

# Survey of India.

## GENERAL REPORT,

### 1919-20.

From 1st October 1919.

To 30th September 1920.



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

PRINTED AT THE PHOTO-LITHO. OFFICE, SURVEY OF INDIA.  
CALCUTTA,  
1921.

Price Two Rupees or Four Shillings.

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

## NOTICE.

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1. TOPOGRAPHICAL MAPS are published on the scales of 4 MILES TO 1 INCH, 2 MILES TO 1 INCH AND 1 MILE TO 1 INCH:—

(a) THOSE SURVEYED AFTER 1905 are printed in colours, in sheets 24 INCHES × 19 INCHES, price Rs. 1-8-0 per copy.

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(c) 4 miles to 1 inch maps are printed in two editions, viz., LAYERED and POLITICAL, as described in para. 4, price Rs. 1-8-0 per copy. Those from old surveys are printed in black and styled PROVISIONAL, price ONE RUPEE per copy.

2. GEOGRAPHICAL MAPS are also obtainable as follows:—

(a) SOUTHERN ASIA SERIES, scale 1:2,000,000 or nearly 32 miles to 1 inch, in LAYERED and POLITICAL editions, as described in para. 4, size 36 inches × 24 inches, price Rs. 3 per copy.

(b) INDIA AND ADJACENT COUNTRIES, scale 1:1,000,000 or nearly 16 miles to 1 inch, in LAYERED and POLITICAL editions, and from old surveys as PROVISIONAL ISSUES, size 24 INCHES × 19 INCHES, price Rs. 1-8-0 per copy.

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

(d) GENERAL MAPS OF INDIA, scale 32 miles to 1 inch, in sets of 12 sheets, each sheet 25 inches × 32 inches, in LAYERED and POLITICAL (without hills) editions, price Rs. 12 per set. Maps of India on various smaller scales and miscellaneous special maps illustrating Railways, etc., are also available.

3. MISCELLANEOUS maps are also published as below:—

(a) PROVINCIAL MAPS, on scales 16 miles and 32 miles to 1 inch.

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(c) CANTONMENT AND TOWN MAPS AND OTHER MISCELLANEOUS MAPS, on various scales and prices.

(d) FOREST MAPS obtainable only from the OFFICER IN CHARGE, FOREST MAP OFFICE, DEHRA DŪN.

4. The styles of printing of 4 miles to one inch and Geographical maps are as follows:—

(a) LAYERED EDITION, printed in colours with contours and graduated layer tints to show altitudes, and shading to emphasize the hills. (Colour ribands along boundaries cannot be added to this edition.)

(b) POLITICAL EDITION, printed in colours with colour ribands along boundaries, contours to show altitudes and shading to emphasize hills.

(c) PROVISIONAL ISSUE, generally printed in black or black with hills in brown. Colour ribands along boundaries are added by hand when required at an extra cost of 2 annas per sheet.

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, etc., at a small extra charge.

7. Maps approved for issue to Government Officials on the *PUBLIC SERVICE* are supplied on *BOOK DEBIT*.

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Postage, packing and V. P. P. charges are extra.

8. THE MAP RECORD AND ISSUE OFFICE will be glad to give, free of charge, any further information.

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## 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,

1919—20.

From 1st October 1919

To 30th September 1920.

### 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 XV 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 30,464\* square miles; and that this brings the total progress since 1905 to 540,774 square miles, leaving 1,280,826 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 28 gives a list of the new publications of the Calcutta Offices during the year. A complete list of departmental publications, apart from maps, may be found in the annual "Records of the Survey of India"; and lists of new maps are published quarterly by the department, as well as in the monthly "Notes of the Survey of India."

5. Progress in the Trigonometrical 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.

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\* Excluding 38 square miles large scale survey on the scale of 12", 16" and 24" = 1 mile.

## 6. The following events are notified:—

- (a) Owing to the shortage of officers the field work was again curtailed, but to a lesser extent than in the previous year.
- (b) The personnel of the Mesopotamian Survey Party was placed on foreign service under the Mesopotamian administration from 1st January 1920.
- (c) The Birjand and South-West Persia Survey Detachments, which had been employed in East and South-West Persia, returned to India on completion of their work in September and May 1920 respectively and were disbanded.  
A party designated the Waziristān Survey Party was formed under a Class I officer for service on the North-West Frontier. This party returned to Mussoorie in June 1920.  
The Military Authorities expressed great satisfaction at the work carried out by these Survey units.
- (d) Major H. T. Morshead, D.S.O., R.E., and Mr. Laltan Khan, I.D.S.M., accompanied Dr. A. M. Kellas on his attempt to climb Mount Kāmet (25,445 feet). The party had not returned by the end of the year but it is known that the attempt failed at 23,500 feet.
- (e) A Training School was formed in Maymyo for instruction of pupils recruited for the parties in Burma.
- (f) The increase in the demand for special and large scale surveys has continued.



## II.—ADMINISTRATION AND PERSONNEL.

7. The actual cost of the department for the financial year ending 31st March 1920 and of the two previous years is shown below:—

|                             | 1917-18.   | 1918-19.   | 1919-20.   | REMARKS.                       |
|-----------------------------|------------|------------|------------|--------------------------------|
|                             | <i>Rs.</i> | <i>Rs.</i> | <i>Rs.</i> |                                |
| Gross actual cost           | 40,33,295  | 38,38,091  | 44,53,872* | * These figures are not final. |
| Deduct receipts and credits | 17,58,796  | 18,83,964  | 20,30,389* |                                |
| Net actual cost             | 22,74,499  | 19,54,127  | 24,23,483* |                                |

8. Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E., administered the department till 20th April 1920 when he proceeded on leave to England. Lieutenant-Colonel W. M. Coldstream, R.E., officiated for him for the rest of the year.

9. The names of the following officers who served in His Majesty's Forces and who died in the Great War have been placed on record by the Governor-General in Council:—

Bt.-Major (Temporary Lt.-Col.) Archibald Alderman Chase, D.S.O., R.E.  
 Captain Rowland Latimer Almond, R.E.  
 „ Edward Carlton Baker, R.E.  
 „ Edward Bellasis Cardew, R.E.  
 „ John Archibald Field, R.E.  
 „ Henry Marshall McKay, R.E.  
 „ George Frederick Thomas Oakes, R.E.  
 Lieutenant Vivian Donald Berry Collins.  
 „ Walter Percy Hales, I.A.R.O.  
 Jemadar Ram Charan, Surveyor.

10. By the reorganisation of the Imperial and Provincial Services of the department, Imperial and certain selected Provincial Officers are now styled Class I officers, the remainder of the Provincial Service being styled Class II. Practically the whole of the various establishments of the department have been reorganised during the year to meet the increased cost of living.

11. Of Class I officers:—Colonel T. F. B. Renny-Tailyour, C.B., C.S.I., R.E., and Lieutenant-Colonel R. T. Crichton, C.I.E., I.A., retired and Major M. N. MacLeod, D.S.O., M.C., R.E., and Major K. W. Pye, D.S.O., R.E., reverted to the Home Establishment.

The following officers were appointed during the year:—

Bt.-Major E. O. Wheeler, M.C., R.E., Captains E. A. Glennie, D.S.O., R.E., H. A. Joly deLotbinière, M.C., R.E., O. Slater, M.C., R.E., and G. Lennox, I.A.

The number of officers on deputation to military duty at the end of the year is 2.

Captain H. G. Salmond whose services were placed at the disposal of this department to assist in experiments in producing maps from aeroplane photographs reverted to the Eastern Bengal Railway.

Of Class II officers:—Mr. H. A. Charrier retired, Messrs R. B. Gildea, F. E. R. Calvert, R. M. Wyatt and A. J. Moore resigned. Mr. W. Newland was transferred to the Government of Bombay. Mr. B. M. Berrill and Mr. P. Simpson were placed on deputation with the Bombay, and Bihār and Orissa Governments, respectively.

The number of officers on deputation to military duty at the end of the year is 2.

In the Upper Subordinate Service, Messrs Hari Ramchandra Jogalekar, and Eknath Battu retired.

The total strength of the department at the close of the Survey year was 55 † Class I officers, 98 ‡ Class II officers and 57 Upper Subordinates, besides specialists, clerks, lower subordinates and menials.

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

*Officers of the Order of the British Empire.*— Captain (Temp. Lieut.-Colonel) R. S. Wauchope, I.A.

*Members of the Order of the British Empire.*— Mr. D. K. Rennick, Extra Assistant Superintendent.

Assistant Commissary and Hon. Lieutenant R. Graham.

*Mentioned in despatches.*— Major H. McC. Cowie, R.E., (second time).

Brevet-Lieut.-Colonel C. P. Gunter, O.B.E., R.E., (second time).

Brevet-Lieut.-Colonel C. M. Browne, C.M.G., D.S.O., R.E., (fifth time).

Captain (Temp. Lieut.-Colonel) R. S. Wauchope, I.A.

Surveyor Khitab Gul.

*Brought to the notice of the Secretary of State for war services.*— Lieutenant R. B. Gildea, I.A.R.O., (resigned).

Mr. F. H. Grant, Extra Assistant Superintendent.

Surveyor Mansab Khan.

*Doctor of Science (Cambridge University).*— Mr. J. deGraaff Hunter, M.A.

*Title of Rai Sahib.*— Mr. Jagdamba Prasad, Extra Assistant Superintendent.

*Title of Ahmudan gaung Tazeik ya Min.*— Maung Pe, Sub-Assistant Superintendent.

13. The following table shows the distribution of officers during the year. The names of officers on deputation to Local Governments or military duty or absent on military duty followed by leave throughout the year are omitted; the names of officers, other than officers in charge, on leave, military duty, or foreign service, during the greater part of the year are also omitted.

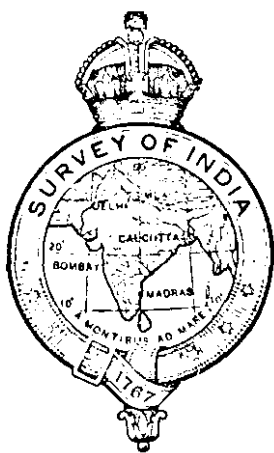
† Including 2 officers on temporary military duty.

‡ Including 2 officers on temporary military duty, but excluding officers re-employed and on deputation to Local Governments.

TABLE I—DISPOSITION OF OFFICERS, 1919-20.

| SURVEYOR GENERAL OF INDIA—  |  | Colonel C. H. D. Ryder, C.I.E., D.S.O., R.E. (on leave from 20th April 1920).<br>Lieut.-Colonel W. M. Coldstream, R.E., Officiating from 20th April 1920.  |   |                                    |   |
|---|--|--|---|------------------------------------|---|
|   | <i>Class I Officers.</i>   | <i>Class II Officers.</i>  | <i>Upper Subordinates.</i>  | <i>Lower Subordinates, &amp;c.</i> |   |
| Surveyor General's Office.  | Major H. J. Couchman, D.S.O., M.C., R.E.<br>Captain W. E. Perry, M.C., R.E.  |  |   |                                    |   |
| * Mesopotamian Survey Party.  | Bt.-Colonel F. W. Pirrie, C.M.G., C.I.E., I.A.<br>Major E. T. Rich, C.I.E., R.E.<br>F. F. Hunter, D.S.O., I.A.<br>Dr. J. deGraaff Hunter, Sc. D., M.A.   | Mr. V. W. Morton<br>C. West<br>B. C. Newland<br>E. C. O'Sullivan, D.C.M.<br>F. B. Kitchin<br>A. F. Murphy  | Mr. Hayat Muhammad Khan, K.S.<br>Nanak Chand Puri, B.A., R.S.<br>Hamid Gul, K.S., C.H.<br>Annada Prasad Ghosh<br>Abdul Latif Khan |                                    | 46 Surveyors, &c.   |
| SUPERINTENDENT, MAP PUBLICATION—  |  | Lieut.-Colonel H. H. Turner, R.E., up to 3rd February 1920.<br>G. A. Beuzeley, D.S.O., R.E., from 4th February 1920.   |   |                                    |   |
|   | <i>Class I Officers.</i>   | <i>Class II Officers.</i>  | <i>Upper Subordinates.</i>  | <i>Lower Subordinates, &amp;c.</i> |   |
| Map Publication Office, Calcutta.   |  | Mr. M. Gustad (re-employed).   |   |                                    |   |
| No. 1 Drawing Office, Map Record and Issue Office and Engraving Office, Calcutta. | Bt.-Lieut.-Colonel C. P. Gunter, O.B.E., R.E.<br>Major H. J. Couchman, D.S.O., M.C., R.E.<br>O. H. B. Trenchard, R.E.<br>C. M. Thompson, I.A.  | Mr. P. Williams<br>Jagdamla Prasad, R.S.<br>Pramaduranjan Ray, R.S.<br>Abinash Chunder Bose<br>C. West<br>Asmit-ullah Khan, K.B.<br>A. B. Hunter<br>Priya Nath Sur<br>L. B. Fitz-Gibbon<br>H. H. P. Butterfield<br>Jiya Lal Sahgal |   |                                    |   |
| Photo.-Litho. Office, Calcutta.   | Major A. H. Gwyn, I.A.   |  |   |                                    |   |
| Mathematical Instrument Office, Calcutta.   | Mr. T. A. Ferrier, C.B.E. (on combined leave).<br>S. Woodhouse (Offg.).  |  |   |                                    |   |
| Bengal & Bihar & Orissa Drawing Office, (Imperial Standard Mapping Section).      |  | Mr. P. Simpson<br>Mr. C. West.   |   |                                    |   |
| No. 6 (Simla) Drawing Office.   | Major L. G. Crosthwait, I.A.<br>C. J. Arbery, M.B.E.   | Mr. R. E. M. Saubolle<br>A. J. A. Drake, D.C.M.  |   |                                    | 4 European Draftsmen.<br>4 Printers.<br>2 Clerks.<br>15 Indian Draftsmen.<br>2 Pupil Draftsmen. |
| SUPERINTENDENT, NORTHERN CIRCLE   |  | Lieut.-Colonel R. T. Crichton, C.I.E., I.A., up to 7th March 1920.<br>Lieut.-Colonel H. L. Crosthwait, R.E., from 8th March 1920.  |   |                                    |   |
|   | <i>Class I Officers.</i>   | <i>Class II Officers.</i>  | <i>Upper Subordinates.</i>  | <i>Lower Subordinates, &amp;c.</i> |   |
| No. 3 Drawing Office, Mussoorie.  | Major L. G. Crosthwait, I.A.<br>Mr. J. A. Freeman  | Mr. E. B. West<br>D. K. Reunick, M.B.E.<br>L. Williams<br>A. A. Graham<br>J. A. Culvert<br>H. G. Shaw (re-employed).   | Mr. Imam Din<br>Jit Singh Rawat   |                                    | 41 Surveyors, &c.   |
| No. 1 Party, Punjab and United Provinces.   | Bt.-Lieut.-Colonel A. A. McHarg, D.S.O., R.E.<br>Captain H. E. Roome, M.C., R.E.<br>Bt.-Major K. Mason, M.C., R.E.<br>Major H. T. Morshead, D.S.O., R.E.   | Mr. G. J. S. Rae<br>P. A. T. Kenny<br>A. M. Talati<br>R. C. Hanson<br>F. J. Grice<br>J. A. Calvert   | Mr. Janna Prasad, R.S.<br>Muhammad Husain Khan<br>Jagdeesh Prasad Vastav<br>Muhammad Khan   |                                    | 49 Surveyors, &c.   |
| No. 2 Party, Punjab, Rajputana and United Provinces.                              | Bt.-Lieut.-Colonel S. W. S. Hamilton, D.S.O., R.E.   | Mr. H. P. D. Morton<br>Duni Chand Puri   | Mr. Muhammad Husain<br>Lakshmi Dutt Joshi<br>Ghulam Hasan<br>Daulat Ram Vohra<br>Lailan Khan, I.D.S.M.                            |                                    | 46 Surveyors, &c.   |
| No. 3 Party, United Provinces.  | Bt.-Major C. G. Lewis, R.E.<br>Mr. H. H. B. Hanby  | Mr. B. M. Berrill<br>J. H. Johnson<br>G. E. R. Cooper<br>Moqimuddin  | Mr. Parva Ram<br>Hamid Gul, K.S.<br>Amir Abdul Salam Matlub Ahmad   |                                    | 33 Surveyors, &c.   |
| No. 4 Party, United Provinces.  | Lieut.-Colonel E. A. Tandy, R.E.<br>R. T. Crichton, C.I.E., I.A.<br>Bt.-Lieut.-Colonel S. W. S. Hamilton, D.S.O., R.E.<br>Major L. G. Crosthwait, I.A.<br>H. T. Morshead, D.S.O., R.E.<br>Lieut.-Colonel H. L. Crosthwait, R.E.<br>Captain L. H. Jackson, I.A. | Mr. Abdul Karim, B.A.  | Mr. Nabidad Khan  |                                    | 1 Clerk.  |
| Sind-Sagar Party, Punjab.   |  | Mr. Dhani Ram Verma<br>J. C. Lewis<br>Abdul Karim, B.A.  | Mr. Chuni Lal Kapur<br>Nabidad Khan   |                                    | 28 Surveyors, &c.<br>106 Local Revenue staff.   |
| No. 22 (Riverain) Party, Punjab.  |  | Mr. Maya Das Puri, R.S.  | Mr. Ram Narsyan Hastir<br>Vidya Dhar Chopra   |                                    | 60 Surveyors, &c.<br>1 Naib Tahsildar.  |
| Waziristan Survey Party, Waziristan.  | Lieut.-Colonel H. L. Crosthwait, R.E.<br>Major H. T. Morshead, D.S.O., R.E.  | Mr. P. A. T. Kenny<br>F. J. Grice<br>J. A. Calvert   | Mr. Muhammad Husain Khan<br>Shib Lal<br>Sadik Ali   |                                    | 9 Surveyors, &c.  |
| Birjand Survey Detachment, North-East Persia.                                     |  | Mr. G. A. Norman   | Mr. Afraz Gul   |                                    | 3 Surveyors, &c.  |
| Simla Survey Detachment, Simla.   |  | Mr. W. H. Strong, M.B.E.   |   |                                    | 10 Surveyors, &c.   |

\* The personnel of the party was transferred to foreign service under the Mesopotamian administration from 1st January 1920.



*Surveyor General's Office,*

*No. 13, Wood Street,*

*Calcutta, 22<sup>nd</sup> June 1921.*

*Colonel C. H. D. Ryder, C.I.E., D.I.C., R.E.,  
Surveyor General of India, has the honour to present The Servants'  
of India Society's Library, Poona*

*with a copy of the General Report on the Operations of the Survey of  
India, during 1919-20 and requests the favour of an acknowledgment  
of the receipt of the same.*

TABLE I—(Continued).—DISPOSITION OF OFFICERS, 1919-20.

|   |   | SUPERINTENDENT,<br>SOUTHERN CIRCLE   |   |                            |                                    |
|---|---|--|---|----------------------------|------------------------------------|
|   |   | { Lieut.-Colonel W. M. Coldstream, R.E., up to 19th October 1919.<br>Major L. C. Thuillier, I.A., from 20th October to 10th November 1919.<br>Lieut.-Colonel E. A. Tandy, R.E., from 11th November 1919 to 20th January 1920.<br>Brevet-Lieut.-Colonel C. P. Gunter, O.B.E., R.E., from 21st January 1920. |   |                            |                                    |
|   |   | <i>Class I Officers.</i>   | <i>Class II Officers.</i>                 | <i>Upper Subordinates.</i> | <i>Lower Subordinates, &amp;c.</i> |
| No. 4 Drawing Office, Bangalore.  | Mr. J. H. Nichol .....                                | Mr. S. F. Norman .....   | Mr. B. V. Narayana Rao .....              | 89 Draftsmen, &c.          |                                    |
| No. 5 Party, Central Provinces.   | Major L. C. Thuillier, I.A. ....                      | Mr. S. F. Norman .....   | Mr. P. S. Vengusvami .....                | 36 Surveyors, &c.          |                                    |
|   |   | " H. B. Simons .....   | " Damodar Khadilkar .....                 |                            |                                    |
|   |   | " F. C. Pilcher .....  | " Pulin Behari Roy .....                  |                            |                                    |
|   |   | " F. W. Smith .....  |   |                            |                                    |
| No. 6 Party, Bombay, Madras, and Hyderabad.                               | Mr. J. O'B. Donaghey .....                            | Mr. E. A. Meyer .....  | Mr. K. G. Mandanna .....                  | 32 Surveyors, &c.          |                                    |
|   |   | " Munshi Lal, B.A. ....  | " Masud Khan .....                        |                            |                                    |
|   |   | " N. S. Harihara Iyer .....  | " E. N. Natesan .....                     |                            |                                    |
| No. 7 Party, Madras.  | Major J. D. Campbell, D.S.O., R.E. ....               | Mr. H. B. Simons .....   | Mr. Eknath Battu .....                    | 16 Surveyors, &c.          |                                    |
|   |   | " S. F. Norman .....   | " K. Narayanasvami Chotti .....           |                            |                                    |
|   |   | " C. E. C. French .....  | " Damodar Khadilkar .....                 |                            |                                    |
|   |   | " J. H. S. Wilson .....  |   |                            |                                    |
|   |   | " Haji Abdul Khabim, K.B. ....   |   |                            |                                    |
|   |   | " F. H. Grant .....  |   |                            |                                    |
| No. 8 Party, Madras.  | Mr. W. M. Gorman .....                                | Mr. C. E. C. French .....  | Mr. H. Narasimhamurti Rao .....           | 42 Surveyors, &c.          |                                    |
|   |   | " S. F. Norman .....   | " Shaikh Muhammad Salik .....             |                            |                                    |
|   |   | " M. Mahadeva Mudaliar, M.A. ....  |   |                            |                                    |
|   |   | " B. T. Wyatt .....  |   |                            |                                    |
|   |   | " M. S. Ganesa Aiyar .....   |   |                            |                                    |
|   |   | " J. C. St. C. Pollett .....   |   |                            |                                    |
| No. 20 Party, Cantonment and Military District Lands in the 9th Division. | Mr. B. R. Hughes .....                                | Mr. C. E. C. French .....  | Mr. Dharmu .....                          | 26 Surveyors, &c.          |                                    |
|   |   | " J. H. S. Wilson .....  | " Jitendra Mohan Mukerji .....            |                            |                                    |
|   |   | " O. D. Jackson .....  |   |                            |                                    |
| Training Section .....  |   | Mr. S. S. McA'F. Fielding .....  |   | 22 Surveyors, and Pupils.  |                                    |
|   |   | SUPERINTENDENT,<br>EASTERN CIRCLE  |   |                            |                                    |
|   |   | { Lieut.-Colonel C. L. Robertson, C.M.G., R.E., up to 24th October 1919.<br>Lieut.-Colonel W. M. Coldstream, R.E., from 25th October 1919 to 19th April 1920.<br>Major E. T. Rich, C.I.S., R.E., from 20th April 1920.   |   |                            |                                    |
|   |   | <i>Class I Officers.</i>   | <i>Class II Officers.</i>                 | <i>Upper Subordinates.</i> | <i>Lower Subordinates, &amp;c.</i> |
| No. 6 Drawing Office, Shillong.   | Mr. M. C. Petters .....                               | Mr. Pramadarajan Ray, R.S. ....  | Mr. Jagdeesh Prasad Vastav ...            | 37 Surveyors, &c.          |                                    |
|   |   | " E. Claudius .....  | " Dalbir Rai .....                        |                            |                                    |
|   |   | " C. S. McInnes .....  |   |                            |                                    |
| No. 9 Party, Bengal.  | Bt.-Lieut.-Colonel R. H. Philimore, D.S.O., R.E. .... | Mr. E. J. Biggie .....   | Mr. Amulya Charan Ghosh .....             | 23 Surveyors, &c.          |                                    |
|   |   | " Anar Krishna Mitra .....   | " Gopal Lal Mitra .....                   |                            |                                    |
| No. 10 Party, Upper Burma.  | Mr. M. C. Petters .....                               | Mr. W. G. Jarbo .....  | Mr. Hayat Muhammad, K.S. ...              | 17 Surveyors, &c.          |                                    |
|   |   | " H. H. Creed .....  | " Dharendra Nath Saha .....               |                            |                                    |
|   |   | " Dharendra Nath Banerji, L.C.E. ....  | " Ram Prasad, R.S. ....                   |                            |                                    |
|   |   |  | Maung Pe, A.T.M. ....                     |                            |                                    |
| No. 11 Party, Lower Burma.  | Mr. J. O. Greiff .....                                | Mr. O. J. H. Hart .....  | Mr. Pratul Chandra Sen Gupta, B. Sc. .... | 26 Surveyors, &c.          |                                    |
|   |   | " E. M. Kenny .....  | " Dalbir Rai .....                        |                            |                                    |
|   |   | " H. T. Hughes .....   |   |                            |                                    |
|   |   | " F. C. Saint .....  |   |                            |                                    |
| No. 12 Party, Assam.  | Major F. B. Scott, I.A. ....                          | Mr. E. G. Harding .....  | Mr. Guriya Sonker Bagchi .....            | 30 Surveyors, &c.          |                                    |
|   |   | " E. M. Kenny .....  |   |                            |                                    |
|   |   | " Prafulla Chandra Mitra, B.A. ....  |   |                            |                                    |
| No. 21 (Burma Forest) Party, Upper Burma.                                 | Mr. H. W. Biggie .....                                | Mr. W. G. Jarbo .....  | Mr. Bhanba Ram .....                      | 9 Surveyors, &c.           |                                    |
|   |   | " C. O. Picard .....   |   |                            |                                    |
|   |   | " C. B. Sexton .....   |   |                            |                                    |

TABLE I—(Concluded).—DISPOSITION OF OFFICERS, 1919-20.

| SUPERINTENDENT OF THE TRIGONOMETRICAL SURVEY           |   | Colonel Sir Gerald P. Lenox-Conyngham, Kt., R.E., F.R.S., up to 15th May 1920.  |   | Major R. H. Thomas, D.S.O., R.E., from 16th May 1920. |  |
|--|---|---|---|---|--|
|  | <i>Class I Officers.</i>  | <i>Class II Officers.</i>   | <i>Upper Subordinates.</i>  | <i>Lower Subordinates, &amp;c.</i>                    |  |
| Superintendent's Office.                               | Major H. T. Morshead, D.S.O., R.E.<br>Captain L. H. Jackson, I.A.<br>Bt.-Major E. O. Wheeler, M.C., R.E.<br>Captain E. A. Glennie, D.S.O., R.E.<br>" O. Slater, M.C., R.E.<br>" G. Lennox, I.A. ( <i>Attached</i> )<br>" H. G. Salmond (on deputation from Eastern Bengal Railway). | Mr. A. Ewing (re-employed) ( <i>Probationers</i> ).<br>Mr. Prafulla Kumar Ghosh, B. Sc.<br>" Bhupendra Nath Saha, M. Sc.<br>" H. M. Critchell<br>" Muhammad Najamuddin, B.A.<br>" T. O. Threlfall | Mr. Laltan Khan, I.D.S.M. ....  |   |  |
| Computing Office.                                      | Dr. J. deGraaff Hunter, Sc. D., M.A.<br>Major C. M. Thompson, I.A.  | Mr. Hanuman Prasad, M.A.  | Mr. Sarat Kumar Mukerji   | 43 Computers, &c.                                     |  |
| No. 2 Drawing Office and Forest Map Office, Dehra Dun. | Major F. J. M. King, R.E.   | Mr. C. C. Byrne<br>" H. P. D. Morton<br>" Rama Prasad Ray, B.A.<br>Major C. H. Tresham<br>Mr. J. McCracken, M.B.E.<br>" T. F. Kitchen<br>" V. P. Wainright<br>" F. C. Saint                       | Mr. Lal Singh, B.B. (re-employed).<br>" Ram Singh, B.S.<br>" Jugal Behari Lal<br>" Baldeo Behari Lal<br>" Satik Ali | 180 Draftsmen, &c.                                    |  |
| No. 13 Party, ( <i>Astronomical</i> ).                 | Dr. J. deGraaff Hunter, Sc. D., M.A.<br>Bt.-Major C. G. Lewis, R.E.<br>Captain G. Lennox, I.A.  |   |   | 1 Computer.   |  |
| No. 14 Party, ( <i>Pendulum</i> ).                     | Lieut.-Colonel G. A. Beazeley, D.S.O., R.E.<br>Bt.-Lieut.-Colonel C. P. Gunter, O.B.E., R.E.<br>Major E. T. Rich, C.I.E., R.E.<br>" R. H. Thomas, D.S.O., R.E.<br>" C. M. Thompson, I.A.<br>Captain E. A. Glennie, D.S.O., R.E.   |   |   | 1 Clerk.  |  |
| No. 15 Party, ( <i>Triangulation</i> ).                | Major R. H. Thomas, D.S.O., R.E.<br>Captain O. Slater, M.C., R.E.   | Lieut. C. S. Melnes   |   | 5 Computers, &c.                                      |  |
| No. 16 Party, ( <i>Tidal</i> ).                        | Mr. O. C. Ollenbach   | Mr. Syed Zille Hasnain, B.S.<br>" D. H. Luxa  |   | 20 Computers, &c.                                     |  |
| No. 17 Party, ( <i>Levelling</i> ).                    | Bt.-Major K. Mason, M.C., R.E.  | Mr. H. G. Shaw (re-employed).<br>" O. N. Pushong<br>" K. S. Gopalachari, B.A.<br>" Narendra Nath Chuckerbutty, L.C.E.   | Mr. Karuna Kumar Das, B.A.<br>" Satish Chandra Mukerjee   | 12 Computers, &c.                                     |  |
| No. 18 Party, ( <i>Magnetic</i> ).                     |   | Mr. E. C. J. Bond, V.D.<br>" Nikunjo Ronjon Mazumdar<br>" Raj Bahadur Mathur, B.A.  | Mr. Bidhu Bhushan Shome   | 2 Magnetic Observers.<br>12 Computers, &c.            |  |
| No. 19 Party, ( <i>Base Line</i> ).                    | Major H. J. Couchman, D.S.O., M.C., R.E.<br>" O. H. B. Trenchard, R.E.<br>" C. M. Thompson, I.A.  |   |   | 1 Clerk.  |  |

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## PART 2.—WORK OF FIELD PARTIES, &c.

### I.—TOPOGRAPHICAL SURVEYS.

14. 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 580,400 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<br>Circle. | Southern<br>Circle. | Eastern<br>Circle. | TOTALS.           |
|---|---------------------------------------|---------------------|---------------------|--------------------|-------------------|
|   |                                       | <i>Sq. miles.</i>   | <i>Sq. miles.</i>   | <i>Sq. miles.</i>  | <i>Sq. miles.</i> |
| 1905-06 ...   | Mostly 2-inch and 1-inch              | 6,278               | 1,660               | 10,822             | 18,260            |
| 1906-07 ...   | ditto ...                             | 7,519               | 7,666               | 8,659              | 28,844            |
| 1907-08 ...   | ditto ...                             | 14,580              | 9,256               | 12,481             | 86,217            |
| 1908-09 ...   | ditto ...                             | 18,624              | 12,526              | 11,542             | 42,692            |
| 1909-10 ...   | Mostly 1-inch ...                     | 28,838              | 12,592              | 9,736              | 46,101            |
| 1910-11 ...   | ditto ...                             | 27,528              | 18,171              | 9,218              | 49,917            |
| 1911-12 ...   | ditto ...                             | 28,852              | 9,115               | 10,654             | 48,621            |
| 1912-13 ...   | Mostly 1-inch and $\frac{1}{2}$ -inch | 28,192              | 18,349              | 11,836             | 58,377            |
| 1913-14 ...   | ditto ...                             | 25,052              | 15,844              | 14,890             | 55,786            |
| 1914-15 ...   | ditto ...                             | 12,834              | 19,286              | 5,056              | 86,676            |
| 1915-16 ...   | ditto ...                             | 8,168               | 17,248              | 6,931              | 82,842            |
| 1916-17 ...   | ditto ...                             | 11,889              | 11,838              | 9,723              | 82,750            |
| 1917-18 ...   | ditto ...                             | 4,202               | 12,181              | 8,896              | 24,779            |
| 1918-19 ...   | ditto ...                             | 509                 | 7,263               | 6,176              | 18,948            |
| 1919-20 ...   | ditto ...                             | 9,145*              | 11,891              | 9,428              | 30,464            |
| <b>Total areas completed to date</b>                            |                                       | <b>221,455</b>      | <b>174,321</b>      | <b>144,998</b>     | <b>540,774</b>    |
| <b>Approximate areas for the whole topographical programme.</b> |                                       | <b>750,000</b>      | <b>542,800</b>      | <b>528,800</b>     | <b>1,821,600</b>  |
| <b>Approximate areas remaining for survey.</b>                  |                                       | <b>528,545</b>      | <b>368,479</b>      | <b>383,802</b>     | <b>1,280,826</b>  |

\* Excluding 38 square miles large scale survey on the scales of 12, 16" and 24" = 1 mile.



Table III.—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1919-20.

| PARTY and LOCALITY.<br><br>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.        |  |
| <b>No. 1 Party—Punjab and United Provinces.</b>                                  |  |                                    |                                |                                    |                          | <b>NORTHERN CIRCLE.</b>  |
| Wooded hills ...   | ... ½-inch Revision Survey ...             | 252                                | 5,218                          | 1,81,704                           | 25·2                     |  |
| Ditto ...  | ... 1-inch Original Survey ...             | 87                                 |                                |                                    |                          |  |
| Ditto ...  | ... 1-inch Revision Survey ...             | 4,841                              |                                |                                    |                          |  |
|  | ... Large-Scale Survey ...                 | 38                                 |                                |                                    |                          |  |
| <b>No. 2 Party—Punjab, Rājputāna and United Provinces.</b>                       |  |                                    |                                |                                    |                          | (a) Excludes Rs. 8,645 debitabale to Rājputāna, Rs. 5,290 cost of ½-inch mapping and Rs. 53,682 cost of training pupils and soldier surveyors. |
| Mountainous, covered with heavy low jungle and thick grass.                      | ... ½-inch Original Survey ...             | 264                                | 2,638                          | 65,417 (a)                         | 24·8                     |  |
| Cultivated plains, open with occasional isolated low rocky hills.                | ... 1-inch Original Survey ...             | 418                                |                                |                                    |                          |  |
| Cultivated plains, open  | ... 1-inch Resurvey ...                    | 1,426                              |                                |                                    |                          |  |
| Ditto ditto  | ... 2-inch Resurvey ...                    | 265                                |                                |                                    |                          |  |
| Ditto ditto  | ... 3½-inch Experimental Aeroplane Survey. | 265                                |                                |                                    |                          |  |
| <b>No. 3 Party—United Provinces.</b>   |  |                                    |                                |                                    |                          |  |
| Wooded hills ...   | ... 2-inch Original Survey ...             | 1,287                              | 1,327                          | 1,05,881 (b)                       | 79·4                     |  |
|  | ... 1-inch Resurvey ...                    | 90                                 |                                |                                    |                          |  |
| <b>TOTALS, NORTHERN CIRCLE:—</b>   |  | <b>9,183 sq. m.</b>                |                                | <b>Rs. 3,02,452</b>                | <b>Cost-rate 32·9</b>    |  |
|  |  |                                    | <b>Sq. miles.</b>              | <b>Rs.</b>                         | <b>Rs. per sq. mile.</b> | <b>SOUTHERN CIRCLE.</b>  |
| <b>No. 5 Party—Central Provinces.</b>  |  |                                    |                                |                                    |                          |  |
| Well-wooded hills and cultivated plains.   | ... 1-inch Original Survey ...             | 2,667                              | 3,027                          | 99,715                             | 32·9                     |  |
|  | ... 1-inch Revision Survey ...             | 360                                |                                |                                    |                          |  |
| <b>No. 6 Party—Bombay, Madras and Hyderābād.</b>                                 |  |                                    |                                |                                    |                          |  |
| Undulating and cultivated  | ... ½-inch Original Survey ...             | 3,383                              | 4,191                          | 94,886                             | 22·5                     |  |
|  | ... ½-inch Supplementary Survey ...        | 108                                |                                |                                    |                          |  |
|  | ... 1-inch Original Survey ...             | 298                                |                                |                                    |                          |  |
|  | ... 3-inch Original Survey ...             | 70                                 |                                |                                    |                          |  |
|  | ... 3-inch Supplementary Survey ...        | 50                                 |                                |                                    |                          |  |
| Wooded hills ...   | ... 1½-inch Original Survey ...            | 282                                |                                |                                    |                          |  |
| <b>No. 7 Party—Bangalore.</b>  |  |                                    |                                |                                    |                          | Did not take the field.  |
| <b>No. 8 Party—Madras.</b>   |  |                                    |                                |                                    |                          |  |
| Undulating and cultivated plains with a coastal belt of palmyra palms.           | ... 1-inch Supplementary Survey ...        | 4,528                              | 4,673                          | 1,21,487                           | 26·0                     |  |
|  | ... 1-inch Original Survey ...             | 147                                |                                |                                    |                          |  |
| Small wooded patches of babul and other trees.                                   | ... 2-inch Forest Survey ...               | 3                                  |                                |                                    |                          |  |
| <b>TOTALS, SOUTHERN CIRCLE:—</b>   |  | <b>11,891 sq. m.</b>               |                                | <b>Rs. 3,15,588</b>                | <b>Cost-rate 26·5</b>    |  |

Table III.—(Concluded).—OUT-TURNS of PLANE-TABLING and COSTS of Topographical Surveys, 1919-20.

| 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. |   |   |
|   |                             |                                    |                                |                                    |                   | <b>EASTERN CIRCLE.</b>  |   |
| <b>No. 9 Party—Bengal.</b>  |                             |                                    |                                |                                    |                   |   |   |
| <i>Flat and cultivated plains</i>   | ... 1-inch Original Survey  | 2,299                              | } 2,344                        | 80,987 <sup>(a)</sup>              | 34.5              | (a) Excludes a sum of Rs. 1,489, on account of half-inch mapping, Rs. 7,008, for twelve-inch mapping, Rs. 169, for twelve-inch computation, Rs. 117, for twelve-inch survey and Rs. 7,127, for instruction of pupils. |   |
| <i>Ditto. ditto.</i>  | ... 1½-inch Revision Survey | 45                                 |                                |                                    |                   |   |   |
| <b>No. 10 Party—Upper Burma.</b>  |                             |                                    |                                |                                    |                   |   |   |
| <i>High mountains with densely wooded valleys.</i>  | ... ½-inch Original Survey  | 2,516                              | } 3,239                        | 1,46,797                           | 45.3              |   |   |
| <i>Densely wooded hills</i>   | ... 1-inch Original Survey  | 728                                |                                |                                    |                   |   |   |
| <b>No. 11 Party—Lower Burma and Northern Shan States.</b>   |                             |                                    |                                |                                    |                   |   |   |
| <i>Intricate hills and low ground covered with mangrove swamp and densely wooded.</i>                                       | ... 1-inch Original Survey  | 1,681                              | } 1,754                        | 2,00,681 <sup>(b)</sup>            | 114.4             |   | (b) Includes cost of Maymyo Drawing Office. |
| <i>High hills sparsely wooded and rocky.</i>  | ... 1-inch Resurvey         | 20                                 |                                |                                    |                   |   |   |
| <i>Low hills with open undulating ground cultivated and scrub jungle.</i>   | ... 3-inch Original Survey  | 108                                |                                |                                    |                   |   |   |
| <b>No. 12 Party—Assam.</b>  |                             |                                    |                                |                                    |                   |   |   |
| <i>Hills, consisting partly of a plateau cut up by ravines with stretches of grass lands and foot hills densely wooded.</i> | ... ½-inch Original Survey  | 1,099                              | } 1,967                        | 1,24,261                           | 63.2              |   |   |
| <i>Plains, partly under cultivation and partly densely wooded.</i>  | ... 1-inch Original Survey  | 578                                |                                |                                    |                   |   |   |
| <i>Plains and hills densely wooded</i>  | ... 2-inch Original Survey  | 290                                |                                |                                    |                   |   |   |
| <b>No. 21 (Burma Forest) Party—Upper Burma.</b>   |                             |                                    |                                |                                    |                   |   |   |
| <i>Wooded hills</i>   | ... 2-inch Original Survey  | 88                                 | } 124                          | 94,877                             | 765.1             |   |   |
| <i>Ditto.</i>   | ... 4-inch Original Survey  | 36                                 |                                |                                    |                   |   |   |
| <b>TOTALS, EASTERN CIRCLE:—</b>   |                             |                                    |                                | 9,428 sq. m.                       | Rs. 6,47,543      | Cost-rate 68.7  |   |
| <b>GRAND TOTALS:—</b>   |                             |                                    |                                | 30,502 sq. m.                      | Rs. 12,65,583     | Cost-rate 41.4  |   |

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

**15. No. 1 Party.**—5,180 square miles of topographical survey were completed during the year under report chiefly 1-inch and  $\frac{1}{2}$ -inch revision survey in the Simla Hill States, Sirmūr, Mandi and Kāngra district.

The party also completed the large scale surveys of the cities of Lahore and Ferozepore which had been commenced during the previous season (*vide* page 18). In addition a large scale survey of Mussoorie City was carried out at the cost of the City Board (*vide* page 42).

**16. No. 2 Party.**—This party surveyed an area of 264 square miles on the  $\frac{1}{2}$ -inch scale in Alwar State, 441 square miles on the scale of 1 inch = 1 mile in the Gurgaon district of the Punjab, 962 square miles on the scale of 1 inch = 1 mile in the Muttra and Aligarh districts of the United Provinces, 412 square miles on the scale of 1 inch = 1 mile in the Bharatpur State and 29 square miles on the scale of 1 inch = 1 mile in the Alwar State, both of the Rājputāna Agency, making a total of 1,844 square miles on the 1-inch scale, and 265 square miles on the scale of 2 inches = 1 mile (for instructional purposes) in the Muttra and Agra districts of the United Provinces. Traversing was also carried out in the Bharatpur State.

The country surveyed on the scale of  $\frac{1}{2}$  inch = 1 mile in Alwar State was hilly and difficult of access, being mostly covered with heavy low jungle and thick grass, while that surveyed on the scales of 1 inch and 2 inches = 1 mile, and the area traversed, consisted of cultivated plains open and easy except for a few isolated low rocky hills in Bharatpur State.

The party also combined with No. 13 Party (*vide* page 20) in an experimental aeroplane survey on a scale of approximately  $3\frac{1}{2}$  inches = 1 mile of an area comprising 125 square miles in the Bharatpur State of the Rājputāna Agency, 398 square miles in the Agra district and 7 square miles in the Muttra district of the United Provinces, the whole consisting of cultivated plains except for the few rocky out-crops in the neighbourhood of Fatehpur Sikri.

Half this area was also surveyed on the scale of 2 inches = 1 mile.

The large scale survey of Mount Abu and vicinity commenced in July 1919 on the scale of 24 inches = 1 mile comprising a total area of 5,076 acres was completed (*vide* page 42).

**17. No. 3 Party.**—This party surveyed an area of 1,327 square miles mainly on the scale of 2 inches = 1 mile in the Garhwāl, Almorā and Naini Tal districts of the United Provinces, and triangulated an area of 1,250 square miles in Garhwāl and Almorā districts and in Tehri-Garhwāl State.

The survey of Kumaon hills is being executed chiefly in the interests of the Forest Department, (*vide* page 16) and the maps for that department, as well as the public edition, will be published on the scale of 2 inches = 1 mile.

**18. No. 4 Party.**—This party continued in abeyance until June 1920, when preparations for taking the field were commenced. Later, however, it was decided that the party should not take the field, and these preparations were discontinued in September 1920.

**19. Training.**—17 pupil surveyors were entertained and, in addition, 5 vacancies caused by resignation and discharge of men entertained in 1918 and 1919 were filled up by recruitment of new men, thus

making a total of 22 men. Of these 18 were under instruction in drawing and 4 in computations as pupil computers during recess, at the close of which the pupil surveyors will take the field with No. 2 Party for training in survey. The pupil surveyors entertained in 1918 and 1919, who received training in the plains in No. 2 Party, were distributed for further training in hill survey during the coming field season as follows:—

|                  |            |
|------------------|------------|
| To No. 1 Party   | ... 16 men |
| "    "    3    " | ... 16 "   |

The soldier surveyors undergoing their first period of training were posted as follows for training in survey during the coming field season:—

|                                  |          |
|----------------------------------|----------|
| 4 men (1st year) to No. 2 Party. | (Plains) |
| 5 men (2nd year) to No. 1 Party. | (Hills)  |
| 5 men (2nd year) to No. 3 Party. | (do.)    |

**20. Recess Work.**—The progress of fair-mapping was retarded owing to the special drawing which had to be undertaken by this Circle on a number of the N.W. Frontier sheets in connection with additional surveys done recently on those sheets by the Waziristān Survey Party, and by special mapping connected with East Persia.

The fair-mapping of the following sheets of the current and previous season's survey remained for completion on 30th September 1920:—

|                            |        |
|----------------------------|--------|
| Sheets on the 1-inch scale | ... 21 |
| Sheets on the 2-inch scale | ... 16 |
| Sheets on the ½-inch scale | ... 2  |
| Town guide Maps            | ... 2  |

**21. Record Section.**—This section has been formed for the preparation of triangulation data and charts for publication of the triangulation pamphlets. It also deals with the custody and issue of triangulation and traverse records, printed maps, office copies of printed maps, original plane-table sections and office forms &c.

**22.** Particulars of special work done by Nos. 1, 2, 3, 22 and the Sind-Sāgar Parties will be found on pages 18, 42 and 43.

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

**23. No. 5 Party.**—This party surveyed an area of 3,027 square miles on the scale of 1 inch = 1 mile in the Chhindwāra, Seoni, Narhsinghpur and Bālāghāt districts of the Central Provinces. The country consisted of jungle-clad hills and well-wooded cultivated plains.

**24. No. 6 Party.**—This party surveyed an area of 4,191 square miles on different scales in the Bijāpur and Dhārwar districts of Bombay, the Bellary district of Madras and the Raichūr, Mahbūbnagar and Atrāf-i-balda districts of Hyderābād (Deccan), and triangulated an area of 60 square miles in the Atrāf-i-balda districts of Hyderābād, (Deccan). The country surveyed is mostly undulating and cultivated, except the wooded hills of the forest areas.

**25. No. 7 Party.**—This party did not take the field during the year, but remained in Bangalore engaged on half-inch mapping and the preparation of triangulation pamphlets and charts from materials supplied by this and other parties of the Southern Circle.

**26. No. 8 Party.**—This party surveyed an area of 4,673 square miles on the scale of 1 inch = 1 mile in the Tinnevely and Rāmnād districts of Madras. The area surveyed comprised undulating plains, highly

cultivated and thickly dotted with tanks and scattered huts and villages. In the coastal tracts there were numerous patches and belts of palmyra palms, which were a marked feature of the country.

**27. Training Section.**—After a preliminary course of instruction in the vicinity of Bangalore in plane-tableing for about a month and a half, 20 pupil surveyors were given instruction in field surveys on the scale of  $1\frac{1}{2}$  inches = 1 mile in the Anantapur district of Madras about 100 miles north of Bangalore. At the close of the field season in April 1920 six of these pupils were sufficiently advanced to be transferred to parties in recess and seven more, after further training in No. 4 Drawing Office, were sent to parties in August to assist in the drawing of fair maps. Of the remaining seven two were discharged and five were considered likely to be efficient detail surveyors after further training in field work during next field season. The training of eight probationers for the Upper Subordinate Service was taken up in May 1920 but at the close of the survey year only three of these were considered suitable for final retention and the remainder were permitted to resign their appointments.

**28. Recess Work.**—The fair maps of the whole area surveyed this year, with the exception of 4 half-inch sheets of No. 6 Party, have been completed. These sheets will be finished long before the next recess season, as that party is not taking the field during 1920-21. Half-inch mapping from published modern one-inch sheets and quarter-inch mapping are dealt with on page 39.

**29.** The report on the survey of cantonments and military stations undertaken by No. 20 Party appears on pages 18 and 19.

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

**30. No. 9 Party.**—This party surveyed an area of 2,344 square miles on the scales of  $1\frac{1}{2}$  inches and 1 inch = 1 mile in the neighbourhood of Calcutta, work falling in districts Nadiā, Jessore, Khulnā, Twenty-four Parganas, Hooghly and Howrah.

The country surveyed, being in the plains of Bengal, is absolutely flat and covered with marshes, *bils* and tanks; it is densely populated and the villages are large and well wooded; the country immediately round Calcutta and along both banks of the Hooghly is congested with buildings and factories.

The city of Calcutta was not resurveyed, but reductions were taken from the latest large scale maps and revised on the ground.

Towards the south work reached the Sunderbans area, where the country is cut up with tidal rivers and creeks.

**31. No. 10 Party.**—This party surveyed a total area of 3,239 square miles on the scales of 1 inch and  $\frac{1}{2}$  inch = 1 mile, in the Myitkyinā, Putao and Upper Chindwin districts and unadministered territory of Upper Burma. In Myitkyinā and Upper Chindwin districts, the area surveyed consisted mostly of hills covered with dense forest growth, ranging in altitude from 700 feet in the valley of the Uyu river to 11,000 feet above mean sea level on the Kumon Bum range. In Putao district the area comprised a portion of the drainage of the Mali Hka and 'Nuai Hka rivers and ranged in altitude from 1,900 feet to 19,000 feet.

A camp of three surveyors, under an Upper Subordinate officer, remained in Putao district during the summer to complete the detail survey of that portion of the district usually under snow in the winter.

**32. No. 11 Party.**—Survey operations were continued in Lower Burma, in the Mergui district where 1,631 square miles were surveyed on the scale of 1 inch = 1 mile, and 1,629 square miles were triangulated in advance for detail survey.

The party also surveyed, for military requirements, 103 square miles of country in the Hanthawaddy district, on the scale of 3 inches = 1 mile (*Vide* page 44).

A surveyor was also deputed to accompany the Assistant Superintendent, North Hsenwi, Northern Shan States, for the demarcation and resurvey of a portion of the Burma-China boundary in the Kokang district. (*Vide* page 44).

The country surveyed in the Mergui district comprises the upper reaches of the Ngawun stream hitherto *terra incognita*, Kesseraing island, and the lower basin of the Lenya river. The inland portion consists of intricate hills rising to 4,000 feet in elevation at the main watershed. Both hills and valleys are densely wooded. Towards the sea coast the country is cut up by numerous creeks and fringed with mangrove swamps.

**33. No. 12 Party.**—This party surveyed an area of 1,967 square miles on the scales of 2 inches, 1 inch and  $\frac{1}{2}$  inch = 1 mile, in the districts of Lakhimpur, Bālipārā Frontier Tract, Khāsi and Jaintiā Hills, Sylhet, Cāchār and Nowgong. An area of 1,801 square miles of triangulation and 232 linear miles of traversing, covering an area of 173 square miles, was carried out in the districts of Khāsi and Jaintiā Hills, Sylhet, Cāchār, Nowgong and Nāgā Hills in advance of detail survey.

The area surveyed in the districts of Lakhimpur and Sylhet was flat country partly covered with dense jungle and partly cultivated. The remaining districts consisted of partly open and partly densely wooded hills rising to about 6,000 feet.

**34. No. 21 (Burma Forest) Party.**—Particulars of work done by this party will be found on page 17.

The area, over which operations extended, is hilly with forest growth of varying density.

**35. Recess Work.**—Only 1 one-inch sheet out of 31 one-inch and half-inch sheets surveyed during the year under report, was received in the circle drawing office for publication up to 30th September 1920. Most of the remaining sheets will be fair-mapped by the parties before the close of this recess season.

The fair-mapping of 2 half-inch sheets of season 1917-18 and 5 one-inch and 2 half-inch sheets of season 1918-19 was in arrears on 30th September 1920.

## II.—FOREST SURVEYS.

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

### NORTHERN CIRCLE.

37. **United Provinces. Kumaun Forest Circle.**—The following areas which include non-forest areas were triangulated in advance for future detail surveys on the 2-inch scale:—

|   |     |     |        |        |
|---|-----|-----|--------|--------|
| In the <i>North Garhwāl Forest Division</i> | ... | 280 | square | miles. |
| <i>South</i> "       "       "              | ... | 480 | "      | "      |
| <i>East Almorā</i> "       "                | ... | 220 | "      | "      |
| <i>Rānīkhet</i> "       "                   | ... | 88  | "      | "      |

In addition detail surveys on the scale of 2 inches = 1 mile were carried out as follows.

|   |     |     |        |        |
|---|-----|-----|--------|--------|
| In the <i>Nainī Tal Forest Division</i> | ... | 36  | square | miles. |
| <i>Central Almorā</i> "       "         | ... | 248 | "      | "      |
| <i>East Almorā</i> "       "            | ... | 57  | "      | "      |
| <i>Rānīkhet</i> "       "               | ... | 155 | "      | "      |

**Western Forest Circle.**—No surveys were carried out in this circle during the year, but some additional expenditure in connection with the survey of 1918-19 in the *Chakrātā Forest Division* was incurred during the year under report.

### SOUTHERN CIRCLE.

38. **Madras. Southern Forest Circle.**—In the *Tinnevelly Forest Division* 1·8 and 1·1 square miles were surveyed on the 2-inch scale of the *Milavittān*, and *Valliyūr* and *Extension Reserved Forests* respectively.

### EASTERN CIRCLE.

39. **Assam. Western Forest Circle.**—In the *Cāchār Forest Division* 133 square miles of the *North Cāchār* and *Barail Reserved Forests* were surveyed on the scale of 2 inches = 1 mile, and 27·2 miles of boundaries were traversed of these Reserves including that of *Krungmin*. In the *Khasi and Jaintia Hills Forest Division*, 62 square miles of *Blocks I and II* of the *Narpuh Reserved Forest* were surveyed on the scale of 2 inches = 1 mile, and 33·8 miles of their boundaries were traversed.

**Eastern Forest Circle.**—In the *Lakhimpur Forest Division* 80 square miles of the *Dulong*, *Kakoi* and *Rangā Reserved Forests* were surveyed on the scale of 2 inches = 1 mile, and 60·8 miles of the boundaries of the two latter Reserves were traversed. In the *Nowgong Forest Division* 21·4 miles of the boundaries of *Rangkhang*, *Habaipur* and *Barpāni Reserved Forests* were traversed, and an area of 13 square miles of the last named Reserve was surveyed on the scale of 2 inches = 1 mile.

**40. Burma. Tenasserim Forest Circle.**—In the *Tenasserim Forest Division* an area of 281 square miles of the Ngawun Chaung Reserve was surveyed on the scale of 1 inch = 1 mile.

**No. 21 Party.—Burma. Northern Forest Circle.**—In the *Kathā Forest Division*, 6·1 miles of the boundary and 16·8 miles of interior lines of the Mezabya Reserve were traversed as a preliminary to future detail survey. In the *Mansi Forest Division*, 14 miles of the boundary and 7·5 miles of interior lines of the Mode and Hwelit Reserves were traversed, and in addition an area of 34·7 square miles was surveyed on the 4-inch scale of the whole of the Reserve of Nansiaung and three Extension Blocks and parts of Chaunggyibya and Mode.

**Southern Forest Circle.**—In the *Meiktila and Southern Shan States Forest Divisions* areas of 70·4 and 12 square miles were surveyed on the 2-inch scale respectively of the following Reserves:—Myittha, Pyinyaung, Yebokson East and West Blocks, which were completed, and Magwe of which only a portion was surveyed. Traverses of 149·8 miles of the forest boundaries and 13·8 linear miles of interior lines were carried out in the Reserve of Yupadaung of the former division and in Magwe, Wetpyuye and Kalaw Reserves of the latter division.

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

**41. No. 1 Party.**—An area of 24·7 square miles of Lahore City and environs was surveyed on the scale of 12 inches to a mile from new aerial mosaics prepared by the party; 10·9 square miles of Ferozepore City and environs were also surveyed on scales of 16 inches and 6 inches = 1 mile from similar aerial mosaics. Details of the Mussoorie survey will be found on page 42.

**42. No. 2 Party.**—The fair drawing of the "Town Guide" and "Environs" maps of Agra, Allahābād, Benares and Cawnpore has been completed and the maps submitted for publication.

Considerable delay occurred in the supply of the prints required from the aeroplane survey, carried out in 1918-19, for the preparation of the maps of Lucknow City; this was due to the Royal Air Force squadron being withdrawn for other duties. The fair drawing will not be completed before February 1921. Details of the survey of Mount Abu will be found on page 42.

**43. No. 3 Party.**—(*Simla Survey Detachment*).—This detachment surveyed an area of 1,270 acres on the scale of 220 feet = 1 inch, completing the area required for the Simla extension scheme. The area surveyed was mapped in 10 sheets by No. 3 Drawing Office, the mapping of 8 sheets of the previous season's survey being completed by the detachment.

**44. No. 20 Party.**—During the year under report the party completed the survey of the cantonments and military lands of Secunderābād and Bolārum, St. Thomas's Mount, Pallāvaram, Fort St. George, Poonamallee, Cannanore and Velichi military district land, on the 16-inches to a mile scale, and the revision of surveys, executed in 1908-09 of the bāzārs of Secunderābād and Bolārum on the scale of 50 feet to one inch.

The survey of Wellington and military lands, and the revision of Bangalore Civil and Military Station on the scale of 16-inches to a mile, and the bāzārs of St. Thomas's Mount, Poonamallee, Pallāvaram and Cannanore on the scale of 64-inches to a mile are in progress.

The traversing and triangulation of Wellington, Fort St. George and military district lands, Pallāvaram, Velichi military district land, Poonamallee, Cannanore for 16 and 64-inch surveys and the General, Shūle and Halsūr bāzārs of Bangalore have been completed.

Levelling of 57·5 linear miles was undertaken in cantonments on which to base the traverse heights at a cost-rate of Rs. 50·7 per linear mile.

The fair mapping of the following cantonments and military lands have been completed during the year:—Aurangābād, Hosūr, Ahmadnagar, Jhānsi, Manora and Bellary.

49 sheets have been fair mapped and submitted to press and 90 are at different stages of completion.

The out-turn on the 16-inches to a mile scale of original survey was 14,449 acres and of revision survey 1,925 acres, and that on the 64-inches to a mile scale was 441 acres; 57 plans of 943 acres of the Secunderābād and Bolārum bāzārs on the scale 50 feet to 1-inch, originally surveyed in 1908-09, were also revised.

The cost-rate of original detail survey on the scale of 16-inches to a mile was Rs. 1·7 per acre and the average daily out-turn per surveyor 11·2 acres; the cost-rate of revision survey on this scale was Rs. 0·9 per acre, and the average daily out-turn per surveyor 27·50 acres, the

corresponding figures for survey on the scale of 64 inches to a mile being Rs. 19·6 per acre and 1·03 acres per surveyor respectively.

The testing in linear miles per square mile of survey on the 16 and 64-inch scales is 3·6 and 13·4 respectively, and 10 linear miles per square mile for the 50-foot revision.

The cost-rate of revision survey of 57 plans of Secunderābād and Bolārum bāzārs comprising an area of 943 acres on the scale of 50 feet to an inch was Rs. 7·9 per acre; the average daily out-turn of revision per surveyor was 2·3 acres.

The cost-rate of triangulation and traversing for all scales of survey was Rs. 0·18 per acre, the daily out-turn per traverser being 9 stations and 0·8 linear miles, the number of stations being 13 to a linear mile.

The daily out-turn of traversing for the 50 feet to the inch original survey of bāzārs in Bangalore was 15 stations and 0·48 linear miles; the number of stations being 31 to a linear mile.

The total area fair-mapped was 12,988 acres on the 16-inch scale and 164 acres on the 64-inch scale, and corrections and additions to 77 plans of 1,226 acres on the scale of 50 feet to the inch were completed.

The cost-rate of fair-mapping on the 16-inch scale was Re. 0·6 per acre, that for the 64-inch scale being Rs. 5·9 per acre.

The cost-rate of correcting 77 fair sheets on the 50-foot scale of surveys executed in 1908-09 of the Secunderābād and Bolārum bāzārs was Rs. 3·3 per acre.

**Alphabetical List of Cantonments and Military Stations surveyed and published in modern style, on the scale of 16 and 64 inches = 1 mile, up to the end of 1919-20.**

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

## IV.—THE TRIGONOMETRICAL SURVEY.

## GEODETTIC OPERATIONS.

45. No. 13 Party.—Astronomical.—No latitude operations were carried out during the year under report. The personnel of this party was employed at the Head Quarters Office of the Trigonometrical Survey for the greater part of the year but during February and March 1920 was employed on aeroplane survey at Agra and surrounding area, *vide* page 12.

46. No. 14 Party.—Pendulum.—No pendulum operations were carried out during the year under report and the personnel of this party was reduced to a minimum and employed in miscellaneous work.

47. No. 15 Party.—Triangulation.—The party did not take the field during field season 1919-20.

48. No. 16 Party.—Tidal Operations.—During the year under report tidal registrations were carried out by means of self-registering tide-gauges at the stations given in the following list:—

| Stations.                 | Date of commencement of observations. | Date of closing of observations. | Number of years of observations. | REMARKS.                  |
|---------------------------|---------------------------------------|----------------------------------|----------------------------------|---------------------------|
| 1. Aden ... ..            | 1879 ...                              | Still working                    | 41                               | *With a small tide-gauge. |
| 2. Karāchi ... ..         | { 1868 ...                            | 1886                             | *18                              |                           |
|                           | { 1881 ...                            | Still working                    | 89                               |                           |
| 3. Bombay (Apollo Bandar) | 1878 ...                              | "                                | 42                               |                           |
| 4. Bombay (Prince's Dock) | 1888 ...                              | "                                | 32                               |                           |
| 5. Madras ... ..          | { 1880 ...                            | 1890                             | 10                               |                           |
|                           | { Restarted 1895                      | Still working                    | 25                               |                           |
| 6. Kidderpore ... ..      | 1881 ...                              | "                                | 39                               |                           |
| 7. Rangoon ... ..         | 1880 ...                              | "                                | 40                               |                           |
| 8. Moulmein ... ..        | { 1880 ...                            | 1886                             | 6                                |                           |
|                           | { Restarted 1909                      | Still working                    | 11                               |                           |
| 9. Port Blair ... ..      | 1880 ...                              | "                                | 40                               |                           |

In addition to the above, the actual records of high and low water at Bhaunagar, Chittagong and Akyab were obtained from tide-pole readings taken during daylight by the Port Officers concerned.

Hourly readings throughout the day and night were carried out at Basrah on an ordinary wooden tide-pole by the Military authorities, and a copy of these readings was supplied weekly throughout the year to this department by the Director, Inland Water Transport, Mesopotamia. The observations for the year commencing 1st January 1919 were reduced by the method of harmonic analysis, and the constants thus deduced were used in the computations of data for the Basrah tide-tables for 1921.

These data were forwarded on the 18th December 1919 to the Director, National Physical Laboratory, Teddington, England, for the preparation of the tide-tables with the aid of the tide-predicting machine.

The tide-tables for 1921 have not been received as yet.

Tidal registrations at the nine observatories now working have, on the whole, been carried out satisfactorily and will be continued during the coming year.

The above observatories were all inspected during the year under report, and, in addition, the proposed site for a tidal observatory at Tavoy was also inspected. This was found to be unsuitable, and as no other suitable site was located, the question of a tidal observatory at Tavoy is being held in abeyance by the Burma Government.

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

PERCENTAGE OF ERRORS IN PREDICTED TIMES AND HEIGHTS.

| Year.                | AT OPEN COAST STATIONS. |                               |                             |                             |   | AT RIVERAIN STATIONS.         |                     |                             |   |            |           |           |           |           |
|----------------------|-------------------------|-------------------------------|-----------------------------|-----------------------------|---|-------------------------------|---------------------|-----------------------------|---|------------|-----------|-----------|-----------|-----------|
|                      | Number of Stat. ns.     | IN TIME.                      |                             | IN HEIGHT.                  |   |                               | Number of Stations. | IN TIME.                    |   | IN HEIGHT. |           |           |           |           |
|                      |                         | Within 15 minutes of actuals. | Within 8 inches of actuals. | Within 8 inches of actuals. | Within $\frac{1}{10}$ of mean range at springs. | Within 15 minutes of actuals. |                     | Within 8 inches of actuals. | Within $\frac{1}{10}$ of mean range at springs. |            |           |           |           |           |
|                      |                         |                               |                             |                             |   |                               |                     |                             |   | H.W.—L.W.  | H.W.—L.W. | H.W.—L.W. | H.W.—L.W. | H.W.—L.W. |
| 1910                 | 6                       | 81                            | 83                          | 98                          | 98  | 95                            | 96                  | 3                           | 57  | 52         | 68        | 71        | 89        | 94        |
| 1911                 | 6                       | 84                            | 84                          | 98                          | 99  | 97                            | 98                  | 3                           | 65  | 51         | 68        | 66        | 90        | 90        |
| 1912                 | 6                       | 82                            | 82                          | 97                          | 98  | 97                            | 98                  | 4                           | 70  | 58         | 74        | 62        | 94        | 91        |
| 1913                 | 6                       | 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         | 78        | 67        | 94        | 92        |
| 1916                 | 6                       | 81                            | 82                          | 96                          | 97  | 96                            | 99                  | 3                           | 81  | 68         | 73        | 62        | 98        | 87        |
| 1917                 | 6                       | 75                            | 72                          | 96                          | 98  | 96                            | 97                  | 3                           | 78  | 65         | 69        | 64        | 92        | 88        |
| 1918                 | 6                       | 88                            | 82                          | 97                          | 97  | 97                            | 96                  | 3                           | 76  | 68         | 66        | 65        | 90        | 89        |
| 1919                 | 6                       | 78                            | 75                          | 96                          | 97  | 97                            | 98                  | 3                           | 74  | 65         | 70        | 69        | 98        | 92        |
| Average of ten years | ...                     | 81                            | 80                          | 97                          | 98  | 97                            | 98                  | ...                         | 72  | 61         | 70        | 64        | 92        | 90        |

50. No. 17 Party.—Levelling.—Two double detachments were employed during the past season on the levelling operations mentioned below:—

(a) & (b).—In the Punjab.

Revision of the line from Ferozepore *via* Moga and Jagraon to Ludhiāna along the Ludhiāna-Ferozepore road. (Part of line 61).

New line from Amritsar *via* Jullundur and Phillaur to Ludhiāna along the Grand Trunk road. (New line 56 F). This is part of line 137 of the New Level Net.

(c) & (d).—In the Sind-Sāgar Doāb.

New line from Shāhpur T.S. *via* Leiah and Khairāwāla to Shorkot Road railway station.

New line from Khairāwāla *via* Jandānwāla to near Wānbhachrān railway station.

(e) & (f).—In Assam and Bengal.

Revision of the line from Silchar *via* Karimganj to Comilla (Line 77 H and part of 77 F).

(g).—In the U. P.

Revision of the section Bareilly to Lucknow (Part of line 64).

Lines (a) and (b) were undertaken owing to loss of bench-marks on old lines and to complete circuits.

Lines (c) and (d) were new lines levelled at the request of the Irrigation Department of the Punjab.

Lines (e) and (f) were relevelled to ascertain whether any crustal subsidence had taken place during the Srimangal earthquake of 8th July 1918.

Line (g) was revised owing to the loss of old bench-marks due to time.

The total out-turn was 358 miles of primary levelling of high precision and 424 miles of secondary levelling of precision.

The heights of 16 primary and 534 secondary bench-marks were determined.

Very interesting results were obtained by the relevelment of the Silchar-Couilla line, which showed that definite subsidence had occurred on one side of the geological fault in the earthquake area.

A system has been drawn up by which it is hoped that in future all levelling asked for by the Irrigation, Public Works, and other government departments can be undertaken within a reasonable time on payment by the departments concerned.

**51. No. 19 Party.—Base Line Operations.**—No work was undertaken by this party during the year under report. The officers and establishment posted to it from time to time for administrative purposes were employed on miscellaneous work.

### MAGNETIC SURVEY.

**52. No. 18 Party.—Magnetic.**—Since the magnetic elements undergo very appreciable changes within a short space of time, it was decided to take observations at the repeat stations at intervals of every five years in order to obtain reliable values of the annual changes; hence the repeat stations, which were observed at in 1914-15, were visited again in 1919-20. Three detachments were employed in completing the field season's programme which comprised observations to determine the declination, dip and horizontal force at the 75 repeat stations in India, Burma and Ceylon and at 5 new stations which were selected this season and permanently marked, two being in Upper Burma, one in Lower Burma, one in Bengal and one in Assam: these 5 extra stations were much needed for shaping the true course of the lines of equal annual change in these particular localities. Complete sets of observations were also taken at the Dehra Dūn, Toungoo, Kodaikānal and Alibāg observatories for the comparison of instruments.

#### *Publication of the results of the Magnetic Survey to epoch.*

It is regretted that the publication of the results of the magnetic survey from 1901 to 1915 and reduced to the epoch 1909·0, which was promised last year, will not be available before the coming year. It has been considered advisable to revise the constants of all the instruments employed, in order to obtain a more accurate determination by utilizing the additional data derived in recent years. It has now, therefore, been decided to recompute the results with greater refinement, and, as observations have been taken this season at the repeat stations, to include all the recent observations and bring the publication up to 1st January 1920.

The reduction of the observations of the detail survey will next be taken in hand and revised. The results of the disturbed areas will then be studied to ascertain whether these areas exhibit any prominent magnetic features. It is doubtful, however, whether the investigation of the latter results will reveal any definite sources of attraction as the

observations in the disturbed areas are very conflicting and appear to show that the disturbances are of a purely local nature, depending entirely upon the unequally magnetized rocks hidden close below the ground surface.

*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 1919 have been completed: the mean values of these elements derived from all days, excluding those of great disturbances, are given in the table below:—

MEAN VALUES OF THE MAGNETIC ELEMENTS AT OBSERVATORIES IN 1919

| Observatory.   | Latitude<br>&<br>Longitude.      | Dip.      | Declination. | Horizontal<br>Force. | Vertical<br>Force. |
|----------------|----------------------------------|-----------|--------------|----------------------|--------------------|
|                | °   '   "                        | °   '   " | °   '   "    | C. G. S.             | C. G. S.           |
| Dehra Dūn ...  | { 30 19 19 N }<br>{ 78 3 19 E }  | N 44 54·8 | E 1 56·1     | ·32962               | ·32863             |
| Toungoo ...    | { 18 55 45 N }<br>{ 96 27 3 E }  | N 23 8·3  | W 0 20·2     | ·39097               | ·16707             |
| Kodaikānal ... | { 10 13 50 N }<br>{ 77 27 46 E } | N 4 33·5  | W 1 44·5     | ·37753               | ·03010             |

## PART 3.—OFFICE WORK.

### I.—HEAD QUARTER OFFICES.

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

53. 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. 56 to 60, 67, 68 and 73.

Work under war conditions ceased shortly after the commencement of the year; the requisitions by the Army for maps, &c., have largely diminished in consequence. The demand for instruments has, however, remained much above the normal.

54. No. 6 Drawing Office at Simla was placed under the Superintendent, Map Publication, during the year.

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

- (a) Topographical maps on the scale of 1 inch = 1 mile.
- (b) Topographical maps on the scale of  $\frac{1}{2}$  inch = 1 mile.
- (c) Topographical maps on the scale of  $\frac{1}{4}$  inch = 1 mile.
- (d) Geographical maps on the 1:1,000,000 scale (about 1 inch = 16 miles).
- (e) Geographical maps on the 1:2,000,000 scale (about 1 inch = 32 miles).
- (f) General maps on smaller scales.
- (g) Special maps.

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

(a) **Topographical maps on the scale of 1 inch = 1 mile.—**

During the year 104 modern sheets have been published. This is a considerable increase on the number published during the previous year.

Index map No. 2 at the end of this report shows the progress made in the publication of the modern 1-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 1-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               | 26              | 115    |
| 1911-12  | 68                                 | 33               | 58              | 159    |
| 1912-13  | 104                                | 60               | 58              | 222    |
| 1913-14  | 71                                 | 38               | 49              | 158    |
| 1914-15  | 97                                 | 48               | 9               | 154    |
| 1915-16  | 85                                 | 69               | 50              | 204    |
| 1916-17  | 23                                 | 40               | 22              | 85     |
| 1917-18  | 18                                 | 12               | 13              | 43     |
| 1918-19  | 32                                 | 19               | 6               | 57     |
| 1919-20  | 15                                 | 37               | 52              | 104    |
| Total Published  | 691                                | 491              | 501             | 1,683  |
| Probable number of 1-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 $\frac{1}{4}$ -inch scale | 911                                | 564              | 473             | 1,948  |
| Approximate number remaining for publication   | 550                                | 974              | 1,063           | 2,587  |
| Approximate number of public 1-inch sheets in India  | 2,152                              | 2,029            | 2,037           | 6,218  |

1 one-inch sheet of those surveyed during 1915-16, 4 one-inch sheets of those surveyed during 1916-17, 9 one-inch sheets of those surveyed during 1917-18 and 31 one-inch sheets of those surveyed during 1918-19, remain to be published.

In addition to the above, preliminary editions (in colours) of 13 one-inch sheets, prepared from modern revenue surveys, have been published during the year pending their topographical revision. 11 "Village boundary" editions of modern one-inch sheets have been published for Local Governments.

94 modern one-inch, 6 preliminary editions of one-inch, and 22 old style one-inch sheets have been reprinted during the year.

(b) **Topographical Maps on the scale of  $\frac{1}{2}$  inch=1 mile.**—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 $\frac{1}{2}$ -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     |
| Totals ... ..  | 187   | 29                           | 216    |
| Approximate number of half-inch sheets in India ... .. | .....   | .....                        | 1,630  |

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

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

(c) **Topographical maps on the scale of  $\frac{1}{4}$  inch=1 mile.**—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.

The production of these maps is still delayed owing to the more urgent work on those of the half-inch scale.

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*     |
| Totals ... ..   | 15                                   | 12               | 33              | 60†    |
| Approximate number of "degree" sheets in India ... .. | 170                                  | 140              | 140             | 450    |

\* 7 of these were drawn in No. 1 Drawing Office.

† 20 of these are preliminary editions, having been prepared from surveys (on various scales) prior to 1905.



7 preliminary sheets in colours from comparatively modern surveys have been published and 11 are in hand.

In addition to the above, 1 modern public quarter-inch sheet has been reprinted during the year.

14 "degree" sheets have been prepared in No. 1 Drawing Office from the old engraved quarter-inch Atlas sheets, brought up to date and published (in black only) as provisional issues; and 8 of such sheets which were published previously have been reprinted during the year. These "provisional" degree sheets, including those in hand, now cover the greater part of the area of India for which modern "degree" sheets are not likely to be available for some time.

(d) **Geographical Maps on the 1:1,000,000 scale.**—(i) **The "India and Adjacent Countries" Series** (*Vide* Index map No. 5).—During the year 2 new sheets of this series have been published, 3 sheets have been engraved and 6 modernized and republished to supersede old editions, and 23 sheets have been reprinted.

(ii) **La Carte Internationale du Monde.**—(*Vide* Index map No. 6).—A full description of the genesis of this series was given in the General Report for 1913-14; 3 sheets of this series have been published during the year, 8 sheets have been published up to date.

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

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

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

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

"Town-guide" maps, on the scale 12 inches = 1 mile, of several of the larger Indian cities are under preparation; the Calcutta-Howrah "Town-guide" map (in 16 sheets) was completed during the year, also the maps of Rāwalpindi and Campbellpore.

The maps Simla Mahasu (in 10 sheets) and Simla Mashobra (in 14 sheets) on the scale of 220 feet to 1 inch of the Simla extension surveys have been published.

A map of Bombay City (in 12 sheets) was published on the scale of 400 feet to 1 inch from reductions of the Bombay City Surveys of 1914-1918.

**56. Map Record and Issue Office.**—An Imperial Officer was attached exclusively to this office during the year. The work is being placed as far as possible on a commercial basis and considerable changes in the routine methods have taken place.

To meet the demands for more up to date information in respect of the maps that are available, a new catalogue is under preparation and will be issued early next year.

The reduction in demand is due to the cessation of military operations.

## OFFICE WORK.—HEAD QUARTER OFFICES.

27

The issues on cash payment still increase steadily.

Issues.—FROM MAP RECORD AND ISSUE OFFICE, 1919-20.

| YEAR.   |                              | ON BOOK DEBIT<br>(TO GOVERNMENT<br>OFFICIALS). |              | ON CASH PAY-<br>MENT (TO PRI-<br>VATE INDIVI-<br>DUALS AND MAP<br>AGENTS). |              | FREE ISSUES<br>(DEPARTMENTAL<br>AND TO INDIA<br>OFFICE). |              | TOTAL.                             |              |
|---------|------------------------------|--|--------------|--|--------------|--|--------------|------------------------------------|--------------|
|         |                              | Number<br>of<br>Printed<br>Copies.             | Value<br>Rs. | Number<br>of<br>Printed<br>Copies  | Value<br>Rs. | Number<br>of<br>Printed<br>Copies.                       | Value<br>Rs. | Number<br>of<br>Printed<br>Copies. | Value<br>Rs. |
| 1919-20 | Depart-<br>mental.           | 108,027  | 59,290       | 35,683   | 41,086       | 48,190   | 41,157       | 191,900                            | 1,41,533     |
|         | Extra-<br>depart-<br>mental. | 1,163,824                                      | 1,07,533     | 101,288  | 14,382       | 28,854   | 9,702        | 1,293,966                          | 1,31,617     |
|         | Total ...                    | 1,271,851                                      | 1,66,823     | 136,971  | 55,468       | 77,044   | 50,859       | 1,485,866                          | 2,73,150     |
| 1918-19 | Total ...                    | 2,227,010                                      | 3,87,085     | 101,322  | 47,663       | 37,204   | 32,539       | 2,365,436                          | 4,67,287     |
| 1917-18 | Total ..                     | 795,810  | 2,12,861     | 39,183   | 35,795       | 48,550   | 39,382       | 883,543                            | 2,88,038     |

Table IV.—Publications received in Map Record &amp; Issue Office, 1919-20.

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

| Class of Maps.   | Scale.      | NUMBER OF DIFFERENT MAPS OF EACH CLASS RECEIVED. |                            | Number of copies printed. | Value.          |
|--|-------------|--|----------------------------|---------------------------|-----------------|
|  |             | New Publications.                                | Reprints and New Editions. |                           |                 |
| <b>DEPARTMENTAL.</b>   |             |  |                            |                           |                 |
| <b>GENERAL MAPS.</b>   |             |  |                            |                           | <i>Rs.</i>      |
| Maps of India ... ..   | Various     | ...  | 4                          | 3,900                     | 8,000           |
| <b>GEOGRAPHICAL MAPS.</b>                                      |             |  |                            |                           |                 |
| Map of India ... ..  | 1"=32 miles | ...  | ...                        | ...                       | ...             |
| Southern Asia Series ... ..                                    | 1:2,000,000 | ...  | ...                        | ...                       | ...             |
| India and Adjacent Countries Series                            | 1:1,000,000 | 2  | 32                         | 21,500                    | 21,500          |
| La-Carte Internationale du Monde                               | 1:1,000,000 | 3  | ...                        | 900                       | 900             |
| <b>TOPOGRAPHICAL MAPS.</b>                                     |             |  |                            |                           |                 |
| Quarter-inch Modern ... ..                                     | 1"=4 miles  | 1  | 1                          | 2,000                     | 2,000           |
| Do. (Prely.) ... ..  | 1"=4 miles  | 7  | ...                        | 8,540                     | 9,210           |
| Do. (Provl.) ... ..  | 1"=4 miles  | 14   | 8                          | 8,700                     | 8,676           |
| Half-inch Modern ... ..  | 1"=2 miles  | 39   | 3                          | 21,990                    | 22,496          |
| Do. (Prely.) ... ..  | 1"=2 miles  | 1  | ...                        | 500                       | 563             |
| One-inch Modern ... ..   | 1"=1 mile   | 104  | 94                         | 115,955                   | 115,309         |
| Do. (Prely.) ... ..  | 1"=1 mile   | 13   | 6                          | 8,515                     | 8,893           |
| Old Style sheets ... ..  | Various     | ...  | 35                         | 6,310                     | 8,510           |
| <b>SPECIAL MAPS.</b>   |             |  |                            |                           |                 |
| District Maps ... ..   | 1"=4 miles  | ...  | ...                        | ...                       | ...             |
| Administration Report Maps                                     | 1"=8 miles  | ...  | 4                          | 173                       | 65              |
| Provincial Maps ... ..   | Various     | ...  | 2                          | 1,150                     | 1,386           |
| Plans of Cities and Cantonments                                | Various     | 33   | 11                         | 6,500                     | 9,863           |
| Index Maps ... ..  | Various     | 3  | 38                         | 49,900                    | 7,738           |
| Miscellaneous Maps ... ..                                      | Various     | 12   | 22                         | 8,473                     | 8,244           |
| <b>Total</b> ... ..  | .....       | <b>232</b>                                       | <b>260</b>                 | <b>265,006</b>            | <b>233,353</b>  |
| <b>EXTRA-DEPARTMENTAL.</b>                                     |             |  |                            |                           |                 |
| Maps ... ..  | Various     | 135  | 43                         | 292,159                   | 94,540          |
| Plans and diagrams ... ..                                      | Various     | 95   | 10                         | 147,413                   | 16,865          |
| Illustrations ... ..   | .....       | 93   | 16                         | 192,254                   | 28,634          |
| Miscellaneous ... ..   | .....       | 41   | 49                         | 562,639                   | 19,528          |
| <b>Total</b> ... ..  | .....       | <b>364</b>                                       | <b>118</b>                 | <b>1,194,465</b>          | <b>1,59,567</b> |
| <b>Grand Total</b> ... ..                                      | .....       | <b>596</b>                                       | <b>378</b>                 | <b>1,459,471</b>          | <b>3,92,920</b> |
| <b>B.—From the Trigonometrical Survey Office, Dehra Dūn.</b>   |             |  |                            |                           |                 |
| Various ... ..   | .....       | 37   | 17                         | 4,165                     | 4,165           |
| <b>C.—LETTERPRESS.</b>   |             |  |                            |                           |                 |
| 1. Survey of India General Report, 1918-19. Price Rs. 2 or 4s. |             |  |                            |                           |                 |

**57. No. 1 (Head Quarters) Drawing Office.**—This office is divided into six sections each under its own supervising officer.

(1) *The Compilation Section.*—Deals with “La Carte Internationale du Monde au 1,000,000,” with all “Geographical” maps on scales smaller than the 1:1,000,000, and with miscellaneous work.

(a) “La Carte Internationale du Monde au 1,000,000”. One sheet has been sent to press, another is ready for the press and patterns for the engraving of four sheets are under preparation.

(b) The Southern Asia Series, scale 1:2,000,000. Patterns for the engraving of five sheets are at different stages of completion.

(c) The most important “miscellaneous” maps dealt with by this section have been the “Town-guide” map of Nowshera which has been completed and sent to press, and the map of the island of Bombay originally prepared in 12 sections by the Bombay City Survey which was rearranged into 10 sections, and the sheets sent to press.

In addition to the above this section also prepared and sent to press the following:—(i) index, on 1/5 M scale showing surveys and publications of 1-inch sheets (ii) border specimen for 1-inch, ½-inch and ¼-inch sheets and (iii) the stump shaded originals of 3 one-inch sheets. The preparation of a revised type table for topographical maps is also in hand.

(2) *The “One-Millionth” Section.*—Is responsible for all maps of the “India and Adjacent Countries” Series on the 1:1,000,000 scale.

(a) Engraved Editions.—The patterns for six sheets have been completed and sent to the Engraving Office and those for four sheets are still in hand.

(b) Helio Editions.—One sheet has been completed and sent to press and another is in hand.

(c) The originals of ten sheets have been corrected and sent to press for reprint.

(3) *The Quarter-Inch Section.*—This section deals with the fair drawing of quarter-inch sheets, either as “Preliminary” editions or as “Provisional” issues compiled mainly from surveys on different scales executed prior to 1905.

(a) Nine “Preliminary” editions have been sent to press and nine “Preliminary” and four “Provisional” sheets are in hand.

(b) During the year under report the correction of 6 original fair sheets for reprint was in hand, 3 have been sent to press.

(4) *The Mapping and Reprint Section.*—Deals mainly with the corrections of fair sheets (both modern and old style) for reprint and also with the fair mapping required for all special maps (whether Departmental or Extra-departmental) on all scales. The latter include a Railway guide map for the Oudh and Rohilkhand Railway and an improved form of grid indicator cards for military purposes.

(a) The fair sheets of 211 published sheets (170 modern and 41 old style) on the 1-inch, ½-inch and ¼-inch scales have been corrected and brought up to date and sent

to press for reprint. In addition 15 fragmentary sheets have been completed to edge from old material as far as possible and 5 sheets have been enlarged, corrected and brought up to date, and sent to press for publication in colours.

- (b) The fair sheets of 90 new one inch topographical sheets from the different circles and drawing offices received for publication have been scrutinised and corrected before being sent to press.
- (c) Press order proof corrections have been inserted on the original fair sheets of 144 modern topographical sheets after publication.
- (d) The fair sheets of 32 special maps on various scales have been drawn for other government departments, etc. and sent to press.

(5) *The Office Copy Section.*—Is mainly employed in maintaining a complete record of all additions and alterations to details on published sheets for incorporation on future editions and reprints of the sheets.

- (a) Additions and corrections have been entered on the existing "office copies" of 2,808 published sheets; 482 "office copies" of newly published or reprinted sheets have also been prepared during the year.
- (b) The miscellaneous work of this section includes the checking and recording of the areas surveyed and contained in all one-inch and half-inch fair sheets received in the Map Publication Office for publication and the supply of authenticated copies of records to officials and private persons.

(6) *The Examining Section.*—Is responsible for the examination of the sheets which are drawn by the other sections in the office and also for the general scrutiny of a large number of sheets, fair drawn in other circles and drawing offices, before publication.

- (a) 176 cases affecting 285 fair sheets have been dealt with by this section during the year.

The variety and amount of miscellaneous work which passes through this section in connection with the fair mapping of the whole department are too large to be separately detailed.

**58. Engraving Office.**—(1) *Engraving Section.* (a) As in the previous year, most of the engravers have continued to be employed on new or modernized editions of maps of the "India and Adjacent Countries" Series, on the 1:1,000,000 scale. Out of seven sheets taken up one has been completed, another has been finished with the exception of the contours, two others are nearing completion whilst the remaining three are well advanced.

Of the "La Carte Internationale du Monde", scale 1:1,000,000, two sheets have been completed and four new sheets projected.

(b) Of the Southern Asia Series, on the 1:2,000,000 scale, two sheets viz. Madras and Brahmaputra, are well in hand.

(c) The new map of India on the 1:4,000,000 scale is in abeyance for the present.

(d) Periodic corrections have been carried out on the plates of all the general maps of India on various scales as also on index charts. The new index chart on the 1:6,000,000 scale for the Annual Report (two plates) has been completed. Miscellaneous work is mostly extra-departmental and includes a plate for the Viceroy's certificate printed on vellum for Territorial units serving in India, also six plates of specimens of lettering for apprentice draftsmen, the engraving of various kinds of scales required for the Army, and of titles on a considerable number of photogravure plates. Several old plates have also been repaired.

(2) *Printing Section*—29,040 impressions were pulled during the year compared with 25,544 during the previous year on the same number of machines. Most of these impressions were extra-departmental orders and consisted of 9,430 photogravure prints, 10,041 scales and 3,465 miscellaneous prints on parchment and vellum for the Army Department. Printing on parchment and vellum from plates is a particularly difficult work requiring special care and skill and this year there was a larger order than usual for such prints. Height indicator card scales pulled from copper plates have been printed on both sides of the cardboard; this is the first time that this has been attempted.

151 plates were dealt with in the Steel-facing section.

**59. Photo-Litho. Office.**—The Litho. out-turn is somewhat smaller than those of the 3 previous years, there having been a considerable decrease in urgent reprinting orders for the Army since the peace terms have been signed. The output therefore has gone back to normal.

One new litho. machine press was received from England near the end of the year.

Engraved maps in colour are now dealt with photographically, as forecasted last year; although the reproduction is not yet perfect, the saving in time and labour is enormous. For one colour work the transfer method is still probably the better.

New processes have been evolved whereby one or more tints can be added to a helio plate by exposure in the printing frame instead of by transferring in a hand press; layer plates are now made without using a camera, the layer original being prepared on glass instead of on paper.

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

TABLE A.

| 1       | 2               | 3                                | 4                       | 5                        | 6      |
|---------|-----------------|----------------------------------|-------------------------|--------------------------|--------|
| Year.   | Cost of office. | Value of out-turn at cost-rates. | NUMBER OF MAPS PRINTED. |                          |        |
|         |                 |                                  | Departmental.           | Other than Departmental. | Total. |
| 1917-18 | Rs. 2,08,784    | Rs. 4,34,124                     | 817                     | 3,812                    | 4,629  |
| 1918-19 | 2,21,218        | 4,54,243                         | 637                     | 4,203                    | 4,840  |
| 1919-20 | 2,20,643        | 4,19,636                         | 786                     | 3,118                    | 3,904  |

TABLE B.

| 1       | 2  | 3                                       | 4  | 5                         | 6               | 7                   |
|---------|--|---|--|---------------------------|-----------------|---------------------|
| Year.   | Number of impressions pulled in Litho. Branch. | Number of half-tone impressions pulled. | Number of line-block impressions pulled. | TYPE SECTION OUT-TURN.    |                 |                     |
|         |  |   |  | Pages or items published. | Copies printed. | Impressions pulled. |
| 1917-18 | 4,796,813                                      | 224,903                                 | 1,193,418                                | 7,476                     | 942,811         | 1,677,147           |
| 1918-19 | 4,248,913                                      | 183,413                                 | 1,151,678                                | 5,577                     | 1,233,211       | 1,829,380           |
| 1919-20 | 3,013,622                                      | 122,522                                 | 727,255                                  | 4,656                     | 1,564,552       | 2,742,584           |

TABLE C.  
PHOTO. BRANCH.

|                         | 1917-18. | 1918-19. | 1919-20. |
|-------------------------|----------|----------|----------|
| Negatives ... ..        | 5,500    | 4,190    | 6,658    |
| Zinc Plates ... ..      | 8,426    | 7,227    | 9,161    |
| Half-tone blocks ... .. | 380      | 554      | 544      |
| Line blocks ... ..      |          |          |          |

60. **Mathematical Instrument Office.**—During the year from 1st April 1919 to 31st March 1920, there was a decrease in the demands made on this office (*vide* item 1 in para. 2), as well as in the value of work done (*vide* item 6 in para. 2), and there was respectively a profit of Rs. 71,839 and Rs. 20,109 against a profit of Rs. 1,21,573 and Rs. 39,762 in 1918-19.

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

|   | 1917-18.                | 1918-19.                | 1919-20.                |
|---|-------------------------|-------------------------|-------------------------|
|   | Rs.                     | Rs.                     | Rs.                     |
| 1. Total issues to Public Offices as shown in the Profit and Loss statements of stores.             | 8,88,658                | 7,64,795                | 5,54,959                |
| 2. Value of repairs to instruments received for repairs and returned in serviceable condition.      | 53,133                  | 50,904                  | 48,002                  |
| 3. Value of instruments received from Government Officers when no longer required.                  | 85,209                  | 1,33,730                | 51,503                  |
| 4. Book value of the stock of instruments, &c., in Serviceable Stores.                              | 3,92,268                | 4,22,818                | 4,06,059                |
| 5. Book value of the stock of instruments, &c., in Repairable Stores.                               | 1,04,394                | 1,10,554                | 79,057                  |
| 6. Total value of work done in the Workshop ...   | 3,41,627                | 4,35,023                | 3,67,343                |
| 7. Value of instruments manufactured in the Workshop for Serviceable Stores.                        | 1,85,737                | 2,17,342                | 1,95,907                |
| 8. Value of instruments purchased locally ...   | 4,30,336                | 2,72,462                | 70,276                  |
| 9. Value of instruments and materials obtained from England through the Director General of Stores. | 66,380                  | 67,174                  | 1,57,694                |
| 10. Average No. of employees and their pay ...  | No. 504<br>Rs. 1,83,719 | No. 556<br>Rs. 1,63,759 | No. 599<br>Rs. 1,28,770 |

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

## II.—DEHRA DŪN OFFICES.

## TRIGONOMETRICAL SURVEY OFFICE.

**61. Computing Office.**—A large amount of computation was done both on departmental and non-departmental requisitions. The adjustments of Mawkmai and Mong Hsat series, Kashmir series and Russian triangulation have been taken in hand. Great progress has been made in remodelling computation forms and adapting them to paper of foolscap size.

In view of the enormous mass of minor triangulation requiring adjustment, a method shorter than that used in geodetic triangulation must be devised in order to make the work of adjustment practicable. Considerable progress has already been made in finding a shorter method leading to consistent results.

Dr. Hunter also prepared a long note on the specifications of microscope theodolites, in view of certain developments in glass gratitudes and other details. This has been sent to the Director General of Stores, India Office, by whom it was called for.

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

32 Triangulation pamphlets were published and issued during the year.

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

1. Records of the Survey of India, Vol. XIV, 1918-19.
2. Departmental Paper No. 9.
3. Triangulation pamphlets covering 79 degree sheets.
4. Levelling pamphlets, 44, 53 and addenda to levelling pamphlets 63, 72 and 73.
5. Auxiliary Tables, Part I (reprint).
6. Hand Book of Levelling.
7. Catalogue of Library books.
8. Topo. Hand Book, Chapter III.
9. Air Photo. Surveying.
10. Waziristān Report.

*Observatories.*—Meteorological observations were continued as usual, and the Omori seismograph was in operation throughout the year. Photographs of the sun were taken on 324 days, the sun being obscured on the remaining days of the year.

*Preservation of Trigonometrical Stations.*—571 stations were repaired by the district officers at a cost of Rs. 3,118. Out of 359 districts from which reports were due, 15 failed to make returns. 9 districts of the Hyderābād State have not submitted annual returns although reminders were sent.

**62. No. 2 (Dehra) Drawing Office.**—During the year under report the work in this office was carried out by seven sections.

(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 15 miscellaneous sheets and charts were fair drawn, proved and finally sent to press and 58 sheets were hand coloured.

(2) *The Compilation Section.*—Deals with the compilation and fair mapping of Geographical maps on different scales. Out of 9 sheets on 1:1,000,000 scale, shown as in hand last year, 8 sheets were completed and sent to press and fair mapping of the remaining one is nearly completed. The rough compilation of 5 more sheets on this scale has been taken up this year in addition to that of the 5 sheets shown in hand last year, making 10 sheets in hand. Four sheets with hills of the new Himālayan map on 1:3,000,000 scale shown in hand last year, have been fair mapped and sent to press for publication on 1:2,500,000 scale. The rough compilation of 2 more sheets of the Southern Asia Series on 1:2,000,000 scale was taken in hand during the year in addition to the one shown in hand last year.

(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. Out of 12 sheets shown in hand last year, 8 sheets were completed and sent to press during the year leaving 4 sheets in hand, which are under scrutiny by Sir Aurel Stein. Of the sheets sent to press for publication 14 sheets are still in the colour proof stage.

(4) *The Half-inch Section.*—This section was formed as a result of the Surveyor General's decision during his inspection last spring that a half-inch mapping section should be re-started in this office. The 4 sheets shown as remaining in hand at the end of last year have been completed and sent to press for publication, and 12 more sheets have been taken in hand.

(5) *The Field Section.*—Mr. P. Davis was appointed from home as a first division draftsman and was attached to this office. This section was formed under him for the training of draftsmen and pupils in the rapid style of drawing field operation maps on the lines of the system adopted in the late campaign in Mesopotamia, and also in drawing outline and doing reverse printing on zinc plates. Fair progress is being made.

(6) *The Examining Section.*—Examines the majority of the important sheets drawn in this office and instructs the pupil draftsmen in drawing, hand printing and in the use of drawing instruments. 72 sheets on various scales were examined and disposed of and a number of specimens of drawing and rapid style hand printing was prepared by this section during the year.

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

The following is the summary of the work of the office during the year 1919-20:—

| Class of maps.   | Scale. | Balance of sheets on 1st October 1919. | Sheets received in 1919-20. | Sheets sent to press in 1919-20. | Balance of sheets in hand on 1st October 1920. | REMARKS.  |
|--|--------|--|-----------------------------|----------------------------------|--|---|
| Triangulation charts   | .....  | 18                                     | 27                          | 34*                              | 11   | * Proved and finally sent to press.                                       |
| Levelling charts scale 1"=16 miles.  | .....  | .....                                  | 5                           | 4†                               | 1  | † Do.   |
| Index charts to illustrate reports.  | .....  | .....                                  | 4                           | 4‡                               | .....  | ‡ Do.   |
| Cantonment plans for correction.   | .....  | 52                                     | 199                         | 198§                             | 53   | § Corrections carried out in both originals and office copies and stored. |
| Cantonment plans for publication.  | .....  | .....                                  | 127                         | 68¶                              | 59   | ¶ Proved and finally sent to press.                                       |
| Colour guides  | .....  | 10                                     | 498                         | 58                               | 450  | Includes colouring of cantonment plans.                                   |
| <b>GEOGRAPHICAL MAPS.</b>  |        |  |                             |                                  |  |   |
| Scale 1/M Fair sheets  | .....  | 9                                      | .....                       | 8                                | 1  |   |
| Scale 1/M Rough compilation  | .....  | 5                                      | 5                           | .....                            | 10   |   |
| Scale 1/2½M Fair sheets  | .....  | 4                                      | .....                       | 4                                | .....  |   |
| Scale 1/2M Rough compilation.  | .....  | 1                                      | 2                           | .....                            | 3  | For engraved edition.   |
| Sir Aurel Stein's explorations in Chinese Turkistan and Kansu in 1900-01, 1906-08 and 1913-15, for publication on 2/M scale. | .....  | 12                                     | .....                       | 8                                | 4  | Of the sheets sent to press previously 14 are in the colour proof stage.  |
| Half-inch sheets   | .....  | 4                                      | 12                          | 4                                | 12   |   |

*Photo.-Zinco. Section.*—During the year 1919-20, the work undertaken comprised :—

Cantonment Maps.  
 Indexes and Triangulation Charts.  
 Forest Maps.  
 Sir Aurel Stein's Maps.  
 Miscellaneous Maps.  
 Extra-departmental Maps.

In the year under report, the Vandyke section placed at the disposal of the Superintendent Northern Circle, has since returned to Dehra Dūn as the Waziristān Survey Party was disbanded. A detachment of 4 men (2 litho-draftsmen, 1 photographer and 1 helio-printer) was sent to Baghdād, in order to re-inforce the Mesopotamian Survey Party.

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 Cyanotype prints. |
|---------|------------------|-------------------|---------------|--|
| 1917-18 | 1,130            | 1,719             | 345,776       | 127                                    |
| 1918-19 | 1,193            | 1,475             | 275,276       | 229                                    |
| 1919-20 | 1,414            | 2,087             | 316,114       | 562                                    |

**63. Forest Map Office.**—The class of work entrusted to the four technical sections of this office has been described in a previous report; the distribution of work has been continued on the same lines, and the progress made during the year 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 1919. | Received during the year 1919-20. | Drawn and sent for publication in 1919-20. | In hand on 30th September 1920. | Published during the year 1919-20. | Total number of copies printed. |
|---------------|------------------------------|-----------------------------------|--|---------------------------------|------------------------------------|---------------------------------|
| (a) ...       | .....                        | 59                                | 59   | .....                           | 55                                 | 21,823                          |
| (b) ...       | 68                           | 17                                | 48   | 32                              | 36                                 |                                 |
| (c) ...       | 17                           | .....                             | 18   | 4                               | 6                                  |                                 |
| (d) ...       | 14                           | 15                                | 21   | 8                               | 38                                 |                                 |
| (e) ...       | .....                        | 18                                | 18   | .....                           | 7                                  |                                 |
| (f) ...       | 36                           | 59                                | 27   | 68                              | 25                                 |                                 |
| (g) ...       | 1                            | 29                                | 24   | 6                               | 42                                 |                                 |
| TOTALS...     | 131                          | 192                               | 205  | 118                             | 211                                |                                 |

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

(2) *The Portfolio Section.*—Office copies of 185 maps and colour specimen of 49 maps were prepared, corrections on 191 sheets were completed, and 2,597 sheets were coloured by hand for issue. All arrears regarding office copy corrections to be made from Notifications received to date have now been worked off.

(3) *The Map Record Section.*—The number of maps, diagrams and other records, received for storage was 21,626, and 17,948 maps, &c., valued at Rs. 17,403 were issued. Sales by book-transfer to Government departments amounted to Rs. 9,159 for 13,930 maps, &c., these figures show an increase of 5,940 maps and Rs. 1,907 over those for last year. Cash sales to the public amounted to Rs. 3,725 for 1,745 maps, an increase of Rs. 415 over the amount realised the previous year.

(4) *The Book-Binding Section.*—The section dealt with 352 volumes for the Forest Research Institute and 76 volumes for the library of the Trigonometrical Survey, the value realized being Rs. 1,013, an increase of 103 volumes and Rs. 312 over the figures for last year. In addition 412 envelopes were made for Height Indicator cards and the cost viz. Rs. 171 realized by book-transfer; 2,675 maps of various sizes were mounted on cloth for issue.

## III.—CIRCLE AND LOCAL DRAWING OFFICES.

**64. No. 3 Drawing Office (Northern Circle).**—During the year 5 two-inch sheets out of 21 and 19 one-inch sheets out of 40 previously surveyed, were fair-mapped by parties and have been submitted for publication. In addition to these 5 one-inch sheets were redrawn and 3 one-inch sheets were brought up to date and completed to margin in the Circle drawing office and submitted for publication.

*Half-inch sheets compiled from modern one-inch and old style half-inch maps.*—26 half-inch sheets, 25 of which were drawn in the Circle drawing office, have been submitted for publication during the year.

*Modern material available.*—There are 89 half-inch sheet areas of which the component one-inch sheets have been published; of these the fair-mapping of 24 sheets is in hand. In addition to the above, there are 9 half-inch sheet areas of which some of the component one-inch sheets, though surveyed, have not been submitted for publication.

*Quarter-inch sheets drawn from the published sheets of the modern one-inch and half-inch maps (and old style maps).*—During the year, 1 quarter-inch sheet was fair-mapped in the Circle drawing office and submitted for publication. The fair-mapping of 2 quarter-inch sheets is in hand while that of 2 others is in abeyance.

*Modern material available.*—There are 24 quarter-inch sheet areas of which the component one-inch or half-inch sheets have been published.

In addition there are 3 quarter-inch areas of which some of the component one-inch sheets have not been submitted for publication.

*Special maps.*—During the year 18 sheets of the Simla Extension Survey, scale 220 feet = 1 inch; 16 sheets Mount Abu Survey, scale 1 inch = 220 feet; 12 sheets Town Guide and Environs Maps Surveys scale 12 inches and 4 inches to a mile respectively; 2 sheets of the biennial survey of Delhi and vicinity map, scale 4 inches = 1 mile and 5 of the Royal Artillery Practice Camp Maps, scale 3 inches = 1 mile, were fair-mapped and submitted for publication.

*Hill-shaded sheets.*—33 one-inch and half-inch sheets were stump shaded and submitted for publication.

*Layer guides.*—Nil.

*Colour patterns and press order proofs.*—Press order proofs and colour patterns of 81 sheets were submitted for publication. In addition to these the yellow and green colour patterns of 27 sheets and the yellow colour patterns of 18 sheets were specially prepared and submitted during the year for future reprint purposes.

*Miscellaneous.*—The traverse plots of 30 *mauzas* in 54 sheets, scale 16 and 32 inches = 1 mile, of the Gondā district were prepared and the cost of preparation recovered from the Deputy Commissioner, Gondā.

For the purpose of reprint, the office copies of 197 one-inch sheets were corrected, brought up to date and submitted for publication during the year.

The special village boundary editions of 11 one-inch sheets were prepared in the Circle drawing office and submitted for publication during the year.

The fair sheets of 46 half-inch sheets were brought up to date and submitted for reprint during the year.

**65. No. 4 Drawing Office (Southern Circle).**—During the year, 25 one-inch sheets and 2 half-inch sheets which had been fair-mapped by parties were finally examined and sent for publication. At the end of the year every sheet, the survey of which had been completed during previous years, was submitted for publication.

*Half-inch sheets compiled from modern one-inch maps.*—2 sheets were fair-mapped and submitted for publication, and 25 sheets which had been fair-mapped by No. 7 Party were finally examined and submitted for publication. At the end of the year 11 sheets were in hand.

*Modern material available.*—There are 11 half-inch sheet areas completely surveyed on the one-inch scale but of which the component one-inch sheets have not yet been submitted for publication. All half-inch sheets of which all the component one-inch sheets have been so submitted have either been submitted for publication or are in hand.

*Quarter-inch sheets compiled from modern one-inch and half-inch sheets (and old style maps).*—3 quarter-inch sheets were fair-mapped and submitted for publication.

*Modern material available.*—There are 9 quarter-inch sheet areas of which all component half-inch sheets have been submitted for publication. In addition there are 6 quarter-inch sheet areas completely surveyed but of which the component half-inch sheets have not yet been submitted for publication; of these the fair-mapping of 12 sheets is in hand.

*Special maps.*—Revised edition of the Ootacamund Hunt map was fair-mapped. Kāpra and Rājankunti (Royal Artillery Practice Camp) maps were finally examined and submitted for publication.

*Hill-shaded sheets.*—36 were prepared.

*Layer guides.*—Nil.

*Colour patterns.*—Were prepared for 61 sheets.

*Triangulation charts.*—6 were finally examined and submitted for publication.

|   |     |     |       |
|---|-----|-----|-------|
| <i>Photo.-zinco. work.</i> —Number of reproductions | ... | ... | 160   |
| "    "    enlargements                              | ... | ... | 126   |
| "    "    reductions                                | ... | ... | 344   |
| "    "    Vandyke plates prepared                   | ... | ... | 187   |
| "    "    prints pulled                             | ... | ... | 9,023 |

*Miscellaneous.*—58 plane-table sections of the South-West Persia Survey Detachment were completed as regards headings, scale, &c.; of these 52 on the  $\frac{1}{2}$ -inch scale were submitted to No. 6 Drawing Office for fair-mapping, 3 on the 1-inch scale, 2 on the 4-inch scale and 1 on the 8-inch scale will be fair-mapped in this office.

The usual training in drawing, typing and hand-printing was given to pupil surveyors and pupil draftsmen.

**66. No. 5 Drawing Office (Eastern Circle).**—During the year, 12 one-inch sheets and 5 twelve-inch sheets were fair-mapped by parties from recent surveys and received in the drawing office. There were also 25 one-inch and half-inch sheets received from the parties in the previous year which were under examination and correction. Of these 42 sheets, 41 were finally examined and submitted for publication and the remaining one has been scrutinised and is ready to be despatched.

*Half-inch sheets compiled from modern one-inch and old style maps.*—14 sheets were received from parties in the previous year for final examination, 4 were received in various stages of completion during the

year and 14 were under preparation in the drawing office. Of these 32 sheets, 14 were finally examined and submitted for publication and 18 are in hand.

*Modern material available.*—There are 68 half-inch sheet areas of which the component one-inch sheets have been submitted for publication; of these the fair-mapping of 32 sheets is in hand in the circle.

*Quarter-inch sheets compiled from published sheets of the modern one-inch, half-inch and old style maps.*—The fair-mapping on 11 sheets was in hand and 2 sheets, received from the parties in the previous year, awaited final examination. Of these, 5 sheets were submitted for publication during the year and 7 are now in hand. Work on one sheet is held in abeyance pending completion of the component half-inch sheet recently surveyed.

*Modern material available.*—There are 15 quarter-inch sheet areas of which all component one-inch or half-inch sheets have been submitted for publication; of these the fair-mapping of 3 sheets is in hand.

A rough compilation in one sheet, comprising the area surveyed on the quarter-inch scale by a detachment attached to the Kuki Punitive Measures Force, was prepared and completed to margin by the incorporation of material from old style maps. It was submitted for publication and a small edition will be printed to meet the present requirements of the Assam Government.

*Hill-shaded sheets.*—Material for 20 one-inch, 14 half-inch and 5 quarter-inch sheets were received. There were also 15 one-inch and half-inch sheets in various stages of completion at the close of the previous year. Of these 54 sheets, 47 were completed and submitted for publication and 7 are in hand.

*Layer guides* for 4 quarter inch sheets were received of which 2 were completed and 2 are in hand.

*Colour patterns and press order proofs.*—Proofs for the preparation of 58 colour patterns were received during the year and 25 were in hand at the close of the previous year. A total number of 73 colour patterns and press order proofs were completed and despatched for publication and 10 were in hand on 1st October 1920.

*Triangulation charts and traverse data.*—A special section was formed during the latter part of the year to complete the preparation of charts which had fallen into arrears. The preliminary work of sorting and arranging all volumes and data for areas in Bengal and Assam was completed. There were 18 triangulation charts in hand of which one has been examined and will be shortly submitted for publication.

**67. No. 6 (Simla) Drawing Office.**—This office was placed under the Superintendent, Map Publication, from 1st June 1920.

The *Army Section* has dealt with the preparation and printing of maps and plans for the use of the Army and other government departments.

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

**68. Bengal and Bihār and Orissa Drawing Office.**—(Imperial Standard Mapping Section). This section has been employed as usual on the compilation from modern revenue survey material and from other local maps, and on 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 where no modern work is available.

To reduce the labour of drawing on the two-inch scale and the inconvenience of handling the fair map in two sheets all the 16-inch cadastral maps will in future be first of all reduced to the 4-inch scale, detail to be shown will then be inked up and reduced to the 1½-inch scale and all maps fair-drawn on that scale.

Of Bengal 20 new sheets, and of Bihar and Orissa 5 new sheets have been fair-mapped and submitted for publication during the year.

The section has been accommodated in the Head Quarters Offices.

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

**69. Northern Circle. No. 1 Party.**—At the request of the Mussoorie City Board, an original survey on the scale of 24 inches = 1 mile was carried out during the year, at a cost of Rs. 9,816. The area surveyed was 2.9 square miles, and the task involved some 45 linear miles of traverse and 36 miles of levelling.

*No. 2 Party.*—This party completed the survey of Mount Abu and leased area, on the scale of 24 inches = 1 mile commenced in July 1919, the total area surveyed comprising some 5,076 acres, situated on a plateau about 4,000 feet above mean sea level, the highest point, Adhar Devi, being 4,623 feet. The larger portion consists of cultivated and grass lands, but there is a good deal of rocky and intricate ground covered with scrub jungle and trees. The scheduled boundary of the area, which was very considerably in error, was also corrected. The fair-drawing was undertaken immediately the survey was completed and was submitted for publication in April 1920. The cost rate of survey was Rs. 1.5 per acre and of fair-drawing Rs. 0.4 per acre.

*Sind-Sāgar Party.*—During the year under report, the party was employed on rectangulation of the Sind-Sāgar Doāb in connection with the Punjab Government's Sind-Sāgar Canal and Colonization Project, in Miānwāli, Jhang and Muzaffargarh districts, in continuation of previous seasons.

Sub-division into 100-acre rectangles was carried out over the southern part of the tract, comprising an area of 3549.1 square miles, and embracing parts of Miānwāli, Jhang and Muzaffargarh districts, 22,714 rectangles of 100 acres each were laid out and their corners marked by stones. Practically the whole of the work was tested by the superior revenue staff and the survey staff. The party has now to deal with the sub-division into 100-acre rectangles of the north eastern part of the area, already divided into 120 rectangles of 4,000 acres each. This will be done next field season.

The country under rectangulation lies between the Indus river on the west and the Jhelum and Chenāb rivers on the east and is locally known as the "Thal" (uplands). The tract is a vast rolling desert of sand studded with hillocks covered with stunted vegetation, sparsely populated and almost waterless. There are scattered patches of cultivation irrigated from wells the water of which is generally brackish. The "Thal", with the exception of the central portion which is open, is wooded in parts, a strip of country along its western edge being covered by a dense jungle of trees and high grass. The natural difficulties of the ground tend to impede the work.

In recess the party was employed on completion of the records of the Sind-Sāgar rectangular survey and on preparation of the material for triangulation pamphlets. The purely temporary hands who had been entertained last year were given instruction in traversing, and its computation, in drawing and in typing. In addition to the men above alluded to, 1 soldier surveyor and 8 pupils who were temporarily attached to the party were given training in drawing.

At the request of the Executive Engineer, Thal Survey Division, Miānwāli, 49 published one-inch sheets of the Sind-Sāgar Doāb were marked with 4,000-acre rectangles and corner numbers entered on them.

His further request for 12 sheets of the northernmost area of the Doab marked with 100-acre rectangles was also complied with.

Four indexes on the scale of 1 inch = 4 miles showing the field work of the last year and this year were prepared and supplied to the Irrigation and Revenue Departments. Two indexes indicating the positions of stone depôts on the same scale were also supplied to them.

In addition a considerable amount of miscellaneous work in connection with the proposed extension of rectangulation in the Lower Bāri Doab was done.

*No. 22 (Riverain) Party.*—The party continued the work of traversing, and laying down base lines. 371 linear and 429 square miles of main circuits, 2,650 linear and 491 square miles of minor traverses were executed, and 458 theodolite stations of the former, and 11,590 of the latter in 143 villages, were fixed. 798 corners of 266 squares in 883 square miles were demarcated with permanent mark-stones on both banks of the Sutlej and Chenāb rivers in Muzaffargarh, Multān and Montgomery districts and Bahāwalpur State, to serve as bases for the further survey and demarcation of boundaries and fields in the beds of the rivers. 1,554 plotted and 474 boundary *masāvis* on the scale of 1/2,640, and 34 four-inch sheets, and 2 one-inch indexes were traced and supplied to the Settlement Officer, Multān. 15,181 pages of field books and 3,314 of set-up forming 102 volumes were almost completed. Some arrears of computations still remain to be finished. Besides these, 595 boundary *masāvis* were partly compiled on the scale of 220 feet = 1 inch for the next season's work, and 222 miscellaneous traces including 16 traces (scale 4 inches = 1 mile) supplied to the Executive Engineer, Upper Sutlej Division, showing the riverain traverse data along the Sutlej and Chenāb, were prepared; all the traverse stations marked during the year were plotted on 36 four-inch sheets.

*The Multān suburbs traversing* was begun at the request of the Settlement Officer, Multān, during October 1919, and was finished in February 1920. It was based on the riverain main circuit run along the Chenāb connecting it with Multān Fort, and Multān City Dome. The stations were marked with two bricks placed vertically one above the other. 18 corners of 6 squares were fixed to serve as bases for the future survey. Thirty-three dressed stones were embedded on 15 traverse stations, and on 18 corners of the base lines. 1,114 stations were laid out and 189 linear miles executed in 5 villages covering 20 square miles. 95 plotted *masāvis* on the scale of 55 feet = 1 inch, 184 on the scale of 110 feet = 1 inch and one trace on the scale of 4 inches = 1 mile were supplied to the Settlement Officer, Multān.

*The Gujranwāla town traversing* was started at the request of the President Municipal Committee, Gujranwāla during February 1920, and was finished during April 1920, for the detail survey of the municipal area on the scale of 200 feet = 1 inch. It was connected with Shāhjamāl T. S. XXXVIII, Shāhdara Minaret, and the Chenāb riverain main circuit. The stations outside the congested area were marked with bricks, and inside with 8-inch long iron pegs with round flat tops of 1½-inch radius. In all 617 stations were laid out, 507 for the town survey, and 110 for making the three connections. At the connections the stations were marked with ordinary pegs. 145 linear, and 3 square miles of traversing were done. A trace on the scales of 8 inches and 16 inches = 1 mile showing the stations, and copy of the traverse data were supplied to the President, Municipal Committee, Gujranwāla.

**70. Eastern Circle.**—At the request of the Burma Government, a surveyor was deputed to accompany the Deputy Commissioner of the Hill district of Arakan to survey the boundary between Assam and Burma as decided on by the Deputy Commissioners of the Hill districts of Arakan and Lushai Hills, but as no agreement could be reached at the meeting of the two officers, the boundary could not be surveyed. An area of 310 square miles of unadministered area was, however, surveyed on the  $\frac{1}{4}$ -inch scale.

*No. 11. Party.*—At the instance of the Chief of the General Staff the survey, on the scale of 3 inches = 1 mile, with a vertical interval of 25 feet, was made of 103 square miles of country, on the left bank of the Rangoon river, between Syriam and Kyauktan, in the Hanthawaddy district, Burma.

The country surveyed comprises the Kondan ridge, a laterite spur of the Pegu Yoma, extending through the middle of the area from north to south. The western slopes of the ridge descend in undulating ground to the river bank; on the east, from the base of the ridge, is an open expanse of rice fields. The whole area is well inhabited, and, in the vicinity of Syriam, are the important refineries of the Burma Oil Company.

At the request of the Burma Government, a surveyor was deputed to accompany the Assistant Superintendent, North Hsweni State, to point out from existing one-inch maps, and from the report of the Burma-China Boundary Commission of 1898—1900, the position of the boundary line between existing pillars, along a portion of the boundary in the Kokang district, disputed by the Chinese. The disputed boundary and an area of 20 square miles on the British side were resurveyed, and a trace of the map supplied to the political officer, for the settlement of the questions in dispute at the Chief Political Meetings to be held on the frontier in 1920.

**71. 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 31, in the "Issues" Table and in Table IV of the Map Record and Issue Office report on pages 27 and 28.

In addition to the special maps for other departments which are mentioned in para. 55 (g) on page 26, these extra-departmental publications include Royal Artillery Practice Camp maps and various operations and manœuvre maps for the Army, maps to illustrate the Journals of the United Service Institution, various reports of Government officials, &c., and 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.

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 29 to 31.

**72. Mathematical Instrument Office.**—The manufacture of heliographs, prismatic compasses, scales, protractors, &c., for Military Departments was stopped in the early part of the year, but it has however been taken up again and the large balance on previous orders slowly reduced.

Repair and manufacture for Civil Departments was taken up again and most of the outstanding work for the years 1914, 1915, and 1916 has been completed and that for 1917, 1918 and 1919 is well in hand so that it is hoped to be up to date by end of the cold weather.

Instruments were supplied by this office to many Government offices, Imperial and Provincial.

**73. No. 6 (Simla) Drawing Office.**—In addition to its normal work for the Army the *Army Section* has prepared maps and plans for the Royal Air Force, the Foreign and Political Department, the Commerce and Industry Department and the Journals of the United Service Institution.

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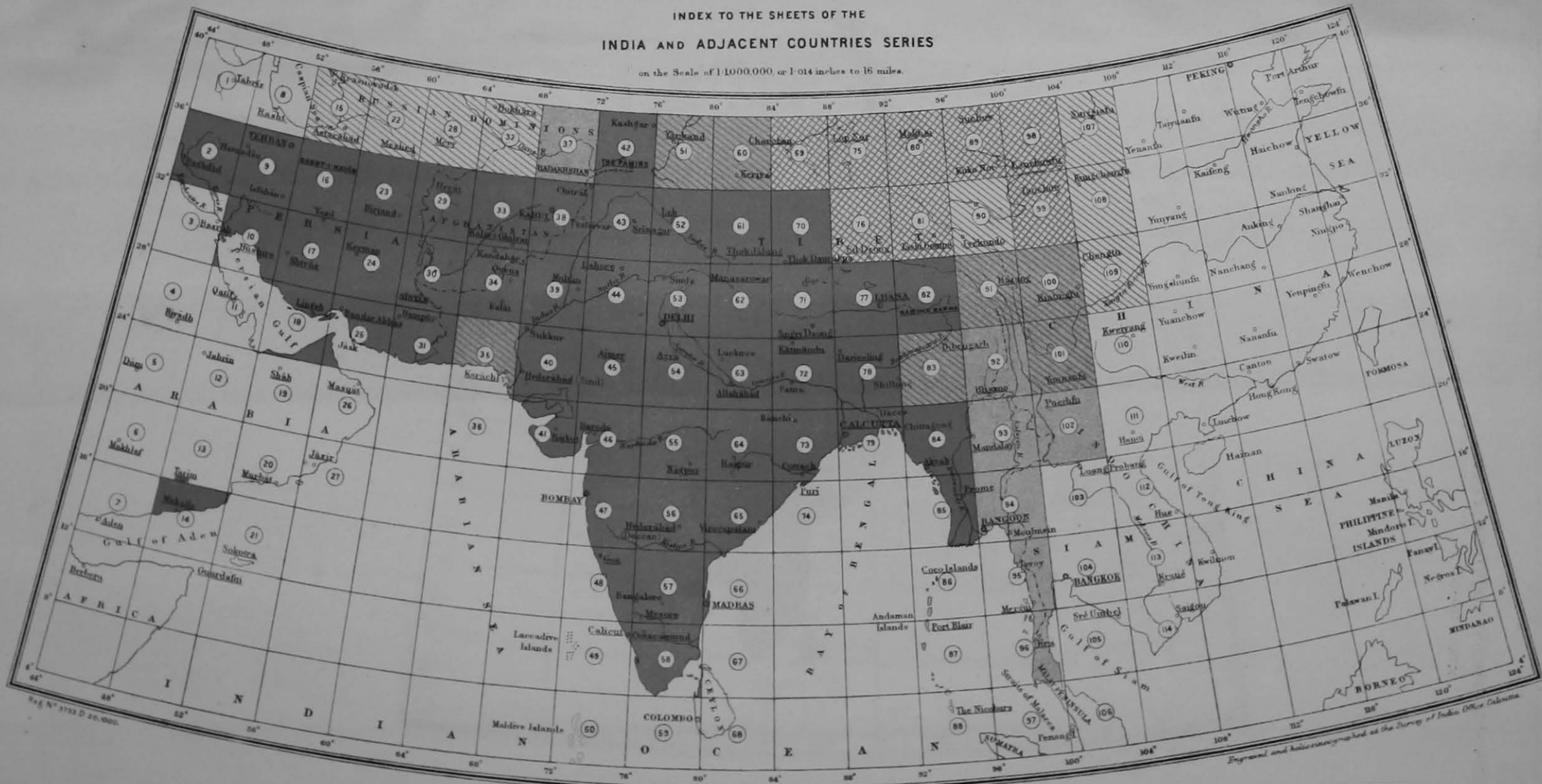
4

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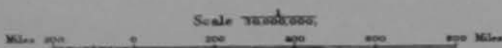
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NOTE

The names underlined on this Index are the title names of the sheets, and their numbers are shown in circles. Sheets 35 and 36, 57 and 66, are published respectively as combined sheets.

REFERENCE

- To illustrate the Report for the year 1913-20
- Shades published without contours & layers
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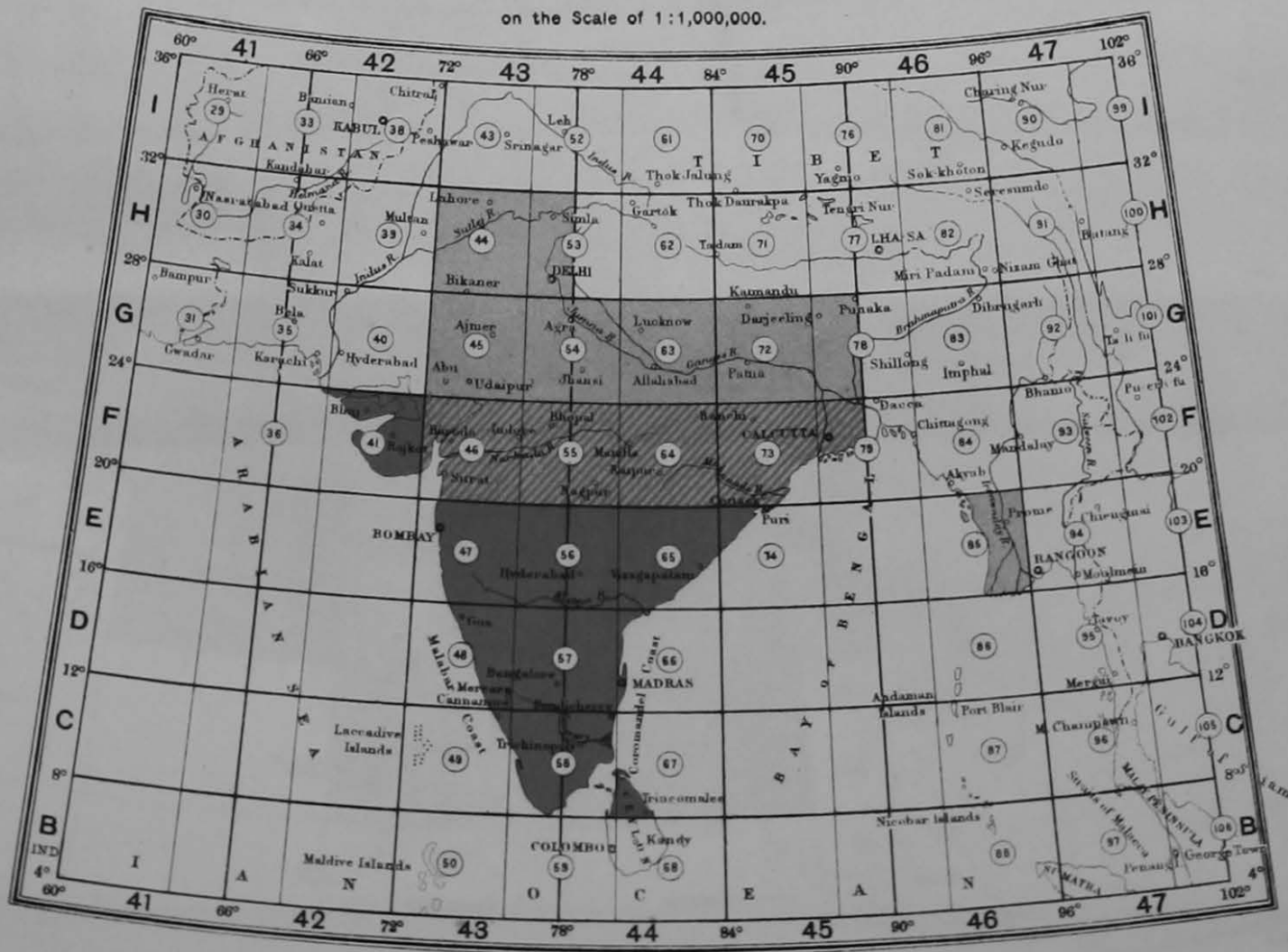
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**INDIA AND ADJACENT COUNTRIES SERIES**

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

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

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

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Sheets published

under publication

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To illustrate the Report for the year 1919-20.

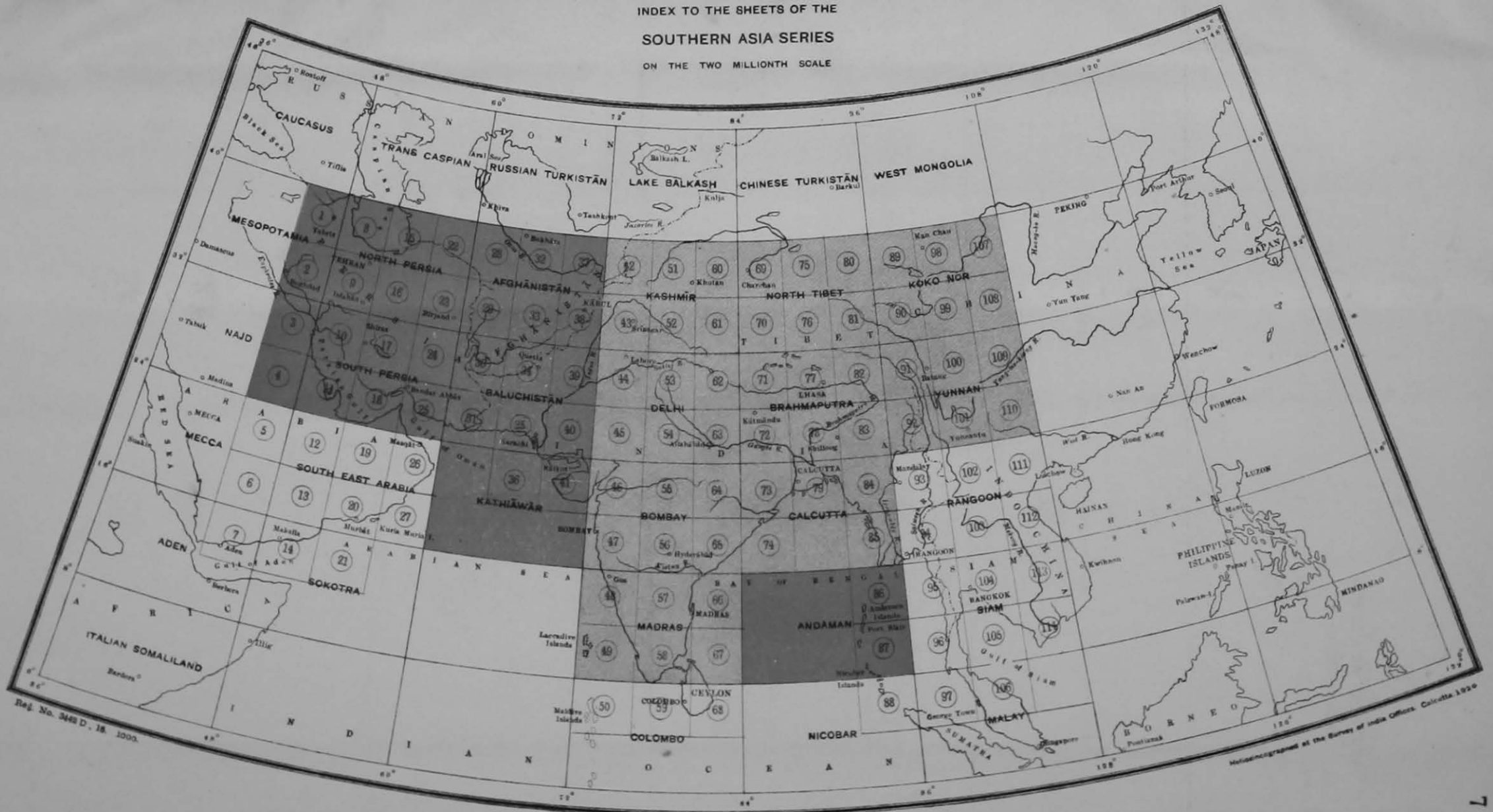


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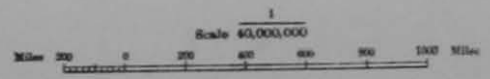
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The E. portions of MESOPOTAMIA and NAJD sheets  
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REFERENCE

To illustrate the Report for the year 1919-20.

- Sheets published with contours & layers. [Solid black box]
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