale @ Rs. 7.39 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 1921-22.

(1) Agra Cantonment.	(24) Kalka Cantonment.
(2) Aurangabad do.	(25) Kamptee do. and Bazar.
(3) Bakloh do.	(26) Karachi Port Trust (Manora)
(4) Balin or Thath (Dalhousie) Camp area.	(27) Landour Cantonment,
(5) Bannu Cantonment.	(28) Meerut do. and Bazar.
(6) Chaman do.	(29) Nasirabad do. do.
(7) Chitral Station.	(30) Nimach do. do.
(8) Dehra Dun Cantonment.	(31) Peshawar do. do.
(9) Deoli do.	(32) Quetta do.
(10) Drazinda Out Post.	(33) Quetta Fort.
(11) Drosh Cantonment.	(34) Quetta Civil Station.
(12) Delhi New do.	(35) Rajkot Cantonment.
(13) Erinpura do.	(36) Rawalpindi do.
(14) Fort Lockhart.	(37) Saharanpur Remount Depot.
(15) Ghairat Station.	(38) Sanawar Cantonment.
(16) Guna Cantonment.	(39) Saugor do.
(17) Hangu do.	(40) Simlkot do.
(18) Hapur (Babugarh) Remount Depot.	(41) Simla Indian Infantry Lines.
(19) Hosur do.	(42) Sitabaldi Fort (Nagpur).
(20) Jandola Out Post.	(43) Thal Cantonment.
(21) Jatta do.	(44) Topa do.
(22) Jhelum Cantonment.	(45) Zim Out Post.
(23) Jullundur do.	

IV.—THE TRIGONOMETRICAL SURVEY.

GEODETTIC OPERATIONS.

44. No. 13 Party.—Astronomical.—During the year advantage was taken of the fact of Bt.-Major K. Mason, M.C., R.E., being in Kashmir on other survey work, to get this officer to carry out Talcott observations for latitude at four stations of the Kashmir triangulation, namely:—

Gogipatri, Poshkar, Zebanwan and Reban. The observations at the two former were of the nature of revision, the earlier observations at those two stations, in 1860, having given indications of defects in the instrument used, with the result that the values of latitude then obtained have always been looked upon with some suspicion. The computation of this work is in hand but the results are not yet available.

The personnel of the party were employed at Headquarters offices of the Trigonometrical Survey.

45. No. 14 Party.—Pendulum, No. 15 Party.—Triangulation, and No. 19 Party.—Base Line Operations.—No field operations were carried out by these three parties, the personnel being employed at the Headquarters offices of the Trigonometrical Survey.

46. No. 16 Party.—Tidal Operations.—Tidal registrations were carried out during the year by means of self registering tide-gauges 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	43	*With a small tide-gauge.
2. Karachi	{ 1868 ...	1880	*13	
	{ 1881 ...	Still working	41	
3. Bombay (Apollo Bandar)	1878 ...	"	44	
4. Bombay (Prince's Dock)	1888 ...	"	34	
5. Madras	{ 1890 ...	1890	10	
	{ Restarted 1895	Still working	27	
6. Kidderpore	1881 ...	"	41	
7. Rangoon	1880 ...	"	42	
8. Moulmein	{ 1880 ...	1886	6	
	{ Restarted 1909	Still working	13	
9. Port Blair	1880 ...	"	42	

In addition, the actual times and heights of high and low-water at Bhaunagar, Chittagong and Akyab were observed by watch and tide-pole, under the supervision of the Port Officers, a monthly record of the observations being forwarded to this office.

Hourly readings of the height of the water, determined by 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 1921, were reduced by the method of harmonic analysis and the constants thus deduced were used in the computation of data for the Basrah tide-tables for 1923.

Tide predictions for the 1923 tide-tables for the Indian ports, including Basrah, were carried out by means of the tide-predicting machine set up at the office of the Superintendent of the Trigonometrical Survey. Dehra Dūn, where, subsequently, the tables were published. Their despatch to Port authorities will be completed by about the end of October 1922.

Tidal registrations have been carried out satisfactorily at nine observatories, except in the case of Bombay (Prince's Dock). Registrations will be discontinued at Prince's Dock, Bombay, which observatory will, however, be kept open by the Port authorities for their own purposes.

During the past year these observatories were all inspected.

47. The following table shows the annual and decadal percentages of error in the predicted times and heights of high and low-water at the nine 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 7% of mean range at springs.	Within 15 minutes of actuals.		Within 8 inches of actuals.	Within 7% of mean range at springs.						
									H.W.—L.W.	H.W.—L.W.	H.W.—L.W.	H.W.—L.W.		
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	93	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	89	92
1920	6	82	81	94	97	97	98	3	76	66	64	62	89	86
1921	6	77	72	94	97	97	99	3	74	66	75	71	92	94
Average of ten years.	...	80	79	96	97	97	98	...	75	64	71	64	92	89

48. *Tide-predicting machine.*—This machine was received from the National Physical Laboratory, Teddington, England, towards the end of September 1921. After necessary repairs had been carried out, it was erected at Dehra Dūn, the predictions for the 1923 tide-tables being completed by the middle of August 1922.

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

- (a) *In Bengal and Bihār, for the Nadiā Rivers Scheme.*
 - (i) From Dhuliān to Jangipur.
 - (ii) From Tinpahār to Barharwā.
- (b) *In Bengal, for the Irrigation Department.*
 - (i) From Calcutta, via Bārāsāt, Husainābād, Jessore and Jhenida to Chuādānga.
 - (ii) From Jessore to Bārāsāt.
- (c) *In Bihār.*
 - (i) From Jhārsugrā to Purūliā.

In the Central Provinces and United Provinces.

 - (ii) From Jhānsi to Saugor.
 - (iii) From Garhmuktesar to Aligarh.

These lines were levelled to provide a cross connection between the old level lines.

- (d) *In Bombay, for the Sukkur Barrage Project.*
 - (i) From Shikārpur (Sind) to Kambar.

- (ii) From Wāriāso to Rato-Dero.
- (iii) From Madad-Chāndia to Mehar.
- (iv) From Ruk to Sehwan.
- (v) From Daur to Lundo.
- (vi) From Shāhpur to Mahrābpur.
- (vii) From Tando Alāhyār to Hyderābād (Sind).
- (viii) From Rohri to Jām Sāhib.
- (e) *In Bombay, for the Nira Right Bank Canal Scheme.*
 - (i) From Nira Bridge to Bhatgar.
 - (ii) From Nira Bridge to Zalki.
- (f) *In Bombay, Punjab and Rājputāna.*
 - (i) From Virangām to Rājkot.
 - (ii) From Rājkot to Jorya.
 - (iii) From Jorya to Shikārpur (Cutch).
 - (iv) From Shikārpur (Cutch) to Navānār.
 - (v) From Navānār to Nakhtarāna.
 - (vi) From Jacobābād to Shikārpur (Sind).
 - (vii) From Shikārpur (Sind) to Rohri.
 - (viii) From Rohri to Reti.
 - (ix) From Reti to Khānpur.
 - (x) From Khānpur to Bahāwalpur.
 - (xi) From Bahāwalpur to Multān.
 - (xii) From Multān to Jhang.
 - (xiii) From Khānpur to Islāngarh.
 - (xiv) From Islāngarh via Sheo, Barmer, Bālotra and Luni Junction to Mārwar Pāli.
 - (xv) From Surat to Dhūlia.

These lines were levelled in accordance with the procedure prescribed for high precision work, and form lines 102, 104, 105 and 113 of the new level net of India.

- (g) *In Bombay.*
 - (i) From Nāndgaon to Ahmadnagar, via Manmād.
 - (ii) From Sholāpur to Bijāpur, via Zalki.

These lines were levelled to form cross connections between lines of the old net.

- (h) *In Punjab and Kashmir.*
 - (i) From Wazirābād to Sūchitgarh.
 - (ii) From Sūchitgarh to Islāmābād.

These lines were levelled to complete the circuit taken into Kashmir in season 1912-13.

The total out-turn consisted of 1,452 miles of primary levelling and 2,195 miles of secondary levelling; of this 1,383 miles of secondary levelling were executed at the request of Local Governments, Irrigation Departments, &c.

MAGNETIC SURVEY.

50. 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, dip and horizontal force, 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 party.

Observations at Repeat Stations.—Magnetic observations were taken this field season at the six repeat stations—Quetta, Karāchi, Bina, Dibrugarh, Barrackpore and Waltair; these stations are visited annually to supplement the 5-yearly observations at all repeat stations, taken in order to obtain reliable determinations of the annual changes in the magnetic elements.

Publication of the results of the magnetic survey.—The final reduction of observations taken at observatories, in the field and at repeat stations, to the epochs 1909·0 and 1920·0 is very nearly completed and it is hoped that the tables of the results and the necessary maps &c., most of which have already been sent to press, will be ready for publication about the middle of 1923.

Special observations.—In response to an appeal by Dr. L. A. Bauer, Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, addressed to magnetic observatories in all countries, for co-operation in special simultaneous magnetic observations in connection with the Solar eclipse of the 21st September 1922, magnetic observations were taken at the Dehra Dūn, Toungoo and Kodaikānal observatories. Declination, dip and horizontal force were observed at Dehra Dūn, but at the Toungoo and Kodaikānal observatories, where the observatory staffs are small, only declination observations were taken. The three observatories were favourably situated within the shadow belt of the eclipse and it is hoped that the results of the observations obtained in India will be of value to Dr. Bauer in his investigation of the effects of the eclipse.

The magnetic elements at the observatories.—The computation and tabulation of the values of declination, dip, horizontal force and vertical force for the three observatories, Dehra Dūn, Toungoo and Kodaikānal, for the year 1921, 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 THE OBSERVATORIES IN 1921.

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 45 4·2	E 1 47·1	·32945	·33025
Toungoo ...	{ 18 55 45 N } { 96 27 3 E }	N 23 7·0	W 0 26·8	·39132	·16704
Kodaikānal ...	{ 10 13 50 N } { 77 27 46 E }	N 4 38·5	W 1 54·2	·37832	·03071

V.—GEOGRAPHICAL SURVEYS AND EXPLORATION.

51. Geographical Surveys in Bhutān and Tibet.—Captain H. R. C. Meade, I.A., and Mr. Bansi Ram, Sub-Assistant Superintendent, accompanied the Political Officer of Sikkim on a mission to Bumtang to confer the insignia of the G. C. I. E. on His Highness the Mahārāja of Bhutān.

Leaving Yatung on June 20th, the party reached Bumtang on the 20th of July and returned by the Manlakachung La Pass through the southern portion of Tibet by the Yamdo Tso lake to Gyāntse, where it arrived on the 27th of August.

Areas aggregating 6,500 square miles were plane-tabled on the scale of one inch to 4 miles, the work being based generally on triangulation carried out during the journey.

PART 3.—OFFICE WORK.

I.—HEAD QUARTER OFFICES.

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

52. 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. 54 to 58, 66, 67 and 81.

53. 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 95 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	19	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
1921-22	20	46	29	95
Total published ...	726	548	549	1,823
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	515	917	1,015	2,447
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 17 one-inch sheets, prepared from modern revenue surveys, have been published during the year pending their topographical revision.

47 modern one-inch, 9 preliminary editions of one-inch, and 79 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
1921-22	75	7	82
Totals	321	38	359
Approximate total number of half-inch sheets in India	.....	.....	1,630

14 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
1921-22	1	3	6	10
Totals	17	15	39	71
Approximate number of "degree" sheets in India	170	140	140	450

1 preliminary sheet in colours from comparatively modern surveys has been published and 14 are in hand.

In addition to the above, 8 modern and 2 preliminary public quarter-inch sheets have been reprinted during the year.

39 quarter-inch 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 12 of such sheets which were published previously have been reprinted during the year. These "provisional" quarter-inch 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 3 new sheets of this series have been published, 6 sheets have been engraved and 13 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. 12 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.

(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 not been published during the year; three provincial maps and the map of India and Adjacent Countries (on the scale of 1 inch = 32 miles) have been reprinted.

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

5 "Town-guide" maps, and 4 "Environ" maps on the scales 12 inches = 1 mile and 4 inches = 1 mile, respectively, have been published.

The "Town-guide" maps published during the year are those of Allahābād, Benares, Ferozepore, Lahore and Peshāwar.

A map of Mount Abu on scale 6 inches = 1 mile has been published and a city map reprinted during the year.

54. Map Record and Issue Office.—A larger number of requisitions and enquiries for maps have been received both from the public and from Government Officials than during the previous year, resulting in larger sales.

The value of map issues was Rs. 3,41,488 which may be compared with Rs. 2,11,014 in 1913-14. This increase is due to improved management, advertising, and increases in the price of the maps.

Demands for our new Catalogue of Maps have been so heavy that all copies printed in 1921 are exhausted, and a revised edition is under preparation.

A Class I Officer has been attached exclusively to this office since 3rd March 1922, and a great deal of sorting and re-arrangement has been effected. One notable economy has been the conversion of large numbers of obsolete maps into envelopes, office forms, &c., for the use of the department, instead of selling them off as waste paper.

A branch office for the convenience of the Calcutta public has been temporarily established at 5, Esplanade East, for the display and sale of departmental publications. The resulting increase in sales has so far been most satisfactory.

A system of enclosed steel shelves for storage of maps is urgently needed and a small beginning in this direction has been made.

An Office Manual of Instructions for the conduct of business in the Map Record and Issue Office was also published during the year.

Issues.—FROM THE MAP RECORD AND ISSUE OFFICE, 1921-22.

YEAR.		ON BOOK TRANSFER (TO GOVERNMENT OFFICIALS).		ON CASH PAYMENT (TO PRIVATE INDIVIDUALS AND MAP AGENTS).		FREE ISSUES.		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.
1921-22	Departmental Maps.	71,641	77,757	45,560	49,560	60,061	66,169	177,262	1,93,486
	Extra-departmental Publications.	•	•	59,190	12,515	7,751	2,734	1,218,132	1,48,002
	Total ...	1,222,832	2,10,510	104,750	62,075	67,812	68,903	1,395,394	3,41,486
1920-21	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	1,485,866	2,73,150
1913-14	Total ...	.....	94,539	.....	58,832	56,491	57,643	.....	2,11,014

NOTE :—The figures for 1913-14 were obtained by combining those for issues made by the Photo.-Litho. Office with those for the Map Record and Issue Office as in that year both offices issued maps.
• These figures include 26,850 diagrams, value Rs. 2152, issued by the Photo.-Litho. Office.

Table IV.—Publications received in Map Record & Issue Office, during the year 1921-22.

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

Class of Maps.	Scale.	NUMBER OF DIFFERENT MAPS OF EACH CLASS RECEIVED.		Number of sheets printed.	Value.
		New Publications.	Reprints and New Editions.		
DEPARTMENTAL.					
GENERAL MAPS.					<i>Rs.</i>
Maps of India	Various	1	1,000	500	
GEOGRAPHICAL MAPS.					
Map of India and Adjacent Countries	1"=32 miles	2	18,000	18,000	
Southern Asia Series	1:2,000,000	...	...	...
India and Adjacent Countries Series	1:1,000,000	3	7,200	10,800	
La Carte Internationale du Monde	1:1,000,000	2	600	600	
TOPOGRAPHICAL MAPS.					
Quarter-inch, Modern	1"=4 miles	12	21	22,535	32,489
Do. (Prely.)	1"=4 miles	1	2	1,250	1,875
Do. (Provl.)	1"=4 miles	40	15	13,000	16,450
Half-inch, Modern	1"=2 miles	87	21	53,870	98,805
Do. (Prely.)	1"=2 miles	...	...	...	...
One-inch, Modern	1"=1 mile	99	57	74,090	1,08,135
Do. (Prely.)	1"=1 mile	17	9	10,000	15,000
Do. (Provl.)	1"=1 mile	1	...	250	975
Old Style sheets	Various	...	79	16,250	27,204
SPECIAL MAPS.					
District Maps	1"=4 miles	...	...	...	...
Administration Report Maps	1"=8 miles	...	3	670	257
Provincial Maps	Various	...	3	1,685	2,133
Plans of Cities and Cantonments	Various	10	4	6,970	12,891
Index Maps	Various	...	75	107,625	12,433
Miscellaneous Maps	Various	56	11	31,479	17,933
Total	.....	328	316	366,474	3,75,880

EXTRA-DEPARTMENTAL.

Maps	Various	233	59	197,186	59,238
Plans and diagrams	Various	1,801	41	246,271	28,087
Illustrations	.....	185	1	57,989	10,593
Miscellaneous	.....	233	111	822,712	41,134
Total	.....	2,452	212	1,324,158	1,39,052
Grand Total	.....	2,780	528	1,690,632	5,14,932

B.—From the Trigonometrical Survey Office, Dehra Dūn.

Various	Various	12	18	1,335	9,625
---------	---------	----	----	-------	-------

C.—LETTERPRESS.

1. Survey of India General Report, 1920-21. Price Rs. 2 or 4s.
2. Catalogue of Maps published by the Survey of India, 1921. Price Re. 1 or 2s.
3. Hand-book of Topography, Chapter VI, 1922. Price Re. 1 or 2s.
4. Survey of India Copy Book of Lettering, 1921. Price Rs. 3-8 or 7s.
5. A Description of the Survey of India Small Scale Maps (Gratis).

55. 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 sheets sent in for publication during 1920-21, were published during the year under report. Seven sheets were reported in hand last year, two new sheets were taken up during the year. Of the nine sheets, contour patterns of four sheets and outline patterns of two sheets have been supplied to the Engraving Office. Outline patterns of the remaining three sheets are in hand. Stump-shaded original of one of the four completed sheets is in hand.

(b) *The Southern Asia Series, scale 1:2,000,000.*—Of the seven sheets reported in hand last year, complete contour pattern of one sheet, and complete outline and partly complete contour patterns of two sheets have been sent to the Engraving Office. Of the four remaining sheets, contour patterns of three sheets and outline pattern of one sheet are in hand. No new sheet was taken in hand during the year under report.

(c) *India and Adjacent Countries, scale 1:4,000,000.*—Corrections in Tibet area received from the Superintendent of the Trigonometrical Survey have been carried out and sent to the Engraving Office.

(d) *Miscellaneous.*—

(i) Shaded originals of two sections of the 32-mile map of India have been revised for reprint.

(ii) Various indexes for the Catalogue of Maps have been brought up-to-date.

(iii) The usual indexes for the General Report have been completed.

(2) *The “One-Millionth” Section.*—

(a) *Engraved editions.*—Of seven completed sheets of last year, five were sent in for publication, and stump-shaded originals of the remaining two sheets are in hand. There were four sheets in hand at the close of the last year and two new sheets have been taken up during the year under report. Of these six sheets, outline and contour patterns of one sheet have been sent to the Engraving Office and outline patterns of the remaining five sheets are in hand.

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

(c) *Reprints.*—Seven sheets have been brought up-to-date and sent to press. One is in hand.

(d) *Miscellaneous.*—The border specimen for 1/M sheets (Helio. edition) is being revised, engraved patterns of twelve standard indexes have been prepared and sent to the Engraving Office for correction of plates.

(3) *The Quarter-Inch Section.*—

- (a) Original compilation and drawing.—Thirteen $\frac{1}{4}$ -inch sheets (preliminary edition) were in hand last year and four new sheets (3 preliminary and 1 modern) have been taken up this year. Of these seventeen, two have been transferred to the Southern Circle for completion, four completed and sent to press, and the remaining eleven are in hand.
- (b) Reprints.—New contour originals of two sheets in hand last year have been completed and the sheets have been sent to press for reprint. Three $\frac{1}{4}$ -inch and one $\frac{1}{2}$ -inch sheets were brought up-to-date and sent to press for reprint. Guide showing corrections for the reprint of one engraved $\frac{1}{4}$ -inch sheet was prepared and sent to the Engraving Office for correcting the plates.
- (c) Miscellaneous.—
- (i) Stump-shaded originals of 24 $\frac{1}{4}$ -inch sheets were prepared (including 19 for No. 6 Drawing Office) and sent to press.
 - (ii) Grid indicator scales were drawn on the originals of fourteen sheets.
 - (iii) Originals for standardised foot-notes for transfrontier $\frac{1}{4}$ -inch and $\frac{1}{2}$ -inch sheets were drawn.
 - (iv) Black prints of plane-table sections of 30 sheets have been pasted together and sent to press for supply of blue prints to parties for fair-drawing.

(4) *The Reprint Section.*—

- (a) 43 old style ($15' \times 30'$) one-inch sheets (including 16 sheets in hand at the close of last year) were corrected and sent to press for reprint; of these, four fragmentary sheets were completed to edges from available material. Seventeen sheets remain in hand.
- (b) Seven one-inch sheets (including one in hand at the close of last year) were corrected to modern graticules, brought up-to-date and sent to press.
- (c) 44 (provisional) $\frac{1}{4}$ -inch sheets (including 12 in hand at the close of last year) were compiled from the Indian Atlas and other material and sent to press for publication. Of these, six fragmentary sheets were completed to edges from available material. Eleven sheets are still in hand.
- (d) Ten $\frac{1}{4}$ -inch sheets compiled from Indian Atlas material (including five in hand at the close of last year) were corrected against office copies and sent to press for reprint. Eleven sheets are still in hand.
- (e) Three Indian Atlas sheets and four miscellaneous maps have been corrected against office copies and sent to press for reprint.

Total number of sheets sent for reprint during the year under report is 111. Total number of sheets still in hand is 39.

(5) *The Mapping Section.*—

- (a) 124 modern topographical sheets were corrected and brought up-to-date against office copies and sent to press for reprint, seven sheets remain in hand.

- (b) Press order proof corrections have been inserted on the original fair sheets of 177 topographical sheets after publication. Corrections to ten more sheets are in hand.
- (c) The original of the 64-mile Railway map of India, map of India showing districts and provinces, and six other miscellaneous maps were brought up-to-date and sent for reprint.
- (d) 57 fair and print original sheets and contour patterns of various special maps were taken in hand during the year under report. 50 sheets have been completed and sent to press and seven are still in hand. These include maps prepared for census, railway, industrial, military and other departments. Trace originals of 43 maps have been prepared for military purposes.
- (e) Minor corrections to 2,122 stock copies of modern maps were carried out for the Map Record and Issue Office.

(6) *The Office Copy Section.*—

- (a) Additions and corrections received from various local authorities, have been entered on the existing "office copies" of 2,686 published sheets. 589 "office copies" of newly published or reprinted sheets have also been prepared during the year.
- (b) The miscellaneous work of this section includes supply of authenticated copies of revenue and historical maps, revenue data from field-books and other records to officials and private persons and checking of area statements on fair sheets against Auxiliary Tables and keeping a record of these areas.

(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 before publication of a large number of sheets drawn in other circles and drawing offices.

166 cases affecting 227 sheets have been examined during the year. Seven cases affecting thirteen sheets remain in hand.

In addition to the above current work, this section supplied scientific data to various officials, kept up corrections to Imperial Gazetteers, examined projections on copper plates of sheets in the Engraving Office, checked geographical names in various Survey of India publications, examined proofs of diagonal scales and of the Index to Chapter VI of the Topo. Hand-book, drafted corrections to various departmental hand-books and border specimens and carried out other miscellaneous work.

56. Engraving Office.—(1) *Engraving Section.*—The Engraving Office has been employed on the following during the year:—

- (a) *India and Adjacent Countries*, scale 1:1,000,000. Of eleven sheets in hand, six have been completed and sent for publication, one is under final examination and the remaining four sheets are all well in hand. No new sheets were projected.
- (b) *La Carte Internationale du Monde*, scale 1:1,000,000. Of seven sheets in hand, two have been published, three are well advanced, and the remaining two are in hand. Two new sheets were projected.

- (c) *Southern Asia Series*, scale 1:2,000,000. Of eight sheets in hand, two (Colombo and Madras) passed through final examination and were sent for publication, four sheets are nearing completion, and the remaining are in hand. No new sheets were 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 all the 1 inch = 32 miles index sheets have been made more prominent. A cover for the Copy Book of Lettering has been designed and engraved. Office copy corrections have been completed on twelve plates of the map of India and Adjacent Countries, scale 1 inch = 32 miles. Corrections and additions to 1/4 M India are in hand. A new large tint plate has been ruled for the Photo.-Litho. Office, size 40" x 27". A number of titles has been engraved on photogravure plates for the Photo. Society of India, and the Geological Survey. Twenty-one district maps and the 3" plan of Calcutta have been revised and brought up-to-date. A half-anna postage stamp was drawn for H. M. Mint for reproduction.

(2) *Copper Plate Printing Section*.—29,876 impressions were pulled during the year compared with 32,502 during the previous year. 37% were scales and charts, 32% photogravures, 31% India Atlas sheets and miscellaneous. About 46% of the entire output was for extra-departmental purposes. In the Electro-typing Section 76 plates were dealt with.

57. Photo.-Litho. Office.—The number of maps printed in the *Litho.* Branch is considerably larger, though the number of pulls is slightly less, than was the case last year, but the out-turn may be taken as normal under post-war conditions.

The out-turn of the *Type Section* has fallen very considerably as compared with last year. This fall is in the main due to the fact that a large proportion of the work done has consisted of hand-books, &c., entailing heavy work on compositors, with the result that the machines have often been idle.

The out-turn of the *Process Engraving Section* shows a small rise, the smaller number of half-tone impressions being more than made up for by the increased number of line-block impressions.

During the year one new proving press driven by an electric motor has been installed and is working well.

A new process for obtaining photographically the tints on double lined roads and in water formations has been worked out and perfected by Shaikh Ghulam Nabi, in charge Powder Process Section. This process is found particularly useful in the case of complicated sheets.

The following tables briefly summarise the work of the office during the last 3 years :—

TABLE A.
WHOLE PHOTO.-LITHO. OFFICE.

1	2	3	4			5			6		
			Year.	* Cost of office.	Value of out-turn at cost-rates.	NUMBER OF SHEETS PRINTED.					
						Departmental.	Other than Departmental.	Total.			
	<i>Rs.</i>	<i>Rs.</i>									
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
1921-22	3,05,038	5,37,535	666		2,993						3,659

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

TABLE B.—LITHO. BRANCH.

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.
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	
1921-22	3,543,470	90,633	745,670	2,854	933,391					1,766,319	

TABLE C.—PHOTO. BRANCH.

	1919-20.	1920-21.	1921-22.
Negatives ...	6,658	5,786	5,894
Zinc plates ...	9,161	7,591	7,395
Photogravure plates ...	544	490	475
Half-tone blocks ...			
Line blocks ...			

58. **Mathematical Instrument Office.**—During the year (from 1st April 1921 to 31st March 1922) there was an increase in the demands made on this office for instruments, &c., (*vide* item 1 in para. 2 below), and the Store Section of the Office made a profit of Rs. 47,044 against a profit of Rs. 35,681 in 1920-21. There was however a decrease in the value of work done (*vide* item 6 in para. 2 below) and a loss of Rs. 38,910 occurred in the Workshop Section of the Office against a profit of Rs. 26,793 in 1920-21, but taking the two sections together there was a net profit of Rs. 8,134. Mr. Ferrier, the permanent Officer in charge, was on leave up to 6th September 1921 and Mr. S. Woodhouse acted for him up to that date, and Mr. P. A. Hughes acted for the latter as Officiating Works Manager. The loss in the Workshop Section was chiefly due to the following reasons :—

- (a) Formation of an Optical Section under an Assistant Optical Manager, (Mr. R. C. Malcolm), on Rs. 800 per mensem who joined the Mathematical Instrument Office early in April 1921.

(b) Retention of the services of Mr. F. C. Lee (pay Rs. 500 per mensem) for a period of 8½ months after the arrival of Mr. Malcolm pending the termination of his agreement. Mr. Lee was employed on miscellaneous work during this period.

(c) Decrease in the demands on the Workshop by public offices for repair and manufacture work.

As regards (a)—The Optical Section is doing a great deal of very useful work for the military department such as repairing range-finders, binoculars, telescopes, compasses, sight dials, &c., in addition to the usual optical work for civil departments. In connection with the above this section is training a number of young Indians in optical work. This year (1922-23) the out-turn under these heads is much better and no further loss on account of this section is anticipated. When this section is well established, it should prove very profitable.

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

	1919-20.	1920-21.	1921-22.
	Rs.	Rs.	Rs.
1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.	5,54,959	4,74,911	5,32,768
2. Value of repairs to instruments received for repairs and returned in serviceable condition.	48,002	96,089	1,18,445
3. Value of instruments received from Government Officers when no longer required.	51,503	70,484	58,743
4. Book value of the stock of instruments, &c., in Serviceable Stores.	4,06,059	5,06,988	6,91,499
5. Book value of the stock of instruments, &c., in Repairable Stores.	79,057	1,07,873	1,25,646
6. Total value of work done in the Workshop	3,67,343	4,81,809	4,20,408
7. Value of instruments manufactured in the Workshop for Serviceable Stores.	1,95,907	1,82,644	1,76,123
8. Value of instruments purchased locally	70,276	41,063	11,296
9. Value of instruments and materials obtained from England through the Director General of Stores.	1,57,694	2,98,795	4,58,016
10. Average No. of employees and their pay	No. 599 Rs. 1,28,770	No. 618 Rs. 1,77,655	No. 628 Rs. 1,93,658

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

II.—DEHRA DŪN OFFICES.

TRIGONOMETRICAL SURVEY OFFICE.

59. Computing Office.—Professional Paper No. 18, "A criticism of Mr. R. D. Oldham's Memoir, *The Structure of the Himalayas and of the Gangetic Plain*, as elucidated by Geodetic Observations in India," by Lieut.-Colonel H. McC. Cowie, R.E., was published during the year. It is pointed out in this paper that, owing to the assumptions and limitations introduced by Mr. Oldham in his calculations, the conclusions drawn by him do not serve to simplify the problem of the Indo-Gangetic trough.

A large amount of computation and compilation was done in complying with both departmental and non-departmental requisitions. Special mention may be made of the geodetic report compiled for submission to the first General Conference held at Rome in April 1922.

Data were compiled for the prediction of tides for 40 ports for 1923 by means of the tide-predicting machine.

In addition, the tide-tables for 9 riverain ports for 1923 were completed from the diurnal charts.

The triangulation executed by Bt.-Major E. O. Wheeler, M.C., R.E., during the Mount Everest Expedition was computed, and the triangulation connecting the Madras Longitudinal Series with the Cuddapah triangulation was adjusted.

The preparation of a revised and extended 5th edition of the Auxiliary Tables of the Survey of India is in progress. Part III of this edition has been completed, and a small stock printed.

The revision of Chapter III (1914) of the Handbook of Topography is almost complete, but the publication is likely to be delayed owing to pressure of work in the printing office.

279 requisitions for data from departmental and non-departmental officials were complied with.

Triangulation pamphlets covering 60 degree sheets were printed and 50 issued in the course of the year.

Levelling pamphlet No. 62 was printed and issued, and levelling pamphlet No. 63 and the Mesopotamia levelling pamphlet are under reprint.

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

1. Records of the Survey of India, Volume XV, 1919-20.
2. Memoir on the Maps of Chinese Turkistān and Kansu (Sir A. Stein, K.C.I.E.).
3. Explorations in the Eastern Karakoram and the Upper Yārkand Valley (Lieut.-Colonel H. Wood, R.E.).
4. Tide Tables for Indian Ports, 1923.
5. 60 Triangulation Pamphlets.
6. Levelling Pamphlet No. 62 and addenda or slips to Pamphlets Nos. 34, 35, 39, 40, 45, 47, 53, 54, and 72.
7. Auxiliary Tables, Part III.
8. Appendix to Levelling of Precision.
9. The Auto-stereo plotter, a translation from the French of Paul Corbin. (Lieut.-Colonel H. McC. Cowie, R.E.).
10. Note on the stage reached by the Geodetic Operations of the Survey of India in 1920 (Lieut.-Colonel H. McC. Cowie, R.E.).

11. The following also are in hand:—

- (i) Records of the Survey of India, Volume XVI, 1920-21.
- (ii) Handbook of Topography, Chapter II, (Revised).
- (iii) Author's Catalogue of Books of Trigonometrical Survey Office Library.

Observatories.—Meteorological observations were continued as usual, and the Omori Seismograph was in operation throughout the year.

Photographs of the sun were taken on 275 days, the sun being obscured on the remaining days of the year.

Preservation of Trigonometrical Stations.—745 stations were repaired by district officers at a cost of Rs. 4,943. Out of 361 districts from which reports were due, 22 failed to make returns.

60. No. 2 (Dehra) Drawing Office.—During the year under report the work of this office was carried on principally by six sections but a seventh section was formed towards the end of the year.

(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, 36 maps, charts and diagrams were dealt with and sent to press and 149 sheets hand-coloured.

(2) *The Compilation Section.*—Deals with the compilation and fair-mapping of geographical maps on different scales. Two fair sheets on 1/M scale shown as in hand last year were completed and sent to press. Six sheets of rough compilation on 1/M scale were in hand at the end of last year, two more sheets were received during the year; of these two have been compiled and are being fair-mapped, two sheets have been sent to Calcutta to be engraved and four are in hand. Of the rough compilation of sheets on the 1/2 M scale, four were in hand at the end of last year; two have now been completed and sent to Calcutta to be engraved and two remain in hand. Four sheets of stump-shading were in hand at the end of last year, and five more were taken up during the year; out of these seven have been completed and two remain in hand. The fair-mapping of four of the seven half-inch sheets, which were in hand at the end of last year has been completed and they have been sent to press and three remain in hand.

(3) *The Stein Section.*—Deals with the fair-mapping of Sir Aurel Stein's explorations in Chinese Turkistān and Kansu in 1900-01, 1906-08 and 1913-15. Forty-three sheets of this series had already been published at the end of last year, three sheets have been published this year, and two are in different stages of publication. The fair-mapping of one sheet shown as in hand last year is still in progress. Eleven special triangulation charts and one levelling chart of this area were received during this year for fair-drawing and are in hand.

(4) *The Half-inch Section.*—Deals with the fair-mapping of half-inch sheets. Sixteen sheets were sent to press during the year and thirteen sheets are in hand, these with the seven sheets mentioned in the report of the Compilation Section make up the total of 36 sheets reported as in hand in last year's report.

(5) *The Examining Section.*—Examines the majority of the important sheets drawn in this office. 135 sheets have been examined during the year and 34 sheets are in hand.

(6) *The Cantonment Mapping Section.*—The section has been lately formed to help No. 20 Party (Cantonment) to clear off the arrears of cantonment mapping. 17 sheets have been received and are in hand.

(7) *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 maps published by the Department for occasional issue to the public and for departmental use. It also deals with the despatch of sheets issued from Dehra Dūn and with all correspondence on the subject.

The following is the summary of the work of the office during the year 1921-22 :—

Class of maps.	Balance of sheets on 1st October 1921.	Sheets received in 1921-22.	Sheets sent to press in 1921-22.	Balance of sheets in hand on 1st October 1922.	REMARKS.
Triangulation charts ...	18	75	76	17	
Levelling charts, scale 1/M	1	2	2	1	
Index charts to illustrate reports.	1	4	4	1	
Cantonment plans for publication.	93	84	143 (a)	34	(a) Completed and sent to press.
Cantonment plans for correction.	4	51	44 (b)	11	(b) Corrections carried out in both originals and office copies.
Cantonment maps fair-drawing.	...	17	...	17	
Miscellaneous maps, charts and diagrams.	1	62	42	21	
Colour guides of cantonment and other maps.	70	234	149	155	
Half-inch sheets ...	36	...	20	16	
GEOGRAPHICAL MAPS.					
Fair sheets, scale 1/M ...	2	2	2	2	
Rough compilation, scale 1/M	6	2	4 (c)	4	(c) Two sheets have been compiled and are being fair-mapped, and two sheets have been sent to Calcutta for engraved edition.
Rough compilation, scale 1/2M	4	...	2 (d)	2	(d) Sent to Calcutta for engraved edition.
Stump-shading, various scales	4	5	7	2	
Sir Aurel Stein's explorations in Chinese Turkestan and Kansu in 1900-01, 1906-08 and 1913-15. for publication on 2/M scale.	1	...	...	1	Out of the 5 sheets sent to press last year, three have been published and two are under publication.

Photo-Zinco. Section.—During the year 1921-22, the work undertaken comprised :—

- Cantonment maps.
- Indexes and Triangulation charts.
- Forest maps.
- Maps, illustrative of Sir Aurel Stein's explorations.
- Miscellaneous maps.
- Extra-departmental maps.

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.
1919-20 ...	1,414	2,087	316,114	562
1920-21 ...	1,430	1,911	436,996	447
1921-22 ...	1,480	2,028	305,415	...

61. 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 1921.	Received during the year.	Drawn and sent for publication during the year.	In hand on 30th September 1922.	Published during the year.	Total number of copies printed.
(a) ...	*3	80	81	2	54	} 23,551
(b) ...	94	83	73	54	83	
(c) ...	13	5	7	11	2	
(d) ...	4	8	12	...	16	
(e) ...	...	4	4	...	4
(f) ...	19	45	32	32	36	
(g) ...	*5	1	5	...	4	
Total 1921-22. }	*136	176	214	99	199	
Total 1920-21. }	...	248	258	...	278	30,588

* The preparation of one of these maps was cancelled.

(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 Administrative 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 215 maps and colour specimens of 74 maps were prepared; corrections on 149 sheets were completed, 84 office copies were coloured up and 1,758 sheets were coloured by hand for issue on indent. In addition this section corrected the forest information on 152 maps for the various Survey of India Drawing Offices which required them for compiling the half-inch and degree sheets.

(3) *The Map Record Section.*—The number of maps, diagrams and original fair sheets received for storage was 13,466; 4,401 maps, &c., valued at Rs. 8,623 were issued. Sales by book-transfer to government departments amounted to Rs. 5,705 for 2,814 maps; these figures show an increase of 832 maps and Rs. 2,005 above those for last year. Cash sales to the public amounted to Rs. 2,339 for 752 maps, an increase of Rs. 577 above the amount realized the previous year, attributable to the increase in the price of maps and not to a larger number sold.

(4) *The Book-Binding Section.*—This section dealt with 624 volumes for the Forest Research Institute, the value realized by book-transfer being Rs. 1,681, an increase of 137 volumes and Rs. 432, over the figures for last year. In addition, 2,423 maps of various sizes were mounted on cloth for issue.

62. The re-indexing of all the forest triangulation and traverse data lodged in this office, was taken up during the year for the purpose of preparing a comprehensive list of these records, and supplying printed copies to the Superintendents of the Survey Circles, in order that they may always have at hand, the fullest information as to the data available for their forest survey operations. More than half of this work has already been done, and it is hoped to issue the list in a few months' time.

III.—CIRCLE AND LOCAL DRAWING OFFICES.

63. No. 3 Drawing Office (Northern Circle).—During the year 11 two-inch sheets out of 31, 38 one-inch sheets out of 75 and 1 half-inch sheet out of 8 previously surveyed, were fair-mapped by parties and submitted for publication.

Half-inch sheets compiled from one-inch sheets.—16 half-inch sheets, 14 of which were drawn in the Circle Drawing Office, have been submitted for publication during the year.

Modern material available.—The fair-mapping of 6 half-inch sheets, of which the component two-inch and one-inch sheets have been published or sent for publication, is in hand. In addition to the above, there are 19 half-inch sheet areas of which some of the component two-inch or one-inch sheets, though surveyed, have not been submitted for publication.

Quarter-inch sheets compiled from modern one-inch and half-inch sheets.—During the year 8 quarter-inch sheets were fair-mapped in the Circle Drawing Office and submitted for publication.

Modern material available.—There are 20 quarter-inch sheet areas of which the component one-inch or half-inch sheets have been published; of these the fair-mapping of 11 sheets is in hand. There are besides the above, 13 quarter-inch sheet areas of which the component two-inch, one-inch and half-inch sheets though surveyed have not been published.

Special maps.—The colour patterns of Benares and Environs, Delhi and Vicinity in four sheets, Guide map of Mount Abu, Guide map of Mussoorie, scale four inches = 1 mile and Mussoorie City Map, scale twenty-four inches = 1 mile, were prepared and submitted for publication.

Hill-shaded sheets.—27 one-inch, half-inch and quarter-inch sheets were stump-shaded and submitted for publication.

Layer guides.—Nil.

Colour patterns and press order proofs.—The press order proofs of 68 one-inch, half-inch and quarter-inch sheets were prepared and submitted for publication. In addition to these the yellow and green colour patterns of 11 one-inch sheets were specially prepared during the year for future reprint purposes.

Miscellaneous.—The traverse plots of 17 "mauzās" in 41 sheets, scales sixteen and thirty-two inches = 1 mile, of the Gondā district, were supplied to and the cost of preparation recovered from the Deputy Commissioner, Gondā district.

64. No. 4 Drawing Office (Southern Circle).—During the year, 48 one-inch sheets previously surveyed and mapped and 7 one-inch sheets surveyed and mapped during the year by parties and received before the 30th September 1922 were finally examined and submitted for publication. There are no arrears.

Half-inch sheets compiled from modern one-inch sheets.—8 sheets were mapped and submitted for publication. There are 13 sheets in hand of which 1 will very shortly be submitted for publication.

Modern material available.—The material for 9 sheets of which the component one-inch sheets have not yet all been published has been received but the mapping has not yet been commenced. There are 10 half-inch sheet areas completely surveyed on the one-inch scale but of which all the component one-inch sheets have not yet been submitted for publication.

Quarter-inch sheets compiled from modern one-inch and half-inch and old style sheets.—7 sheets were mapped and submitted for publication. There are 14 sheets in hand of which 2 will very shortly be submitted for publication.

Modern material available.—The material for 1 sheet has been received the mapping of which has not yet been commenced. There is 1 sheet of which the component half-inch sheets are under publication and for which the material has been asked for and in addition there are 9 sheets of which the areas have been completely surveyed but of which the component half-inch sheets have not yet been submitted for publication.

Reprint sheets.—1 quarter-inch sheet was corrected and submitted for publication and 1 quarter-inch sheet is in hand.

Colour patterns.—Were prepared and submitted to the Superintendent, Map Publication, for 107 sheets.

Hill-shaded sheets.—Were prepared and submitted to the Superintendent, Map Publication, for 31 sheets.

Layer guides.—Were prepared and submitted to the Superintendent, Map Publication, for 5 sheets.

<i>Photo.-Zinco. work.</i> —Number of reproductions ...	212
" " enlargements ...	195
" " reductions ...	221
" " Vandyke plates prepared ...	183
" " prints pulled ...	7,057

Special maps.—The three-inch military map of Secunderābād and Bolārūm mapped by No. 6 Party was finally examined and submitted for publication. The one-inch military map of Shirāz (Persia) the mapping of which was commenced in No. 6 Party was completed, finally examined and submitted for publication. The mapping of a four-inch military map of Būshire (Persia) which was commenced in No. 6 Party has been completed and the map will very shortly be submitted for publication. 15 two-inch sheets of the special forest survey of Hyderābād (Deccan) which were mapped by No. 6 Party were finally examined and submitted for publication.

Miscellaneous.—Preparation of index maps.

The usual training in drawing and typing was given to pupil surveyors and pupil draftsmen.

65. No. 5 Drawing Office (Eastern Circle).—The following are the numbers of sheets received from field parties during the year:—

Scale 12 inches to 1 mile	...	3
" 4 " "	...	4
" 2 " "	...	8
" 1 inch "	...	22
" ½ " "	...	16
Total	...	53

Two of the half-inch sheets have been retained in the office, as there is a possibility of further survey being obtained in them next year, and the other 51 sheets have been submitted for publication.

Half-inch sheets compiled from modern one-inch and old style sheets.—24 of these sheets have been in hand, including 4 which were drawn at Maymyo; 19 have been submitted for publication and 5 remain in hand.

Modern material available for half-inch mapping.—There are 18 modern half-inch sheets ready for drawing of which the component one-inch sheets have been published but the drawing of which has not yet been begun.

Quarter-inch sheets compiled from modern one-inch, half-inch and old style sheets.—Four sheets have been completed and submitted for publication.

Modern material available for quarter-inch mapping.—There are 5 quarter-inch sheets whose half-inch component sheets have been published, the drawing of which has not yet been put in hand.

Hill-shaded sheets.—62 sheets have been prepared and submitted. There are no arrears.

Layer guides.—One has been prepared and submitted. There are no arrears.

Colour patterns and press order proofs.—These have been submitted for 87 sheets and, in addition, the colour guides for 5 sheets have been prepared for reprint purposes.

66. No. 6 (Simla) Drawing Office.—The *Survey Section* has been employed on the compilation and fair-drawing of transfrontier maps on the one-millionth, half-inch and quarter-inch scales and incorporating additional information on sheets previously published.

During the year 30 quarter-inch sheets and 5 half-inch sheets were fair-drawn and submitted for publication and 3 quarter-inch sheets and 5 half-inch sheets were corrected and brought up to date and sent to press for reprint.

The *Army Section* is employed on the preparation and printing of maps and plans for the use of the Army and other Government Departments.

During the year 282 maps and plans were dealt with and 42,104 copies printed on the litho-printing presses.

67. Bengal and Bihār 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.

16 new sheets of Bengal and 14 new sheets of Bihār and Orissa have been fair-mapped and submitted for publication during the year. One degree sheet (preliminary edition) was also submitted for publication.

PART 4.—WORK FOR OTHER GOVERNMENT DEPARTMENTS.

68. Northern Circle. No. 2 Party.—A surveyor was deputed in November 1921 to carry out a survey on the eight-inch scale of the Headworks of the Western Jumna Canal for the Superintending Engineer of the Irrigation Circle. The survey of the area, which comprised 8.93 square miles, was completed in February 1922 at a cost-rate of Rs. 121.3 per square mile.

At the request of the City Board, Mussoorie, a surveyor was deputed during recess to carry out the survey of 40 acres on the scale 1 inch = 40 feet in the vicinity of Bhatta village. Work was commenced on 1st July 1922 and completed by the 25th September 1922 at a cost-rate of Rs. 16.7 per acre.

A section of this party completed the traverse of Allahābād City and Municipal areas for detail survey on the sixty-four-inch and sixteen-inch scales commenced in 1920-21 for the Allahābād Improvement Trust. 35.35 linear miles in an area of 1,324.8 acres, and 78.34 linear miles in an area of 31.91 square miles were traversed at cost-rates respectively of Rs. 79.7 and 18.0 per linear mile, while the number of plot charts for the sixty-four-inch and sixteen-inch areas prepared was 30 and 44 respectively. On completion of the above, the section was transferred to Imperial Delhi where they traversed the boundaries of demarcated areas of leased lands. 57.44 linear miles were traversed at a cost-rate of Rs. 58.8 per linear mile, and a schedule of the boundaries has been prepared for permanent record in book form for the Chief Engineer, Public Works Department, Delhi.

69. No. 4 Party.—At the request of the United Provinces Government and with the concurrence of the Benares State Durbar, an officer was deputed to examine and report on the disputed boundary between Benares State and United Provinces lying along the Ganges river. The dispute, which dates back to 1848, is due to the lateral movements of the river and reaches an acute stage whenever sufficient silt from the previous floods has been deposited on the sand banks to make them cultivable. The report, together with the original survey on the eight-inch scale and a spare trace of the disputed area, was submitted in due course through the proper channel. The expenditure in connection with the deputation was shared equally by the Benares State and United Provinces Government.

70. No. 20 Party (Cantonment).—The party completed the survey of the bāzār area in Bangalore, on the scale of 1 inch to fifty feet. This area comprised 35 sheets, the cost of survey and mapping of which, will be borne by the Bangalore Municipality. Regarding their preparation, mention might be made here of an unusual method adopted for classifying buildings. A distinctive style of hachuring is being used to illustrate the several kinds of roofing material; this has involved much laborious pen-work and for such cases in future a system of reference numbers, or letters, or grades of stippling by mechanical means, might be tried.

The cost-rates of this work are given on page 21.

71. No. 22 (Riverain) Party.—The party continued the work of traversing and laying down base lines. 2,269 linear and 413 square miles of minor traverse in the Indus, Chenāb and Panjnad riverain tracts

in the Muzaffargarh district were executed, 10,284 theodolite stations in 84 villages were fixed. 213 corners of 71 squares in 246 square miles were demarcated with permanent mark-stones on both banks of the Panjnad river in the Muzaffargarh district and Bahāwalpur State, to serve as bases for future survey and demarcation of boundaries and fields in the bed of the river. 27 missing stones of 9 old base lines along the Indus river in the Muzaffargarh district were relaid at the request of the Settlement Officer, Muzaffargarh. 1,154 plotted and 453 boundary *masāvis* (settlement mapping sheets) on the scale of 1/2,640, and 28 four-inch sheets were traced and supplied in time to the Settlement Officer, Muzaffargarh. Besides these, 564 boundary *masāvis* were partly compiled on the scale of one inch = 220 feet for the next season's work, and 257 miscellaneous traces were prepared, all the traverse stations marked during the field season were plotted on 28 four-inch sheets.

Lahore "Nazul" Land Survey.—The survey on the scale of 1 inch = 40 feet, undertaken towards the end of recess 1921 at the request of the Deputy Commissioner, Lahore in connection with the Lahore city extension scheme, was continued till the 10th November 1921; 33·5 acres were surveyed till the end of September 1921 and 16·0 acres were surveyed subsequently, making the final total area of 49·5 acres.

Khair Special Survey.—This was undertaken, in continuation of the last year's work, for the Attock Oil Company at their request through the Deputy Commissioner, Attock district. The work consisted in surveying, on the eight-inch scale, with contours at 10 feet interval, the adjoining productive area to the south of the eastern extension, and re-demarcating the boundaries of the eastern and southern extensions dealt with last year. The topography was based on supplementary traversing. In all, 125 theodolite stations were laid out in 19·07 linear miles and 6 intersected points with heights were fixed for detail survey and boundary demarcation. The work was commenced in April and finished in July 1922. An area of 0·15 square mile was surveyed and 6·75 linear miles of boundary was re-demarcated. The last year's survey of the central portion, area 4 square miles, was corrected at the request of the Company to show new works that had been completed subsequently. Four miscellaneous traces were prepared, all the traverse stations marked, and intersected points were plotted on the 8-inch sheets of the last year.

72. No. 23 (Punjab Rectangulation) (old Sind-Sāgar Party).—During the year under report the party was employed on rectangulation, in connection with the Punjab Government Sutlej Valley Canal and Colonization Project, in the Multān and Montgomery districts and Bahāwalpur State.

It having been decided that, to enable the whole area to be sub-demarcated in 3 field seasons, the Survey Department should only demarcate to 100-acre rectangles, only the area in which the exterior sides of 2,400-acre rectangles had been demarcated to 25-acre rectangles in the previous season was demarcated to 25-acre rectangles this season.

A total area of 1,588·2 square miles was rectangulated, 4,020 rectangles of 25-acre and 9,159 rectangles of 100-acre were laid out, and their corners marked with stones. An area of 1,992·1 square miles or 1,643·2 linear miles was traversed in advance for the purpose of laying down corners of 2,400-acre rectangles, and 646 such corners were located.

The country under rectangulation lies along the Sutlej river from Ferozepore on the north-east to the boundary of Sind on the

south-west. It is bounded on the north-west by the old bed of the Beas and the Chenab and Indus rivers, and on the south-east by the boundary of the Bikaner State and the old bed of the Ghaggar. A strip of country on both banks of the Sutlej river is well cultivated. The country to the north is a flat plain, covered with scrub jungle, very thick in many parts, and reserved as Government "Rakhs". The country to the south consists of a sand desert, studded with hillocks, which in some parts rise over 50 feet. Both these tracts are practically waterless.

In recess the party was employed on completion of the records of the rectangular survey, traverse computations and preparation of triangulation charts.

73. The Bhopal Traverse Detachment.—Was formed on the 18th October 1921 with a view to traversing village boundaries for the cadastral survey of the Bhopal State, on the scale 16 inches to a mile. The nature of ground under survey was undulating, and interspersed with rocky knolls. The country was partly covered with dense jungle and in other parts well cultivated.

Only 5 trained men were transferred from the Survey of India Department and all the other hands were entertained and trained. The work was entirely based on G. T. values. In all, 936 linear miles of main and sub-circuit traverses were executed, and 3,987 theodolite stations laid out, in an area of 327 square miles, along the boundaries and interior of 165 villages of the Durahā *tahsil* of the northern district; and 235 dressed stones were embedded on theodolite stations to serve as permanent marks for the future survey and demarcation. 355 sheets were plotted on the scale 16 inches to a mile, 24 four-inch sheets were traced, and the areas of 169 polygons were computed by universal theorem and planimeter, and supplied to the State Officials during the year. Besides this, several miscellaneous traces were prepared; and all the work done during the year was plotted on the scale 4 inches to a mile.

74. Southern Circle.—At the request of the Madras Government the settlement of the Mysore-South Kanara boundary was continued from the previous season.

Representatives of the Madras Government and of the Mysore Durbar, accompanied by Mr. J. O'B. Donaghey met at Gundia on the 5th January 1922.

Owing to illness Mr. Donaghey was replaced by Mr. V. W. Morton, who took over the work on the 13th February 1922.

About 61 miles of the boundary were finally settled during this season and a record prepared on prints of the Madras Forest four-inch survey sheets. The total length of the boundary finally settled up to date is now 85 miles.

The work has been temporarily stopped during season 1922-23, for financial reasons, but will probably be resumed during season 1923-24.

75. Lectures delivered by Lieut.-Colonel C. P. Gunter, O.B.E., R.E., during the year under report were as follows:—

Lecture on "Maps" and "Surveys" to the Intelligence Class at Poona on the 22nd April 1922.

Lecture on "Maps" and "Surveys in War" to an Intelligence Class at Bangalore on the 7th June 1922.

A course of instruction in Survey for Artillery Officers was held in Bangalore from the 11th to the 16th September 1922. Six officers of the Royal Field Artillery attended.

76. 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, 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.

An Upper Subordinate officer, Mr. Bansi Ram, was placed on deputation under the Government of Burma in connection with the survey of the boundary between the Lushai Hills and Burma from the 1st January to 6th April 1922.

77. Trigonometrical Survey.—At the request of the Chief Engineer, Oudh and Rohilkhand Railway, a large scale survey of the Lucknow Station Yard and of the Railway property adjoining the Lucknow Cantonment was carried out during the year.

At the request of the Bombay Government, a detachment of No. 17 Party executed, in the Sukkur Barrage area, a network of levels involving 889 miles of levelling, the cost being borne by the local Government concerned, (*vide* pages 23 and 24). Work was also undertaken by the same party in the Nira right bank canals area, the cost being defrayed by the Bombay Government, (*vide* page 24).

In Bengal, certain lines of levels were run for the Nadiā rivers scheme and for the Irrigation department, (*vide* page 23).

Some minor triangulation was carried out by a small detachment of No. 15 Party in the Akora Practice Camp area at the request of the military authorities.

78. At the request of the Punjab Government, about 49,000 miles of close levelling has been undertaken in the Sutlej Valley Irrigation area. It is hoped that this, which is additional to the ordinary programme, will be completed in two seasons.

79. 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 36, in the "Issues" table and in Table IV of the Map Record and Issue Office report on pages 30 and 31.

In addition to the special maps for other departments which are mentioned in para. 53 (*g*) on page 29, these extra-departmental publications include 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 32 to 35.

80. Mathematical Instrument Office.—The manufacture and repair of range-finders, binoculars, telescopes, sight dials, directors, prismatic compasses, scales, protractors, &c., for the military departments continued during the year under report. General repair and manufacture for civil departments is well up to date.

81. No. 6 (Simla) Drawing Office.—In addition to its normal work for the Army, this office has prepared maps and plans for the Commerce, Foreign and Political, Legislative, Meteorological and Public Works Departments and the Hydro-Electric Survey of India.

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

To illustrate the Report for the year 1921-22.

Key to Half Inch Sheets.

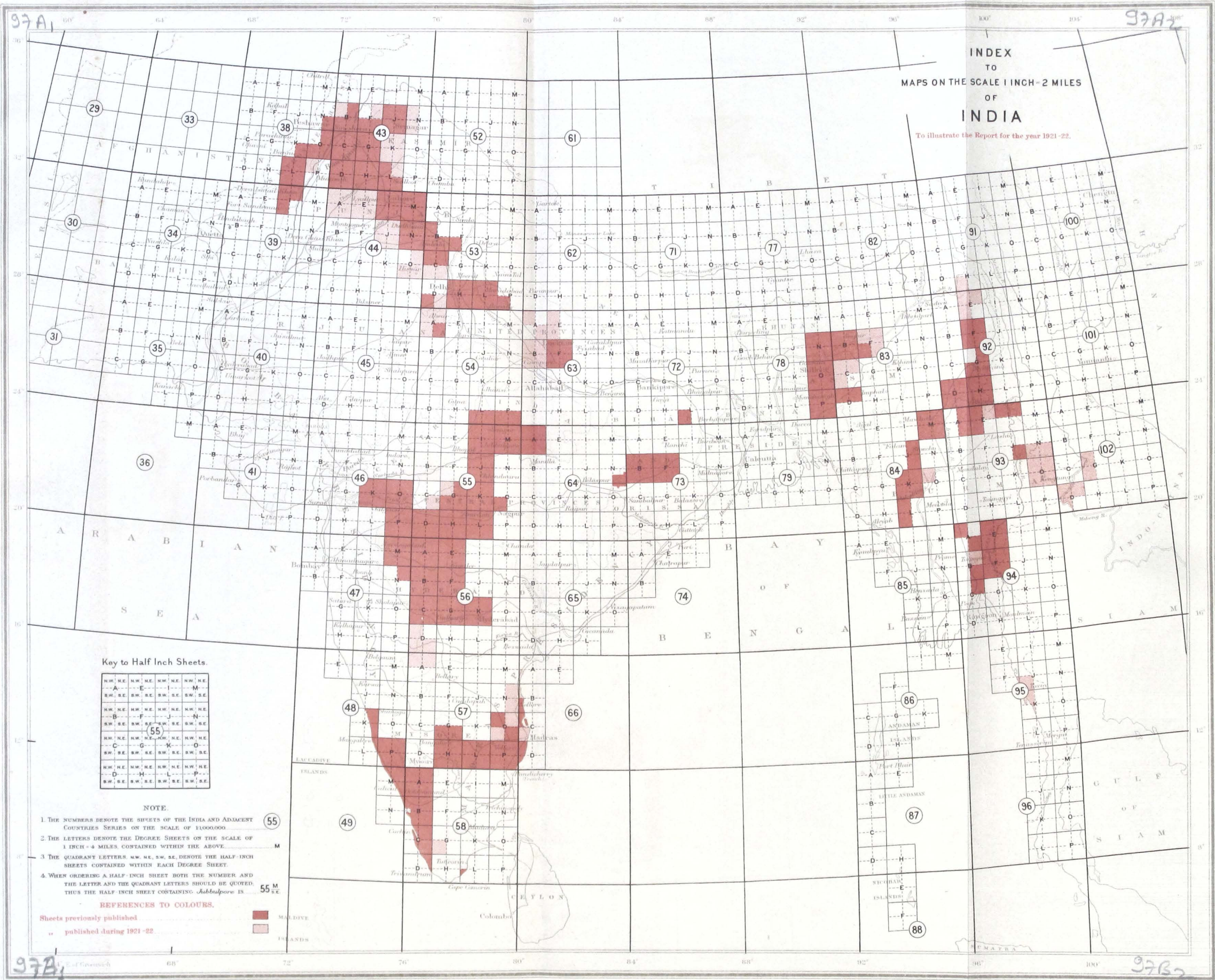
N.W.	N.E.	N.W.	N.E.	N.W.	N.E.
A	E	I	M	A	E
S.W.	S.E.	S.W.	S.E.	S.W.	S.E.
N.W.	N.E.	N.W.	N.E.	N.W.	N.E.
B	F	J	N	B	F
S.W.	S.E.	S.W.	S.E.	S.W.	S.E.
N.W.	N.E.	N.W.	N.E.	N.W.	N.E.
C	G	K	O	C	G
S.W.	S.E.	S.W.	S.E.	S.W.	S.E.
N.W.	N.E.	N.W.	N.E.	N.W.	N.E.
D	H	L	P	D	H
S.W.	S.E.	S.W.	S.E.	S.W.	S.E.

NOTE.

1. THE NUMBERS DENOTE THE SHEETS OF THE INDIA AND ADJACENT COUNTRIES SERIES 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. 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 *Subulpoore* IS 55 M S.E.

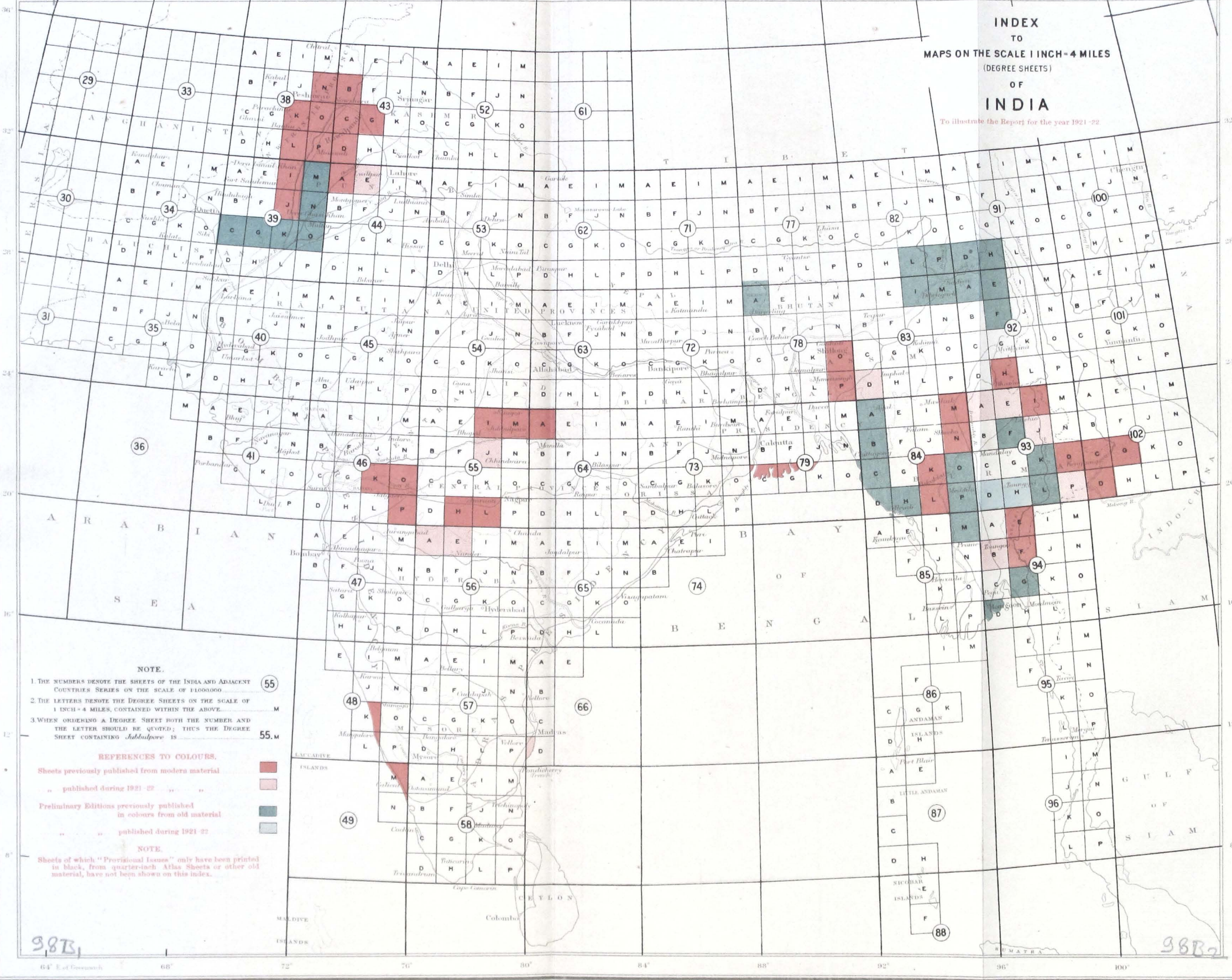
REFERENCES TO COLOURS.

- Sheets previously published ■ MALDIVE ISLANDS
- " published during 1921-22 ■ INDIA



INDEX TO MAPS ON THE SCALE 1 INCH=4 MILES (DEGREE SHEETS) OF INDIA

To illustrate the Report for the year 1921-22



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; THUS THE DEGREE SHEET CONTAINING Jabalpur is

55 M 55.M

REFERENCES TO COLOURS.

- Sheets previously published from modern material
- published during 1921-22
- Preliminary Editions previously published in colours from old material
- published during 1921-22

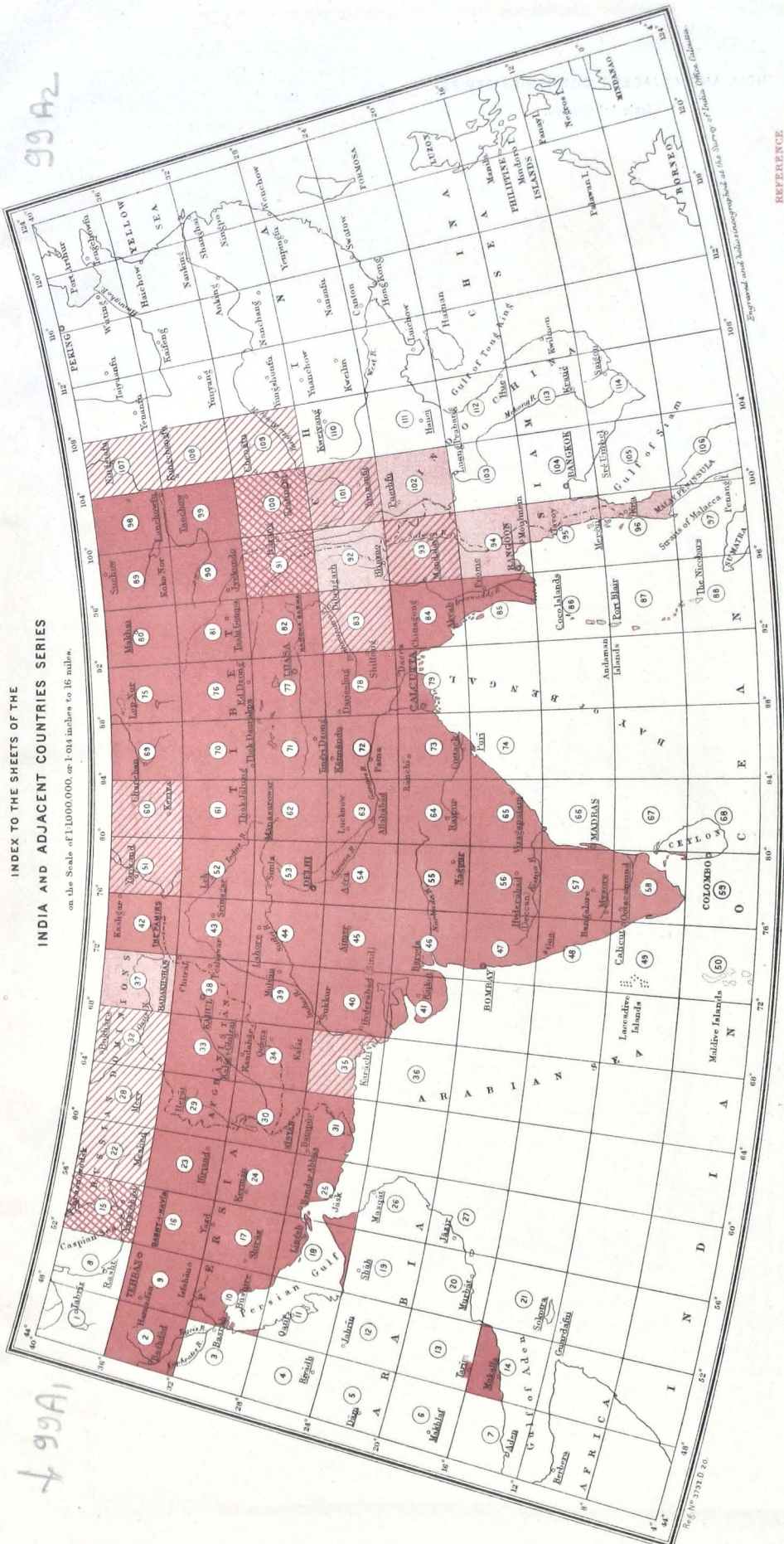


NOTE.

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.

99A2

INDEX TO THE SHEETS OF THE
INDIA AND ADJACENT COUNTRIES SERIES
 on the Scale of 1:1,000,000, or 1:944 inches to 16 miles.



99A1

REFERENCE

To illustrate the Report for the year 1921-22

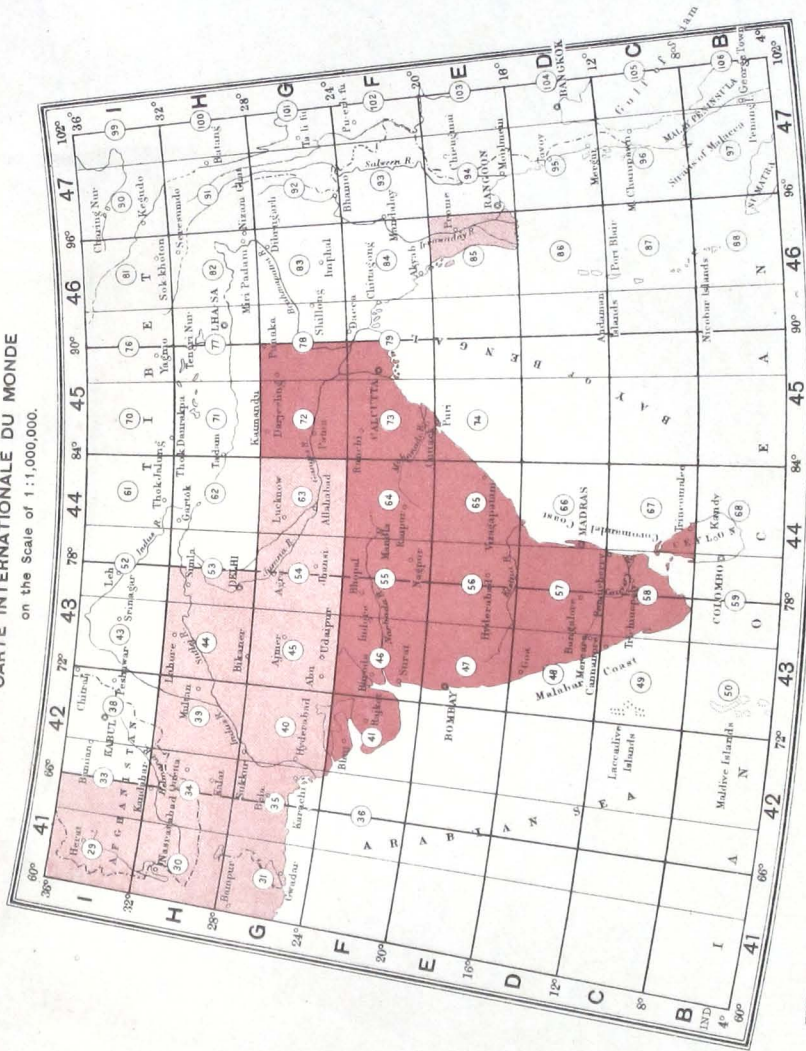
Sheets published without contours & layers
 with contours & layers
 under publication
 in hand



NOTE.

The names underlined on this Index are the title names of the sheets and their numbers are shown in circles. Sheets 55 and 56, 57 and 58, 59 and 60, 61 and 62, 63 and 64, 65 and 66, 67 and 68, 69 and 70, 71 and 72, 73 and 74, 75 and 76, 77 and 78, 79 and 80, 81 and 82, 83 and 84, 85 and 86, 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 its letter corresponding to its position, e.g., the sheet which includes Bombay is N 5-38.

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.

Ref. No. 3431 D., B.

REFERENCE.

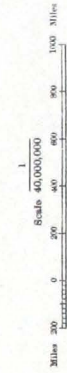
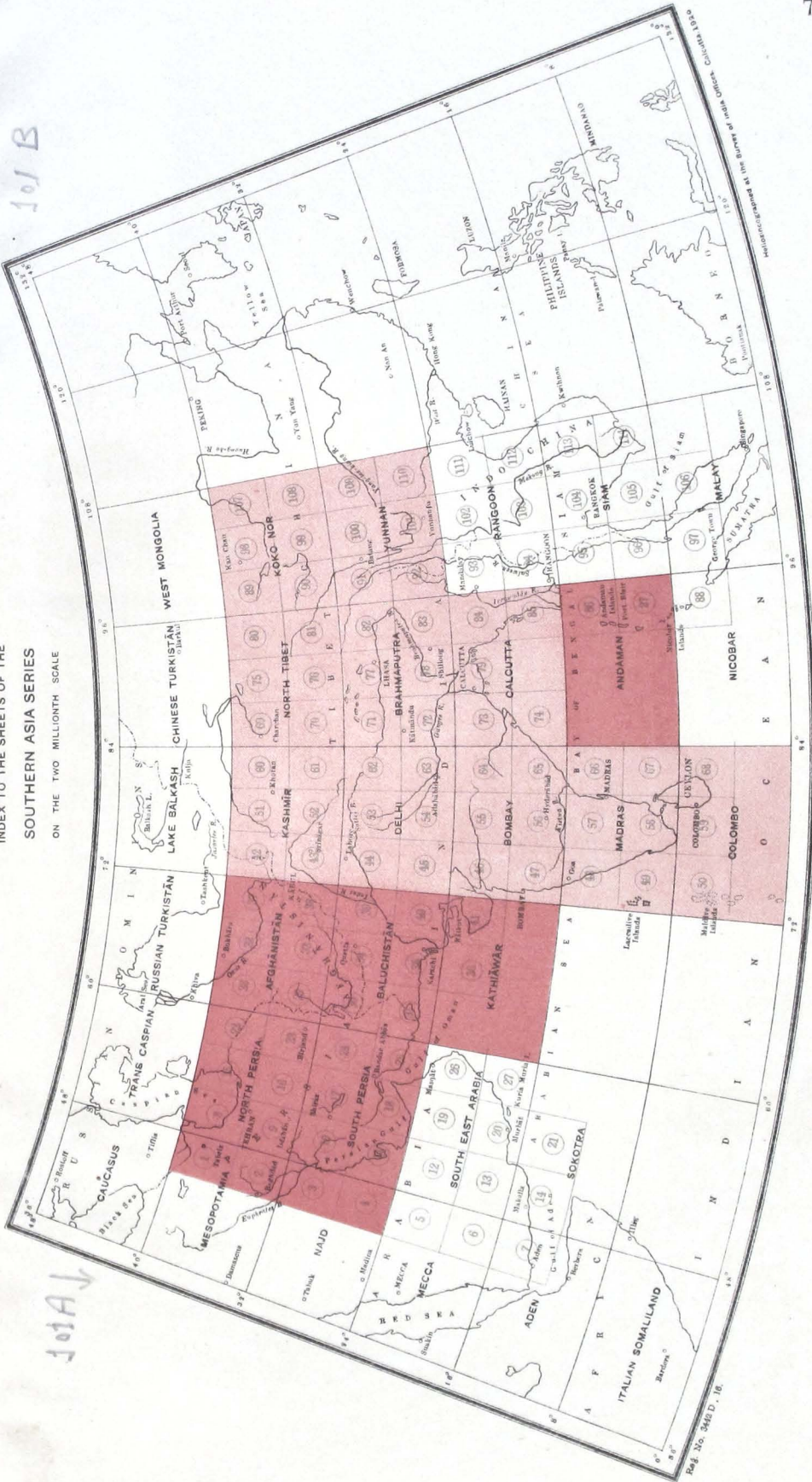
- Sheet published
- under publication
- in hand



1000

To illustrate the Report for the year 1931-32

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



REFERENCE

To illustrate the Report for the year 1921-22

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

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

