GENERAL REPORT

ON THE

Operations of the Survey of India Department,

ADMINISTERED UNDER THE GOVERNMENT OF INDIA

DURING

1885-86.

PREPARED UNDER THE DIRECTION OF

LIEUTENANT-COLONEL H. R. THUILLIER, R.E.,

OFFICIATING SURVEYOR GENERAL OF INDIA.

CALCUTTA:

PRINTED BY THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

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Price Three Rupees.

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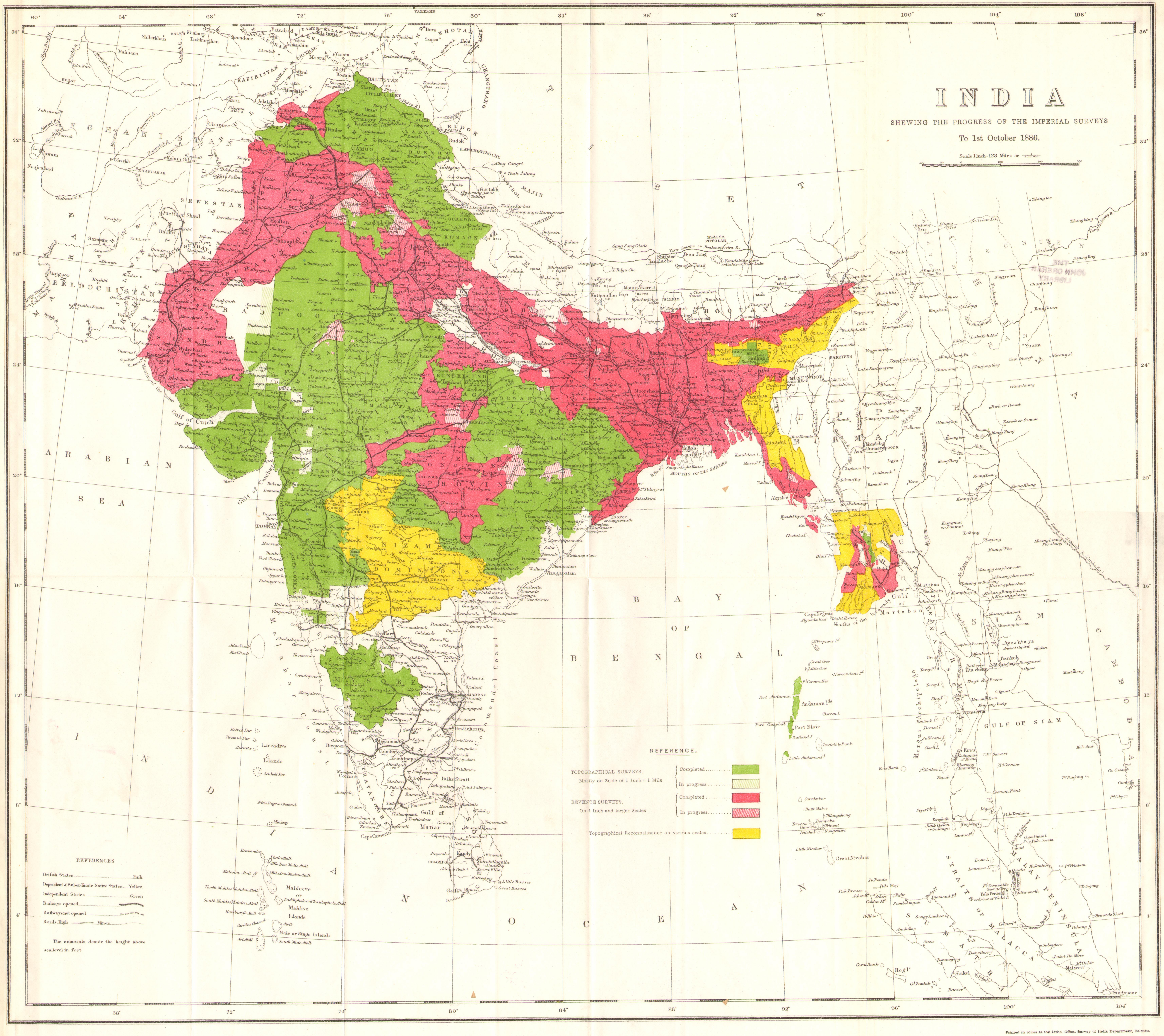

INDIA
SHEWING THE PROGRESS OF THE IMPERIAL SURVEYS
To 1st October 1886.
REFERENCE.
TOPOGRAPHICAL SURVEYS,
Mostly on Scale of 1 Inch = 1 Mile
Completed
In progress
REVENUE SURVEYS,
On 4 Inch and larger Scales
Completed
In progress
Topographical Reconnaissance on various scales
REFERENCES
British States Pink
Dependent & Subordinate Native States Yellow
Independent States Green
Railways opened
Railways not opened
Roads, High Minor
The numerals denote the height above sea level in feet
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
GULF OF SIAM

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., Officiating Surveyor General of India,
Survey of India Offices, Calcutta, February 1887.

Printed in colours at the Litho Office, Survey of India Department, Calcutta.

INDEX CHART
TO THE
GREAT TRIGONOMETRICAL SURVEY
OF
INDIA

SHOWING COLONEL LAMBTON'S NET WORK OF TRIANGULATION IN SOUTHERN INDIA,
THE MERIDIONAL AND LONGITUDINAL CHAINS OF PRINCIPAL TRIANGLES,
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THE HIMALAYAN & THE SOOLIMANI RANGES,
AND THE POSITIONS OF BANGKOK AND KANDAHAR.
Completed to 1st. October 1886.

Scale 1 Inch = 96 Miles or 1/6,082,560

300 200 100 0 100 200 300

REFERENCES

The course of the Levelling operations is shewn by a dotted line
The stations where the Latitude has been observed astronomically by a star
The stations where an Azimuth has been observed astronomically thus
The Pendulum stations, thus
The Principal triangulation done in Southern India before the year 1830 is shewn by fine lines, after that year by thick lines.
The Longitudinal Arcs are shewn thus
do do do (Revised) do do

BAY OF BENGAL

ANDAMAN ISLANDS

Great Coco I. · Little Coco I. · Landfall I. · North Andaman · Port Cornwallis · Interview I. · Middle Andaman I. · South Andaman I. · Port Blair ★ (Longitude determined) Tidal Station · Ritchie's Archipelago · Rutland I. · Little Andaman I.

Tenth Edition

COMPILED UNDER THE ORDERS OF COL. J. T. WALKER, R.E., F.R.S. &c. SUPERINTENDENT GREAT TRIGONOMETRICAL SURVEY OF INDIA AT DEHRA DOON, AUGUST 1870.

Engraved at the Surveyor Generals Office.
Calcutta Novr. 1870.
Corrected up to October 1886.

Outline by H. James. Writing by J.M. Dalziel
Engraved under the Superintendence of C.W. Coard

Correction for Annual Report, Season 1884-85.

Page 3.

In "Statement of Administrative and Technical Offices of the Survey of India Department", in column headed "Names of Offices and Sections", under the word "Technical",—

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GENERAL REPORT

ON THE

Operations of the Survey of India,

DURING THE SURVEY YEAR

1885-86.

PART I.

INTRODUCTORY.

The operations of the Survey parties, and the work in the several branches of the Head-quarter Offices of the Survey of India, which are now reported upon, are for the year ending 30th September 1886.

2. The general direction of the Department and the superintendence of the Topographical Branch was carried on by Colonel G. C. DePrée, Surveyor General, up to the 23rd February 1886, when he was compelled by ill-health to proceed on furlough. From that date the duties have been performed by Lieutenant-Colonel H. R. Thuillier, R.E., who was then appointed to officiate as Surveyor General. The immediate superintendence of the Revenue Branch was continued by Lieutenant-Colonel Thuillier, Deputy Surveyor General, up to 11th March 1886, when Colonel J. Sconce, S.C., Deputy Surveyor General, the permanent incumbent of the post, returned from furlough and resumed charge. The direct charge of the Trigonometrical Branch has remained in the hands of Colonel C. T. Haig, R.E., Officiating Deputy Surveyor General, throughout the year.

3. The operations which have been carried out during the year under review are shown in the following tabular statement, and they are described in detail in Part II of this Report in the order in which they are given below:—

Statement of Survey Operations and Field Parties.

Name and *locale* of operations.	Page in this Report.	Executive Officers.	Designation of Survey Party.	Scale of Survey.	Administrative Superintendent.
Triangulation.					
Coast (Madras) . .	11	Mr. E. C. Ryall . . .	Secondary Triangulation.	. . .	D. S. G. Trig.
Topography.					
Andaman Islands . .	12	Major G. Strahan, R.E. . Captain J. R. Hobday, S.C. Mr. G. D. Cusson.	Andaman Survey (No. 4 Topo. Branch).	4″ and ½″=1 mile for reproduction.	Ditto Topo.
Baluchistan . . .	13	Lieutenant-Colonel J.R. Wilmer, S.C.	Baluchistan Survey (No. 3 Topo. Branch).	2″ and ½″=1 mile for reproduction.	Ditto ditto.
Cutch	16	Colonel A. Pullan, S.C. .	Cutch Survey . .	2″=1 mile for reduction to half scale.	Ditto ditto.
Deccan	17	Lieutenant-Colonel D. C. Andrew, S.C.	No. 11 Rev. Branch	2″=1 mile for reduction to half scale.	Ditto Rev.

Statement of Survey Operations and Field Parties—continued.

Name and *locale* of operations.	Page in this Report.	Executive Officers.	Designation of Survey Party.	Scale of Survey.	Administrative Superintendent.
Gujarát	18	Lieutenant-Colonel W. F. Badgley, S.C. Mr. J. Newland.	Gujarát Survey	2″=1 mile for reduction to half scale and 200ft. = 1 inch (city) for reproduction.	D. S. G. Topo.
Mirzapur	19	Mr. W. H. Patterson	Mirzapur Survey (No. 5 Topo. Branch).	2″=1 mile for reduction to half scale and 16″=1 mile for reproduction.	Ditto Trig.
Mysore	21	Major J. R. McCullagh, R.E. Lieutenant H. M. Jackson, R.E.	Mysore Survey (No. 8 Topo. Branch).	1″=1 mile for reproduction.	Ditto Topo.
Rajputana	23	Lieut.-Colonel R. Beavan, S.C. Lieutenant W. H. Pollen, R.E.	Rajputana Survey (No. 1 Topo. Branch).	1″ and ½″=1 mile for reproduction.	Ditto Trig.
South Marátha	24	Major J. Hill, R.E. Lieutenant F. B. Longe, R.E.	No. 10 Rev. Branch.	2″=1 mile for reduction to half scale and 8″=1 mile, Skeleton Forest Survey.	Ditto Rev.
Forest Surveys.					
Burma	26	Mr. H. Hörst	Burma Survey (No. 7 Topo. Branch).	4″ and 2″=1 mile for reproduction.	Ditto Topo.
Cadastral Surveys.					
Akyab	28	Lieutenant-Colonel H. S. Hutchinson, S.C.	No. 7 Rev. Branch	16″=1 mile for reproduction.	Ditto Rev.
Basti	29	Lieutenant-Colonel S. H. Cowan, S.C.	No. 4 Ditto	16″=1 mile for reproduction.	Ditto ditto.
Bilaspur	31	Lieutenant-Colonel E. H. Steel, S.C.	No. 2 Ditto	16″=1 mile for reproduction.	Ditto ditto.
Gorakhpur	34	Major J. E. Sandeman, S.C.	No. 5 Ditto	16″=1 mile for reproduction.	Ditto ditto.
Kámrúp	37	Mr. E. C. Barrett	No. 6 Ditto	16″=1 mile for reproduction.	Ditto ditto.
Mozufferpore	39	Lieutenant-Colonel W. Barron, S.C.	No. 8 Ditto	16″=1 mile for reproduction.	Ditto ditto.
Traverse Surveys.					
Ajmere	43	Mr. A. J. Gibson	Ajmere Detachment	16″=1 mile (skeleton plots).	Ditto ditto.
Jubbulpore and Damoh	44	Mr. G. H. Cooke	No. 9 Rev. Branch	16″=1 mile (skeleton plots).	Ditto ditto.
Punjab	46	Lieutenant-Colonel F. Coddington, S.C.	No. 1 Ditto	2″=1 mile compilation for reduction to half scale.	Ditto ditto.
Raipur	47	Lieutenant-Colonel W. H. Wilkins, S.C.	No. 3 Ditto	16″=1 mile (skeleton plots).	Ditto ditto.
Sambalpur	48	Mr. A. D'Souza Mr. P. A. G. Cowley.	Sambalpur Detachment.	16″=1 mile (skeleton plots).	Ditto ditto.
Geographical and Miscellaneous.					
Himalaya	50	Colonel H. C. B. Tanner, S.C. Captain R. A. Wahab, R.E.	Himalaya Survey	4″ and 2″=1 mile for reduction to half scale.	Ditto Trig.
Upper Burma	53	Captain J. R. Hobday, S.C.	Upper Burma Detachment.	½″ and ¼″=1 mile	Ditto Topo.
Nepal and Tibet	54	Explorers M. H. and R. N.			Ditto Trig.
Tidal and Levelling Operations.					
Tidal Operations	55	Major J. Hill, R.E.	Tidal and Levelling Party.		Ditto ditto.
Spirit-levelling	57	Major A. W. Baird, R.E.			
Geodetic.					
Latitude operations and Electro-Telegraphic determinations of Longitudes.	58	Major G. Strahan, R.E. Major W. J. Heaviside, R.E. Lieutenant S. G. Burrard, R.E.	Nos. 1 and 2 Astronomical Parties.		Ditto ditto.

TRIANGULATION.

4. It will be seen from the last statement that only one small party was employed in secondary triangulation. The operations of this party extended from Cocanada to Masulipatam on the East Coast, with the object of fixing the positions of beacons erected at suitable points, and of other permanent and conspicuous marks, natural or artificial, for the use of the Marine Survey Department.

5. The annexation of Upper Burma will ere long lay the Government under the necessity of extending the principal triangulation over the newly acquired territory, but in the present state of the country it would be premature to formulate details for so extensive a project: it will suffice to say that for such a large area a very accurate trigonometrical basis will be required for the subsequent surveys, if they are to be undertaken on a scale at all in keeping with those in India Proper.

6. The secondary series, in extension of the Eastern Frontier Series, through the Malayan peninsula down to Singapore, still remains to be executed, and would have been commenced ere this had officers and funds been available for the purpose.

SPECIAL OPERATIONS.

7. The two transit instruments having been returned from England, where they had been sent for repairs, the Latitude operations were suspended, and the Electro-telegraphic observations for the determination of differential Longitudes were resumed by the Astronomical Parties. Nine arcs have been measured between stations of the Trigonometrical Survey.

8. The Tidal observations have been duly continued in accordance with the original programme for obtaining a systematic record of the tidal phenomena on Indian coasts. Four new observatories have been established, *viz.*, at Bhávnagar, Cochin, Cocanada and Chittagong; and three have been closed, *viz.*, at Diamond Harbour, Amherst and Moulmein, where the usual period of five years' registration had been completed; Moulmein having been continued for a sixth year owing to certain peculiarities in the tides of that port.

TOPOGRAPHY.

9. During the preceding year, thirteen field parties had been employed on Topographical Surveys, exclusive of Forest Surveys: of these, two parties had completed the work assigned to them, *viz.*, the Assam and North-East Frontier Party, and the Malwa Party. Under the orders of the Government the former of these parties was broken up and the latter was diverted to Revenue operations; a third party which had been employed temporarily during that year, on topographical operations in the Shwegyin District, Lower Burma, was also withdrawn for cadastral operations in the Central Provinces, so that during the year under review the topographical surveys were reduced to ten parties, of which the Himalaya Party has as yet yielded little but triangulation and the skeleton traversing to meet the requirements of the Settlement Department in connection with the *Patwari* survey. The regular topographical operations were carried on by those parties in continuation of the work of the previous year, with the exception of the Konkan Survey, which had been completed and the party transferred to the Southern Marátha country. During the year the surveys of the Andaman Islands, of Cutch and of Mysore, have been completed.

10. It had been intended to employ the party set free from the Andaman Survey in regular survey operations in the newly acquired province of Upper Burma during the current field season, but owing to the unsettled state of the country it has been decided to postpone the commencement of these operations until more favourable conditions exist, and the party will, in the meantime, be engaged in carrying out a topographical survey of the Nicobar Islands, which is much needed.

The completion of the Mysore Survey has released a party to undertake the topographical surveys in the Madras Presidency, which have been hitherto carried on by the Madras Survey Department under the Local Government, and the transfer of which to the Imperial Survey Department has been lately decided

on. The uncompleted portions of the following districts will therefore be surveyed by this Department on the standard scale of 1 inch=1 mile, *viz.*—Ganjam, Vizagapatam, Tinnevelly, Madura, South Canara and Malabar, comprising an aggregate area of about 12,400 square miles.

The party lately employed in Cutch, as well as that recently engaged in the South Deccan, was transferred at the close of the year under report to undertake Revenue Survey work in the Central Provinces, so that at the present time the number of parties employed on topographical surveys is reduced to eight, excluding the Burma Party, the operations of which are confined to Forest Surveys.

11. The general out-turn of topography executed during the year amounts to 19,162 square miles, which is exclusive of Forest Surveys and of the standard mapping compiled by the Punjab Party from *Patwari* surveys :—

5,518	square miles surveyed on the		½	-inch scale.
2,826	,,	,,	1	,,
10,784	,,	,,	2	,,
28	,,	,,	4	,,
6	,,	of city survey ,,	26·4	,,

In connection with the Baluchistan Survey, reconnaissance surveys were also executed on the ¼ inch and ⅛ inch scales, embracing an area of about 30,000 square miles.

RIVERAIN AND FOREST SURVEYS.

12. The Riverain Survey, on the scale of 4 inches=1 mile, along the Gogra River, carried on in District Fyzabad in connection with the cadastral survey of the Basti District, has been completed; and a series of maps embracing the entire low-lying tracts on both sides of the river, with the details of the village boundaries, intended to facilitate the restoration of boundaries when changes occur in the course of the river, has been prepared.

13. A forest survey on a new system has been begun in the Belgaum District, but as the work was taken in hand late in the season, a small area only has been accomplished. The maps of this survey are on the scale of 8 inches to a mile and are little more than skeleton maps, showing village and forest boundaries, together with perennial streams and made roads; they are intended to be completed by the officers of the Forest Department to the extent that may be necessary to make them serve as working plans. These Belgaum forests lie within the area under topographical survey by the South Marátha Party, so that their full topography is being surveyed simultaneously on the 2-inch scale along with the partial details on the larger scale, as required by the Forest Department.

14. The Burma Party has continued the survey of the forests in the Prome and Tharrawaddy Districts, where, in addition to the physical difficulties of the country which were met with as usual, the outbreak of disturbances by dacoits materially influenced the progress of the operations and added greatly to the anxieties and responsibilities of the surveyors. The interruptions to the work and loss of time involved by the necessity for changing the programme during the season, and the subsequent withdrawal of the party from the field a month earlier than usual, have naturally caused a diminution in the out-turn of work compared with that of the previous year.

The areas of these operations are :—

	Square miles.
Riverain	36
Forest	330

CADASTRAL SURVEYS.

15. The operations of four Cadastral Parties have been continued in the same districts in which they had previously been employed; these are, the two North-West Parties in Districts Gorakhpur and Basti; the Assam Party, in the Kámrúp District; and the Burma Party, in the Akyab District. Another old cadastral party has been transferred from the Henzada District of Burma to the Mozufferpore District of Bengal to initiate a cadastral survey there. A new cadastral party has been raised on the nucleus of the late Shwegyin Topographical Party for the cadastral survey of District Biláspur in the Central Provinces. Thus six cadastral parties have been working during the season. In the North-West Provinces, the two parties employed there have continued the preparation

of the same papers which constitute the Record of Rights and furnish the basis for a new Settlement, and, as before, have also compiled the statistical statements of crops and classes of inhabitants. The Gorakhpur Party has a total cost rate, both for survey work proper and for all extraneous work done for the Settlement, of ₹170-5 per square mile, which is practically the same as last year's rate, while the work done in the Survey office has actually been increased by the transfer of the preparation of the Urdu *jamabandis* from the offices of the Deputy Collectors. The Basti rate is considerably less than that of last year, but is still higher than the Gorakhpur rate, being ₹197-1-6 per square mile. The higher rate is fully accounted for by the small size of the fields, which gives a very much larger number per square mile to be surveyed and recorded. The Basti rate per field is considerably less than the Gorakhpur rate per field. The survey expenditure in both parties has been carefully watched, and it is still believed that any reduction in the cost of the joint operations of survey and settlement must come from the Settlement Department. The fairing of records, which in one of the districts is said to cost more than the original preparation, is again brought to notice as an item of settlement expenditure on which a considerable reduction might be effected.

16. In the Kámrúp District of Assam, the cadastral survey has been carried on under the same system as in previous seasons, and the work includes the preparation of a *khasra* (register) specially adapted for the *raiyatwari* tenure obtaining in the province. The cost rate has been reduced from ₹215-5 of the past season to ₹196-3 of the present season.

17. In the Akyab District of Burma, the operations consist of purely survey work, no register of any kind being prepared. The out-turn includes some narrow strips of country situated in different valleys, which has made the supervision of the work a matter of considerable difficulty. The rate has been reduced from ₹294-13 of the previous season to ₹244-1 during the present season.

18. In Bengal, the cadastral survey, with preparation of a record of rights, for Mozufferpore has been undertaken as an experimental survey under the Bengal Tenancy Act, the experiment having been instituted for the purpose of testing the feelings of the people of Behar, with regard both to the mapping of the holdings and to the concurrent inquiries into occupancy rights, as well as to ascertain the probable cost of such operations with the view to their being extended, if all matters should be found favourable, to other permanently settled districts of the province of Bengal. The result of the experiment as concerns the temper of the people was in every way satisfactory. The landlords offered no opposition, as had been feared they might have done through their regarding the formal recording of the rights of the tenants as a restriction of their proprietary rights. The tenants did not object to the measuring of their fields, which had been partly expected, through apprehension of an increase of rents, though it was also evident that they were still ignorant of the great advantages accruing to them from the accurate record which was being made of their holdings, and generally they were found to be passively indifferent to the operations which were being conducted. The cost of the survey has been at the total rate of ₹269 per square mile (or about 6 annas 9 pies per acre), made up of a rate of ₹140 for the operations of survey proper, and of ₹129, the sum of the rates for writing and compiling the records. (See tabulated statement of rates at page 64). The total rate is obtained after including with the expenditure several charges not likely to be repeated, and which have been incurred through the party having to be transported from a distant province and having to be equipped for new operations. The rate has also been obtained from an out-turn of 413 square miles, which is only about half of what a party might ordinarily be expected to accomplish in Behar after being specially organized and trained, but which could not be exceeded during the first season, when there had been no preparatory traversing, when many new men had to be taught surveying, and all had to be instructed in the particulars required to be recorded in the village papers. For next season, local establishments had been trained, and if the survey had been continued, it was confidently expected that an area of 800 square miles would have been accomplished, and that the entire operations of survey and preparation of the record of rights would have been effected for less than ₹200 per square mile, or below 5 annas

an acre. As regards the stoppage of the survey, it is unnecessary to offer any remarks except to express regret at the abandonment of a work calculated to be of great benefit to the public interest, to the interest of landlords, and to the interest of tenants, and to place on record that the cause of the stoppage has been the failure of the Bengal Government to obtain sanction to the levying of cesses from landowners and tenants to cover half the cost of the operations which was part of the project when the experimental survey was undertaken.

19. For the new cadastral party which has been employed in the Biláspur district, the old establishment of the Shwegyin Party provided only for the traversing part of the work, and the larger proportion of the party required for the field surveying and writing the village papers had to be engaged in the North-West Provinces, from among the large numbers of men who make surveying a profession in many of the districts there, and thence they were taken down to Biláspur, where local *amins* were not available. The system of preparing the village records required for a settlement concurrently with the survey, as is followed in the North-West Provinces, has been adopted for Biláspur. This system was new to most of the members of the party, and all had to make strenuous exertions to learn, not only the system, but also to acquire a knowledge of the nature of the land tenures in Biláspur. The result of the season's operations is highly creditable to all concerned, a total area of 763 square miles having been cadastrally surveyed, out of which the records have been written in 606 square miles. The cost rate on the latter, or completed area, is ₹169-11, which, it is confidently expected will be reduced next season.

The areas surveyed cadastrally are:—

	Square miles.
North-West Provinces	1,603
Assam	468
Burma	661
Bengal	413
Central Provinces	763
TOTAL	3,908

TRAVERSE SURVEYS.

20. The Punjab Party has continued the same operations as last reported. Its main work is skeleton traversing to determine the co-ordinate distances of village tri-junctions for the construction of general maps on which the topographical details are inserted by transfer from the Settlement Survey village maps. The co-ordinate distances are also employed in districts coming under settlement survey, to test the accuracy of the frame-work for the village maps which is laid out by the Settlement surveyors on their own system. In several districts not yet surveyed for settlement purposes, the traversing might be utilized, with slight modifications in its design, as a basis for the construction of the village maps, but the Settlement authorities prefer to lay out a frame-work for themselves. The Survey party, besides compiling general maps from Settlement Survey materials, also tests the topography after the maps have been compiled.

21. In the Central Provinces, the system which had been tried as an experiment for two seasons in Districts Raipur and Sambalpur, of surveying the boundaries of blocks of fields, within which the *Patwaris* were intended to insert the individual fields, has been abandoned, partly because of the difficulty which was experienced in recognizing the plotted boundaries on the ground, and partly because it was found that the *Patwaris* could survey equally well with the assistance of traverse points only. In place of the "field block" survey, a simple skeleton traverse survey has been substituted, which will furnish points in suitable positions on the boundaries of small villages, and, in large villages, additional points in the interior of the village lands, so as to form complete skeleton maps on which the *Patwaris* will plot their measurements of the fields. The scheme involves the fixing of substantial mark-stones at all the traverse points. This system will be extended to 17 districts in the Central Provinces, and when fully developed will employ an extreme number of five survey parties. During the past season, two full parties and one half party have been employed in Districts

Raipur, Sambalpur, Jubbulpore, and Damoh, and a total area of 5,269 square miles has been surveyed.

22. A small detachment has been employed in District Ajmere, extending to the *jagir* and to a few minor *istimrar* villages the same system of boundary traversing for the purposes of a settlement survey of the fields as had been carried on for the *khalsa* villages during two previous seasons. All the survey work of this nature required in Ajmere-Merwara has now been completed.

The areas which have been traversed are —

	Square miles.
Punjab	3,770
Ajmere	243
Central Provinces	5,269
TOTAL .	9,282

GEOGRAPHICAL RECONNAISSANCES AND EXPLORATIONS.

23. The year under review has been a memorable one as regards geographical surveys and reconnaissances. The delay in the settlement of the Russo-Afghan Boundary was turned to profit by the Survey officers attached to the British Commission, *viz.*, Major Holdich, Captains Gore and Talbot, all of the Royal Engineers. By making the most of every opportunity which presented itself, and being efficiently aided by their native staff, they have succeeded in making a reconnaissance survey of a very large portion of Afghanistan, amounting to an area of about 120,000 square miles—a result which is believed to be unique in the annals of geographical surveying. The whole of this work is based on a net-work of triangulation, mainly executed by Captain Talbot, R.E., extending from Mashhad on the west, to beyond Kabul on the east, and to Farah on the south, a fact which gives the work a value far beyond that generally appertaining to geographical surveys.

The longitudes of the triangulation depend on the value of the longitude of Mashhad telegraphically determined by Captain Gore, R.E., as described in the appendix to the Annual Report for 1884-85.

24. In addition to the legitimate work of surveying and delimiting the actual Russo-Afghan Boundary, the whole of the Province of Herat, including the hitherto unknown and exceedingly interesting Taimani and Firozkuhi country, has been mapped; almost the entire Province of Afghan-Turkistan has been surveyed or reconnoitred, including a large portion of the Hazara country lying in the neighbourhood of Bamian, while, during the return march of the Commission, all the important passes of the Hindu Kush have been surveyed and reported on.

25. In addition to this, the survey of a considerable portion of Eastern Khorasan has been executed, in continuation of which work, Captain Gore, returning to India through Persia, has surveyed the route from Herat *vid* Birjand through the Lut desert to Kirman and Bandar Abbas.

26. The Survey Party were much indebted to Major Maitland and Captain Peacocke, R.E., of the Quartermaster General's Department, for several valuable reconnaissances.

27. The detailed report on the geographical results of the Afghan Boundary Commission will be drawn up by Major Holdich, R.E., and published as a separate volume by order of the Government.

28. The Government of India have been pleased to acknowledge the valuable services of the Survey officers attached to the Mission, and have expressed their satisfaction with the results obtained.

29. Colonel Woodthorpe, R.E., whose deputation to join the Gilgit Mission was mentioned in the last Annual Report, has thoroughly sustained his reputation as a most able and intrepid explorer, and he has brought back a mass of valuable information and surveys of the very important and hitherto little known districts of Yasin, Chitral, Hunza and Wakhan; his surveys cover an area of some 10,000 square miles, nearly all of which was hitherto only known to us by report or from the rough reconnaissances of native explorers.

30. In Upper Burma, a small detachment under Captain Hobday has been engaged since April 1886 in adding to our scant knowledge of the geography of that country as far as the movements of the troops allowed.

31. Our geographical knowledge of Nepal and Tibet has been extended by the route survey of Explorer M—H, who, having followed up the Dudhkosi River to its source, crossed the great Himalayan ridge at a pass about 24 miles west-north-west of Mount Everest and proceeded northwards to Dingri Maidan. Thence he proceeded westwards to Jongkhajong (about 90 miles due north of Khatmandu) and returned to India *viâ* Naiakot and the Naraini or Gunduk River.

32. The routes followed up by Explorer R—N have also opened up the general geography of Western and Eastern Bhutan, of which but little was known, and have furnished a good nucleus for the compilation of Sheet No. 7 of the North-East Trans-frontier Series of maps. Starting from Darjeeling, the explorer crossed the Sikkim frontier at the Pángula Pass and proceeded at first eastwards and then southwards along the Wongchhu River to Baxa in the Jalpáiguri District. He next started from Dewángiri in Assam, and proceeding northward, crossed the Himalayan ridge in latitude 28° and longitude 91¾°, and thence found his way to Odálguri *viâ* Tawáng. Further information on the foregoing routes will be found in Part II, but the detailed accounts and maps illustrative of the same cannot be got ready in time for this Report.

PUBLICATIONS.

33. The work in the various Cartographic Offices has been carried on with much activity, and a large amount of work has again been turned out. The total number of maps issued during the year amounted to 210,288 and their value to ₹1,66,749. Considerable progress has been made in the Lithographic Office with the publication of the series of maps illustrating the physical and material state of India, originally prepared for the Calcutta Exhibition of 1883-84. The preliminary Canal Map of India, on the scale of 1 inch=32 miles, was under preparation and ready for printing. The Contour Map on the same scale, showing the mean elevation of the different parts of the country, has been published. On the smaller scale of 1 inch=80 miles, two maps which have been published are worthy of special notice, one illustrating the distribution of the principal religions of India, which shows at a glance the habitat of the men professing the principal religions, and the other the density of population based on the census of 1881. These maps are excellent specimens of chromo-lithography, and will compare fairly well with similar work executed in other countries.

The Military and Railway Map of India, on the scale of 1 inch=32 miles, which was referred to at page 10 of the last Annual Report, has made good progress. Four sheets have been drawn on stone for printing in four colours, and seven more sheets remain to be finished. The map is being prepared for the Military authorities, and will be as complete in all military details as is compatible with the small scale.

34. The value of photo-zincography as a means of rapidly making the results of surveys available to the public, is shown by the fact that no less than 370 sheets of standard maps of the Topographical and Revenue Surveys in the Andamans, Burma, Gujarát, Káthiáwár, Konkan, Mysore and the Punjab have been photo-zincographed and published during the year: some however are reprints. Among City and Cantonment Plans, the City of Mysore, on the scale of 12 inches=1 mile, and that of Jeypore with Amer, 6 inches=1 mile, printed in two colours, may be mentioned. A large number of District Maps, on the scale of 1 inch=8 miles, intended for the illustration of Administration Reports, have been published and are available for District officers requiring them.

The work of reproducing the results of the cadastral surveys in the North-West Provinces, Burma, Assam and Bengal has steadily proceeded, and during the year 5,203 sheets have been published, partly by photo-zincography from the original sheets, and partly by zincography from tracings made in lithographic ink.

GENERAL REMARKS.

35. The large demands that have been made on the Survey Department for officers required to accompany political missions and military expeditions, and for other special work, combined with the circumstance of a larger percentage than usual being absent on medical leave, has rendered the efficient prosecution

of the regular work of the department peculiarly difficult. This has been the subject of remark in the Annual Reports for the past two years, and during the year under review, the paucity of officers has been still more seriously felt. There has been absolutely no reserve of trained officers, and the administration of the department has consequently been a task of considerable anxiety; it is necessary to record that the working machinery of the department has been limited to a dangerous extent.

36. During the year the Department has sustained the loss of the services of Lieutenant-Colonel J. Herschel, R.E., F.R.S., by his retirement on 10th March 1886, after a service of 26 years in the Survey Department, during which period he has aided largely in maintaining the scientific character of its operations. For the first few years he was employed on the Principal Triangulation, and took an important share in the measurement and reduction of the Base-lines at Bangalore and Cape Comorin: he commenced the observations for Latitude with Strange's Zenith Sectors, and also initiated the electro-telegraphic observations for Longitude in conjunction with Captain (now Major-General) W. M. Campbell, R.E., and systematised the procedure for the reduction of both. He was entrusted by the Royal Society with the charge of the observations of the eclipse of the sun on the 18th August 1868, which he sucessfully conducted, and obtained results most valuable to science; he also took part in the observations of the solar eclipse of 12th December 1871, conducted by Colonel Tennant, R E. During his service in the Computing Office at Dehra his mathematical talent was of great value: it was to his exertions there that the department owes the method of treating the computations of polygonal figures according to the principal of minimum squares, in place of the old method, by successive approximation. Colonel Herschel has also rendered valuable assistance in the investigations connected with the reduction of the Pendulum observations, and he contributed materially to Volume V of the Account of the Great Trigonometrical Survey, which is devoted to that subject. Since November 1879, Colonel Herschel has been employed on special duty in England, in collating the data obtained from Pendulum observations in other parts of the world, with a view to combining them with the results of the Indian observations—a work involving much patient research.

37. A collection of specimens of every kind of map, and of the different processes employed in reproduction by the Survey Department, was sent to the Colonial and Indian Exhibition of 1886, as well as an elaborate model of India, based on the 32-mile map, made in plaster-of-paris by Major C. Strahan, R.E. It was the first attempt at anything of the kind. The vertical scale is 12 times the horizontal one, so that the mountains are well seen, the highest peak of the Himalayas being nearly 2 inches in height.

38. The Geographical Society of Paris have awarded a gold medal to the Explorer A-K, Pundit Kishen Sing, in recognition of his valuable services in connection with geographical explorations in Tibet during the years 1879-82. Much additional knowledge of this country had been hoped for from the Tibet Mission, to which Colonel Tanner had been attached as Survey Officer, but these expectations were unhappily not realized.

PART II.

SUMMARY OF THE OPERATIONS OF THE TRIGONOMETRICAL, TOPOGRAPHICAL AND REVENUE SURVEY PARTIES.

TRIANGULATION.

COAST—GODAVARI AND KISTNA DISTRICTS.

THE COAST SURVEY PARTY.

39. On the transfer of Mr. D'Souza, the officer who during the two previous seasons had conducted these operations, the charge of the party was entrusted to Mr. E. C. Ryall, who was directed to continue the triangulation southwards from the side, in the vicinity of the Godávari River, where it had terminated in May 1885.

Personnel.

Mr. E. C. Ryall, Officiating Deputy Superintendent, 4th grade.

Mr. R. W. Senior, Assistant Surveyor, 2nd grade.

40. The party left Calcutta on the 25th of October, but owing to the rough weather met with, they did not reach Cocanada till the 4th November. The country to the south having been reported to be under water, Mr. Ryall determined to prospect the ground for himself before commencing operations. He met "with nothing but creeks and extensive swamps, divided here and there by long, narrow strips of palmyra and cocoanut." As the swamps were not of fresh water, but due to the flood and spring tides, he saw that it would be useless to wait any longer, so he hurried back to Cocanada to entertain boats and men and to lay in supplies. The approximate work (consisting of the selection of suitable stations, their building, and the clearing of the rays between them), was sufficiently advanced by the 3rd of December to allow the commencement of observations. After a week's instruction, Mr. Senior was detached to Masulipatam with orders to work northward, while Mr. Ryall purposed triangulating southwards till a junction was effected. The old triangulation of the Madras Coast Series furnished bases for emanation of the southern section, while the northern was in continuation of that of the previous season; the object of the triangulation being, as stated in former reports, to construct beacons for the benefit of the Marine Department, and to fix their positions as well as the positions of other conspicuous objects and landmarks.

41. Owing to repeated attacks of malarious fever, Mr. Ryall was unable to contribute as much work as he had hoped He nevertheless carried down the series for a distance of 65 miles, and, having effected a junction with Mr. Senior's work at the southern mouth of the Godávari, proceeded to Masulipatam to continue the triangulation further south, when severe illness compelled him to retire from the field. Mr. Senior, however, carried on the work of the party till the close of the season, bringing up the out-turn to 145 miles (direct distance) of triangulation, by which the positions of nine beacons and of seven other permanent and conspicuous objects were fixed.

During the recess, the records of the previous season were re-examined and finally arranged, and the usual calculations and charts illustrative of the work now reported on were prepared.

TOPOGRAPHY.

ANDAMAN SURVEY.

42. During the year under review, the survey of the Andaman Islands, with the exception of a large part of Little Andaman, which was impracticable, has been successfully completed. The operations consist of a general survey of the group of islands on the scale of $\frac{1}{2}$ inch = 1 mile, with special portions round the Settlement of Port Blair on the 4-inch scale.

Personnel.

Captain J. R. Hobday, S.C., Officiating Deputy Superintendent, 4th grade, in charge up to 20th March 1886.
Major G. Strahan, R.E., Deputy Superintendent, 1st grade, in charge during the recess season.
Mr. G. D. Cusson, Assistant Surveyor, 1st grade, in charge from 20th March to 17th May 1886.
,, J. Keating, Assistant Surveyor, 2nd grade.
,, D. Campbell Assistant Surveyor, 2nd grade.

Sub-surveyors.

Har Lal Singh, Faida Ali and Ali Nawaz Khan.

The party under Captain Hobday left its recess quarters at Mussooree on 31st October 1885, and proceeding to Calcutta, embarked there for Port Blair, which was reached on 24th November. The field operations were concluded on 23rd April 1886.

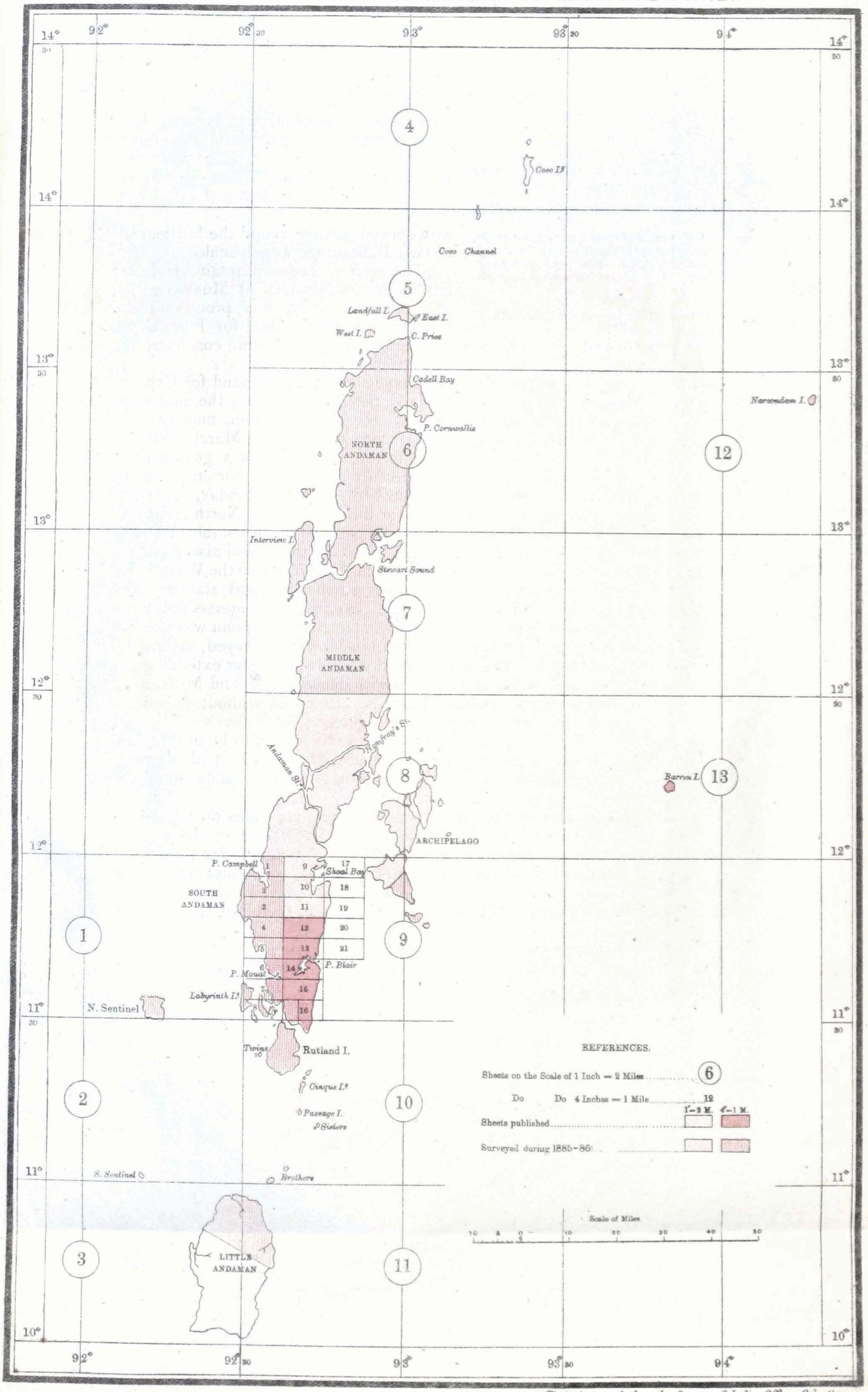
43. In March, the Military authorities made an urgent demand for Captain Hobday's services for survey operations in Upper Burma, and as the field work in the Andamans was then nearly finished, he was transferred, making over charge of the party to Mr. Cusson, the senior Surveyor, on 20th March. Before leaving, Captain Hobday drew up instructions for Mr. Cusson's guidance for completion of the field operations which were carried out in an efficient manner.

44. The triangulation, which was executed by Captain Hobday, covers an area of 955 square miles and was extended over the whole of the North Andaman and the outlying islands, and as friendly relations had been established with the inhabitants on the north coast of Little Andaman, this island also was connected in the following manner. The ray between the stations on the West Sister and Passage Islands was used as a base from which additional stations were thrown out on both the Brother Islands, and therefrom an intersected point was fixed on the north-west corner of the Little Andaman. This point was used as an origin and 24 miles of coast line, and a few creeks were surveyed, embracing an area of 68 square miles. The island afforded no facilities for extending the triangulation further, as it is flat and covered with dense jungle, and Mr. Cusson reports that "a theodolite traverse could not be attempted without previously coming to a good understanding with the natives along the western and southern shores, as their disposition to strangers was known to be hostile, and that even on the northern coast, chain measurements could not be made owing to the excitable nature of the people and their eagerness to lay hands on all the iron they saw with the party."

45. The detail survey comprised an area of 28 square miles on the 4-inch scale and 1,464 square miles on the $\frac{1}{2}$-inch scale. The nature of the country surveyed on the latter scale is thus described "numerous hilly islands, difficult of approach, covered with dense forest and intersected by numberless creeks, with frequent and extensive mangrove swamps, peopled by a few wandering savages and no supplies procurable." Much of the topography, therefore, is little more than reconnaissance.

46. The difficulties and hardships attending the survey of these islands were mentioned at page 14 of the General Report for last year, and they were met with to an equal degree during the season under review. Much credit is due to Captain Hobday and his assistants for the manner in which they have accomplished this arduous piece of work, and this has been heartily acknowledged by the Superintendent of Port Blair and the Nicobars, who has already brought to the notice of the Government of India the excellent work done by the party. The success of the operations was, however, largely due to the assistance so freely given to the Survey officers by the local authorities. Owing to the loss of the steamer *Reclaimer*, which was wrecked during the previous year, the Survey party was dependent on the local steamers, and during the greater part of the past season, the *Nancowry*, under the command of Mr. Holland, was placed at Captain Hobday's disposal. Convict labour was also provided for clearing hill-tops and making paths where required through forests,

INDEX TO THE SHEETS OF THE ANDAMAN TOPOGRAPHICAL SURVEY.



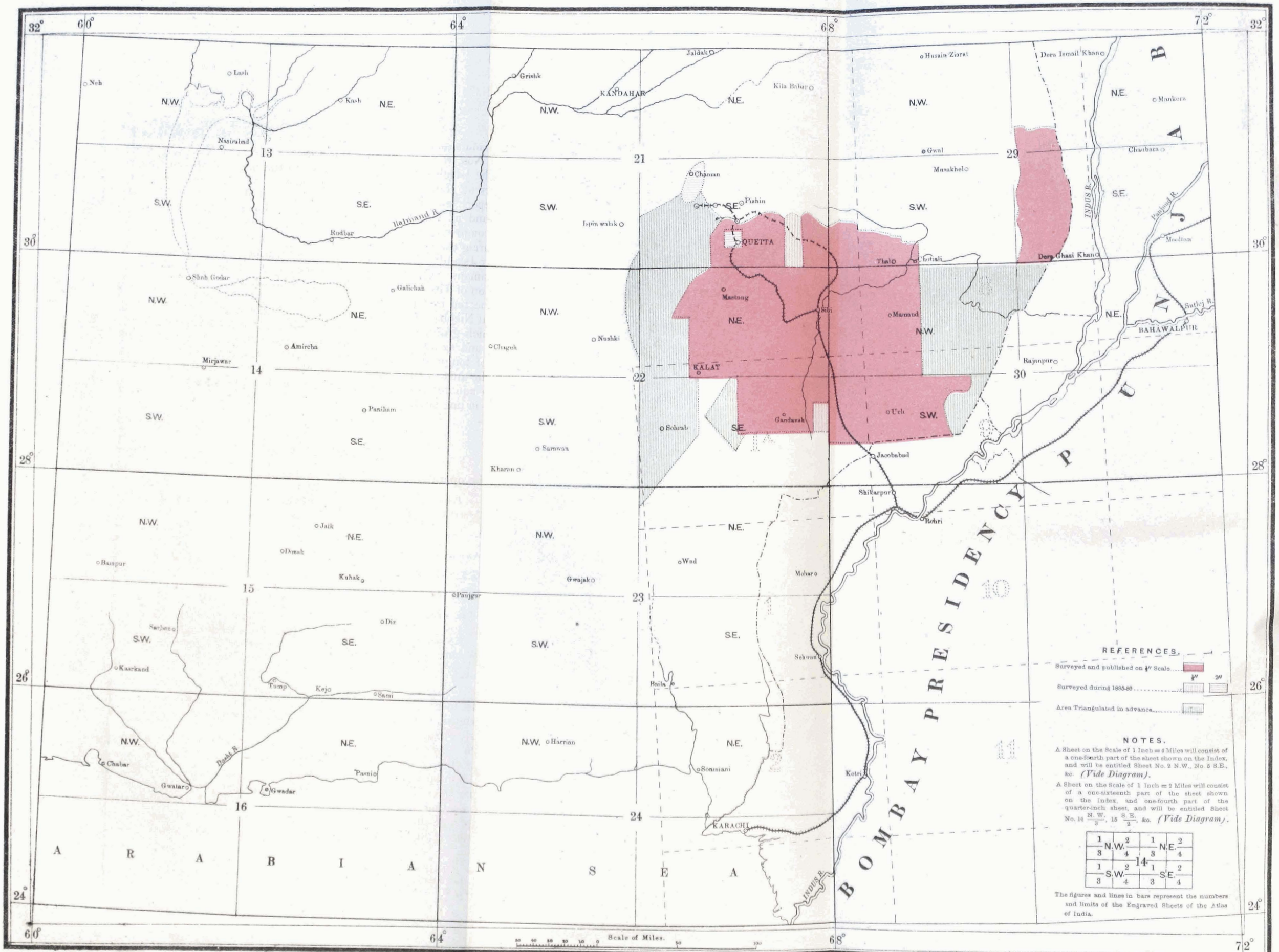
Photozincographed at the Survey of India Offices Calcutta.

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India, Survey of India Offices, Calcutta, December*

1886.

INDEX TO THE SHEETS OF THE BALUCHISTAN SURVEY, NORTH WESTERN TRANS-FRONTIER.

On the Scales of 1 Inch = 4 Miles and 2 Miles.



REFERENCES.

Surveyed and published on 1″ Scale

Surveyed during 1885-86 — 4″ 2″

Area Triangulated in advance

NOTES.

A Sheet on the Scale of 1 Inch = 4 Miles will consist of a one-fourth part of the sheet shown on the Index, and will be entitled Sheet No. 2 N.W., No. 5 S.E., &c. *(Vide Diagram).*

A Sheet on the Scale of 1 Inch = 2 Miles will consist of a one-sixteenth part of the sheet shown on the Index, and one-fourth part of the quarter-inch sheet, and will be entitled Sheet No. 14 $\frac{N.W.}{3}$, 15 $\frac{S.E.}{2}$, &c. *(Vide Diagram).*

1/3	N.W. 2/4	1/3	N.E. 2/4
1/3	S.W. 2/4	1/3	S.E. 2/4

14

The figures and lines in bars represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Scale of Miles. 50 40 30 20 10 0 50 100

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*
Survey of India Offices, Calcutta, January 1887.

Photozincographed at the Survey of India Offices, Calcutta.

and the men worked excellently. Captain Hobday expresses his deep sense of the valuable help he has at all times received from Colonel Cadell, V.C., the Superintendent, and from the Marine and Settlement Officers.

47. The only accident which happened during the season was the capsizing of a boat containing two constables and six convicts in the surf off North Sentinel Island. It is reported by Colonel Cadell that "Mr. Holland and Captain Hobday, on seeing the accident, at once put off in boats from the *Nancowry*, and at great personal risk saved all but one Sikh constable, who was drowned."

48. During the recess season the fair maps of the following sheets have been drawn and submitted :—

Sheets Nos. 6, 7 and 16 on the 4-inch scale, and Nos. 1, 3, 5, 6, 7, 9, 10 and 11 on the $\frac{1}{2}$-inch scale. These complete the maps of the Survey.

A chart of the triangulation in 2 sheets has also been prepared. The General Report on the triangulation of the whole of the Islands has been drawn up, and all the records connected with the work of the Andaman Party have been completed and submitted to head-quarters.

49. During the current season, this party will be employed in the survey of the Nicobar Islands. The scales of survey will be the same as those employed on the Andamans. Owing to the distances between the main islands, and, with the exception of Great Nicobar, their small elevation, it is improbable that they can be connected by triangulation ; independent surveys will, therefore, be necessary of Great Nicobar, of Car-Nicobar and of Camorta and its adjacent islands, in each of which group it will be necessary to observe for latitude and to measure a base-line and azimuth, and if time and opportunity permit, to determine the difference of longitude between one or more of them and Port Blair by chronometers. The area of the islands is comparatively small, not exceeding probably 600 or 700 square miles, so that it is hoped that the work required may be accomplished in one season.*

BALUCHISTAN SURVEY.

50. The operations of this party during the past season were almost entirely of a special nature, to meet the requirements of the Military Department, and consisted of :—

(i) A survey on the 2 inches = 1 mile scale of the Khwája-Amrán Mountains, a range lying some 50 miles north-west of Quetta, on the road to Kandahar.

(ii) A survey on the 2-inch scale of the country surrounding Quetta.

(iii) An exploration of the routes between Registan and the Baluchistan frontier.

Personnel.

Lieutenant-Colonel J. R. Wilmer, S.C., Officiating Deputy Superintendent, 3rd grade.
Mr. M. J. Ogle, Surveyor, 3rd grade.
„ T. E. M. Claudius, Surveyor, 4th grade.
„ E. A. Wainwright, Assistant Surveyor, 1st grade.
Mr. W. C. G. Barckley, Assistant Surveyor, 1st grade.
Mr. A. Kitchen, Assistant Surveyor, 1st grade.
Mr. E. Graham, Assistant Surveyor, 1st grade.

Sub-surveyors.

Mr. F. Rozario, from 1st March, Ahmad Ali, Abdul Rasul, Hussain Bux, Sheikh Mohidin, Kadar Sharif, Abdul Rahman, and four soldier surveyors.

51. The remaining operations comprised a small area of topographical survey on the $\frac{1}{2}$-inch scale, to complete two sheets in which gaps had been unavoidably left ; and the extension of triangulation in advance for future detail operations on the regular scale of survey.

52. On the 15th October a small detachment under Mr. Claudius left recess quarters for Quetta, to commence the preliminary work of triangulation for the Khwája-Amrán survey ; operations were commenced on the 17th November, and by the 22nd December the triangulation was completed. The intense cold and inclement weather which then set in, rendered further out-door work impracticable, the range under survey having an average height at its summit of about 8,300 feet above the sea. The detachment was thus driven into winter quarters,

* Captain Hobday reports that all the assistants have afforded him entire satisfaction ; and Major Strahan adds that, during the recess season, he had reason to be satisfied with their diligence and acquirements, especially in the case of Mr. Keating, who rendered excellent service.

which were fortunately available for their protection in the fort of Gulistan, and here the members were occupied in computing the results of their observations until joined by the remainder of the party at the end of January.

53. The main body of the party arrived at Quetta on the 27th December, after a trying march through the Bolan Pass - the railway then not being open for regular traffic - but owing to the severe weather, with constant snow-storms, it was forced to remain there under canvas until 22nd January, when a break in the weather occurred. It then joined the detachment at Gulistan. The weather, however, continued unfavourable until the middle of February, when some Sub-surveyors were sent out to survey the low-lying country at the foot of the Khwája-Amrán Hills. Very little survey work was accomplished, however, during February, and it may be said that the detail survey was not fairly begun until the 1st March. This survey, which included the determination of contours by the water-level along the sides of the hills at vertical intervals of 500 feet, was completed by the end of May. The portion of the range surveyed was from the Ghwája Pass on the south to the Bogra Pass on the north, including the posts of Kila Abdulla and Gulistan, in which the ground is described as very rocky, steep and intricate.

54. On the completion of the Khwája-Amrán survey the whole strength of the party was transferred to Quetta to take up the 2-inch survey required in that neighbourhood for which the triangulation had meanwhile been done and computed. Portions of the very high hills, some of them rising to 11,000 feet above sea-level, not being required in such full detail were not re-surveyed, but have been inserted in the fair map by enlargement from previous surveys.

55. The country surveyed on the $\frac{1}{2}$-inch scale, included a portion of the Harnai Valley and the hilly and barren country south of it; also a portion of flat open ground in Kachi to complete a gap in Sheet 22 $\frac{S.E.}{2}$. The survey was executed by Mr. A. Kitchen in a very creditable manner.

56. The triangulation in advance of the detail operations of the season was entrusted to Mr. Claudius, who carried the operations southwards from Gulistan generally along the meridian of 66°, over the southern portion of Peshin, the whole of the fertile valley of Shorawak and the hilly tract of Shorarud. This piece of triangulation is the more valuable as it has connected the Kandahar, Kalat and South-West Baluchistan Series, and furnishes good bases for further extension westwards. Mr. Claudius has written an interesting description of the country he traversed which will be printed separately.

57. The out-turn of work during the season comprises the triangulation and topography of an area of 620 square miles on the 2-inch scale, the survey of which was close and searching, the average number of plane-table fixings being 24 per square mile; the topography of 514 square miles on the $\frac{1}{2}$-inch scale; and 4,350 square miles of triangulation in advance for future topographical work on the $\frac{1}{2}$-inch scale. These operations were not concluded till the end of June when the party returned to recess quarters, having had a long and trying field season in which extremes of both heat and cold were experienced. The results of their labours are creditable to all concerned.

58. The four native soldiers, who had been attached to parties of the Survey Department in the previous year for instruction in surveying, were allowed to remain another season for a further course: they have all been employed in the Baluchistan Party this year and rendered excellent service in it. They took a fair share in the field operations, each having surveyed independently on the 2-inch scale an area of from 40 to 50 square miles which was well tested and found to be very satisfactory. Their work was a very useful addition to the out-turn of the party, and Colonel Wilmer reports that they have all proved themselves to be able and accurate plane-tablers. They are now thoroughly trained, and have been sent back to military duty and three other soldiers have replaced them for instruction.

59. The cost of these surveys is Baluchistan is high, but this is in a great measure accounted for by the exceptional expenditure that has to be incurred for protective escorts to the surveyors. Each detachment this year, whether under an European assistant or a Sub-surveyor, had to be protected by a tribal guard of 11 men, the monthly cost of each guard amounting to R217; this proved a very heavy item in the cost. The Agent to the Governor General at first suggested that the party should be accompanied by troops from the garrison

at Quetta as well as by tribal guards, but the Political Agent for Peshin considered that the presence of troops was unnecessary, which proved to be the case, as, with the exception of one or two petty annoyances, everything went well, and the party left the country without any complaints having been made on either side.

60. In addition to the regular operations of the party, explorations were made, on the requisition of the Quartermaster General, of the routes leading from Registan to the Quetta and Baluchistan frontier. Two Sub-surveyors, Ahmad Ali and Sheikh Mohidin, were detailed for this duty; they were each accompanied by a soldier student under training, and were placed under the orders of the Agent to the Governor General for Baluchistan, by whom arrangements were made for their protection and safety. Ahmad Ali, starting from Nushki, succeeded in making a reconnaissance survey with the plane-table of nearly 20,000 square miles, three-fourths of which was on the $\frac{1}{4}$-inch scale and the remainder on the $\frac{1}{8}$-inch scale. His exploration extended up to the Persian frontier, embracing country well to the north and south of the route followed by the Boundary Commission in 1884, including 360 miles of the course of the Helmund River with its numerous villages on both banks. He has submitted with his maps a very copious report of the piece of country surveyed, which, however, having been written in the Persian character, will take some time in being translated and reduced to suitable form. The results of the expedition are in every way very creditable to Ahmad Ali. The country explored by Sheikh Mohidin is that portion of Registan immediately west of the Khwája Amrán range. His plane-tabling covers an area of about 10,000 square miles, on $\frac{1}{8}$-inch scale, chiefly desert, through which all the important routes have been laid down.

61. Owing to the field operations of the party having been prolonged to so late a date, the recess season was limited to a period of three months only; it was impossible therefore in the time to complete all the fair maps of the ground that had been surveyed. They were taken up in the order of urgency, and the following have been completed and submitted for reproduction:—Sheets 22 $\frac{SW}{2}$ and 21 $\frac{SE}{4}$ of the general survey on the $\frac{1}{2}$-inch scale; the sheets of the Quetta 2-inch survey, which have been designed in two large sections, not of the standard size or pattern, as this arrangement would have involved a larger number of sheets, but well suited to exhibit the country operated in, either in separate sections or by joining them in one general map. The drawing of the sheets of the Khwája Amrán Survey was proceeded with as far as possible, and arrangements have been made to continue this work during the current field season without detriment to the progress of operations. Colonel Wilmer has also furnished tracings from the field sections of both these surveys for the use of Railway and Military Engineers to meet urgent requirements, and this has, to some extent, interfered with the drawing of the compiled fair maps. The computations of the triangulation have been completed and progress made with the General Degree Reports.

62. During the current field season it is intended to triangulate the portions remaining in Sheets 22 $\frac{SE}{1}$ and $\frac{SE}{3}$, the whole of 22 $\frac{SE}{4}$, 23 $\frac{NE}{1}$, $\frac{NE}{3}$ and the portions of 23 $\frac{NE}{2}$ and $\frac{NE}{4}$ which fall in Baluchistan. Detail survey on the $\frac{1}{2}$-inch scale will be carried on in the southern half of Sheet 29 $\frac{SW}{4}$, the whole of Sheet 30 $\frac{NW}{2}$ and the portions of sheets 30 $\frac{NE}{1}$, $\frac{NW}{4}$ and $\frac{SW}{2}$ comprising Baluchistan territory.

63. The recess office of the party was inspected on the 23rd September at Mussooree by the Deputy Surveyor General in charge of the Revenue Branch, who reports that the field sections are effective representations of a difficult country, and show the several surveys to have been executed with very great care. Colonel Wilmer had amply tested the accuracy of the work by numerous inspections during the progress of the surveys. The fair maps were being drawn in the office with much artistic skill.*

* Colonel Wilmer reports as follows:—"Mr. Ogle worked well throughout; Mr. Claudius is a most willing and able assistant; he rendered valuable aid in every way, and his services are brought to special notice. Mr. Wainwright is a good plane-tabler and draftsman, and his work was executed neatly and correctly. Mr. Barckley is a hardy, hard-working assistant, energetic and very willing, and turned out a good amount of work. Mr. Kitchen is hard-working, always cheerful and ready, and a very good draftsman; his name is also brought forward for favourable notice. Mr. Graham is very energetic, hard-working and a good plane-tabler. All the Sub-surveyors worked well and steadily throughout the season, especially Ahmad Ali Khan, Abdul Rasul, Hussain Bux and Sheikh Mohidin." Ahmad Ali Khan is particularly mentioned for his excellent out-turn of reconnaissance survey and perseverance under difficulties.

CUTCH SURVEY.

64. This party left recess quarters at Poona on the 22nd November 1885, to resume field work in Cutch. The field operations were continued till 31st March 1886, and they comprised the completion of the topographical survey of Cutch with its adjacent "Ran," and of the peninsula of Nagar Párkar, as well as of small portions of North Gujarát falling within the marginal sheets of the Cutch Survey. A small piece of minor triangulation was also executed, covering an area of about 250 square miles, in order to connect the triangulation of the season of 1883-84 with that of 1884-85.

Personnel.

Lieutenant-Colonel A. Pullan, S.C., Deputy Superintendent, 2nd grade, in charge.
Mr. C. Tapsell, Surveyor, 4th grade.
,, W. A. Fielding, Assistant Surveyor, 1st grade, retired on 1st April 1886.
,, G. T. Hall, Assistant Surveyor, 1st grade.
,, H. A. Charrier, Assistant Surveyor, 3rd grade.

Sub-surveyors.

N. D. Patwardhan, | G. R. Bhopatkar, and 9 others.

65. The out-turn of area topographically surveyed is 3,805 square miles, 1,500 of which is cultivable land, the remainder Ran and grass waste: it was all surveyed on the 2-inch scale for reduction to and publication on the 1-inch scale: 146 linear miles of traverses were run to demarcate *taluka* boundaries in North Gujarát. The accuracy of the detail survey was tested by 356 linear miles of traverses, and in some parts by *in situ* examinations and it was found to be good.

66 Colonel Pullan reports that the country surveyed this season was generally bare, sterile and devoid of interest, both in Cutch and in the opposite mainland of Gujarát, between which stretches the Great Ran, white with salt incrustations. Here and there, however, well cultivated spots occur, notably the oasis of Antarnes, a rich and well-watered village in the middle of the Ran. The little peninsula of Nagar Párkar is, it is added, too stony to be productive.

67. A general description of the country—the topographical survey of which has just been completed—would be superfluous here, as the *Bombay Gazetteer* lately published contains a full and well-written account of Cutch, and little that is new can now be said of prosperous, peaceful "Suryashtra." A few notes, however, on the portion surveyed this year will be found in the appendix, page i.

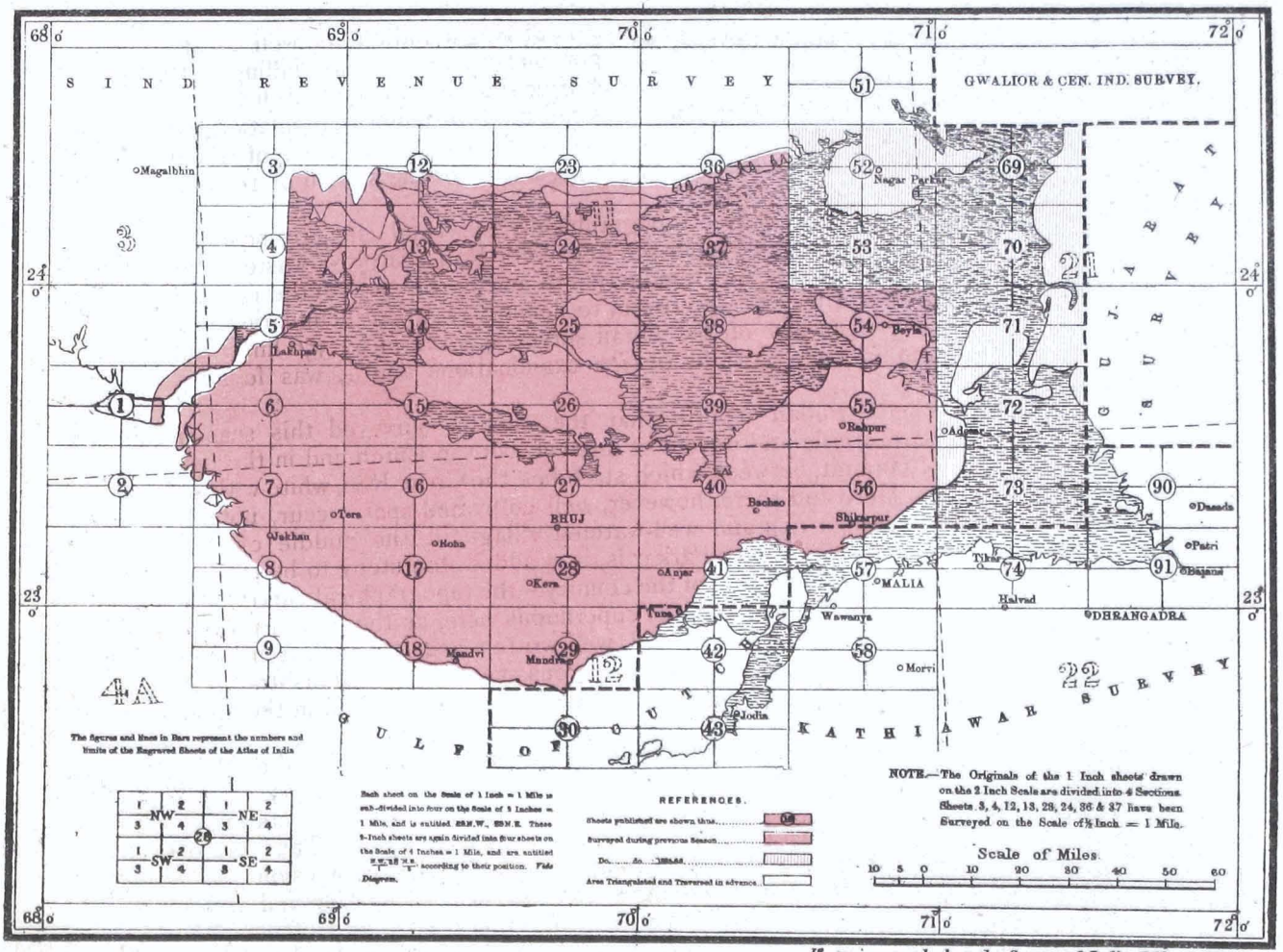
68. During the recess the fair drawing has been completed of sheets 52 and 53 which were surveyed during season 1884-85, and of sheets 69, 70, 71, 72, and 73 of this season's work; the general reports on Degree Sheets IV, V, VI, VII and VIII have been prepared and all records completed. Thus the survey of the Province of Cutch has been brought to a successful conclusion.

69. Colonel Pullan acknowledges the cordial co-operation and assistance he has received in all matters connected with the survey, from Colonels Reeves, Goodfellow and Phillips, and Diwan Bahadur Manibai Jasbai; also from Duffadar Kali Khan of His Highness the Rao's Police, who accompanied him during the whole of the operations. He also brings to notice the valuable help he received during last season from Mr. Kesheb Lall Mozumdar, Thanadar of Sántalpur.

70. This party has now been re-organized and transferred to the Revenue Branch for traverse operations in the Central Provinces, and during the field season of 1886-87 will be employed in the Districts of Saugor and Narsinghpur under the superintendence of Mr. E. J. Jackson, Deputy Superintendent, 4th grade *

* Colonel Pullan reports that Messrs. Tapsell, Fielding and Hall did a very satisfactory season's work, and he highly commends Mr. Fielding's capacities; that Mr. Charrier executed a very creditable out-turn, and shows a considerable aptitude for hill sketching and drawing. The Sub-surveyors all worked well, and the following are specially mentioned:—G. R. Bhopatkar, Keshu V. Kolekar and Shiv Ram Khandoji.

INDEX TO THE SHEETS OF THE CUTCH TOPOGRAPHICAL SURVEY.



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REFERENCES.

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8	8	18	16	36	24	53	32	73	40
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12	10	24	18	38	26	55	34		

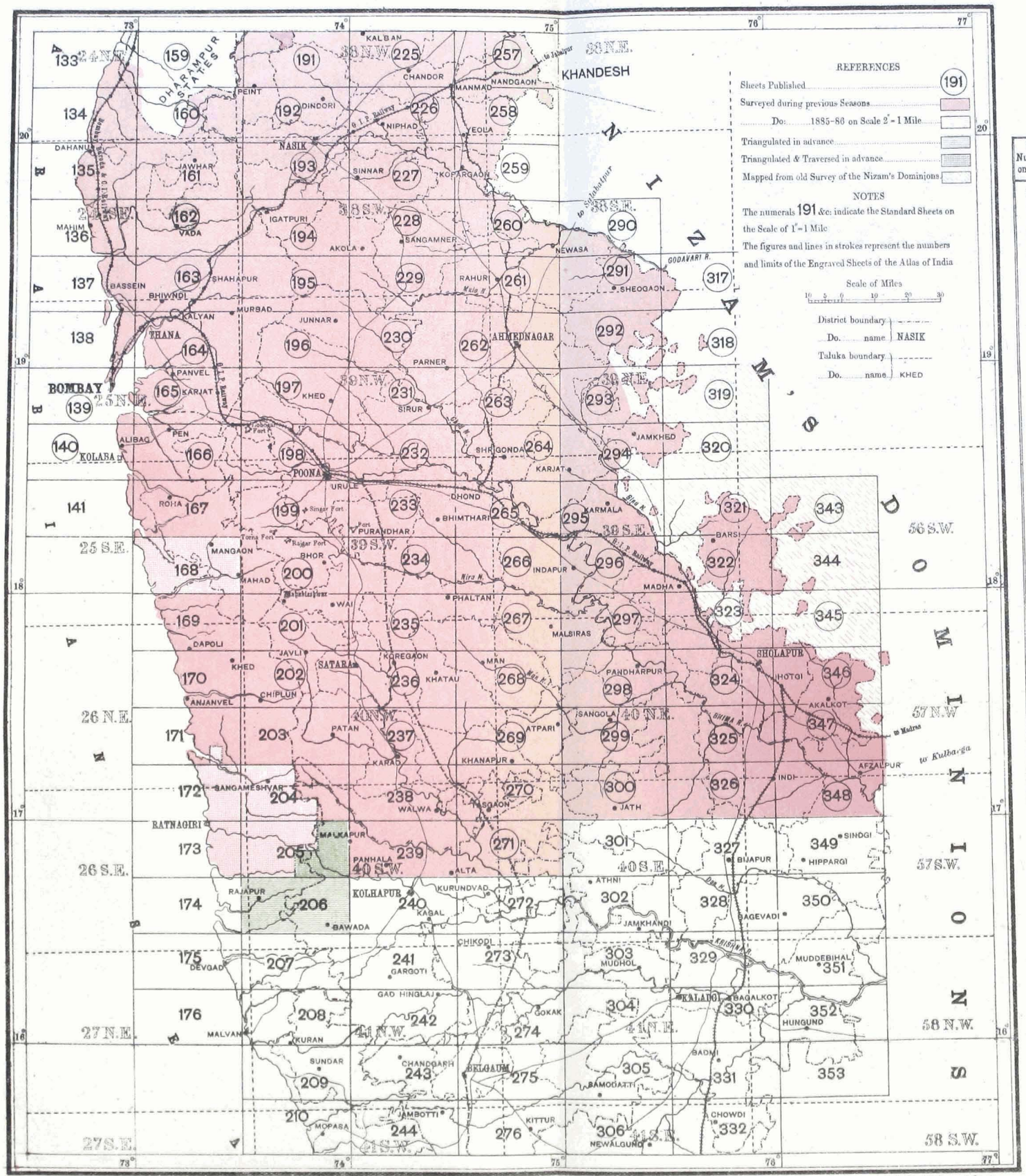
Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India, Survey of India Offices, Calcutta, December*

1886.

BOMBAY SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE DECCAN AND KONKAN.

No. 11 PARTY.



REFERENCES

New Numbers on Index	Old Numbers on Sheets	New Numbers on Index	Old Numbers on Sheets
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159	4^	323	50
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264	32	162	79
294	33	161	80
320	34	185	81
199	35	186	82
233	36	187	83
265	37	188	84
295	38	189	85
321	39	140	86
343	39^	178	87
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234	41	239	89
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Photozincographed at the Survey of India Offices Calcutta.

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*

Survey of India Offices, Calcutta, November 1886.

DECCAN SURVEY.

(No. 11 Party, Revenue Branch.)

71. This party left its recess quarters at Poona during the first week in November 1885, in two sections, the first or smaller section proceeding to undertake the topographical survey of Sheet 168, which, comprises parts of the Kolába District and Janjira States, and was detached from the rest of the work, while the main body proceeded to the Ratnagiri District for the topographical survey of Sheets 172, 173, 204 and 205. The detachment in the Kolába District joined the main body when the survey of Sheet 168 was completed; and the party remained in the field until 20th of May 1886. Sheets 172, 173 and 204 have been finished, but three plane-table sections of Sheet 205 had to be left untouched. The separate areas of the several districts and States which have been included in the topographical survey, which as usual is on the 2-inch scale, are shown in the following statement, which gives also the total area, *viz* :—

Personnel.

Lieutenant-Colonel D. C. Andrew, S. C., Deputy Superintendent, 2nd grade, in charge.
Mr. J. T. U. Coxen, Surveyor, 4th grade, up to 31st October 1885.
„ C. Tapsell, Officiating Surveyor, 4th grade, up to 31st October 1885.
„ J. Hickie, Assistant Surveyor, 1st grade.
„ P. White, ditto do.
„ C. George, ditto 2nd grade, from 1st November 1885.
„ A. George, Assistant Surveyor, 2nd grade.
23 Sub-surveyors and others.

	Square miles.
Kolába District	278·82
Habsan State (Kolába Agency)	215·61
Ratnagiri District	1129·21
Sátára District	2·56
Vishhálgad State (Kolhápur and South Marátha Agency)	49·47
TOTAL	1675·67

72. Besides the topography, the traversing of Sheets 173, 205 and part of 172 had to be done. Sheet 206 has been triangulated in advance; but no further advance work was done on account of the intended withdrawal of the party for survey work elsewhere.

73. The topographical survey has as usual been as carefully and minutely carried out as the scale would admit, and the different kinds of lands, that is, whether cultivated or grazing land, or land covered with jungle, have been shown as far as has been practicable without impairing the clearness of the maps. The village boundaries have, as usual, all been surveyed and afterwards compared with the Bombay Revenue Survey maps. As regards forest boundaries, those in Sheet 168 have been surveyed in accordance with maps furnished by the Forest Settlement Officer of the Kolába District; but in Sheets 172, 173, 204, the forests of the Ratnagiri District not having yet been finally settled or demarcated, their boundaries have been taken up only according to what could be learnt locally concerning the preliminary demarcation. The accuracy of the topography of the field sections has been tested by *in situ* examinations at 168 stations, and by 14 linear miles of check surveys.

74. The sections on the 2-inch scale of Sheets 168, 172, 173 and 204 have been drawn and sent to Calcutta to be reduced and published in standard sized sheets on the 1-inch scale. They are also suitable for publication on the original scale of survey if required. The 2-inch sections of Sheet 205 cannot be sent in as the survey is unfinished, but they will be completed next year after the remaining portions have been surveyed, as is intended, by the South Marátha Party. The sheets of the large scale survey, 80 inches to a mile, of the town of Pandharpur have been completed and made over, at the request of the Municipal Commissioners of the town, to the Bombay Government Photozincographic Office at Poona.

75. Under orders of the Government of India, conveyed in Revenue and Agricultural Department letter No. 28-25—1, dated 11th January 1886, this party has been withdrawn from the Bombay Presidency and transferred to the Central Provinces to carry on a traverse survey there in aid of a settlement survey. It has been employed in the Bombay Presidency since October 1872 and during the fourteen seasons of its employment there under several officers, has surveyed

topographically a total area of 24,867 square miles. On its withdrawal now, it leaves undone (according to a revised programme sanctioned by the Government of India in Revenue and Agricultural Department letter No. $\frac{522}{129}$ B. S., dated 18th September 1884, which assigned to it the part of the Bombay Presidency as far south as the parallel of 16° N. Latitude), a remaining area of about 11,953 square miles of which the survey has not as yet been provided for by allotment to any other party.

76. A few descriptive notes of the part of the Ratnagiri District, which has been surveyed, furnished by Colonel Andrew, are included in the appendix, page i.*

GUJARAT SURVEY.

77. Colonel Badgley was in charge of this party at the commencement of the field season, but on the 21st February he was transferred to the charge of the Photographic and Lithographic Offices at Calcutta, in place of Colonel Waterhouse, who was proceeding on furlough The charge of the Gujarát Party then devolved on Mr. Newland, the senior Surveyor, owing to the paucity of officers in the Senior Division, and it was found impossible to appoint another officer till the end of the recess season. Mr. Newland, however, carried on the work and completed the programme for the year in a very creditable manner.

Personnel.

Lieutenant-Colonel W. F. Badgley, S.C., Deputy Superintendent, 3rd grade, in charge, to 21st February.
Mr. J. Newland, Surveyor, 4th grade, in charge, from 21st February.
Mr. G. A. Knight, Asst. Surveyor, 1st grade.
„ S. F. Norman, „ „ 2nd „
„ C. Norman, „ „ 2nd „
„ P. J. Serrao, „ „ 3rd „
And 26 Sub-surveyors.

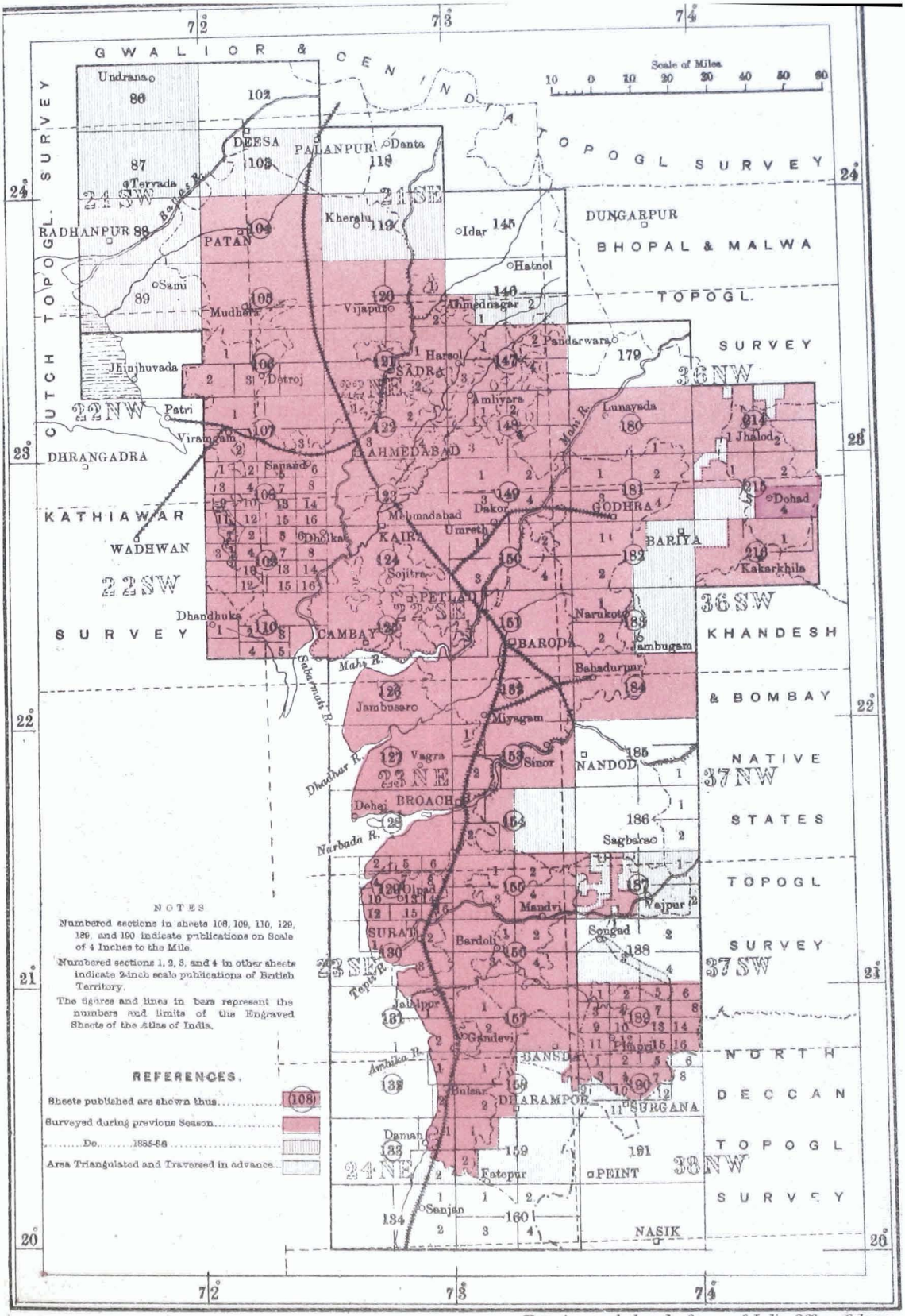
78. A small detachment left Poona on the 15th October to undertake the preliminary traverse work for the survey of the city of Baroda on the scale of 200 feet = 1 inch, which was commenced this season. The bulk of the party left recess quarters for the field by the 15th November, proceeding to their respective ground of operations in Northern Gujarát, in the Panch Mahals, and in Baroda.

79. The original programme for the field season did not include triangulation, as it was thought that the area which had accrued from previous years was sufficient; but owing to the rapidity with which the topographical work progressed in the open plains of Northern Gujarát, it was found expedient to triangulate Sheets 87 and 188. Thus during the season an additional area of 749 square miles was triangulated: also 422 linear miles were traversed with the theodolite, viz., 78 miles in Baroda city, 118 miles to supplement triangulation, and 226 miles of the Baroda State boundary.

80. In the Baroda city, 27 linear miles of spirit-levels were run, fixing 63 bench-marks, and based on Great Trigonometrical Survey series of levels of former years. The detail survey of the city, covering an area of $6\frac{1}{4}$ square miles, was finished by the 31st March. A small party was detached in March to accompany a special Boundary Commission deputed to settle the boundary between the Gaekwar's territory and the Dangs States, as well as the boundaries of a few villages along the Baroda frontier, which had remained under dispute for many years. A small area of 17 square miles and 11 linear miles of boundaries were surveyed on the 1-inch scale, which occupied the detachment about three months. Colonel Bullock, the Boundary Commissioner, in his No. 138, dated 13th September 1886, to the Bombay Government, speaks very highly of the assistance he received from Mr. G. A. Knight, Assistant Surveyor, who accompanied him.

81. Notwithstanding the extra work as detailed above, which was thrown on the party this year, the unusually large area of 2,524 square miles was topographically surveyed on the 2-inch scale for the standard sheets of Gujarát. This large out-turn is due in a great measure to the easy nature of a large portion of the country, Sheets 88, 89, 103, and the greater part of Sheet 119, consisting merely of open plains with few topographical features. In Sheets 214, 215 and 216, however, the country was more rugged and was also densely wooded, consequently the progress of the surveyors was there much slower. Again, in Sheet 187 still greater hindrances were met with and a meagre out-turn obtained, owing to the difficult nature of the country, its extreme unhealthiness at all seasons of the year and to the dearth of water and inhabitants—three of the worst enemies a

* Colonel Andrew gives a very satisfactory report of the good services of Mr. J. Hickie and Mr. C. George. He mentions with great regret the death of Sub-surveyor Ramji Lall, a very good traverse surveyor and an exceptionally honest, hard-working man.



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REFERENCES.

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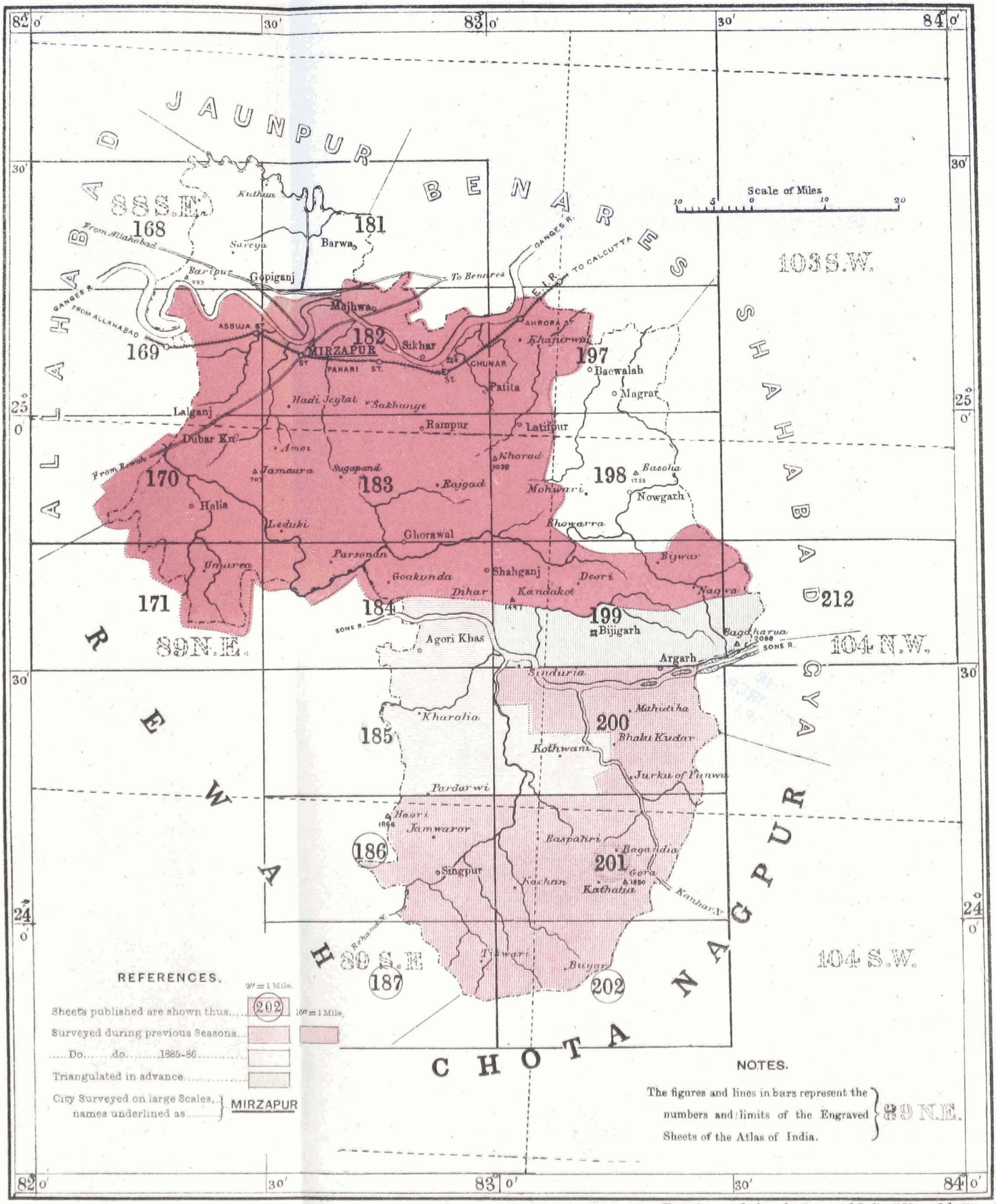
71	87	78	106	5	120	12	127	19	134	29	151	36	158	43	183	50	190		
72	88	79	107	6	121	13	128	23	145	30	152	37	159	44	184	51	191		
73	89	80	108	7	122	14	129	24	146	31	153	38	160	45	185	52	214		
74	102	81	109	8	123	15	130	25	147	32	154	39	179	46	186	53	215		
75	103	82	110	9	124	16	131	26	148	33	155	40	180	47	187	54	216		
76	104	3	118	10	125	17	132	27	149	34	156	41	181	48	188				

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*

Survey of India Offices, Calcutta, December

1886.

INDEX TO THE SHEETS OF THE MIRZAPUR SURVEY.



REFERENCES.

Sheets published are shown thus..... 202 (2″ = 1 Mile. / 1″ = 1 Mile.)

Surveyed during previous Seasons....

.....Do.....do.....1885-86.....

Triangulated in advance.....

City Surveyed on large Scales, names underlined as..... MIRZAPUR

NOTES.

The figures and lines in bars represent the numbers and limits of the Engraved Sheets of the Atlas of India. } 89 N.E.

Photozincographed at the Survey of India Offices, Calcutta

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Survey of India Offices, Calcutta, January 1887.

surveyor can have to contend with. Sickness further retarded the progress of work in this sheet very considerably, and one of the Sub-surveyors succumbed to fever which he contracted while employed on it. Some notes by Mr. Newland on the country surveyed this year will be found in the appendix, page ii.

82. A small drawing office was kept up in the field to work off some arrears of last year's mapping which had accumulated owing to the short duration of the recess season.

83. The party returned to recess quarters at Poona between the 10th and 20th May, and during the recess season the fair mapping has been completed of Sheets 214, 215, 216, 88, 89, and of the greater portions of Sheets 103 and 119, on the 2-inch scale for reduction to one-half. The following sections have been prepared for reproduction to scale—the four complete sections of Sheets 214 and 215 and the N. E. section of Sheet 216. In order to save the labour of extra drawing, the surveyors employed in the Baroda City survey were directed to use every precaution to draw their field sheets neatly and to keep them clean, so that the original sheets might be utilized for the purpose of reproduction. This was successfully carried out, and only one section out of the 16 comprising the whole survey, had to be re-drawn. The printing and finishing of these sections were also completed during the recess. Various maps were in addition prepared and supplied to Colonel Bullock, in connection with the settlement of the Gaekwar's boundary. The large amount of mapping that this party has turned out is very satisfactory, and reflects credit on the Assistants and Sub-surveyors entrusted with its execution. The computations connected with the triangulation and traversing of the year have all been completed and the general reports of Degree Sheets X and XI have been prepared, while some progress has been made with that of Degree Sheet II.

84. During the ensuing season the party will be divided into two sections of equal strength—one section will continue the topographical survey of Gujarát on the 2-inch scale, and will be employed in the following work :—Sheets 102, 118 and 188 will be triangulated; Sheets 86 and 87, part of the Baroda territory in 188, and the unfinished portions of Sheets 190 and 187 will be topographically surveyed, while the boundaries in Sheets 127, 129, 130, 152 and 153 will be traversed for the Baroda Government. The other section will commence the survey on the 8-inch scale of the forest reserves in the southern half of the Thána Collectorate, commencing in the Karjat, Kalyan and Sálsette talukas.*

MIRZAPUR SURVEY.

85. Lieutenant-Colonel Wilmer having been transferred on 1st October 1885 to the charge of the Baluchistan Party, the charge of the Mirzapur Party was temporarily left in the hands of the senior Assistant, Mr. L. J. Pocock, pending the arrival of Mr. Patterson, then in charge of the Malwa Survey.

Personnel.

Mr. W. H. Patterson, Offg. Deputy Superintendent, 4th grade, in charge from 11th November 1885.
Mr. L. J. Pocock, Surveyor, 3rd grade.
„ W. W. McNair, Surveyor, 3rd grade (1st July to 30th September 1886).
„ C. F. Hamer, Surveyor, 4th grade.
„ C. D. Potter, do., do.
„ H. T. Kitchen, Assistant Surveyor, 1st grade.
„ W. H. Lilley, Assistant-Surveyor, 1st grade (transferred 1st May 1886, died 13th May 1885).
„ R. F Warwick, Assistant Surveyor, 2nd grade (transferred 1st November 1885).

Sub-surveyors.

Azim Khan, Prem Raj, Barkat Ali, Gurdutt Singh, and 10 others | Kistodhan Chatterjee, Writer, and 6 Computers and Draftsmen.

Two student soldiers—Lal Sing, 19th Bengal Cavalry, and Bhoop Sing, 28th Punjab Infantry (transferred 1st November 1885).

86. The operations of the season under report may be summarized as follows :—

(*a*) Detail survey on the scale of 2 inches=1 mile, with the triangulation required for the same;

(*b*) Skeleton survey of the village boundaries (by running theodolite traverses) in the Dúdhi Pargana, for revenue purposes, on the scale of 16 inches=1 mile;

(*c*) Theodolite traverses fixing village tri-junctions in the Bhadohi Pargana, for utilizing the 16-inch

* Mr. Newland reports: "I am much obliged to all the assistants of the party for their zealous aid and hearty co-operation during the time I have been in charge; the willing and cheerful way in which they have performed their various duties is highly commendable. Mr. S. Norman has done most excellent service in the Drawing Office. To Mr. C. Norman I am greatly indebted for the copious notes furnished by him. The Sub-surveyors have also worked very well."

scale village plans of the settlement in the compilation of the sections of certain sheets which were not to be surveyed in detail;

(*d*) Bringing up of the records and General Reports of the Bhopal and Malwa, and of the Khándesh and Bombay Native States Surveys, which had been left incomplete (see paragraphs 89 and 95 of the Annual Report for 1884-85).

87. Under head (*a*), 487 square miles of detail survey were executed, completing the north-east and south-east sections of Sheets 184 and 185 and the north-west and south-west sections of Sheet 200; and 194 square miles of triangulation in Sheets 184 and 199 was done. The former was rigorously tested in the field, either by the executive officer or by one of his assistants, and in nearly every instance found to be correct. There are now about 250 square miles of ground triangulated in advance of the detail survey in Sheets 199 and 212.

88. The operations noticed under head (*b*) have now been completed. During the season under report, the theodolite was set up at 180 stations, embracing 38·6 linear miles of traverse. This work was begun in 1883: it covers an area of 646·8 square miles, including 205 villages, the boundaries of which have been plotted on 721 sheets. The records of these operations have been finally deposited in store at Dehra Dun.

89. The entire cost of the Dúdhi Survey from first to last has been calculated at ₹39,000, giving the rate per square mile of ₹60·5 and per village of ₹190·5.

90. Under class (*c*), the work involved the setting up of the theodolite at 6,419 stations, embracing 1172·6 linear miles of traverse; and an examination of the settlement village maps shows that, with the help of the traverses now run, they can be utilized for the compilation of the sections of sheets 168, 169, 181 and 182. As a check on the bearings of the traverse lines, astronomical azimuths were observed at 10 stations.

91. Owing to the large quantity of mapping that remained unfinished in 1884-85, and which involved the re-examination of six sections of 2-inch scale survey drawn in that year, and the examination and finishing up of no less than 532 of the 721 sheets of the Dúdhi Survey, the mapping of the field work now reported on unfortunately did not make as much progress as it otherwise would have done. Sections 184 S.E., 185 N.E. and S.E., and 200 S.W. have been partially drawn *in outline*, the object being to show the hills on the final map in brown by double printing, as has recently been done in the case of the large scale map of Jeypore. The completion of these outline maps, as well as the compilation of the sections of the four sheets named under class (*c*), will form part of the work to be done in the coming field season.

92. Under class (*d*) the following has been done:—(1) The General Report for Degree Sheet No. IX of the Bhopal and Malwa Survey has been completed and bound, but a little work remains to be done to complete the duplicate copy of certain of the records appertaining thereto; (2) the General Report for Degree Sheets Nos. VIII and IX of the Khándesh and Bombay Native States Survey has also been completed, and considerable progress made with that of Degree Sheets Nos. III and VI of the same survey; and (3) the angle books of both the Bhopal and Malwa and of the Khándesh and Bombay Native States Surveys have all been examined, completed and forwarded to Calcutta for final deposit.

93. The ground surveyed on the 2-inch scale during the past season was, as usual, very intricate and covered with jungle, the only new feature being that more villages were met with this season along the banks of the Son river and the Rewah boundary. Ferries across the Son exist at Patera, Ghoria, Kotah and Silpi, and across the Rihand at Obre, where the main road crosses from Robertsganj *vid* Chopan to Khairwa.

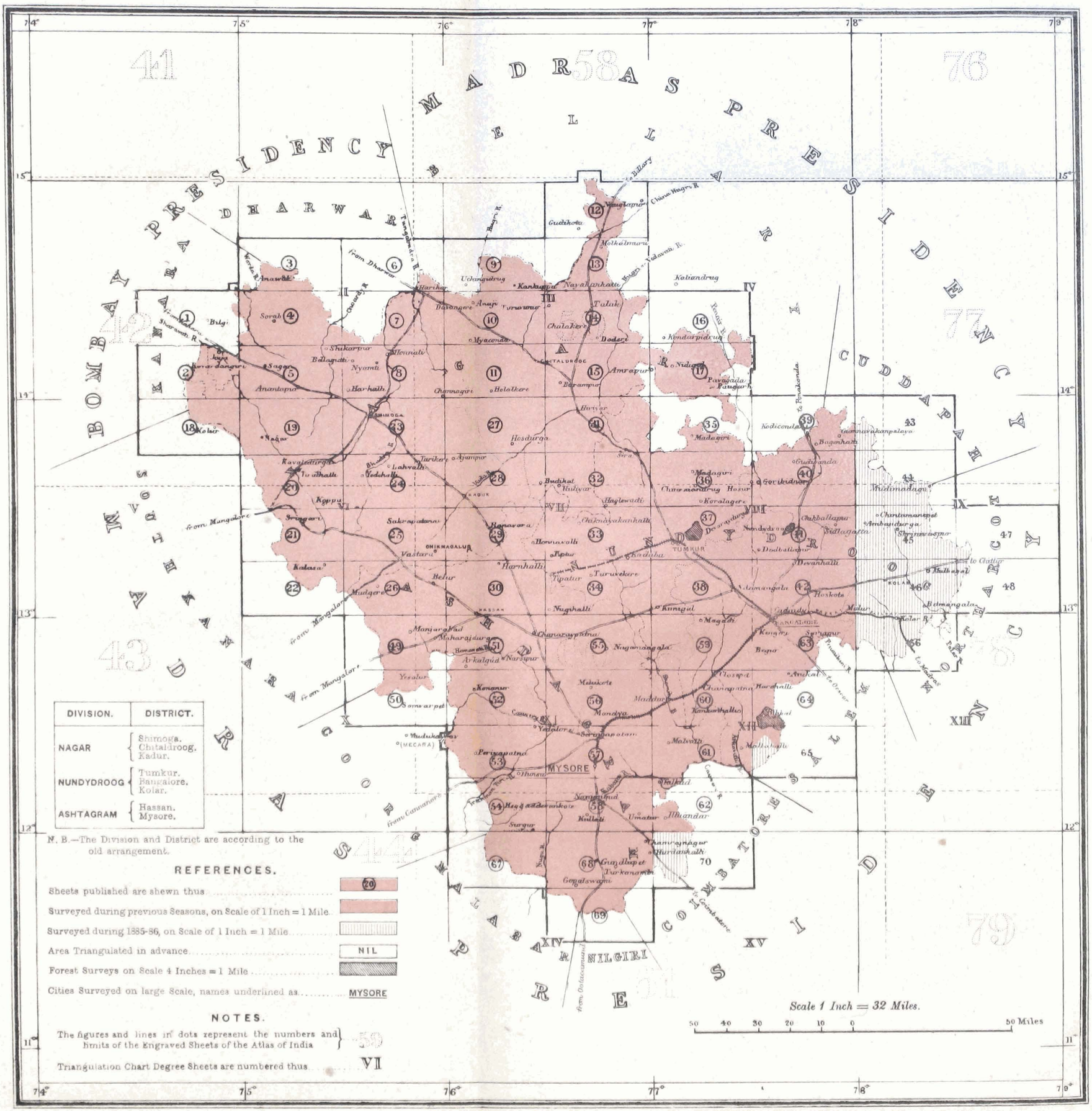
94. Owing to the frequent showers of rain which fell during the field season, not only was the health of the party maintained, but the supply of water, which usually runs short in March and April, was duly replenished.

95. The programme of field work for the ensuing season is, *firstly*, to complete the triangulation required in sheets 197 and 198 (about 400 square miles), and detail survey on the 2-inch scale in sheets 198, 199, and 212 (about 500 square miles); *secondly*, to complete the boundary survey of 10 villages in Pargana Bijaigarh (left incomplete by the Revenue Survey Party under Colonel

INDEX TO THE SHEETS OF THE MYSORE TOPOGRAPHICAL SURVEY,

To accompany Surveyor General's Report for 1885-86

On the Scale of 1 Inch = 1 Mile.



DIVISION.	DISTRICT.
NAGAR	Shimoga. Chitaldroog. Kadur.
NUNDYDROOG	Tumkur. Bangalore. Kolar.
ASHTAGRAM	Hassan. Mysore.

N. B.—The Division and District are according to the old arrangement.

REFERENCES.

Sheets published are shewn thus 20

Surveyed during previous Seasons, on Scale of 1 Inch = 1 Mile.

Surveyed during 1885-86, on Scale of 1 Inch = 1 Mile.

Area Triangulated in advance ..... NIL

Forest Surveys on Scale 4 Inches = 1 Mile .....

Cities Surveyed on large Scale, names underlined as ..... MYSORE

NOTES.

The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India } 50

Triangulation Chart Degree Sheets are numbered thus VI

Anderson); and *thirdly*, to take up and finish the main and village circuit traverses in the Chakia Estate (about 120 square miles) of the Maharaja of Benares, for the execution in 1887-88 of a cadastral survey of the tract, the cost of which the Maharaja has agreed to pay for at R160 per square mile, exclusive of the cost for the printing of the maps.

96. It is expected that the field work of this party in the Mirzapur District will be completed in 1887-88.*

MYSORE SURVEY.

97. The field operations of this party were conducted by Major McCullagh, R.E., who remained in charge until 23rd March 1886, when he was compelled by ill-health to take leave to England. He was relieved by Lieutenant H. M. Jackson, R.E., who has held the executive charge from that date.

Personnel.

Major J. R. McCullagh, R.E., Officiating Deputy Superintendent, 3rd grade, in charge, up to 23rd March 1886.
Lieutenant H. M. Jackson, R.E., Officiating Deputy Superintendent, 4th grade, in charge, from 23rd March 1886.
Mr. A. J. James, Surveyor, 4th grade.
„ F. Kitchen, ditto, ditto.
„ H. Todd, ditto, ditto.
„ J. A. Barker, Asst. Surveyor, 1st grade.
„ R. Todd, ditto ditto.
„ J. M. Kennedy, ditto 2nd grade, up to 14th June 1886.
„ T. J. J. Mills, Assistant Surveyor, 3rd grade.

Sub-surveyors.

Janki Dass. | Raghavayengar. | Tiruvenkatsami and 7 others.

98. The portion of country that remained for survey had been previously triangulated, so that the field operations during the season under report were confined to detail survey on the standard scale of 1 inch = 1 mile. A small detachment, consisting of one Surveyor and four Sub-surveyors was kept in recess quarters to bring up the Degree Reports, &c., while the rest of the establishment proceeded to the field early in November 1885. The field work progressed steadily until the completion of the survey in the middle of April 1886.

99. The area topographically surveyed amounts to 2,570 square miles on the scale of 1 inch = 1 mile, the greater portion of which lies in the Kolar District; the remaining portion being on the south-east frontier of the province in Sheets 65 and 70. The nature of the country surveyed in Kolar is typical of the open and undulating parts of the province which have been described in previous reports, and which present no great difficulties to the surveyor. The country in Sheets 65 and 70, however, presented serious obstacles to rapid progress. The portion of the Chamrajnagar and Yelandur frontiers is the most mountainous part of Southern Mysore, being in fact the lower steps of the Nilgiri plateau. A great part is covered with dense jungle, and this, combined with the long grass which grows all over the hills, except on the higher peaks, renders even locomotion most difficult. A few notes on the country plane-tabled will be found in the appendix, page ii b.

100. The field plans of the detail survey were carefully tested almost entirely by Major McCullagh, and their accuracy was fully established. One section in Sheet 70 was unavoidably not regularly examined owing to the distance that the examiner would have been obliged to travel. It was surveyed, however, by an European assistant of long experience and tried ability, in whose integrity there is every confidence. A great portion of the ground was, however, subsequently gone over with a trace of the sheet, by Lieutenant Jackson while on privilege leave, and the features were found to be well represented.

101. During the recess season the fair maps of the area completed have been prepared in 9 standard-sized sheets; 6 Degree Charts of triangulation were revised, corrected and completed, and 12 quarter sheet reductions to the scale of the Atlas of India were prepared. The General Reports of 7 Degree Sheets were completed and thus the whole of the records connected with the Mysore survey were brought to a satisfactory termination by the 1st October 1886.

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* Mr. Patterson reports favourably of all his assistants, excepting two Sub-surveyors, whose services have been dispensed with.

102. The area of the Mysore State proves to be 29,305 square miles, which is over 2,000 square miles in excess of the estimated area. In addition to this, a strip of the country has been surveyed outside and all round the State boundary, averaging about a mile in width. This aggregates 1,634 square miles, so that the total area which has been surveyed on the 1 inch = 1 mile scale amounts to 30,939 square miles. The mapping of the same is contained in 70 standard sheets, 4 sheets of Reserved Forest Surveys and 19 sheets of Cantonment and City Surveys.

103. The survey was commenced in November 1875, and has thus taken eleven years to complete. The original desire of the Local Administration was that the survey should be completed in five years, and with this object, two full topographical parties were organized and sent to Mysore. Unfortunately at the very outset of the operations, unexpected and serious difficulties were met with in consequence of the famine and drought which prevailed in Mysore, and nearly throughout the southern peninsula during 1876 and 1877. Owing to the distressed state of the country it was found impossible to utilize and keep the establishment in full employment on survey work. Measures were then adopted to place at the disposal of the Public Works Department for employment on relief works every assistant whose services could not be utilized on survey; and nine European Surveyors and several Sub-surveyors were thus transferred temporarily. On financial grounds it was also decided that only one party should be employed in future on the survey; so in November 1877, reductions were enforced, and the reduced parties were combined and formed into one party of ordinary strength with which the survey has been since accomplished. Thus for the first three years, during which the country laboured under famine difficulties, the progress of the general survey was unavoidably much retarded, the out-turn of topography during that period being only 4,701 square miles; the completion therefore of the remaining large area of 26,238 square miles in eight years is highly satisfactory and creditable to all concerned in the survey, especially so when the very difficult nature of a considerable portion of the country is taken into consideration.

104. The total cost of the survey amounts to ₹9,07,626, which gives an average mileage rate of ₹29-5-4 over the whole area of survey; but the cost includes surveys on the 4-inch scale of 84 square miles of State forests, and on the 12-inch scale of 57 square miles comprising the city of Mysore and the cantonment and city of Bangalore. The average mileage rate was of course considerably enhanced by the slow progress of the first three years of the survey for the reasons given above, which were totally beyond the powers of prevention of the Survey Department.

105. The entire cost of the Mysore Survey has been borne by the Mysore State. From 1st October 1886, however, the expenditure of the party has been included in the Imperial Estimates.

106. The negotiations with the Madras Government for the transfer to the Survey of India Department of the topographical portion of the work of the Madras Survey Department having been successfully concluded, the Mysore Party has been transferred to the Madras Presidency to undertake this work. The tracts of country that have been made over form portions of the following districts, *viz.*:—Ganjam, Vizagapatam, Tinnevelly, Madura, South Canara and Malabar and comprise an aggregate area of about 12,400 square miles, which is to be surveyed on the scale of 1 inch = 1 mile. The surveys of forests in the above districts, with the exception of those in Ganjam and Vizagapatam, will also be undertaken on the scale of 4 inches = 1 mile, and the cost thereof debited to the Provincial revenues in accordance with the rules prevailing in this department.

107. The Districts of Tinnevelly and Madura have been selected for the operations to be commenced in, and the late Mysore Party, now designated the "Madras Party," has proceeded from Bangalore to Madura and will be employed during the current field season in the topographical survey of the hill portions of those districts.*

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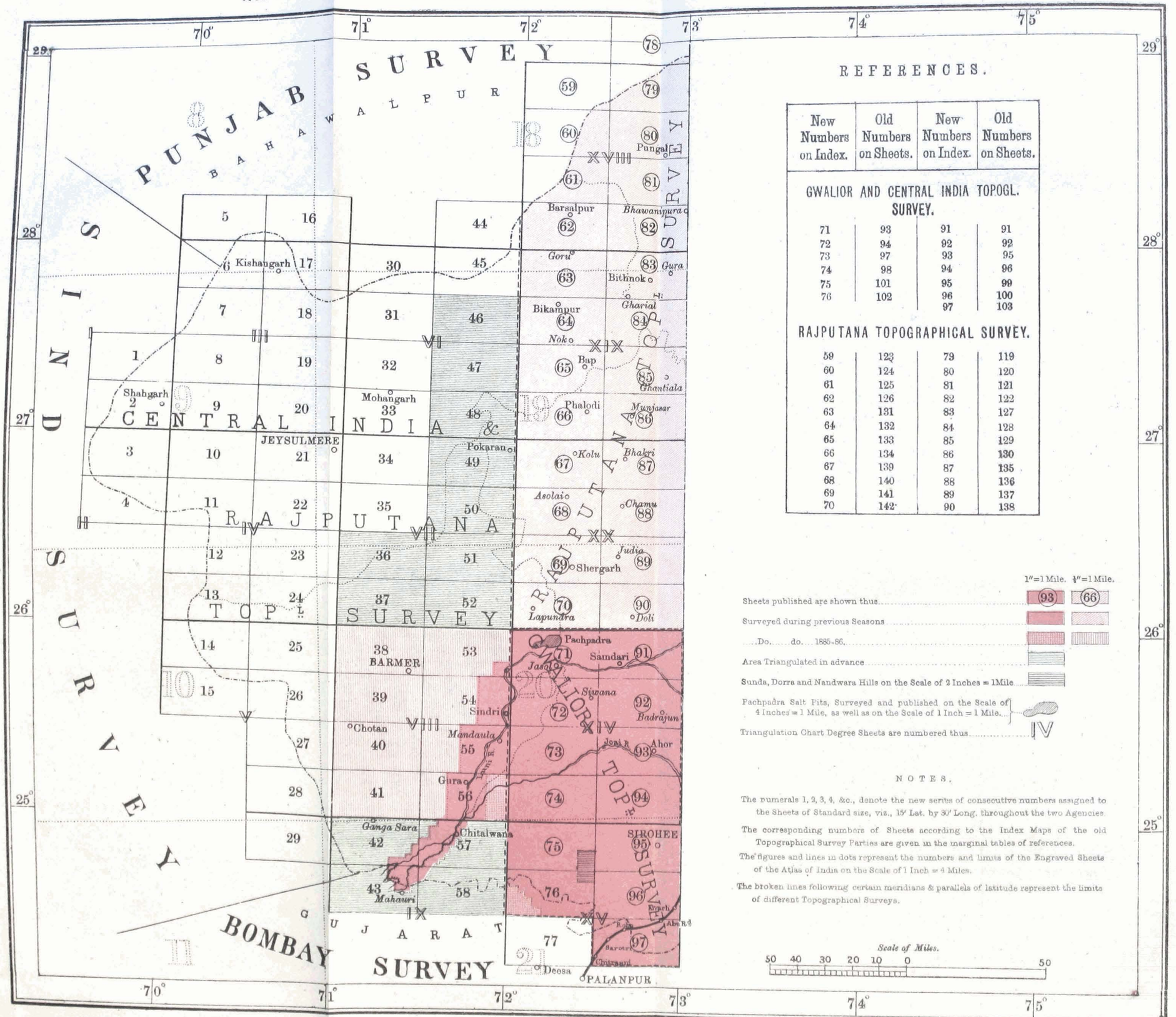
* The assistants, both European and native, are very favourably reported on for their application, industry and willingness.

INDEX TO THE SHEETS OF THE RAJPUTANA TOPOGRAPHICAL SURVEY.



REFERENCES.

New Numbers on Index.	Old Numbers on Sheets.	New Numbers on Index.	Old Numbers on Sheets.
GWALIOR AND CENTRAL INDIA TOPOGL. SURVEY.			
71	93	91	91
72	94	92	92
73	97	93	95
74	98	94	96
75	101	95	99
76	102	96	100
		97	103
RAJPUTANA TOPOGRAPHICAL SURVEY.			
59	123	79	119
60	124	80	120
61	125	81	121
62	126	82	122
63	131	83	127
64	132	84	128
65	133	85	129
66	134	86	130
67	139	87	135
68	140	88	136
69	141	89	137
70	142	90	138

	1″=1 Mile.	¼″=1 Mile.
Sheets published are shown thus	93	66
Surveyed during previous Seasons		
....Do.....do....1885-86.		
Area Triangulated in advance		
Sunda, Dorra and Nandwara Hills on the Scale of 2 Inches = 1 Mile		
Pachpadra Salt Pits, Surveyed and published on the Scale of 4 Inches = 1 Mile, as well as on the Scale of 1 Inch = 1 Mile.		
Triangulation Chart Degree Sheets are numbered thus	IV	

NOTES.

The numerals 1, 2, 3, 4, &c., denote the new series of consecutive numbers assigned to the Sheets of Standard size, viz., 15′ Lat. by 30′ Long. throughout the two Agencies.

The corresponding numbers of Sheets according to the Index Maps of the old Topographical Survey Parties are given in the marginal tables of references.

The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India on the Scale of 1 Inch = 4 Miles.

The broken lines following certain meridians & parallels of latitude represent the limits of different Topographical Surveys.

Scale of Miles.

50 40 30 20 10 0 50

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India, Survey of India Offices, Calcutta, February* 1887.

Photozincographed at the Survey of India Offices, Calcutta.

RAJPUTANA SURVEY.

108. The operations of the party during the year were as follows:—

Personnel.

Lieutenant-Colonel R. Beavan, S.C., Deputy Superintendent, 4th grade, in charge till 1st April 1886.
Lieutenant W. H. Pollen, R.E., Officiating Deputy Superintendent, 4th grade, in charge from 1st April.
Mr. W. Todd, Surveyor, 2nd grade.
,, N. C. Gwynne, ditto 3rd do.
,, G. P. Tate, Asst. Surveyor, 2nd do.
,, M. Gastaud, ditto 2nd do.
,, P. Beechey, ditto 2nd do.
,, C. G. S. Wood, ditto 3rd do.

Sub-surveyors.

Shah Nasiruddin, Sheikh Omar, F. Rosario, Abdul Gufár, Golam Mahomed, Abdul Aziz, and four others.

(*a*) The ordinary detail survey on the ½-inch scale of Sheets Nos. 38 to 41, 53 to 55, and ⅓ of 56 comprising Degree Sheet VIII, embracing portions of Jodhpore and the Maláni District near Bármer and the Lúni River; also on the 1-inch scale of the south-west corner of Standard Sheet No. 76, where the boundaries of the Jodhpore, Sirohi, and Pálanpur States join, and the eastern quarter of No. 56, so as to complete Degree Sheet VIII.

(*b*) The triangulation in advance over Sheets Nos. 36, 37, 43, 58 and 46 to 52.

(*c*) The verifying and correcting of the large number of village boundary maps of the Ajmere-Merwára District, and the revision and bringing up to date of the 1-inch map of the same district.

109. The field season lasted from 1st November 1885 to the 10th May 1886. The out-turn of topography on the ½-inch scale was 3,540 square miles, and on the 1-inch scale 256 square miles. The triangulation in advance covered 5,850 square miles, of which 4,810 square miles in Degree Sheets VI and VII were prepared for ½-inch, and 1,040 square miles in sheets 43 and 58 for 1-inch detail survey. The revision of the Ajmere-Merwára village boundary sheets and the completion of the 1-inch maps of the district has been satisfactorily carried out; and it is gratifying to find that, with one unimportant exception, the original survey was found to be very accurate and complete, so far as the then existing details were concerned; but of course additions had to be made showing the railway and new roads and tanks, &c., which have been constructed since. The out-turn of triangulation would have been considerably greater had not intimation been received that the party would be employed next season in Baluchistan; it was therefore necessary to warn the two assistants engaged on triangulation to square off their work, and help in the execution and examination of the detail survey.

110. The country surveyed is mostly open, but very sandy, with rocky hills to be met here and there, running up to 2,000 feet above sea level. There was generally a difficulty in obtaining drinking water. The River Lúni runs through the eastern portion of Degree Sheet VIII, and on each side of it is the *nayar* land—a black alluvial soil brought down by the river, on which the inhabitants grow wheat: this land is as much as 14 miles in width near the Ran of Cutch. The important places met with were as follows:—The towns of Bármer, the head quarters of the district; Maláni, the residence of the chief of the district; Guranagar on the Lúni, the chief of which has a remarkably fine breed of horses; Sindri on the Luni; and Pokaran, the residence of the chief of the district, in the vicinity of which are some stone quarries.

111. The services of Lieutenant-Colonel Beavan having been required at Calcutta early in April, Lieutenant Pollen was transferred to the charge of the party on the 1st April. The latter officer has therefore conducted the recess duties which may be summarised as follows:—The fair mapping of Sheet No. 76 on the 1-inch, and of the northern and southern halves of Degree Sheet VIII on the ½-inch scale; the fair drawing (for use of engravers) of Sheet No. 21 N. E., quarter of the Indian Atlas, has been well advanced: the chart of the Jeypore and Amer (Amber) triangulation has been completed, while those of Degree Sheets XIV and VIII (for general reports) have been partially done: the General Report of Degree Sheet XIII has been completed, and that of XIV is about three-quarters finished; while the computations of VIII have been examined and set in order, so as to readily furnish the numerical results required for the General Report. For the Ajmere-Merwára revision, the corrections have

been plotted on some 330 16-inch village boundary maps; and having further been reduced, have been transferred to the 1-inch sheets of the district.

112. The party being under orders for transfer to Baluchistan, it was an object to keep in view the more urgent work of bringing up the arrears and squaring off the work as far as possible and the computations of the past field season could not be taken up.

113. The health of the party generally has been good; but the native establishment employed near the Ran of Cutch suffered a good deal from fever.

114. Captain R. A. Wahab, R.E., has now been transferred to the charge of this party, which will be termed No. 16 (Baluchistan II) Party, and Lieutenant Pollen to the South Marátha Party in Bombay.

115. The programme for next field season was at first arranged as follows:— The triangulation in Baluchistan of Sheets No. 22 N.W. and S.W., and the detail survey on the $\frac{1}{2}$-inch scale of portions of Sheets 22 N.E. and S.E.; but in consequence of an urgent demand from the Military Department, the operations will be confined chiefly to special large scale surveys in the neighbourhood of Peshin and Quetta. The extension southwards of the 2-inch survey of the Khwája Amran Range, so as to include the Wach Darra pass, will also be undertaken.

116. Extracts from Lieutenant Pollen's Narrative Report, as well as an account of the country triangulated by Mr. Tate are given on pages iii and iv of the appendix.*

SOUTH MARATHA SURVEY.

(No. 10 Party, Revenue Branch.)

117. This party, lately employed on the survey of the Thána and Kolába Districts, changed its ground, as indicated in paragraph 82 of last Annual Report, to the south of the parallel of 16° N. Latitude, to undertake, partly, a general topographical survey on the 2-inch scale, and, partly, a skeleton traverse survey of the forests, designed to serve as a basis for the construction of working plans by Forest Officers. The field season commenced during the last week in November 1885, and closed for the main body of the party on 25th May, though some detachments remained at work until 10th June.

Personnel.

Major J. Hill, R.E. Deputy Superintendent, 3rd grade, in charge from 23rd October to 28th December 1885.
Lieutenant F. B. Longe, R.E., Officiating Deputy Superintendent, 4th grade, in charge up to 22nd October 1885 and from 29th December 1885.
Mr. J. Peyton, Surveyor, 1st grade, up to 30th June 1886.
„ A. M. Lawson, Surveyor, 2nd grade.
„ W. M. Kelly, Assistant Surveyor, 1st grade.
„ R. R. Dickinson, Assistant Surveyor, 1st grade, from 17th May 1886.
„ O. D. Smart, Assistant Surveyor, 2nd grade, from 14th October 1885.
22 Sub-surveyors, and others.

118. The topographical operations were chiefly confined to the Belgaum District, but parts of Native States, namely, Karundvad Kolhápur, Sángli and Sávantvadi, and of the Dhárwár District, were also surveyed. The areas are shown in the following statement:—

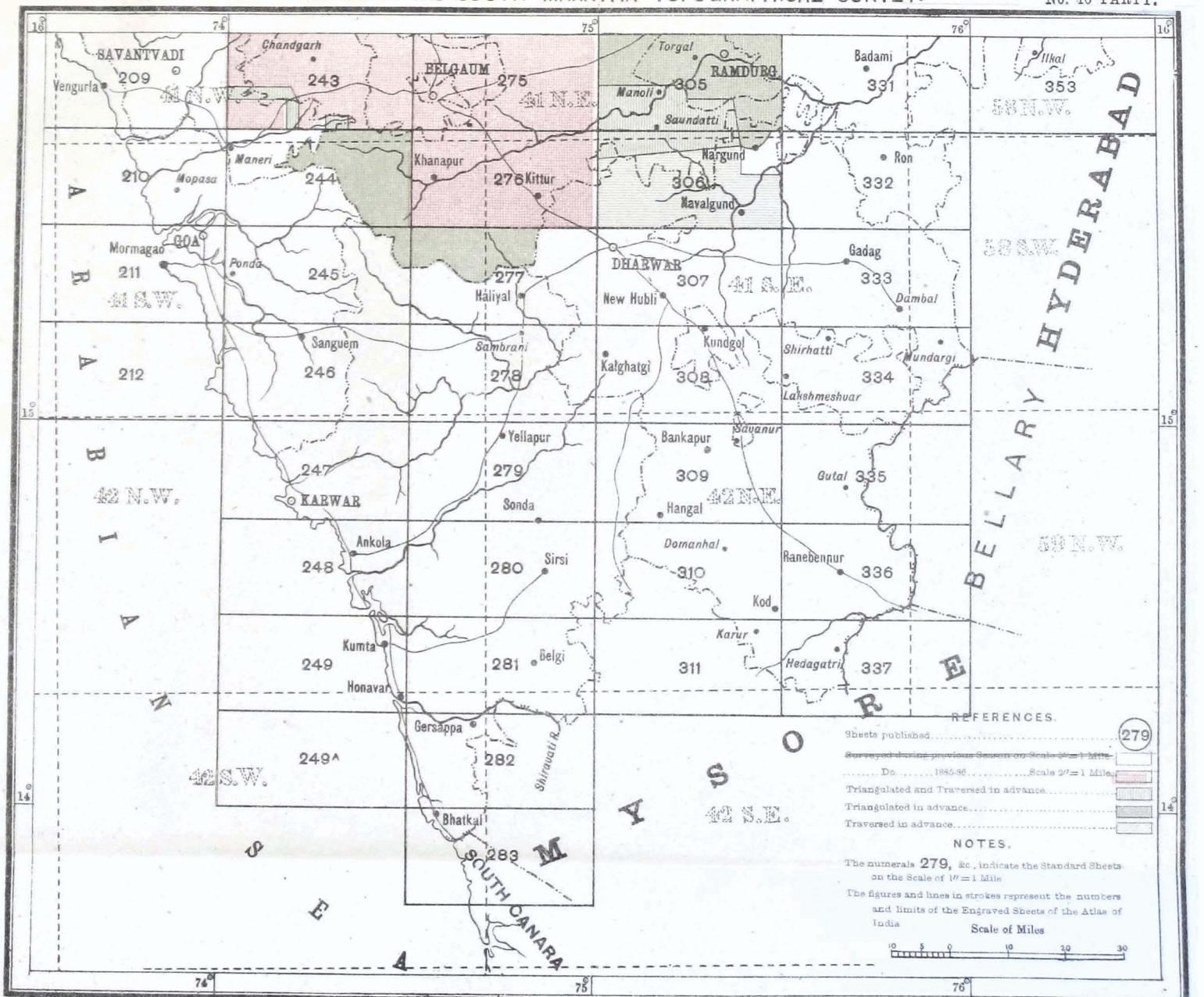
	Square miles.
Belgaum District	1209·9
Dhárwár „	76·2
Karundvad State	113·3
Kolhápur „	6·7
Sángli „	111·0
Sávantvadi „	154·9
Total	1672·0

* The Officer in charge reports well of all his assistants, mentioning Mr. Gwynne in particular.

BOMBAY SURVEY.

INDEX TO THE SOUTH MARATHA TOPOGRAPHICAL SURVEY.

No. 10 PARTY.



Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*

Survey of India Offices, Calcutta December 1886.

The areas triangulated and traversed are 1,210 and 2,316 square miles respectively, of which 850 and 600 square miles are in preparation for next season's topography.

119. By the triangulation, 337 points have been fixed, of which the heights of 306 have been determined; and there are 3,231 traverse stations, 583 of which have been fixed on village tri-junctions. The ground was surveyed as closely as possible, and the accuracy of the details was tested by 124 linear miles of check surveys, as well as by "*in situ*" examinations by the executive officer and by two of his European assistants.

120. The sheets topographically surveyed are Nos. 243, 275 and 276, but of Sheet 243 a small area remains chiefly on the *ghâts*, from which the surveyors were driven away through the setting in of the rains. The country surveyed is of a varied character. In the west, the *ghâts* with their scarps and deep ravines, the whole being covered with forest, rendered the work difficult and laborious, but with the exception of 8 plane-table sections in the *ghâts* the work was easy. In the west of Sheet 276 the country is covered with forest, and in 275 the hills are covered with thorn bushes which made chaining very troublesome. Belgaum with its cantonment and fort fell within the area surveyed, but there is no other place of any great importance, though to the district generally a good deal of historical interest is attached. Some descriptive notes furnished by Lieutenant Longe are given in the appendix, page vi.

121. The forest surveys were exclusively carried on in the Khánápur Taluka of the Belgaum District, and were found to constitute a work of considerable difficulty, as not only was the amount of traversing, required to enclose the forest blocks, very large on account of the boundaries being irregular, while patches of cultivated land which also had to be traversed were interspersed within the forests, but the true boundaries were imperfectly known to the village people, and consequently much delay occurred in searching through the records for information regarding them. The detachment available to be sent into the forests this season was small, and the surveys could not be begun until February after the exact character of the work to be done had been ascertained from the Forest Department. Thus, through the difficulties and delay, the Forest maps of only six villages have been completed, but six more villages have been surveyed and are only awaiting the revision of one of the main traverses to be plotted. The maps are to show all made roads which run through the forests and all perennial streams, as well as all permanent structures, such as temples or survey stations.

122. Next season the forest survey section will be strengthened and made equal to the topographical survey section, and in the first instance the work will be undertaken within a triangle with Khánápur as its apex and the line between Londa railway station and Linganmat as its base, which is the tract specified by the Forest Officers for their immediate requirements. The tract has been triangulated in preparation for the forest traversing.

123. The health of the party was on the whole good, and there were only two serious cases of sickness. The squads working in the forests suffered most, and at one time there was an average of 75 per cent. sick in the Khánápur forests, but this was late in the season after the rains had begun.*

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* Lieutenant Longe mentions that Mr. J. Peyton, Surveyor, 1st grade, suffered from fever during the field season, which for some time incapacitated him from work. Mr. Peyton retired from the department on a superannuation pension on 1st July after a service of 30 years. He had acquired considerable proficiency as an artistic draftsman.

Lieutenant Longe also reports:—Mr. A. M. Lawson again maintained his high reputation, * * * * * * he is a man of the highest value in a party, setting every one in it an example of hard, honest work, cheerfully performed."

"Mr. W. M. Kelly * * * both in the field and in office has worked very well." Mr. R. R. Dickinson * * * is a most careful and trustworthy assistant. Mr. O. D. Smart * * was employed on the forest work. He had many difficulties to contend with, but by care and perseverance he managed to overcome them * * * * his work is accurate and very neatly done.

Lieutenant Longe reports that Fyzoolah Khan, Sub-surveyor, has done very good work and also mentions favorably the names of the following other members of the native establishment, *viz.*, Damodar Gopal, Nursoo Limbadry, Gobind Janardhan, Inamulla Khan, Ramrao Yadhao, Babaji Ramchandra, Muksudi Lall, Abdul Ghani Khan.

FOREST SURVEYS.

BURMA FORESTS.

124. The party, of strength noted in the margin, left recess quarters at Rangoon in two detachments; the one comprising the triangulation and traverse camp on the 20th November, and the other the detail survey camp, on the 28th November 1885. The former section was employed in the Prome District and the latter section in the Tharrawaddy District, and the field operations were continued until 26th April, when they were obliged to be stopped abruptly, owing to the disturbed state of the country.

Personnel.

Mr. H. Hörst, Deputy Supdt., 3rd grade.
„ J. H. Wilson, Asst. Surveyor, 1st grade,
„ C. P. Torrens „ „
„ W. H. Penrose „ „
„ R. A. Gibson „ „
„ W. H. Ewing „ 2nd grade,
(from 1st October 1885).

Sub-surveyors.

Venkat Swamy.
Sher Shah.
Doorgiah.
Sumer Sing.
Rahmat Ali.
Ahmad Sayid, transferred to Mandalay, 1st April 1886.
Sharfuddin
Girdhari Lal, and 14 others and 2 Apprentices.

125. The triangulation has been extended over an area of 263 square miles, embracing both reserved and unreserved forest tracts, and nearly the whole of this area has been covered by the traverse survey.

126. The traverse survey covered an area of 345 square miles. This, together with 190 square miles remaining over from the previous season, gives 535 square miles of advance work, of which 255 square miles will be required to be surveyed on the scale of 4 inches = 1 mile, and 280 square miles on the scale of 2 inches = 1 mile.

127. The area surveyed in detail extended over 330 square miles, exclusive of 24 square miles of overlap. Of this out-turn, 199 square miles, consisting entirely of reserved forests, were done on the 4-inch scale, and 131 square miles comprising unreserved forest tracts on the 2-inch scale. The operations extended over the greater portion of the tracts drained by the Taungnyo River in the Tharrawaddy District, and the Shwele River in the Prome District; also over a portion of the Shwedaung hills, stretching due south of Prome.

128. The ground surveyed on the 4-inch scale was for the most part mountainous, very intricate, and covered with dense jungle; that done on the 2-inch scale consisted of low intricate hills, cut up with innumerable water-courses and covered with heavy jungle.

The out-turn of work is considerably less than that of the previous season, and consequently the average mileage rate has been enhanced, but this is fully accounted for—

(i) by the duration of the field season being nearly a month shorter than usual owing to the disturbed state of the country which prevented the continuance of field work;

(ii) by changes of programme during the season due to the necessity of withdrawing the surveyors from the Yoma Forest, in which dacoits were committing depredations;

(iii) by interruptions caused on other occasions by dacoits which involved a considerable loss of work;

(iv) by the transfer of two Sub-surveyors for work in Upper Burma;

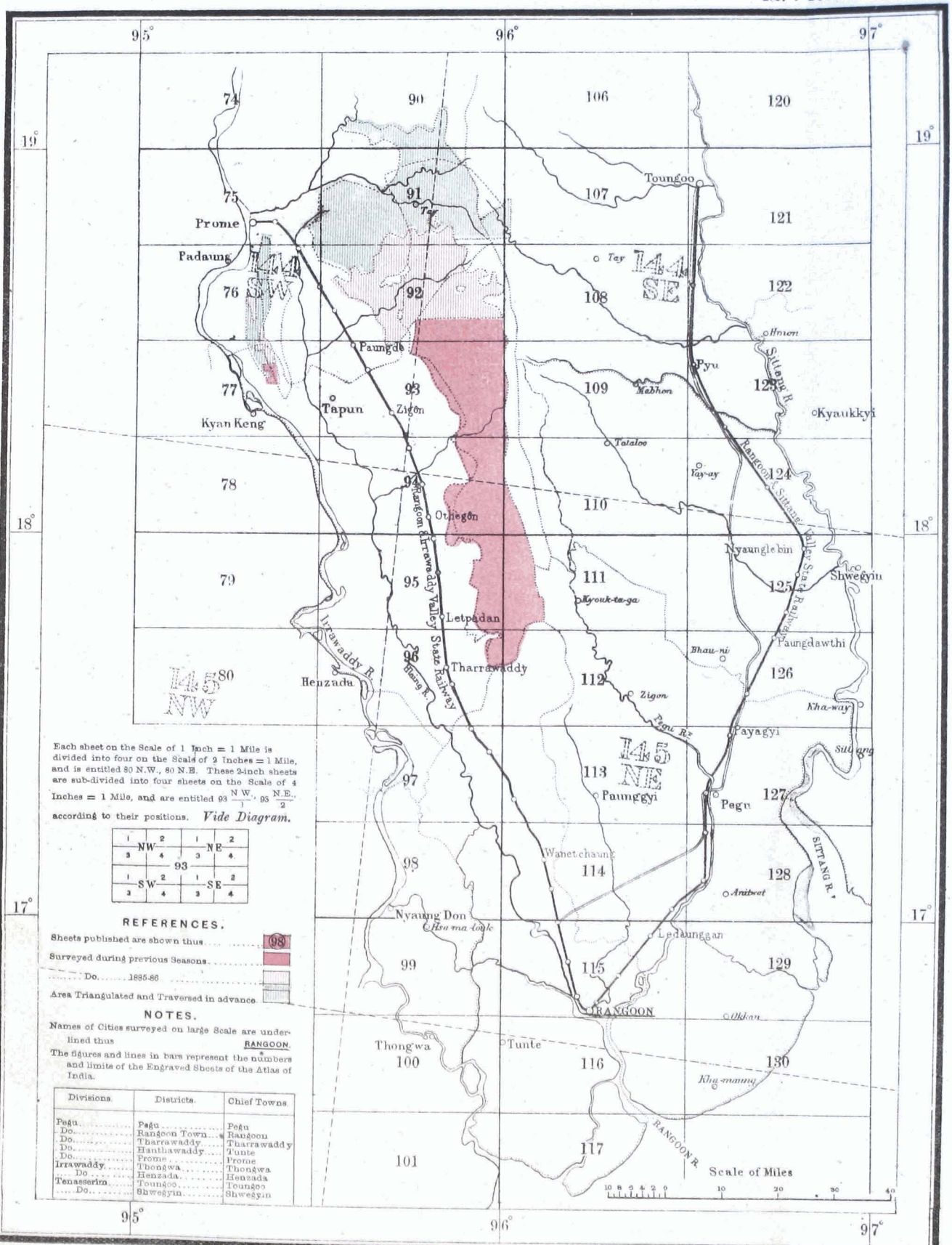
(v) by the unusual unhealthiness of the season.

129. Up to date the total area which has been surveyed is 1,044 square miles, excluding re-survey and overlap, of which 817 square miles are on the 4-inch scale, and 227 square miles on the 2-inch scale.

130. During the past season the Assistants and Sub-surveyors suffered more than usual from malarious fever, but the *klassies* kept their health very well. The total number of days lost from sickness was 317, representing the loss of the services of more than two men per month, or in other words, of 40 square miles on the 4-inch scale.

INDEX TO THE SHEETS OF THE BURMA SURVEY.

No. 7 TOPOGL. PARTY.



Each sheet on the Scale of 1 Inch = 1 Mile is divided into four on the Scale of 2 Inches = 1 Mile, and is entitled 80 N.W., 80 N.E. These 2-inch sheets are sub-divided into four sheets on the Scale of 4 Inches = 1 Mile, and are entitled 93 $\frac{\text{N.W.}}{1}$, 93 $\frac{\text{N.E.}}{2}$, according to their positions. *Vide Diagram.*

1 NW 2 / 3 4	1 NE 2 / 3 4
93	
1 SW 2 / 3 4	1 SE 2 / 3 4

REFERENCES.

Sheets published are shown thus 98

Surveyed during previous Seasons .....

..... Do. ..... 1885-86 .....

Area Triangulated and Traversed in advance.

NOTES.

Names of Cities surveyed on large Scale are underlined thus RANGOON.

The figures and lines in bars represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Divisions.	Districts.	Chief Towns.
Pegu	Pegu	Pegu
Do.	Rangoon Town	Rangoon
Do.	Tharrawaddy	Tharrawaddy
Do.	Hanthawaddy	Tunte
Do.	Prome	Prome
Irrawaddy	Thongwa	Thongwa
Do	Henzada	Henzada
Tenasserim	Toungoo	Toungoo
Do.	Shwegyin	Shwegyin

Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India, Survey of India Offices, Calcutta, January* 1887.

131. Extracts from Mr. Hörst's report, which will be found in the appendix, deal in detail with the delays and difficulties he met with, and under the exceptional circumstances, the out-turn is as much as could have been expected.

132. There were five casualties among the menial establishment caused by dacoits, and one of the European assistants, Mr. Gibson, when returning to quarters, was attacked by a large band of dacoits at Peinzaik, who plundered his camp, and a considerable amount of both Government and private property was thus lost. Fortunately Mr. Gibson escaped unhurt, and as he had taken the precaution to secure the safety of the field maps which had been executed by himself and the detachment during the season, the loss of these valuable records was averted by his forethought.

133. Provision depôts were kept up at five places from 25 to 40 miles from the source of supply. No food of any kind was procurable from the Karens, who, Mr. Hörst states, were plundered by dacoits of all they possessed as early as January; and the Burmans who inhabited a few villages along the Taungnyo and Shwele rivers, either could not, or would not sell any part of their stock of rice.

134. Thirty-one linear miles of check survey were run—not sufficient to test the accuracy of the work—but owing to the abrupt termination of the field season more could not be done. The Assistants and most of the Sub-surveyors were inspected by the officer in charge and the remaining Sub-surveyors by the Assistants in whose vicinity they were at work.

135. During the recess seven complete standard sheets on the 4-inch scale have been drawn, and two sheets as far as the ground has been surveyed; also 9 sheets on the 2-inch scale for reduction to one-half. A triangulation chart has also been drawn, but the printing of the names yet remains to be done. The usual computations, plotting and projection of field sections, &c., for the current season's detail survey have also been done.

136. The programme of operations which was arranged for the current field season is as follows:—The area, 205 square miles, already prepared for detail survey, south and east of Prome, will be taken up first, while a triangulation party will be sent into the Zamayi Reserve in the Pegu Valley for preliminary operations. The triangulation and traverse survey in the Pegu District will be carried on simultaneously in the State Reserves of South Zamayi, Shaudon and Pyeng-ma, which border on the Pegu River and are situated about 40 miles north-west of Pegu.

137. The detail survey operations will be commenced about the 1st December in the Prome District in the Shwedaung hill tract to the south of Prome. Of this, about 60 square miles will be surveyed on the 2-inch scale and 22 square miles, completing the Reserve named Inma Tayokmaw, on the 4-inch scale. The detached Reserves of Daube, Nyaung-Bendet, Pauktan Sinmizwè and Htonyea, aggregating 46 square miles, will also be surveyed on the 4-inch scale, and some tracts which were left unsurveyed last season near Ngapaw in the Paungdé township, aggregating 11 square miles, will be completed on the 2-inch scale.

138. The above programme comprises 68 square miles on the 4-inch scale and 71 square miles on the 2-inch scale, but in addition, about 60 square miles of country contiguous to, and east of that already cadastrally surveyed will be taken up on the 2-inch scale.

139. By the time the foregoing tracts are done, it is expected that sufficient ground will be triangulated and traversed in the State Reserves of South Zamayi, Shaudon and Pyeng-ma to admit of the detail surveyors being moved down from Prome to take up the topography of those reserves on the 4-inch scale.

Since this Report was written it has been found necessary to modify the above programme as regards the work in Prome, owing to the timidity of the Sub-surveyors and klassies, and the impossibility of providing Police guards for all the scattered detachments. On taking the field it was found that in consequence of the presence of dacoits in the neighbourhood of the ground to be surveyed, that it would be futile to attempt to carry out the detail survey of the forests in that tract. With the concurrence of the Chief Commissioner, the work in the Prome District was therefore suspended, and the establishment

*has been drafted chiefly to Upper Burma, where their services can be very usefully employed.**

CADASTRAL SURVEYS.

AKYAB DISTRICT, BURMA.

(No. 7 Party, Revenue Branch.)

140. On the superannuation of Mr. H. B. Talbot (on the 26th October 1885) this party was placed under the charge of Lieutenant-Colonel H. S. Hutchinson. The traversing section of the party was recalled from India somewhat earlier than usual, in order to complete the preliminary boundary work before the arrival of the cadastral section, but little advantage was derived from this early recall, as the country to be operated in was found to be flooded by reason of a late rainy season. The traversing section resumed work on 15th November, and the cadastral section on 5th December. Field work was continued up to 31st May.

Personnel.

Mr. H. B. Talbot, Officiating Deputy Superintendent, 3rd grade, in charge, to 21st October 1885, and superannuated on 26th October 1885.
Lieutenant-Colonel H. S. Hutchinson, S. C., Officiating Deputy Superintendent, 3rd grade, in charge, from 22nd October 1885.
Mr. F. W. Kelly, Officiating Deputy Superintendent, 4th grade, from 15th October 1885.
„ H. R. Littlewood, Surveyor, 2nd grade.
„ G. W. Jarbo, Assistant Surveyor, 1st grade.
„ J. R. Scott, Assistant Surveyor, to 22nd October 1885.
„ J. S. Swiney, Assistant Surveyor, 1st grade.
„ G. S. Willes, Assistant Surveyor, 3rd grade.
18 Sub-surveyors and others

Temporary Establishment.

97 Field surveyors and others.

141. The main part of the cadastral work of the season lay in tracts bordering the Kaladan and Padu Rivers, in the centre of the district, east and north-east of the town of Akyab, but several detached portions have also been surveyed in two separate valleys in the north-west part of the district, which required the establishment to be very much scattered at the beginning of the season. All the detached tracts of the district to be surveyed cadastrally have now been completed, and the remaining tract for cadastral survey consists of a compact block bordering the Kaladan River. As is usual in Burma, a considerable extent of waste land has been found intermingled with the cultivation, amounting in this season to over 50 per cent. of the total area of 661·29 square miles included in the cadastral survey. The separate areas are shown in the following statement:—

	Square miles.
Cultivation	318·13
Jungle and waste	308·46
River areas	34·70
TOTAL	661·29

The cultivated area includes 6,94,056 fields, of the average size of 0·29 of an acre.

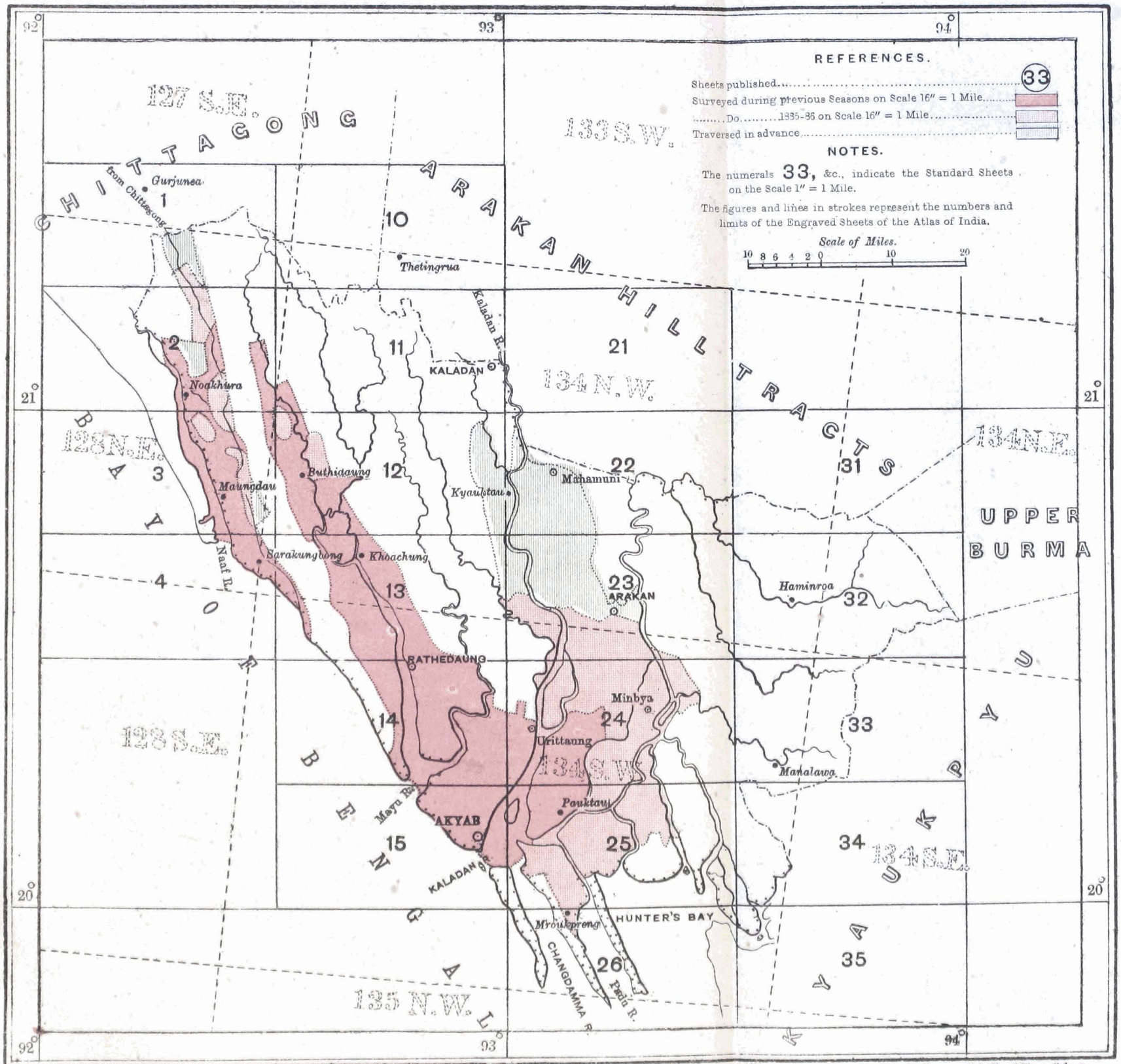
142. Of boundary traverse survey, a total area of 794 square miles was accomplished, of which 469 square miles have been surveyed cadastrally and 325 square miles remain as preparatory work for next season. The chain traverses have been connected with four stations of the Great Trigonometrical Survey and with three other triangulation stations especially fixed for the purpose of additional verification of the chain measurements. Comparisons

* Mr. Hörst reports of his assistants as follows:—Mr. Torrens had charge of the traverse camp and conducted his duties, which were of a harassing nature, in a satisfactory manner. Mr. Gibson, as usual, displayed much energy and devotion to his duties, and surveyed a difficult and dangerous tract. Mr. Ewing, who had no previous experience in triangulation, worked with energy, and was instrumental in having a large gang of dacoits dispersed by leading the Superintendent of Police, Prome District, right up to their encampment. Sub-surveyors Venkat Swamy, Sher Shah, Sumer Singh, Ahmad Sayid, Sharfuddin, Girdhari Lal, and Piari Lal worked very steadily under great difficulties. Sub-surveyor Nasiruddin stood firm and saved much property when a panic occurred among some Sub-surveyors, who forsook private as well as public property in their flight.

LOWER BURMA SURVEY.

INDEX TO THE CADASTRAL SURVEY OF DISTRICT AKYAB.

No. 7 REV. PARTY.



Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*
Survey of India Offices, Calcutta, October 1886.

NORTH WEST PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY OF DISTRICT BASTI.

No. 4 REV. PARTY.

Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*

have thus been instituted with 20 triangulation distances which show the chaining to have an average error of 1·1 foot per linear mile. Observations for azimuth were taken at forty-nine stations.

143. The system of marking a certain number of the traverse stations with stone prisms (which have been adopted for the Akyab District in place of the cylinders of pottery used in other districts in Burma) has been continued; and ordinarily these marks have been put down at all tri-junctions and at stations half a mile apart along the boundaries. As a precaution against the destruction or removal of these marks, notices in Burmese, signed by the Deputy Commissioner, showing the positions of the marks, have been handed to the headmen of villages, holding them responsible for the preservation of the marks.

144. The season, especially at its commencement, was an unusually unhealthy one. Only 12 deaths actually took place in the field, but 57 men of different classes were invalided to India, and the average of the sick who were absent from duty was 26 daily throughout the whole season.

145. The number of the cadastral sheets of the season is 915, which, as usual, are being retained in the party office awaiting Settlement revision before being sent to Calcutta to be printed. The sheets of the previous season, 946 in number, were sent up to Calcutta as they were got ready after revision and were all printed off by the end of November 1886. The general maps on the 2-inch scale will be drawn in the party office, and the traverse stations have been projected on 28 of them.

146. A short descriptive sketch of the features of part of the Akyab District and of one of the exciting amusements of the inhabitants, furnished partly by Colonel Hutchinson and partly by Mr. Jarbo, is given in the appendix, page x.*

BASTI DISTRICT, NORTH-WEST PROVINCES.

(No. 4 Party, Revenue Branch.)

147. This party resumed operations in the Basti District in continuation of its work of last year. No changes were made in the system of survey or in the preparation of the settlement records and statistics, with the exception that a slight modification of soil classification was introduced by the Settlement Officer on the 4th January 1886. Field work was commenced on the 20th October 1885, and closed on 3rd May 1886, when the party returned to recess quarters at Naini Tal.

Personnel.

Lieutenant-Colonel S. H. Cowan, S. C., Deputy Superintendent, 4th grade in charge.
Lieutenant H. M. Jackson, R. E., Assistant-Superintendent, 1st grade., transferred to Mysore on 7th March 1886.
Mr. H. T. Hanby, Surveyor, 3rd grade.
„ W. J. O'Sullivan, Surveyor, 3rd grade.
„ W. C. Price, do. do.
„ L. F. Berkeley, Asst. Surveyor, 2nd grade.
„ R. F. Warwick, do. do.
„ W. E. Johnson, do. 3rd grade.
19 Sub-surveyors and others.

Temporary Establishment.

348 Field surveyors and others.

148. The cadastral survey and village papers of Tahsil Harraiya and part of Tahsil Basti were completed last year; this year, the Basti Tahsil was finished, and the Khalílabad Tahsil so far advanced that only 4 *Tappas* of Pargana Maghar East, remain to be taken up next season. A survey has also been made on the 4-inch scale of the river-side villages in District Fyzabad, lying along the right bank of the River Ghagra (Gogra) opposite Parganas Mahuli West, and Mahuli East, of District Basti. The boundaries of these villages after survey were compared with the boundaries of the Fyzabad District Survey of 1862, and all discrepancies were submitted to the Deputy Commissioner for orders.

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* Colonel Hutchinson writes of the very valuable assistance and support he received from Mr. F. W. Kelly, Assistant Superintendent, who continued at work throughout the recess though much weakened by severe illness. Mr. Kelly has been obliged to take sick leave at the end of the recess and Colonel Hutchinson much regrets his temporary absence. Mr. Littlewood is reported to have maintained his high reputation of former seasons and to have managed the portion of the establishment placed under his charge most successfully. Mr. Jarbo's energy and diligence in the management of the traversing section is much praised; and Mr. Swiney's services both in field and office are said to deserve high commendation.

149. The following table shows the areas which have been surveyed cadastrally and *mauzawar* :—

District.	Pargana.	Description and scale of survey.	Number of villages.	Area in square miles.
Basti	Maghar West	Cadastral, 16″=1 mile	378	112·30
	Mahuli West	Do.	506	173·52
	Mahuli East	Do.	601	216·64
	Maghar East	Do.	787	279·33
	Rasúlpur	Do. / 32″=1 mile	2	·63
	Bánsi East	Do. / 32″=1 mile	2	·62
		Total of Cadastral Survey	2,276	783·04
Fyzabad		Mauzawar, 4″=1 mile	48	36·34
		Total out-turn	2,324	819·38

In the cadastral area, 11,26,230 fields have been surveyed, giving an average area for each field of ·445 acre. Traversing of village boundaries has been extended in advance over an area of 695 square miles, divided into 1,802 villages. Considerable delay was occasioned by the enormous number of boundary disputes, of which 625 remained unsettled on 1st March, and much anxiety was felt concerning the completion of the village papers; but the boundaries were at last adjusted through the appointment of additional Deputy Collectors, and the papers of all the villages were finished by the end of the recess.

150. The field survey has been tested by 2,216 miles of check survey, of which 345 were measured and compared with the field surveyors' maps by European officers, and 1,871 by native inspectors. To confine the angular error of the traverses, azimuth observations were taken at 28 stations, at an average distance apart of 9½ miles on the main circuits. The traverses have been connected with four principal stations of the Great Trigonometrical Survey, and the average error of the Revenue Survey chaining is found to be — 3·15 feet per mile. The names of proprietor and cultivator, details of irrigation, crops, soil, rent, &c., were tested in the *khasra* entries of 3,10,941 fields (27,607 by European officers and 2,83,334 by native inspectors).

151. Theodolite stations to the number of 4,751 have been marked by stone prisms (2½ feet long with 5-inch sides and 1 inch of the top dressed to a triangle having 4-inch sides) giving an average of 6·3 stones per square mile. The total cost has been ₹3,763, of which about ₹1,000 will be recovered from *zamindars*, leaving the remaining cost at the rate of ₹3-11-3 per square mile.

152. The area cadastrally surveyed has been mapped on 1,602 sheets, imperial size, suitable for reproduction by photo-zincography. The 4-inch work on the Fyzabad side of the Gogra, with a line of villages on the other bank entered by reduction from the cadastral 16-inch maps, has been mapped on ten sheets. The compilation of the topographical maps of the Basti District, on the 2-inch scale, for reduction by photography and publication on the 1-inch scale, has been commenced, and 9 sections or quarter sheets have been partially drawn. The 1-inch map of the whole district will probably occupy 31 of these quarter sheets.

153. The rate per square mile for the complete work of survey proper is ₹109-12-1, which includes—

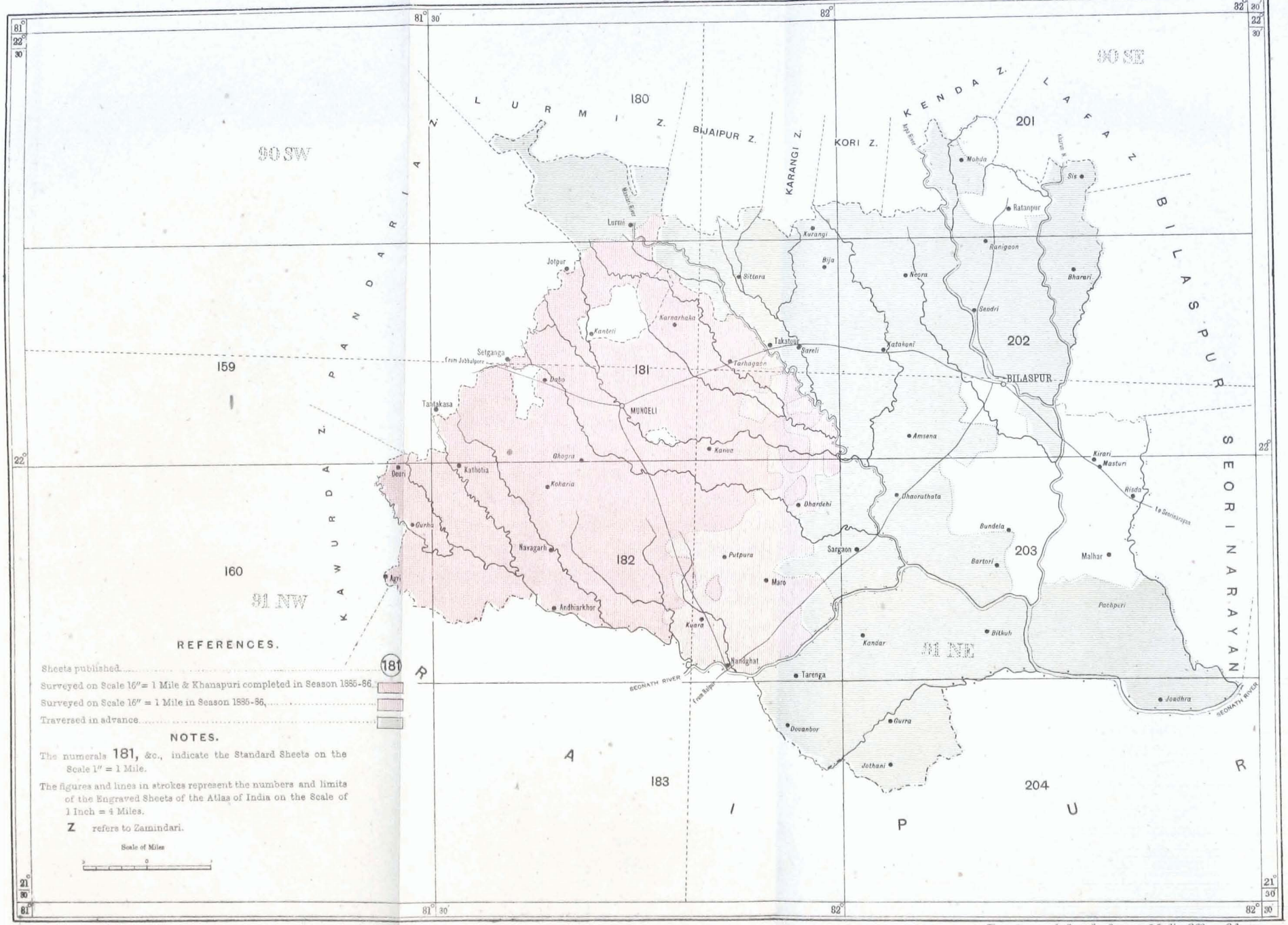
	₹	a.	p.
For permanent marks	3	11	3
„ traversing	22	10	0
„ detail survey	83	6	10

The writing of the record of rights with Urdu *khasra* complete with areas, &c. has cost ₹31,714 or ₹2-13-1 per 100 fields; and the statistics have cost ₹36,787 or ₹3-4-3 per 100 fields; or calculating per square mile (which

CENTRAL PROVINCES SURVEY.

INDEX TO THE SURVEY OPERATIONS IN DISTRICT BILASPUR.

No. 2 REV. PARTY.



REFERENCES.

Sheets published ..... (181)

Surveyed on Scale 16″ = 1 Mile & Khanapuri completed in Season 1885-86.

Surveyed on Scale 16″ = 1 Mile in Season 1885-86.

Traversed in advance.

NOTES.

The numerals 181, &c., indicate the Standard Sheets on the Scale 1″ = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India on the Scale of 1 Inch = 4 Miles.

Z refers to Zamindari.

Scale of Miles

Photozincographed at the Survey of India Offices, Calcutta

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*

Survey of India Offices, Calcutta, October 1886.

however gives no fair idea of the cost of compilations which depends on the extent of the sub-division of properties), the rates are :—

	R. a. p.
For record of rights	40 8 0
" statistics	46 15 8

154. Three junior officers of the Civil Service, Mr. House, Mr. Bower, and Koer Jwala Parshad, were attached to the party for two months under the orders of the Government, North-West Provinces, for instruction in surveying, and are reported to have attained a sufficient knowledge of the various processes.

155. The area remaining for cadastral survey in District Basti is about 1,257 square miles, of which about 732 square miles, containing an estimated number of 15 lakhs of fields, are expected to be surveyed next field season. For traverse survey, the area remaining is only 558 miles ; this will be completed in the next season, and it will be necessary that another district should be assigned to this party before October 1887.

156. Colonel Cowan reports that the Settlement Officer, Mr. Hooper, is most energetic in assisting the progress of the survey, and the Deputy Collectors under him and others of his establishment also further the work in every way they can.

157. The maps and records of the Benares District are now fully completed and some final statistics relating to that district are given in the appendix, page xiii.

158. The recess office of the party was inspected by the Deputy Surveyor General at Naini Tal during October, and was found to retain its old reputation excellent organization. This party has to be kept at a greater strength than any other cadastral party on account of the very large number of fields to be surveyed in Basti; and great credit is due to Colonel Cowan for the efficient manner in which the large establishment is supervised.*

BILASPUR DISTRICT, CENTRAL PROVINCES.

(No. 2 Party, Revenue Branch.)

159. This party, which had formerly been employed on cadastral surveys in Burma, but latterly on a topographical survey in the Shwegyin District of Burma, was transferred to the Central Provinces for the cadastral survey of the Biláspur District, in accordance with the orders of the Government of India conveyed in Revenue and Agricultural Department letter No. $\frac{57}{36\text{-}3}$S., dated 10th February 1885, to the Chief Commissioner of the Central Provinces. The traversing section of the party was first brought up from Burma and sent on, slightly strengthened, to Biláspur, where it commenced work on 15th October. The permanent members of the party who were to be employed with the cadastral sections were brought up later, and they, also with some additions, reached Biláspur on 20th November. The temporary members of the cadastral sections, consisting of 20 *munsarims* and 200 *amins*, were enter-

Personnel.

Mr. E. J. Jackson, Officiating Deputy Superintendent, 4th grade, in charge up to 3rd November 1885.
Lieutenant-Colonel E. H. Steel, S. C., Officiating Deputy Superintendent, 3rd grade, in charge from 4th November 1885.
Mr. G. B. Scott, Officiating Assistant Superintendent, 1st grade.
Mr. F. Grant, Surveyor, 1st grade.
" H. Dowman, Surveyor, 3rd grade, up to 31st October 1885.
" A. Christie, Surveyor, 3rd grade, from 1st November to 31st December 1885.
" J. R. Scott, Assistant Surveyor, 1st grade, from 1st January 1886.
" J. McHatton, Assistant Surveyor, 1st grade.
" G. E. Parker, Assistant Surveyor, 2nd grade, up to 31st October 1885.
" P. A. Peters, Assistant Surveyor, 2nd grade, up to 29th October 1885.
" P. C. H. Smart, Assistant Surveyor, 2nd grade.
" F. W. Moore, Assistant Surveyor, 3rd grade.
25 Sub-surveyors and others.

* Colonel Cowan highly commends the good services of Messrs. Hanby and Price, who had charge of the two cadastral camps, and of Mr. O'Sullivan, who remained during the recess at Fyzabad in charge of the Statistics office.

The other assistants are reported on as follows:—"Mr. Berkeley has been in charge of the traverse camp since the beginning of March: he is a very capable and willing assistant. Mr. Warwick deserves great commendation for the readiness with which he has taken to cadastral work: he has done useful service both in field and recess." "Mr. W. E. Johnson now knows the office work of both traverse and cadastral camps very well, and he has worked diligently."

The following members of the permanent native establishment are said to have done excellent service, *viz.*, English writer Ibu Hosan, Draftsman Meer Asjad Ali, Computers Lal Mohon Gangopadhia, Sew Narain, and Kanaya Lall, and the following are well reported on, *viz.*, Sub-surveyors Inayet-oolla, Munli Manohar, Tola Ram, Bhawani Pershad and Patandin and Computer Pooran.

Of the temporary establishment, Mr. A. D. Lancaster, Supervisor, is said to have rendered most valuable service both in field and office, and the following Inspectors are said to have worked hard and showed themselves able and trustworthy, *viz.*:—Gunga Persnad, Kalim Rai, Boldeo Sahai and Madho Ram.

tained in the North-West Provinces, and were collected in the Biláspur District on 5th December, by which date boundary plots had been got ready for them by the traversing section. The party remained in the field until the end of April 1886, when the heat having become excessive, rendering further field operations impracticable, the field establishments were discharged and the office establishments were taken to Mussooree for recess.

160. Besides the cadastral survey of the fields, the party was required, in accordance with the specification of the Chief Commissioner in letter No. 11S., dated 13th January 1885, to Secretary to the Government of India, Revenue and Agricultural Department, to undertake the writing of the village papers in preparation for a new settlement, on the system which had been adopted for the Basti and Gorakhpur Districts of the North-West Provinces. This part of the work, usually called "*Khanapuri*," was entirely new to all members of the party except to Colonel Steel himself and to a few of the *munsarims* who had been sent for a short time to the Gorakhpur Survey to acquire an insight into the procedure. Colonel Steel had therefore to set to work to teach the *khanapuri* to his European officers and to the field-surveying *amins*. He found it advisable to teach only a certain number of the *amins*, as all were not acquainted with Hindi, in which character the village papers had to be written, besides, the number of the *patwaris* was limited, one of whom had to accompany the *amins* when the *khanapuri* was being taken. About two-thirds of the *amins* were therefore employed on field surveying, and one-third, taking up the completed field maps, were employed on *khanapuri*.

161. On this part of the work, Colonel Steel reports thus:—

"With regard to the detail of *khasra* writing, I have the following remarks to make: *Firstly*, the only trustworthy documents which have been completed in the Biláspur District by the *patwaris* during the past 17 years are the *jamábandis* of 1868 and 1882-83. In the 1868 *jamábandi*, the *sir* land was recorded with greater truth and accuracy than in the *khateoni* of 1867, where, from motives of self-interest, it was generally overstated. In 1882-83 an inquiry was made into suits which was conducted under the supervision of Mr. Purshotum Doss. The inquiry, as far as the employment of such a staff of *patwaris* would admit, was excellent. As a rule, the rest of the records are not worth the paper on which they are written. In any village, I invariably enquired for the year in which the *patwari* visited the place. He had probably been three or four times since last settlement, but on enquiry if he had ever been into the fields, the answer was invariably 'No.' In fact, he wrote, *i.e.*, copied out, the old papers in the village, with certain fancy additions. In writing the *khanapuri*, therefore, as the *patwari* papers were of no value, some method had to be devised of finding out the tenures of new tenants since the last settlement. When the first *khanapuri* writing commenced, we tried to ascertain the tenures by enquiry in the field from the tenant and *malguzar*: we were led to believe from the perusal of the little Raipur book, that these guileless souls would agree in stating the truth. The absolute opposite was the fact. Where the *malguzar* was present, there was a wrangle over every field; where he was absent and a *thikadar* present, he might wrangle or he might not: where there was an agent, his mind, as far as tenure was concerned, was generally a blank. After much thought and discussion with Mr. Purshotum Doss, I devised the "*Fard Takikat*" or list of enquiries, indirect enquiries, into every man's tenure; its use is explained at length in the printed *khasra* procedure: suffice it to say here all difficulties vanished; the naked truth, regarding tenures and possession of *sir*, became apparent, and the work progressed. The battle of *khasra* writing in the Central Provinces was won. The *amin*, on coming into any field, was able to say, 'whose field is this,' and on referring to his 'list of enquiries' could add 'you have cultivated this field ten years, this field before that was so and so's field, and you are *mamuli*.' If it were *sir* land to the *malguzar* or to his agent he could say, 'You got this from so and so eleven years ago, as yet you are only *Khudkasht*.' The soils gave much trouble, not so much in distinguishing them as in classifying them, under the heads laid down. These are:—

Kanhar—Black cotton soil.
Dorsa—Mixed rice and cotton soil.
Matasi—Rice soil.
Kachhar—Sandy loam, on brink of rivers.
Bhata—Red stony plain.

Now, locally there is a poor *Kanhar*, called '*Gurri*,' reddish-orange, and full of nodules of *Kanhar*; also, a hard stony soil, on which short, poor, thin grass grows, which is neither *Gurri*, *Dorsa*, nor yet *Bhata*. These were difficult to place. In writing the *khanapuri*, besides tenants endeavouring to gain right of occupancy to which they were not entitled, we had to guard against false entries of soil, concealment of rents, and the suppression of the fact of the existence of sub-tenants. Besides this, the *malguzar* constantly struggled to call all *Khudkasht*, *Sir*."

The above extract shows the nature of the work that had to be done and the spirit in which it was undertaken. Colonel Steel found his European officers most ready learners of the *khanapuri* duties and most willing workers. In one of his progress reports he states that he and his officers "were in the villages during the whole month checking *khasra* entries. Great attention was paid to this point. The check consists in visiting nearly every *sir* and *khudkasht* field; checking soils and crop entries on the spot; ascertaining if the status of the tenants has been properly recorded; and lastly, ascertaining, as far as possible, that the rents paid by the tenants are rightly recorded."

162. A small hand-book of "Instructions concerning the preparation of the village papers in connection with the Cadastral Survey of District Biláspur" has been drawn up by Colonel Steel, embodying the orders he issued to his establishment from time to time during the season as the work progressed. It has been printed, and it is expected will enable the *khanapuri* to be continued during next season very methodically.

163. Besides the check of the *khanapuri* entries, the check of the field map was carried out rigorously, the European officers having measured 397 linear miles of check survey and the *munsarims* 1,127 miles.

164. The area surveyed, lying entirely within the Mungeli Tahsil and included in 751 villages, amounts to 763·03 square miles of field survey, of which the *khanapuri* has been finished of 649 villages in area amounting to 605·69 square miles. Of village boundary traverse survey, the whole area which has been done is 1,795 square miles, a provision of 1,032 square miles of advance traverse work having thus been made for next field season. The number of fields surveyed is 474,296, giving an average area per field of 1·03 acres.

165. The total expenditure in field and office up to 30th September 1886, the end of the survey year, has been ₹1,34,940, from which the following cost rates per square mile are obtainable, after apportionment of the details of the expenditure to the several parts of the work, *viz*:—

	₹	*a.*	*p.*
(1) Traversing . . . . . (Which includes the plotting of the skeleton traverse sheets.)	16	2	3
(2) Marking Stations	1	8	9
(3) Detail survey . . . . . (Which includes the fair drawing of the original maps and copies, also calculation of areas of fields.)	70	2	3
(4) Khanapuri . . . . . (Which includes the completion of the original vernacular records.)	81	15	5
TOTAL .	169	12	8

166. The above results have been obtained during the first season in a new district and in an entirely new province by an establishment which had to be largely remodelled and to be instructed in a procedure with which they had hitherto been unacquainted, having also to learn the law of their new province and to some extent its language; and it is confidently expected that much lower rates will be exhibited as the result of next season's working. For the present season even more favorable rates than those quoted above might very reasonably be claimed by the exclusion from the total expenditure of a certain share of ₹6,783, the cost of a new equipment of tents, also of parts of the expenditure of ₹16,200 incurred in transporting the party to Biláspur and in salaries during October and November, while only traverse work was being done; likewise of part of the expenditure of ₹12,900 during December, when the cadastral survey was only ten days in actual progress; but the proper sums to be excluded are difficult of calculation, and, as expenditure of the nature referred to has generally to be incurred when a survey party is removed from a distant locality and at the same time remodelled for new operations, no attempt has been made to arrive at estimated rates by an estimated reduction of the expenditure.

167. The Administration of the Central Provinces have decided not to have the cadastral maps of Biláspur printed, as two copies on tracing cloth will

suffice for all requirements. These copies have been prepared and are ready to be sent to the Settlement Officer. Besides the original copies of the village papers, which consist of—

Khasra Jamabandi		Milan Khasra Jinswara

Jamabandi Abstract,

the Administration require copies of these to be prepared, but the requisition was not received in time to admit of the papers of more than 100 villages being copied during the recess.

168. The recess office of the party was inspected at Mussooree during September by the Deputy Surveyor-General in charge of the Revenue Branch, who expresses himself highly satisfied with the state of the records, and who desires to bring to notice the intelligent and energetic manner in which Colonel Steel has undertaken the introduction of the system of record-writing, combined with a cadastral survey, into the Central Provinces, and the high state of efficiency to which he has brought the members of his establishment by his own personal exertions in training them.*

GORAKHPUR DISTRICT, NORTH-WEST PROVINCES.

(No. 5 Party, Revenue Branch.)

169. This party, which has continued throughout the year under the charge of Major J. E. Sandeman, returned from recess quarters at Naini Tal to resume field operations in District Gorakhpur on 15th October 1885, and remained in the field until 10th April 1886. Mr. E. Little, Surveyor, was then left in an office at Gorakhpur with a suitable establishment to prepare the statistical tables and Hindi records; and the rest of the party, with establishment, proceeded to recess at Naini-Tal for the completion of the maps, the traverse computations, the area computations and the Urdu *khasras*.

Personnel.

Major J. E. Sandeman, S.C., Officiating Deputy Superintendent, 2nd grade, in charge.
Captain R. A. Wahab, R.E., Officiating Deputy Superintendent, 4th grade, from 8th November 1885 to 10th April 1886.
Mr. E. G. Little, Surveyor, 3rd grade.
„ T. F. Freeman, Asst. Surveyor, 1st grade.
Mr. J. Murphy, ditto ditto.
„ A. W. Smart, ditto ditto.
„ N. Bedford, ditto 3rd grade.
„ W. V. Skilling, ditto ditto.
17 Sub-surveyors and others.

Temporary Establishment.

540 Field surveyors and others.

170. With the exception of a strip of overlap topographical survey beyond the district boundary in the Sarun District of Bengal, the work has been a cadastral survey on the 16-inch scale, combined with the writing of the village papers, such as have been described in previous Reports. A few changes in procedure have however been introduced, of which the following are the most important :— *1st*—Village boundaries have been surveyed along with the skeleton traverse instead of being left to be surveyed separately for each village with the fields. This is believed to have had the effect of reducing the number of boundary disputes: there having been fewer disputes this year than during the previous year. *2nd*—The *jamábandi* in Urdu is now prepared in the Survey office instead of in the offices of Deputy Collectors. This has not raised the survey rates, and is believed to have saved the expenditure of large sums in the Settlement office. *3rd*—Alluvial *Mahâls* are now demarcated at time of survey, which has

* Colonel Steel, mentioning the names of Mr. G. B. Scott, Messrs. F. Grant, J. McHatton, J. R. Scott, P. C. H. Smart, and F. W. Moore, writes as follows:—

"I have never been associated with a better set of officers, whether it be on account of their general knowledge, their work, or the willing spirit in which they have always carried out my slightest suggestions. Their hearty agreement among themselves, strong sense of mutual reliance and devotion to their duty during a peculiarly trying year has won my esteem and respect."

The name of Mr. G. H. Kineley, writer, and the names of computers Reedoy Chunder Doss and Makkan Lall Singh are also mentioned by Colonel Steel, on account of the excellent work they have done.

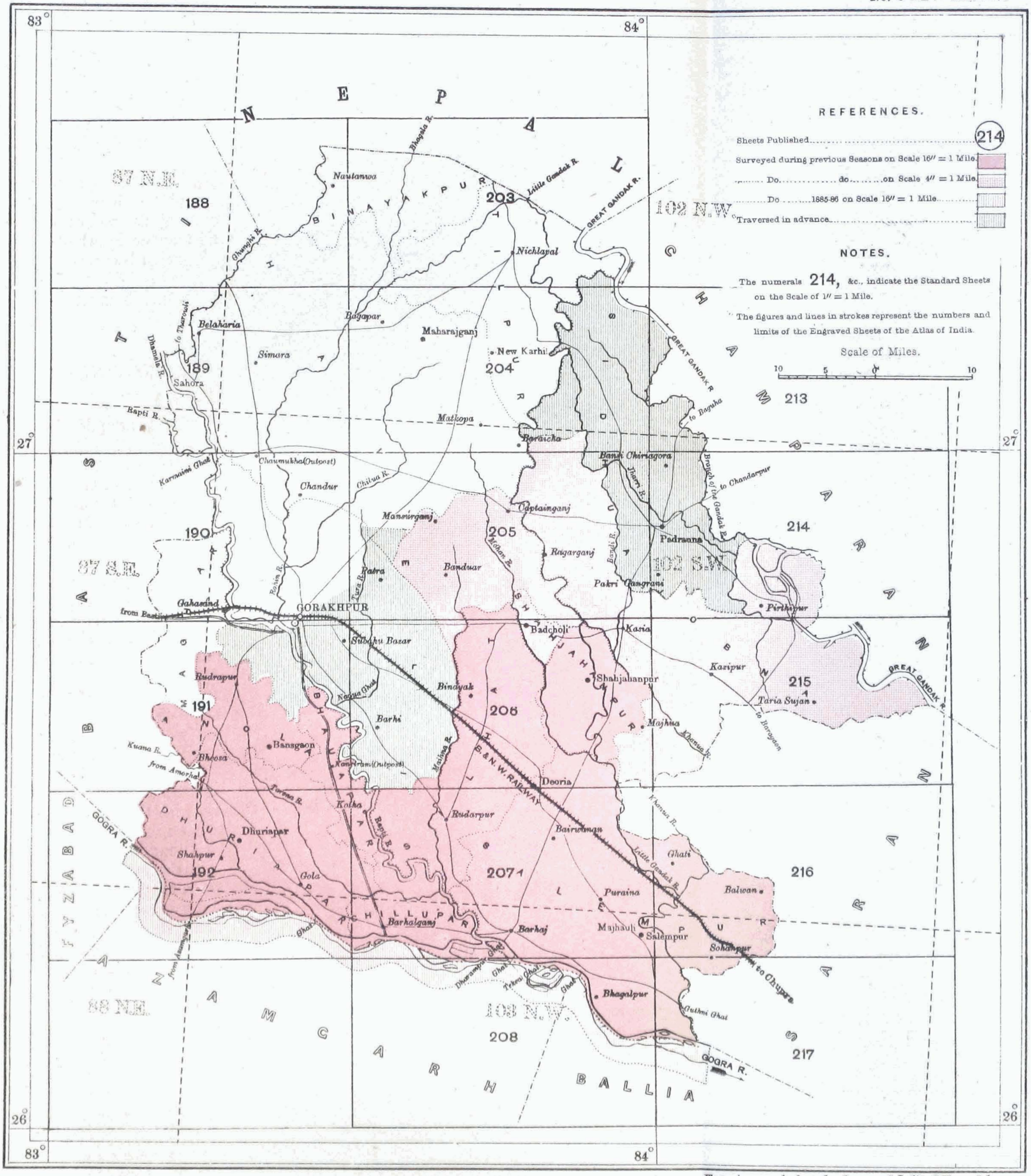
Finally, Colonel Steel reports as follows:—

"I cannot conclude this report without recording the services rendered by my friend and Civil Assistant, Mr. Purshotum Doss, Assistant Settlement Officer. He had a most intimate knowledge of the people, their customs, and everything connected with the district. He is a man of extended knowledge, excellent ability, and untiring energy. I can only say that he identified himself with our work and placed his best services at my disposal. That there was no friction between the Survey and the country people, is mainly due to his excellent management, and I conclude by saying that my warmest thanks are due to him for his courtesy and ever ready assistance.

N. W. PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY OF DISTRICT GORAKHPUR.

No. 5 REV. PARTY.



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Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*

Survey of India Offices, Calcutta, November 1886.

enabled separate *jamabandis* to be prepared of the portions of villages which come under quinquennial settlement. *4th*—The preparation of Hindi copies of the *khasras* at time of survey by the *patwaris* has been discontinued. *5th*—The classification of natural soils has been modified, the fields having been recorded under the three classes—of "table land," "slope," and "low land;" instead of being distinguished as formerly as—"clay," "loam," or "sand." *6th*—The conventional soil zones of "home-lands," "middle" and "out-lying" tracts are no longer marked on the original survey maps. *7th*—The typing of English names on the maps has been reduced and greater prominence has been given to the names in the vernacular. Under directions from the Board of Revenue the definition of a "field" has been altered in the Hand-Book of Instructions and now stands as follows:—

"A field is a parcel of land lying in one spot in the occupation of one cultivator, held under one title, and generally known by some name in the village."

171. Major Sandeman continues to advocate the transfer of the "fairing" of the village papers from the Settlement office to the Survey office, where he believes the work could be done very much more economically through the supervision of the European officers. He understands that this work at present costs R60 or R70 per square mile, which, as he points out, is more than the expenditure on the original papers.

172. The areas of completed survey with records by *tahsils* are shown in the following statement:—

District.	Tahsil.	Description and scale of survey.	Number of villages.	Area in square miles.
Gorakhpur	Hata	Cadastral, 16-inch to a mile.	457	275·38
	Parauna		794	544·71
Total Cadastral Survey	...	...	1,251	820·09
Sarun (Bengal) . . .	...	Topographical, 2-inch.	...	41·07

In addition to the above, preliminary boundary traversing has been executed for 394 square miles of the Parauna Tahsil and for 346 square miles of the Gorakhpur Tahsil. The cadastral area includes 894,028 fields, of which the average size is ·58 of an acre.

173. All theodolite stations have been marked either with stones or burnt clay cylinders. Stones are used for all stations placed on the sites of village boundary marks and for stations at half-mile intervals along streams where the traverse stations are off the actual boundary. For other stations off the boundary and for stations in the interior of villages, cylinders are used. The number of stations so marked are 7,756 with stones, and 2,856 with cylinders, besides which, there are the village tri-junctions permanently marked by the Settlement authorities at the time of the village boundary demarcation.

174. Observations for azimuth to check the angular work of the traverse survey have been taken at 78 stations. The traverses have been connected with 6 stations of the Great Trigonometrical Survey and the triangulation co-ordinates have been used for correcting the distances of the measured traverses. In two cases of comparison with the triangulation, the error of the measured distances is *plus*, averaging ·9 feet per mile, and in eight cases the errors are *minus*, averaging 2·03 feet per mile. The surveys to check the cadastral plotting, executed partly by Assistant Surveyors and partly by native inspectors or *munsarims*, amount to 1,712 linear miles, on comparison with which the work is said to have been found to be very good. The *khanapuri* was also subjected to the usual amount of check. The Assistant Surveyors and four head inspectors,

in addition to the inspectors over squads of *amins*, were constantly moving about, checking the work, and the returns show that 19,786 fields were tested by Assistant Surveyors and 133,176 by inspectors, or 17 per cent. of the whole.

175. There are 15 unsettled disputes on the boundary of the Sarun District of Bengal common with the Parauna Tahsil, maps of which have been prepared showing the demarcated boundaries as well as the boundary lines taken from the maps of 1837, and forwarded to the Settlement Officer. The decisions in the cases of dispute on the same boundary common with the Deoria Tahsil have been appealed against by the Sarun *zamindars*. A new boundary has been demarcated between Districts Gorakhpur and Azamgarh where the Gogra River, owing to a change in its course, had ceased to be the boundary.

176. The cadastral area has been mapped on 1,447 sheets. These will be retained in the office of the party pending the Settlement attestation of the village records, on completion of which they will be sent down in batches to Calcutta to be printed. The series of sheets on the 4-inch scale, numbering 23, of the *diwara* of the Gogra River, mentioned at paragraph 224 of last Report, has been completed. On these, the boundaries of all submerged villages, in which rights are at present dormant, have been traced from the maps of 1837, so that, if the river again changes its course, and claims for the lands in question are made, the maps are ready for relaying the boundaries. The traverse projections of the 2-inch maps of the Gorakhpur District are being done in the party office and the drawing of the topography by reduction from the 16-inch maps will be done in the Surveyor General's Office.

177. Regarding the cost of the operations, Major Sandeman reports :—

The out-turn and rates compare well with those of the two former seasons, although there is only a slight fall on last year's rates. The old form appearing obsolete, I have filled up the one which was adopted for the half-yearly return. The cost of the 16-inch field survey has been separated from that for extraction of areas and finishing up of maps, and the cost of *khanapuri* has been separated from the cost of completion of the Urdu *khasras*. Thus, it can be seen in both cases how much the field work and how much the office work cost separately.

The rates per square mile during the past three seasons are as follow :—

	1885-86.	1884-85.	1883-84.
	R a. p.	R a. p.	R a. p.
(1) Stone embedding	10 4 5	26 9 1	30 8 5
(2) Traversing	20 7 11		
	30 12 4		
(3) 16-inch field survey	44 15 1		
(4) Khanapuri (record of rights)	21 3 1		
(5) Areas (extraction of) and completion of maps	25 9 6	100 11 1	110 7 5
(6) Completion of Urdu records	9 5 9		
	101 1 5		
(7) Hindi records, statistics and soils	38 7 11	43 13 10	36 13 5
	170 5 8	171 2 0	177 13 3

The rates for the current season include the cost of the preparation of the *jamá-bandis* which were prepared by the Deputy Collectors formerly, so that the rates compare more favorably than would at first appear. This has moreover saved a large expenditure in the Settlement office.

178. Messrs. Winter, Cobb and Lovett, of the Civil Service, were attached to the party during January and February 1886, and were instructed in several systems of surveying.

179. The Senior Member of the Board of Revenue, North-West Provinces, inspected the work in the field on the 25th and 26th January, and the Director of Agriculture likewise visited the party on 23rd and 24th March.

180. Major Sandeman writes as follows regarding the Civil Officers with whom he has been associated :—

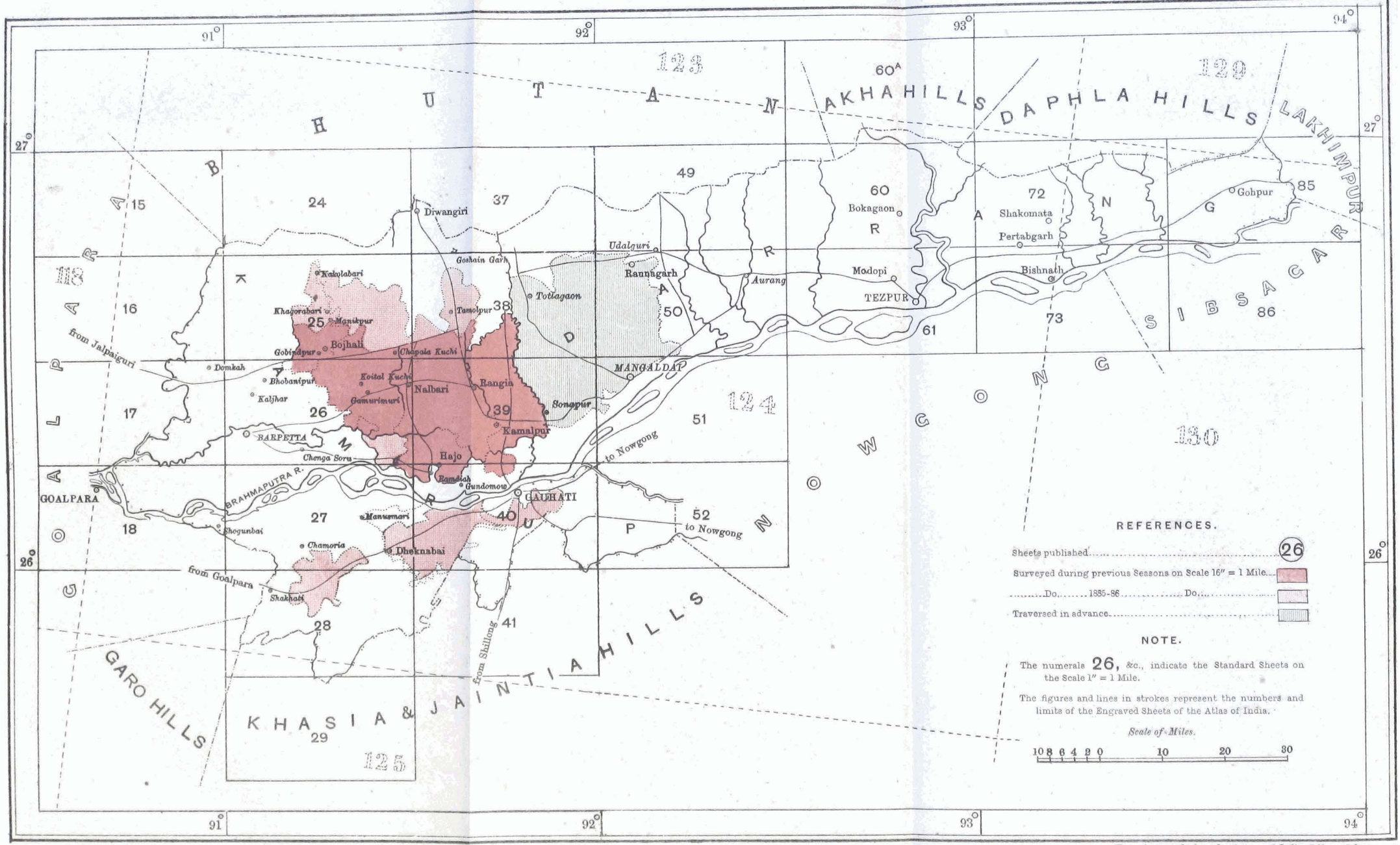
"Again, I have to thank the Settlement Officer, Mr. J. D. LaTouche, for all the aid he has given us; also the Collector of the District, Mr. Mellor, and the Deputy Collectors of Settlement for their co-operation."

181. The recess office of the party was inspected at Naini Tal during October by the Deputy Surveyor General in charge of the Revenue Branch, who expresses himself highly satisfied with Major Sandeman's government of his

ASSAM SURVEY.

INDEX TO THE CADASTRAL SURVEY OF DISTRICTS KAMRUP & DARRANG.

No. 6 REV. PARTY.



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Survey of India Offices, Calcutta, October 1886.

large establishments, the efficiency of which is amply testified by the character of the records and the regularity with which all the work is conducted. Major Sandeman continues his unceasing endeavours to adopt any changes in procedure which may seem likely to conduce to economical working and to more effective collaboration of the Settlement and Survey establishments.*

KAMRUP AND DARRANG DISTRICTS, ASSAM.

(No. 6 Party, Revenue Branch.)

182. This party under Mr. E. C. Barrett resumed cadastral operations in District Kámrúp on 10th November 1885; and at the same time entered District Darrang to undertake the preliminary traversing for a cadastral survey there. Field operations were brought to a close on the 10th May 1886, when the office establishment returned to recess quarters at Shillong. The party continued under Mr. Barrett up to the 4th July; when, on Mr. Barrett's proceeding on three months' privilege leave, Mr. J. H. O'Donel, the senior Surveyor, was placed in temporary charge.

Personnel.

Mr. E. C. Barrett, Officiating Deputy Superintendent, 3rd grade, in charge.
„ J. H. O'Donel, Surveyor, 4th grade, in temporary charge, from 5th July to 4th October 1886.
Mr. D. A. King, Surveyor, 4th grade.
„ J. Connor, Surveyor, 4th grade.
„ J. C. Kelly, Assistant Surveyor, 2nd grade, up to 30th June 1886.
„ J. Smith, Assistant Surveyor, 3rd grade.
24 Sub-surveyors and others.

Temporary Establishment.

298 Field surveyors and others.

183. The nature of the cadastral operations has been the same as during the past two seasons, *viz.*, a 16-inch field survey combined with the writing of a *khasra*. These operations have been carried on in the Kámrúp District, partly in the Gauháti Sub-Division to the south of the Brahmaputra, and partly in the Barpetá Sub-Division to the north of the river. The tracts surveyed in both sub-divisions, cover a total area of 468·18 square miles, which, as will be seen by a reference to paragraph 236 of last Report, is considerably in excess of the area expected to be surveyed under a reduced budget grant. The total number of fields in both tracts is 147,818 of an average size of 2·03 acres.

184. The cadastral survey now completed on the 16-inch scale in District Kámrúp is contained in four separate blocks of villages lying two to the north and two to the south of the Brahmaputra River, and covers a total area of 1,174·39 square miles. The total number of fields surveyed and registered is 583,426, and the average size of the field over all is 1·29 acres. All the large tracts of country under permanent cultivation in District Kámrúp have been surveyed in these four blocks of villages, and it is not contemplated to extend the survey to *jaringhati mouzahs*, where the cultivation is chiefly fluctuating, and where the cost of keeping up the survey records would consequently be great. The cadastral survey has therefore been finished in Kámrúp, and next year it will be carried on in District Darrang.

185. Preliminary traverse operations have been confined to the Mangaldai Sub-Division of District Darrang, where an area of 474·32 square miles has been surveyed in preparation for next year's cadastral survey. In Darrang, the unit known as the village did not exist prior to the commencement of these operations. The smallest of the main sub-divisions was the *mouzah*, and as *mouzahs* cover areas varying from 5 to 30 square miles, it was found necessary to sub-divide them into village blocks of convenient size. The new villages

* Regarding the services of the officers serving under him, Major Sandeman writes in the following terms:—

"Captain Wahab, R.E., while in charge of the traverse camp, gave me his cordial co-operation for which I am much indebted to him. Messrs. Little and Freeman, in charge of the detail camps, have once more given proof of their capacity to manage large survey camps successfully and supervise the preparation of the village records as well as the survey. They, as well as their assistants, Messrs. Murphy and Bedford, have worked most laboriously, and it has been with the utmost satisfaction that I have seen the special allowances which were recommended for them sanctioned by Her Majesty's Secretary of State. Mr. A. W. Smart succeeded Captain Wahab, in charge of the traverse camp, and I have every reason to be satisfied with the manner in which he has superintended the work. Mr. Skilling has done well and is a promising assistant. In the native establishments, the following are deserving of special mention, *viz.*, *Permanent Establishment.*—Puran Chand, Nidha Lal, Joala Pershad, Waris Ali, Ganga Pershad, Ghulam Gaus Khan, Jairam Singh, Abdul Hadi, Lalji Mul. *Temporary Establishment.*—Abdul Hamid, Jai Narain, Hari Singh, Amanat Hosein, Bishambar Sahai, Majibulla, Ramdatt."

have been made as symmetrical as possible, and in area about 600 acres, which will admit of their being plotted on one imperial-sized sheet of paper as ordinarily used for cadastral maps.

186. The cadastral survey has been carefully checked by 1,058 linear miles of test surveys, of which 429 miles were run by European officers and 629 miles by native inspectors. The *khasra* entries of 14,395 fields have been checked by the European officers; and this work has also been independently tested by *munsarims* and Sub-Deputy Collectors of the Settlement staff.

187. Over three-fourths of the *amins* were natives of the North-West Provinces, the remainder being chiefly Bengalis, and only two being natives of the Assam Valley. The Hindustani *amins* as usual did the largest amount of work, but the Bengalis pushed them very closely and their work was quite as good as that of the Hindustanis. One of the Assamese *amins* is said to be an excellent field surveyor.

188. The triple-junctions of all villages are marked by stone prisms, 3 feet long and with 1 foot sides, which have been adopted as theodolite stations. The positions of the theodolite stations intermediate between tri-junctions are indicated by *semal* tree branches planted 5 feet north of the station points.

189. The season's out-turn has been mapped on 653 sheets, tracings of which, with the village *khasras*, were all sent to the Settlement Officer before the end of the recess.

190. The revision survey of the work of season 1884-85 was carried out by ten field parties, each consisting of a Settlement *munsarim* and a Survey *amin*, between 5th November 1885 and 24th February 1886. Out of 396 villages which came under this revision survey, 136 villages were passed without the need of any change whatever.

191. The cost rate of the combined operations of settlement and survey for season 1884-85, which was stated in paragraph 235 of last Report to be ₹269-13-10 per square mile, as arrived at partly from an estimated rate for revision survey, requires a slight alteration in accordance with the actual revision survey rates, as now shown in the following statement:—

Season 1884-85.

	Area.	Rates.	
	Square miles.	Per square mile.	Per acre.
		₹ a. p.	₹ a. p.
Cadastral Survey, with *khasras*	478·05	215 11 3	0 5 4
Revision Survey — Survey expenditure	...	2 8 10	0 0 1
Revision Survey — Settlement expenditure	...	12 8 9	0 0 4
Settlement	....	49 2 6	0 1 3
Combined operations	...	279 15 4	0 7 0

In the following statement for the past season, the revision survey rates are approximate:—

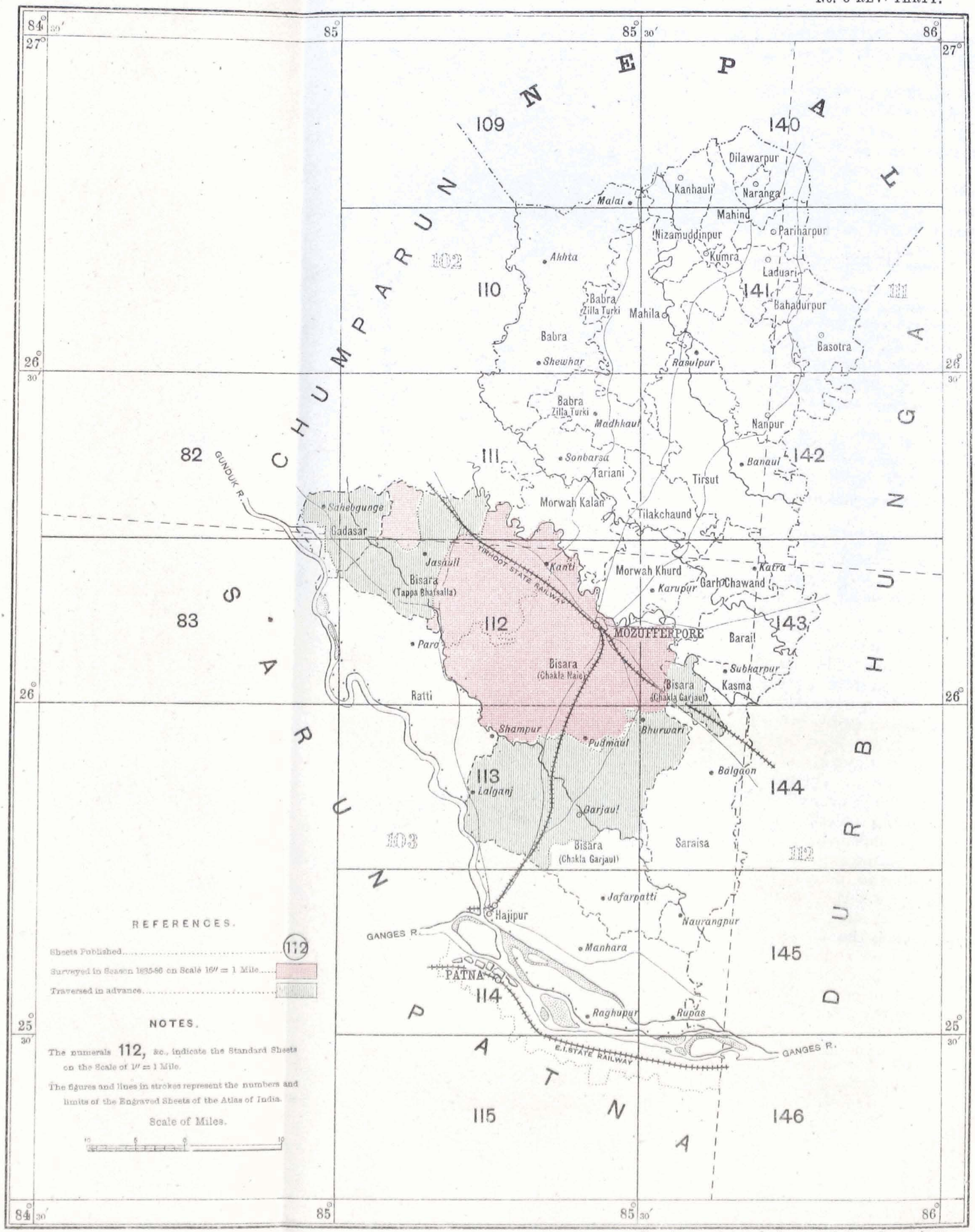
Season 1885-86.

	Area.	Rates.	
	Square miles.	Per square mile.	Per acre.
		₹ a. p.	₹ a. p.
Cadastral Survey, with *khasras*	468·18	199 15 6	0 4 11
Revision Survey — Survey expenditure (App.)	...	2 8 10	0 0 1
Revision Survey — Settlement expenditure (App.)	...	12 8 9	0 0 4
Settlement	...	48 5 4	0 1 3
Combined operations	...	263 6 5	0 6 7

BEHAR SURVEY.

INDEX TO THE CADASTRAL SURVEY OF DISTRICT MOZUFFERPORE.

No. 8 REV. PARTY.



REFERENCES.

Sheets Published 112

Surveyed in Season 1885-86 on Scale 16″ = 1 Mile .....

Traversed in advance .....

NOTES.

The numerals 112, &c., indicate the Standard Sheets on the Scale of 1″ = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India.

Scale of Miles.

Photozincographed at the Survey of India Offices, Calcutta.

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Survey of India Offices, Calcutta, November 1886.

192. The Chief Commissioner of Assam, Mr. W. Ward, visited the Survey camp at Rangiya during February, when he was shown over the camp offices and the procedure adopted by the Survey was explained.

193. Mr. Barrett makes particular mention of the great assistance rendered to the party by the district officials of Kámrúp and Darrang, to whose excellent arrangements he ascribes the entire absence of all friction between the Survey establishments and the village people in either district.*

MOZUFFERPORE DISTRICT, BENGAL.

(No. 8 Party, Revenue Branch.)

194. This party was transferred from Burma to Bengal for the purpose of undertaking in the District of Mozufferpore, in Behar, under the Bengal Tenancy Act (VIII of 1885), an experimental cadastral survey with the preparation of a record of rights, which was sanctioned in letter No. 214—97-1S., dated 1st June 1885, from Secretary to Government of India, Revenue and Agricultural Department, to the Surveyor General of India. The party reached Mozufferpore on the 13th October 1885, under charge of Mr. R. B. Smart, and after having been intermediately held in charge by Mr. W. A. Wilson, the senior Surveyor, was finally made over to Lieutenant-Colonel W. Barron on 16th November 1885. Several transfers of Sub-surveyors from other parties had to be made so as to bring the permanent establishment up to proper strength for the traverse work. The temporary establishment brought from Burma formed merely a nucleus of the full strength required for the cadastral survey and had to be largely added to at Mozufferpore. The traverse survey was begun on 16th October and was closed on 15th April. The cadastral survey could not be taken in hand until the first week in December, and owing to this late date of beginning operations, the work had to be continued into the month of July. Fortunately the rains were late and the season was favourable for the men staying out, otherwise the field season could not have been so long protracted. The party recessed at Mozufferpore.

Personnel.

Lieutenant-Colonel W. Barron, S.C., Deputy Superintendent, 2nd grade, in charge, from 16th November 1885.
Mr. W. A. Wilson, Surveyor, 2nd grade, in temporary charge, from 19th October to 15th November 1885.
„ R. B. Smart, Surveyor, 4th grade, in temporary charge, to 18th October.
„ T. Shaw, Assistant Surveyor, 1st grade, from 18th January 1886.
„ E. P. S. Hill, Assistant Surveyor, 1st grade, from 13th to 28th April 1886.
„ B. R. Hughes, Assistant Surveyor, 2nd grade.
„ A. B. Smart, Assistant Surveyor, 3rd grade.
„ C. G. Lee, Assistant Surveyor, 3rd grade, from 1st March 1886.
23 Sub-surveyors and others.

Temporary Establishment.

132 Field surveyors and others.

195. The cadastral survey was as usual done with great minuteness, every feature being represented which could be shown on the ordinary scale of 16 inches to a mile, which scale had however to be increased for the sake of greater clearness in the case of a few villages near the station of Mozufferpore to that of 24 inches to the mile. The unit of separate measurement and separate area calculation was the "field," defined as, "being the plot separately assessed to rent under existing arrangements and in occupancy of the same *raiyat*." In the village sites, the houses, which are generally scattered with small plots of land attached, have each been treated as a separate "field."

196. The chief papers which have been prepared for the record of rights are the *khasra* or general village register of all the fields, and the *khatian*, or separate register of the fields of each tenant. In both of these the record for each field

* Regarding the services of his establishment, Mr. Barrett reports as follows:—
Mr. O'Donel was in charge of a Cadastral Camp throughout the year, and in addition to his own duties held temporary charge of the party during the three months that Mr. Barrett was on leave. It need only be said of Mr. O'Donel that he has quite upheld his previous reputation in the department. Mr. King, who also supervised a cadastral camp, has given entire satisfaction. Mr. Connor worked very hard throughout the year, and has brought the computations of the traverse work well up to date. Messrs. Kelly and Smith did excellent service during the field and recess seasons. Mr. Kelly was transferred to the Forest Department on 1st July.
The following members of the professional establishment are deserving of mention for steady hard work:—Sub-surveyors Mohan Sing, Tajjuddin, Sakhawat Hossein, and Khurshed Hossein. Computers Saroda Proshad Chuckerbutty, Ganga Ram, and Janardhan Rao, and Golam Hyder Khan, Draftsman. Babu Sitanath Chuckerbutty, cadastral supervisor and head writer, has worked throughout the year with zeal and steadiness; his services are again brought to favorable notice. The following cadastral hands have also done well:—Jhunni Lall, Balbhadria, Haraknarain, and Kedarnath.

includes the names of four *raiyats* of adjoining fields, so as to describe the position of the field irrespective of the map.

197. The soil has been recorded under the headings of "*Dhanhan*" and "*Bhit*" with a distinction between first and second classes of each where such could be ascertained. The crops have been recorded under three harvests, *viz.*, "*Bhadoi*," "*Rabi*" and "*Aghani*;" and where there were mixed crops, the proportions of the different cereals sown have been estimated.

198. A system, unknown in cadastral surveys elsewhere, has been adopted of having the areas of the "fields" computed by the field surveyors (*amins*) and communicated to the *raiyats* on the spot.

199. The area in which the cadastral survey and record of rights have been completed is shown in the following statement:—

Pargana.	Tappa.	No. of villages.	No. of fields.	Area.		Remarks.
				Acres.	Square miles.	
Bisára	Chakla Nai	441	582,200	169,600	265	
...	Bhatsala	215		95,360	149	
	TOTAL	656	582,200	264,960	414	

The above includes the whole of Tappa Chakla Nai, except 3 or 4 square miles within the Mozufferpore Municipality. Of Tappa Bhatsala, about 90 square miles are left unsurveyed. The boundary traverse survey, besides the area cadastrally surveyed, embraced the remaining part of Tappa Bhatsala, part of Tappa Chakla Garjaul of Pargana Bisára, and Pargana Gadehsar. An area of 389 square miles has thus been prepared for a continuance of the cadastral survey.

200. The survey was checked by 1,156 linear miles of test surveys, of which 327 miles were run by the European assistants and head inspectors, and 829 miles by the squad inspectors. The entries in the *khasras* were checked for 178,784 fields, of which the assistants and head inspectors checked 50,055 or 9 per cent. of all the fields, and the inspectors, 128,729 or 22 per cent. of all. For the traverse survey, observations for azimuth were taken at 75 stations and connections were made on five stations of the Great Trigonometrical Survey. By means of the latter seven comparisons were made between triangulation and traverse distances, showing that the chaining had an average error of 1·7 feet per mile.

201. The permanent demarcation of village boundaries has been done partly by the settlement establishment and partly by the surveyors. The former establishment began the work before the arrival of the Survey, and while carrying out the erection of temporary marks at all the bends of the boundaries, undertook to place stones at the tri-junctions. These stones were supplemented by the surveyors who first began by placing other stones of a smaller size at all the boundary theodolite stations; but, afterwards, the plan of marking all the stations with stones was relinquished on account of the expense, and stones were placed only at a certain number of selected stations, inexpensive pottery cylinders being substituted for them at most of the stations. The traverse surveyors overtook the settlement establishment engaged on the temporary demarcation and on fixing the tri-junction stones, and in Chakla Garjaul they surveyed the boundary traverses with the aid of the old Revenue Survey maps without previous demarcation, placing also the tri-junction stones. The village boundaries were first surveyed as pointed out by the village authorities and afterwards compared with the maps of the old Revenue Survey in accordance with which the boundaries had to be mapped. The comparisons showed that, except where there had been river action, the old boundaries had been well preserved.

202. The total expenditure on the survey from the time the party was transferred from Burma up to 30th September 1886, which is the conclusion of the survey year, was ₹1,23,566-5-9. In this, however, as reported by Colonel Barron, are included several items of expenditure that occur on the moving of a survey, from one district to another, also a charge for a new equipment that does not occur every year, and the pay of men non-employed, which may be called

loss of strength, before the survey was fairly started. These items are tabulated by Colonel Barron as follows :—

	₹
Pay prior to 15th October	2,110
Travelling allowances from Calcutta	1,488
Carriage of equipment from Burma	1,308
Cost and carriage of new tents	5,633
Loss of strength at beginning of field season	2,990
Cost of surplus mark-stones	600
Total	14,129

Deducting the above preliminary and extraordinary expenditure, the cost of the work would be reduced to ₹1,09,437-5-9 and the following tables of cost rates on the completed area of 413 square miles—(1) without deducting the extraordinary expenditure, and (2) after deducting this expenditure, are arrived at :

(1) Without deductions—	Per square mile. ₹ a. p.	Per acre. ₹ a. p.	Per field. ₹ a. p.
Stone embedding	14 2 11	0 0 4	0 0 2
Traversing	28 13 3	0 0 9	0 0 4
Detail Survey	97 1 11	0 2 5	0 1 1
Total for Survey	140 2 1	0 3 6	0 1 7
Records (Khanapuri)	59 8 1	0 1 6	0 0 8
Completion of records and statistics, in office	69 8 7	0 1 8	0 0 9
Total for records	129 0 8	0 3 2	0 1 5
GRAND TOTAL	269 2 9	0 6 8	0 3 0
(2) With deductions—			
Stone embedding	12 3 10	0 0 3	0 0 1
Traversing	25 14 7	0 0 8	0 0 3
Detail Survey	88 3 2	0 2 2	0 1 0
Total for Survey	126 5 7	0 3 1	0 1 4
Records (Khanapuri)	53 13 2	0 1 4	0 0 7
Completion of records and statistics, in office	57 8 10	0 1 5	0 0 8
Total for records	111 6 0	0 2 9	0 1 3
GRAND TOTAL	237 11 7	0 5 10	0 2 7

203. Colonel Barron further reports as follows :—

"Several reasons have already been mentioned why the cost rates are high for this season, such as the first season in a district, the necessity of training an establishment, the short out-turn which renders the cost of superintendence greater per square mile than when spread over a larger area, &c. Others may be noted, which would always have a tendency to make the work in Behar cost more than in the North-West Provinces, *viz.*, (1) The village sites: the houses in Behar are not on one compact site, but are scattered about with cultivation between them ; hence instead of being able to treat the village as one number, as is the case in the North-West Provinces, the houses and intermixed cultivation have to be treated as separate fields and each to be recorded under its own number and *patti*. (2) The records: the *khasra* and *khatian* forms are more complicated than those in the North-West. The boundaries of the fields have to be recorded in both documents by giving the names of four *raiyats* on the four sides of the field, and the crops have to be tabulated and calculated for three harvests instead of for two. The *amins* have no *patwaris* to write the *khasras* and *khatians*, and they have besides to take out the areas of the fields on the spot for the satisfaction of the *raiyats*."

"With a well trained establishment, the extra cost of these things would be reduced to a minimum, but there would still remain the extra expenditure on labor which has all to be paid for. The *amins* had to be provided with four chain-and-flag-men instead of one or two, because they could not demand labor from the villagers. During last season, while the cost of the *amins* was ₹13,900, and their *moharrirs* ₹2,665, the cost of their chain-men was ₹16,570."

"During next field season, if work had continued in District Mozufferpore, a considerable reduction in the cost rate would have been effected. A trained establishment would have started at the beginning of the field season, and a full out-turn of 800 square miles

or more of interior survey would have been accomplished, thus reducing, per square mile, the cost of European superintendence by nearly one half, and lessening the square mileage rate under this head by about ₹15 to ₹20; also the charge for *moharrirs* would have ceased, and an endeavour would have been made to obtain some assistance from the villagers, or by paying by the day to secure cheap labor when wanted. The stones for marking stations would have been sparingly used and clay cylinders would have been substituted, thus reducing the cost of marking stations by about ₹10. Altogether it was considered probable that the cost for next season would have been less than 5 annas an acre or below ₹200 a square mile."

204. There are 734 cadastral sheets comprising the season's out-turn, of which simple manuscript tracings have been supplied to the Settlement Officer for immediate use, but the question of the printing of the sheets is still undecided. The sheets have been prepared with titles and adjoining names in the Devanagari character, the only English writing being the name of the village entered alongside of the Devanagari name in the title. General maps (on the 2-inch scale) of the area cadastrally surveyed have been projected, but the drawing still remains to be done.

205. During the field season, Messrs. Walsh and Coxe of the Civil Service were attached to the party to be instructed in surveying and in writing up the records. They each surveyed one village and superintended the writing up of its records.

206. On account of the different procedure in many matters connected with the preparation of the record of rights in Bengal from that in vogue in the North-West Provinces, the nature of the tenures being also different, Colonel Barron found the Hand-Book of Instructions which he had drawn up for the use of cadastral survey parties in the North-West Provinces to be unsuitable for Mozufferpore, and he has drawn up a new edition specially adapted for Mozufferpore, but believed to be suitable for Behar generally. The edition has been prepared both in English and in the vernacular, the latter having been printed in the Persian character.

207. Although it was known in October 1886 that the survey of Mozufferpore would be stopped, yet it was not known whether the survey of an area of about 95 square miles might not be required to complete Parganas Chakla Nai and Bhatsala, or whether the records of the part surveyed would be completed before the party left Mozufferpore. The office establishment therefore worked on during October. In the beginning of November the traversing section of the party was sent to Calcutta to begin the town survey there, but the section employed on the maps and in compiling the records were kept at work at Mozufferpore till 20th November, when final orders were received to close the survey absolutely. Part of the establishment was then paid up and discharged, and the rest transferred to Calcutta and to Sunkerpore, a ward's estate in the Dinagepore District which was opportunely made over for survey.

208. Before the survey was stopped, there had been sent to the Settlement Officer the records of 591 villages containing 474,047 fields with an area of 204,293 acres or 319·21 square miles. Of these, 235 villages have subsequently been published in the *Gazette* to be settled under the Act. They contain 139,929 fields with an area of 58,967·86 acres, or 92·14 square miles, and to these alone will the full benefits of the survey and settlement under the Bengal Tenancy Act apply.

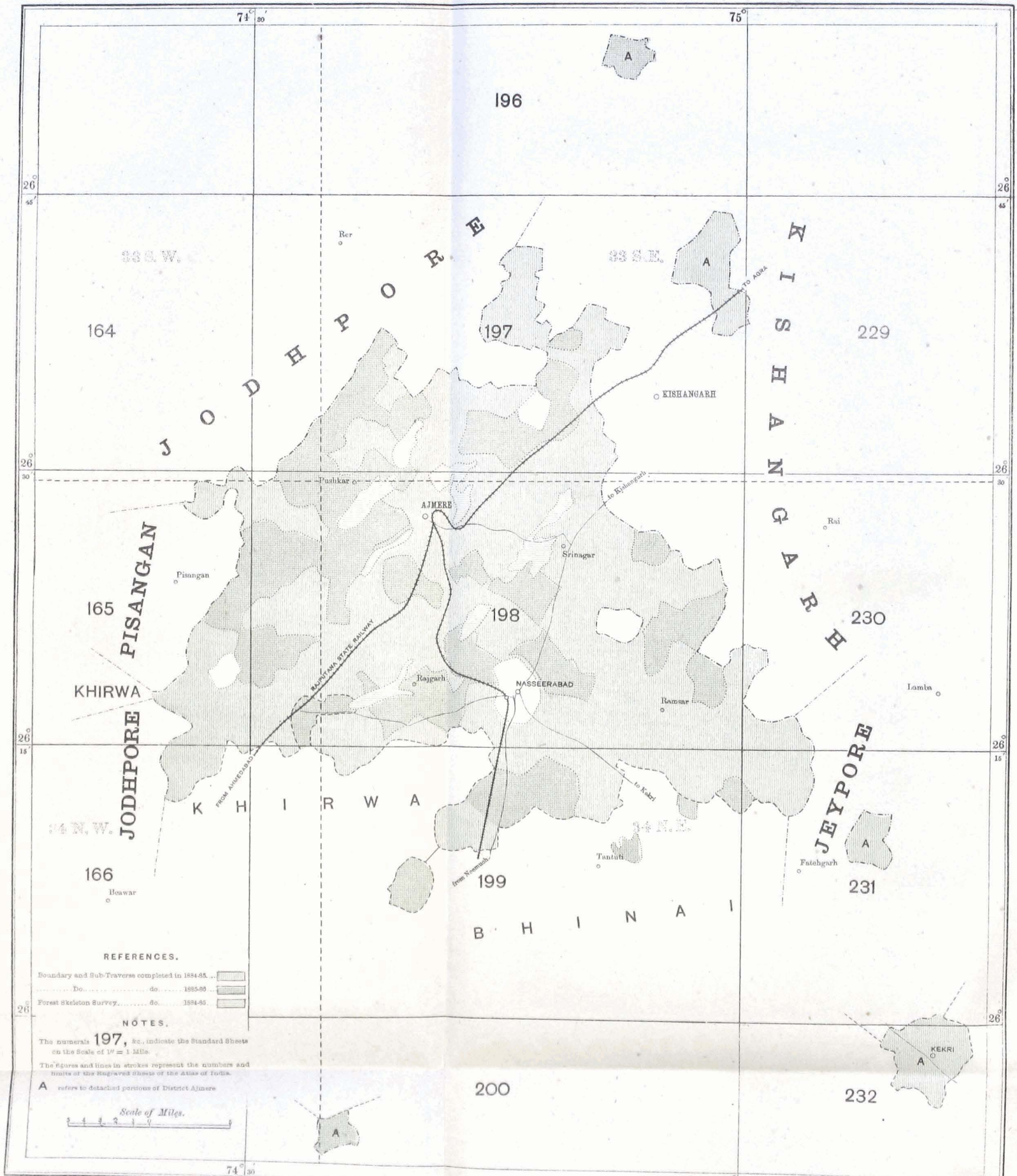
209. The expenses incurred since 30th September 1886 have amounted to ₹7,707-12-3 which amount added to the expenditure of ₹1,23,566-5-9 prior to 30th September, gives the total sum of ₹1,31,274-2-0 as the entire cost of the experimental survey. A great part of this outlay has been incurred on account of maps and records that are now useless, though it may be hoped, only temporarily so. These comprise the cadastral maps and the vernacular village records of the area (95 square miles included in 65 villages) remaining to be given to the Settlement Officer, of which the field area calculations are nearly finished; and the skeleton traverse plots of about 900 villages surveyed in advance for another season's cadastral survey. The incomplete village records have been made over in the state they were in when the work was stopped, to the Settlement Officer at Mozufferpore; and all the original cadastral maps, along with the skeleton preparatory traverse plots, will be deposited in the Surveyor General's Office in Calcutta.

210. The camp office of the party was inspected by the Deputy Surveyor General in charge of the Revenue Branch at Mozufferpore on 15th March 1886.

AJMERE MERWARA.

INDEX TO THE SURVEY OPERATIONS IN DISTRICT AJMERE.

No. 3 REV. PARTY.



REFERENCES.

Boundary and Sub-Traverse completed in 1884-85. ..

..... Do. ..... do. ..... 1885-86. ..

Forest Skeleton Survey. ..... do. ..... 1884-85.

NOTES.

The numerals 197, &c., indicate the Standard Sheets on the Scale of 1″ = 1 Mile.

The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India.

A refers to detached portions of District Ajmere

Scale of Miles.

5 4 3 2 1 0 5

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India.*
Survey of India Offices, Calcutta, October 1886.

Photozincographed at the Survey of India Offices, Calcutta.

The Deputy Surveyor General considers that very great credit is due to Colonel Barron for the amount of work he accomplished with a new establishment and in face of considerable difficulties accompanying the introduction of a cadastral survey with record of rights into a permanently settled district in Bengal. Colonel Barron's good services would, without doubt, have been more conspicuous had he been allowed to carry out the arrangements he had made for undertaking a very much larger area during a second season. The special Hand-Book he has compiled for cadastral survey with preparation of village papers in Behar will, it is believed, be of great value in future cadastral survey operations in that part of the Bengal Province, as well as of much assistance in similar work in Lower Bengal.*

TRAVERSE SURVEYS.

AJMERE DISTRICT, RAJPUTANA.

(DETACHMENT No. 3 PARTY, REVENUE BRANCH.)

211. This detachment, as explained in paragraph 158 of last year's Annual Report, was left in District Ajmere, on the withdrawal of the full party which had been employed on the survey of the *khalsa* villages during the previous season, for the purpose of surveying the boundaries of the *jagir* villages mixed up with the *khalsa* villages but of which the survey had not been sanctioned until receipt, during the recess season, of Government of India, Revenue and Agricultural Department, letter No. 241S., dated 11th June 1885. Besides the *jagir* villages, the Government of India, Foreign Department, telegram No. 994-I., dated 25th March 1886, sanctioned, on the recommendation of the Chief Commissioner of Ajmere-Merwara, the survey of six minor *istimrar* (permanently settled) villages.

Personnel.

Mr. A. J. Gibson, Surveyor, 2nd grade, in charge, from 1st November 1885.
Mr. F. B. Powell, Assistant Surveyor, 3rd grade, from 23rd September 1886.
10 Sub-surveyors and others.

212. The detachment was placed under the charge of Mr. A. J. Gibson, Surveyor, 2nd grade, and it arrived in Ajmere from Mussooree (the recess quarters of the party from which it was drawn) on 1st November 1885. Lieutenant-Colonel E. H. Steel, Deputy Superintendent, who had charge of the Ajmere-Merwara survey during the previous season, though transferred to another province, was directed to exercise a general supervision over the detachment.

213. The work has consisted, as hitherto, of the construction of a village traverse basis suitable for being used for a survey of the fields by *patwaris*, added to which there has also been a survey of the actual boundaries of the villages, and skeleton maps showing both traverse stations and boundaries have been projected and drawn. Two copies of each skeleton map are prepared; one copy is for the use of the *patwari* working under the Settlement Officer, and the second copy is intended to serve for a standard from which other copies may be taken either by photo-zincography or otherwise whenever a revision of the *patwari's* first survey is required. The skeleton maps, as first drawn, are, however, not considered final, as it is found that differences in the boundaries are obtained during the more complete survey of fields by the *patwaris*, and the standard copies of the maps are amended when necessary on receipt from the Settlement Officer of a corrected tracing of the discrepant parts of the boundaries. The final computations of village areas must also be deferred until the sketches of the discrepancies have been received.

214. The detachment has surveyed, during the past season, 51 *jagir* villages and 6 *istimrar* villages, comprising an aggregate area of 243 square miles. The old traverse stations of the *khalsa* villages have been available for a large part of the traversing. They have been supplemented by 2,019 new stations which as usual have been marked with special stones, 16″×6″×4″, having a distinguishing mark cut on them. The boundary pillars were usually substantial slabs of stone, embedded firmly in the ground, but occasionally piles of

* Colonel Barron reports that the European staff of the party have all worked well, mentioning the names of the seniors, Messrs Wilson, R. B. Smart and Shaw, and the juniors Messrs. Hughes, A. B. Smart and Lee, in connection with the shares they respectively took in the different operations.

Favourable mention is made of the following members of the native establishments, *viz.*, of the permanent establishment, Shaikh Abdullah, Pyari Ram, Manohar Lall, Gunga Bisuen, Shamsudin, Salik Ram, and Gajadhar. Of the temporary establishment, Ishar Chandar, Jankee Parshad, Amir Khan, Kanay Raie, Jowala Parshad, Chetram, Raghubir Saran, Abdul Majid, and Bhikhan Khan.

loose stones had been erected instead, which gave much trouble owing to their having been frequently moved during the survey. Many of the boundaries lay in very rugged country, where it was extremely difficult to obtain good chain measurements. One forest reserve has been surveyed on the 4-inch scale at the request of the Forest Department, and the map of the same along with 20 other Forest maps surveyed during the previous season, have been sent to the local Forest Officer. The 57 villages comprising the season's out-turn have been mapped on 266 sheets, copies of which were duly furnished to the Settlement Officer, but as yet the sketches of discrepancies of the boundaries due from that officer have only been received for two villages, so most of the standard sheets are not finally disposed of and their areas are not computed.

215. The standard sheets of the *khalsa* villages of Ajmere surveyed during the previous season have been amended according to the *patwaris'* surveys of the boundaries, and the final areas have been furnished to the Settlement Officer.

216. The amendment of the boundaries on the sheets of Merwara surveyed during the previous season, according to the corrected tracings sent by the Settlement Officer, has been carried out in the office of the Rajputana Party which was engaged on topographical work in that part of the Ajmere-Merwara District; but the boundary amendments only have been done, and the final computations of area still remain. Since the breaking up of the Ajmere detachment, these computations have been carried on in the Surveyor General's Office by computers brought down from one of the field parties for the purpose.

217. A recommendation was made by the Chief Commissioner, Ajmere-Merwara, in letter No. 589-562-II, dated 5th June 1886, to the Secretary to the Government of India, Foreign Department, for the extension of the village boundary survey to the *istimrar* (permanently settled) villages in Parganas Bhinae, Masuda, Kekri, Khirwa and Pisangan of District Ajmere, which cover an area of about 1,240 square miles or more than half the district. The Government of India were prepared to sanction this survey on the understanding that the cost would be defrayed by the *Istimrardars*, (Government of India, Foreign Department, letter No. 3084-I, dated 30th August 1886); but on the *Istimrardars* declaring to the Chief Commissioner their inability to meet the necessary expenses, the project was given up.

218. The recess office of the detachment was inspected at Mussooree during September 1886, by the Deputy Surveyor General in charge of the Revenue Branch, who was satisfied with the pains being taken by Mr. Gibson to ensure accuracy in the records.*

JUBBULPORE AND DAMOH DISTRICTS, CENTRAL PROVINCES.

(No. 9 Party, Revenue Branch.)

219. This party, which has been formed on the remnant of the Malwa Topographical Party as a nucleus, has been raised in accordance with the instructions conveyed in letter No. $\frac{396}{36-10}$S., dated 2nd September 1885, from the Secretary to the Government of India, Revenue and Agricultural Department, to the Surveyor General of India, to carry out a village boundary traverse survey in the districts of Jubbulpore and Damoh to constitute a basis for a survey of the fields to be done by the *patwaris* of the respective districts. The members of the party, many of whom were newly entertained, while some were transfers from other parties, began to assemble at Jubbulpore on 1st November 1885, and were there distributed into two sections, both of which under the two senior Surveyors commenced operations in the two districts simultaneously on 20th November. Field work was continued until the end of

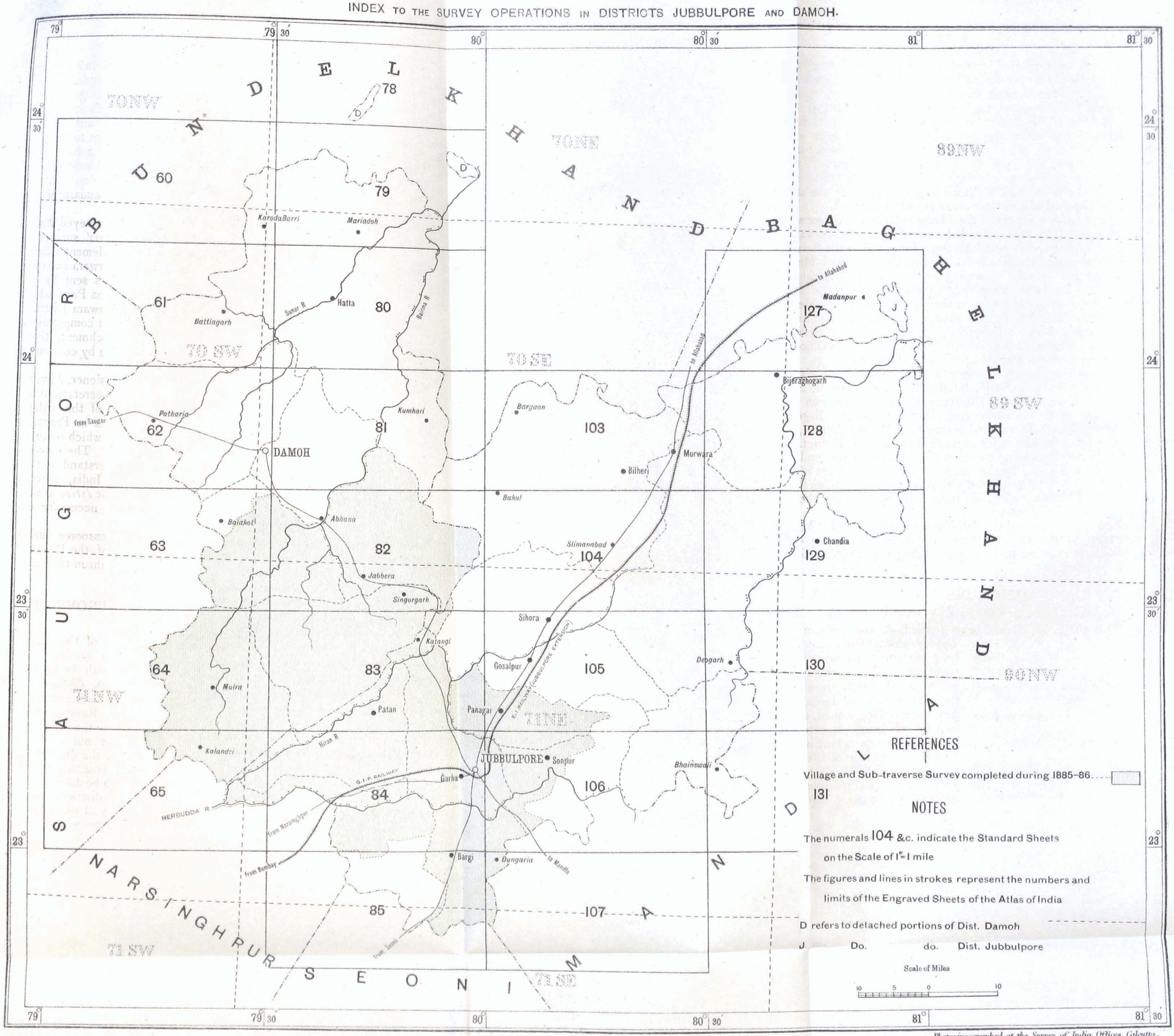
Personnel.

Mr. W. H. Patterson, Officiating Deputy Superintendent, 4th grade, in charge, up to 26th October 1885.
„ G. H. Cooke, Officiating Deputy Superintendent, 3rd grade, in charge, from 27th October 1885.
„ J. A. May, Surveyor, 1st grade, up to 5th November 1885.
„ J. Todd, Surveyor, 2nd grade.
„ H. Dowman, Surveyor, 3rd grade, from 1st November 1885.
„ J. T. U. Coxen, Surveyor, 4th grade, from 1st November 1885.
„ R. R. Dickenson, Assistant Surveyor, 1st grade, up to 30th April 1886.
„ G. Vanderbeck, Assistant Surveyor, 1st grade, up to 31st October 1885.
„ E. P. S. Hill, Assistant Surveyor, 1st grade, from 20th April 1886.
„ C. George, Assistant Surveyor, 2nd grade, up to 31st October 1885.
„ J. A. Higgs, Assistant Surveyor, 2nd grade, up to 30th June 1886.
„ A. Ewing, Assistant Surveyor, 2nd grade, from 1st November 1885.
35 Sub-surveyors and others.

* Mr. Gibson reports most favourably on the services of Sub-surveyor Abdul Karim.

CENTRAL PROVINCES SURVEY.

INDEX TO THE SURVEY OPERATIONS IN DISTRICTS JUBBULPORE AND DAMOH.



REFERENCES

Village and Sub-traverse Survey completed during 1885–86.

NOTES

The numerals 104 &c. indicate the Standard Sheets on the Scale of 1"= 1 mile

The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India

D refers to detached portions of Dist. Damoh

J Do. do. Dist. Jubbulpore

Scale of Miles

10 5 0 10

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Photozincographed at the Survey of India Offices, Calcutta.

May, when the office establishments of both sections proceeded to Mussooree for recess.

220. The requirements of the Chief Commissioner with regard to the traversing are laid down in letter No. 226S., dated 8th April, from the Officiating Junior Secretary, addressed to the Secretary, Government of India, Revenue and Agricultural Department, in which letter the Central Provinces experiment of a survey of blocks of fields is finally condemned, and two matters of essential importance to secure an accurate field survey by *patwaris* are mentioned, *viz.*, (1) The traverse lines must follow village boundaries closely. *(This was afterwards explained to mean that the lines should be sufficiently near the boundary marks to enable the patwaris to plot them by offsets without difficulty).* (2) The traverse stations must not be more than 30 chains apart. These two points have been strictly attended to, and while the specified distance of 30 chains has never been exceeded, the average length of the traverse lines is 15 chains. The distance of 30 chains has also been adopted as the interval at which the sub-traverse lines have been placed in large villages to cut them up into polygons of suitable size to constitute a frame-work for the survey of the fields. Another stipulation made by the Administration of the Central Provinces was for all the traverse stations to be marked in a substantial manner. This has been attended to in the first place by adopting the existing masonry marks at village tri-junctions as traverse stations, and, secondly, by placing at all other stations a roughly-cut stone prism, 2 feet long by 6 inches in thickness. Sometimes the bends of the village boundaries were found to be marked with slabs of stone, instead of with mounds of earth, and where these slabs existed, the use of the special stones was saved; but boundary demarcation of this kind is not common either in the Jubbulpore or Damoh District, and stone marks had almost universally to be adopted and put down by the surveyors. The number of stones put down in both districts was 32,097 at a total cost of ₹5,571, the average number of stones to the square mile on the area surveyed being 14½ and the average cost ₹2-8 per square mile. The cost does not include any share of the pay of the men engaged on the survey who put down the marks as part of their survey duties.

221. The following statement shows the work which has been done in the two districts separately:—

District.	No. of villages.	No. of sub-traverses.	Area, Square miles.	Remarks.
Jubbulpore . . .	864	1,162	965	
Damoh	519	653	1,250	
TOTAL .	1,383	1,815	2,215	

The total cost of the operations up to 30th September was ₹76,012 which gives a cost rate per square mile of ₹34-5-1. Excluding ₹5,571, the cost of the stone marks, and an unusually heavy expenditure—₹2,564—for line-clearing due to the jungle-clad country, the rate per square mile is reduced to ₹30-10-4.

222. The number of skeleton sheets on the 16-inch scale, on which the village traverses will be plotted for the *patwari* survey, is estimated to be over 4,000, but the plotting is somewhat delayed owing to the difficulties that have been met with in bringing up the computations of the very intricate traverses in the hilly and raviny tracts. Copies of the traverse data of the villages and area statements of the village polygons are being prepared for record in the office of the Commissioner of Settlements and Agriculture.

223. In the programme for traverse surveys in the Central Provinces, as detailed in letter No. 560S., dated 10th August 1885, from the Officiating Junior Secretary to the Chief Commissioner, to the address of the Secretary to the Government of India, Revenue and Agricultural Department, the areas for survey in Jubbulpore and Damoh are set down at 3,550 and 1,938 square miles respectively. These areas are found to be exclusive of the areas of the forests which, it had been expected, need not have been calculated with the areas for

survey, but the forests are so much intermingled with the village lands that they have to be traversed in the same way as villages, except that they have not to be cut up by sub-traverses; and thus adding the forest areas, the real areas for survey are:—Jubbulpore, 3,948 square miles; Damoh, 2,831 square miles. Deducting what has been done, the areas remaining are:—Jubbulpore, 2,983 square miles; Damoh 1,581 square miles.

224. The office of the Jubbulpore section of the party was inspected by the Deputy Surveyor General in charge of the Revenue Branch in camp at Jubbulpore during March; and again, the recess office of the whole party was inspected by the same officer at Mussooree during September. The Deputy Surveyor General found that very great pains were being taken to ensure accuracy in all parts of the work, and he considers that the progress made towards the completion of the computations of the traverses of a difficult country with a new establishment was satisfactory.*

PUNJAB PROVINCE.

(No. 1 Party, Revenue Branch.)

225. This party, under Lieutenant-Colonel F. Coddington, having closed its recess office at Simla on 16th October 1885 and collected its field establishments at Ludhiána by 24th October, moved in two sections into Districts Ludhiána and Umballa for a continuance of the operations of the previous season. The operations were subsequently extended into Districts Jullundur, Hoshiárpur, and Gurdáspur and into the Kapurthala State. Field operations were continued by one section up to 10th May 1886, and by the other until 18th May, when the establishments being again reduced, the party returned to Simla.

Personnel.

Lieutenant-Colonel F. Coddington, S.C., Deputy Superintendent, 2nd grade, in charge.
Mr. H. E. T. Keelan, Surveyor, 1st grade, from 22nd October 1885 to 24th April 1886.
Mr. J. S. Pemberton, Surveyor, 2nd grade, from 21st October 1885.
Mr. C. W. Wilson, Asst. Surveyor, 1st grade,
„ G. Campbell „ 1st „
„ J. P. Barker „ 2nd „
„ F. P. Walsh „ 3rd „
from 4th March 1886.
30 Sub-surveyors, &c.

226. The work on which the party is engaged, and which is fully described in paragraphs 239, 240, and 247 of the Report for 1884-85, may be briefly described under the following heads, *viz.*:—

(1) The skeleton traversing of villages for the purpose of determining the co-ordinate distances of tri-junction points; and the projection of maps of the tri-junctions on the scale of 2 inches to the mile.

(2) The insertion of topographical details on these maps by reduction from the settlement survey village maps.

(3) The testing and correcting (when necessary) the reduced maps by examination in the field.

(4) The drawing of fair maps on the 2-inch scale.

227. The areas accomplished under these separate heads in the several districts are as shown below:—

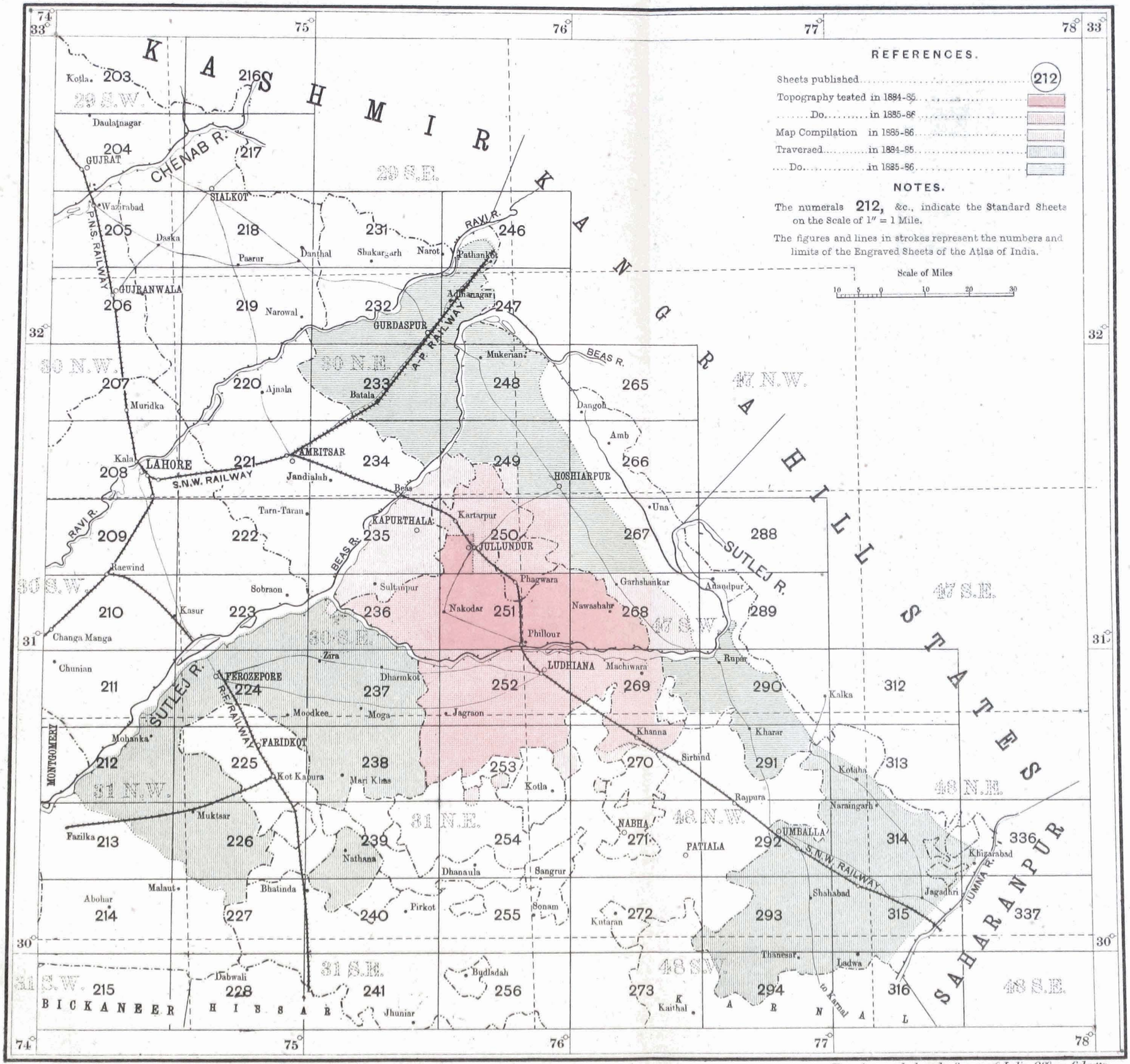
District.	(1) Area traversed.	(2) Area mapped by reduction.	(3) Area tested.	(4) Area finally mapped.
	Square miles.	Square miles.	Square miles.	Square miles.
Gurdáspur	1,070	...	...	...
Hoshiárpur	1,380	758	314	301
Jullundur	20		690	781
Kapurthala (State)	500	748	588	358
Ludhiána	70		1,328	1,184
Umballa	730	416	...	...
TOTAL	3,770	1,922	2,920	2,624

* Mr. Cooke in his Report mentions the names of all his European assistants favourably, giving particulars of the share each had taken in the work of the season. He commends the following members of the native establishment, *viz.*:—Taraprosonnoo Roy, Kally Prosonnoo Nag, Upendra Nath Mukerji, Monohar Daji, Bani Madho, Irfan Ali, Mahadeo Daji, Mahmud Bux, Rur Singh, Gopal Setaram, and Kesho Vaijnath.

PUNJAB SURVEY.

INDEX TO THE SURVEY OPERATIONS IN THE PUNJAB.

No. 1 REV. PARTY.



Photozincographed at the Survey of India Offices, Calcutta.

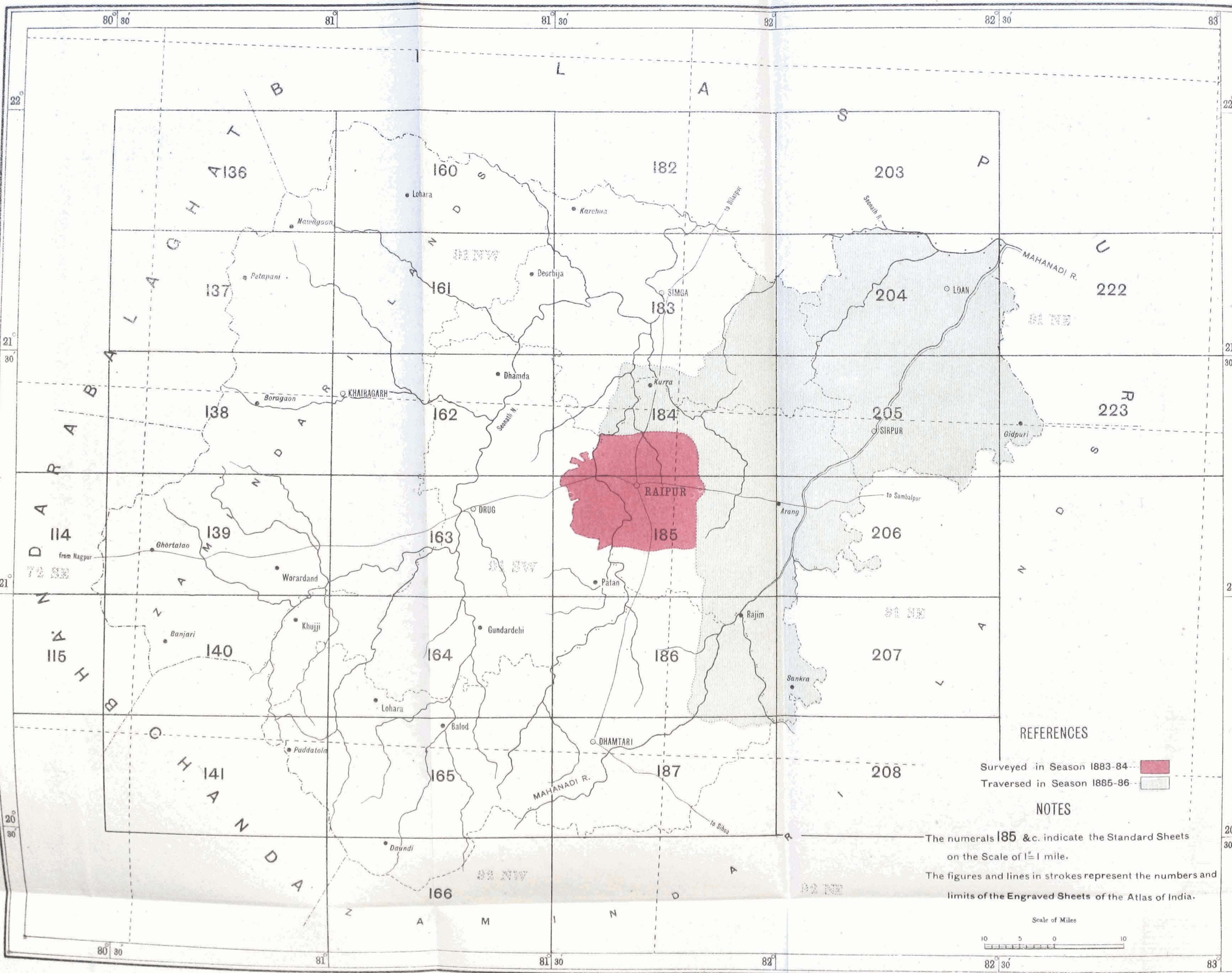
Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*

Survey of India Offices, Calcutta, September 1886

CENTRAL PROVINCES SURVEY.

INDEX TO THE SURVEY OPERATIONS IN DISTRICT RAIPUR.

No. 3 REV. PARTY



BILASPUR
BALAGHAT
BHANDARA
CHANDA
ZAMINDARI
ZAMINDARIS
SAMBALPUR
ZAMINDARIS
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RAIPUR
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SIMGA
Kurra
Arang
Rajim
Patan
Lohara
Karchua
Nawagaon
Petapani
Deorbija
Dhamda
KHAIRAGARH
Boragaon
Ghortalao
Worardand
Khujji
Banjari
Gundardehi
Balod
Paddatola
Daundi
Sankra
LOAN
SIRPUR
Gidpuri
MAHANADI R.
Seonath R.
to Bilaspur
to Sambalpur
to Sihoa
from Nagpur
REFERENCES
Surveyed in Season 1883-84
Traversed in Season 1885-86
NOTES
The numerals 185 &c. indicate the Standard Sheets on the Scale of 1" = 1 mile.
The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India.
Scale of Miles
10 5 0 10

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Photozincographed at the Survey of India Offices, Calcutta.

228. The operations under heads (1), (2), and (3) have been completed in Districts Jullundur and Ludhiána and in the Kapurthala State; and under head (1) only in districts Hoshiárpur and Umballa. About two-thirds of the Gurdáspur District has been completed as regards head (1). The hilly portions of these districts have not been included in this survey.

229. The reductions from the settlement survey maps when tested were found to be very correct representations of the ordinary topographical features, and only a few omissions had to be supplied by new surveys. Usually these were bridges, temples and mile-stones; and the limits of the village sites and the high banks of rivers had sometimes to be revised.

230. Sheets 250 and 252 have been completely mapped and are ready for publication. At present the publication will be on the reduced scale of 1 inch to the mile, but the four 2-inch sections on which the original drawing has been done, are suitable for publication separately on the original scale if ever required. Sheet 253 is drawn on the 2-inch scale as far as it includes portions of revenue-paying districts. A separate drawing of the portion of this sheet, which includes parts of Sikh States, will be prepared on the 1-inch scale, from the old surveys of these States, and the separate drawings having been combined, the entire sheet will be printed showing all the available topography. Sheet 268 is drawn, as far as materials are available, from the settlement survey village maps, but the hill portion of the Hoshiarpur District falling within the sheet, remains for survey by the Himalaya Party.

231. Mr. G. Campbell, Assistant Surveyor, was deputed between 19th November 1885 and 25th January 1886, to assist a civil officer in re-fixing old pillars on a disputed portion of boundary between the Sialkot District and Kashmir territory.

232. The recess office of the party was inspected during September by the Officiating Surveyor General, who was entirely satisfied with Colonel Coddington's management of the party and with the systematic arrangements for carrying out the large amount of work that now devolves on his office, as, in addition to the ordinary work connected with the survey and with the fair mapping thereof, various records are prepared for the Settlement Department, which has added considerably to the recess duties. The records and maps were found to have been well prepared, and the general efficiency of the party was well demonstrated.*

RAIPUR DISTRICT, CENTRAL PROVINCES.

(No. 3 PARTY, REVENUE BRANCH.)

233. This party, which had been employed during the previous season on a traverse and village boundary survey in Districts Ajmere and Merwara, was transferred, under orders from the Government of India conveyed in Revenue and Agricultural Department letter No. $\frac{396}{36-10}$, dated 2nd September 1885, to the Central Provinces to carry on a skeleton traverse survey in the Raipur District in aid of a field survey, which would be executed by the district *patwaris*. A small detachment of the party was left in Ajmere for the boundary survey of *jagir* villages, as referred to in paragraph 158 of last Report. The party on its removal to Raipur was placed under charge of Lieutenant-Colonel W. H. Wilkins, Major (now Lieutenant-Colonel) E. H. Steel having been transferred to No. 2 Party for the cadastral survey of the Bilás-pur District.

Personnel.

Lieut.-Col. W. H. Wilkins, S.C., Officiating Deputy Superintendent, 2nd grade, from 4th November 1885.
Major E. H. Steel, S.C., Officiating Deputy Superintendent, 3rd grade, up to 3rd November 1885.
Mr. A. D'Souza, Officiating Assistant Superintendent, 1st grade, up to 31st March 1886.
Mr. A. J. Gibson, Surveyor, 2nd grade, up to 31st October 1885.
„ W. S. Buttress, Surveyor, 2nd grade.
„ A. Christie, Surveyor, 3rd grade, from 1st January 1886.
„ J. R. Scott, Assistant Surveyor, 1st grade, from 1st November to 31st December 1885.
„ C. W. F. Seyers, Assistant Surveyor, 1st grade, up to 31st October 1885.
„ G. Vanderbeck, Assistant Surveyor, 1st grade, from 1st November 1885.
„ E. F. Berkeley, Assistant Surveyor, 2nd grade, from 1st November 1885.
„ T. W. Babonau, Junior, Assistant Surveyor, 3rd grade.
28 Sub-surveyors and others.

234. The field establishment assembled

* Colonel Coddington reports satisfactorily on the services of Messrs. Keelan, Pemberton, Campbell, Barker, and Walsh; and names the following members of the native establishment as the most worthy of mention, *viz.*, Elahi Bux (1st), Eed Mahomed, Serajudin, Awaz Ali, Ramjas, Elahi Bux (2nd), Maula Bux, and Daswandhi Ram.

at Raipur on 15th November, and field operations were continued up to 15th May, when the office establishment proceeded to Mussooree for recess work. Regarding the retention of the party in the field during May, which was done under an endeavour to complete a proposed area, the Deputy Superintendent reports that very little work was done on account of the intense heat and the many cases of sickness, and he considers there is no adequate return for the expense of keeping up field establishments for a day after 30th April at the latest.

235. The Central Provinces system of "field block" survey having been found unsatisfactory and finally abandoned, as mentioned in paragraph 263 of last Report, the character of the work required of this party and of other traverse parties in the Central Provinces has been that of a simple skeleton traverse, not taking up village boundaries, similar to what is carried on in cadastral survey parties preparatory to the survey of the fields by professional *amins*, except that in the Central Provinces, the Chief Commissioner has stipulated on the following modifications of the ordinary skeletons, *viz.*, that the traverse lines should follow the village boundaries somewhat more closely, and that the interior lines in large villages should be at slightly reduced intervals, so that the work may be rendered easier for the village *patwaris*, who will take the place of experienced *amins*. It has also been stipulated that every theodolite traverse station, whether on the boundary or in the interior of villages, should be permanently marked with a substantial stone.

236. The traverse survey has been extended to the north-east, east, and south-east of the central part of the Raipur District, for which the "field block" survey had been completed, as reported in paragraphs 142 to 154 of the Report for 1883-84, and has covered a total area of 2,169 square miles. The total area is comprised in 13 main circuits which were surveyed by the European officers. These officers also took observations at 135 stations for azimuth; and, when otherwise unemployed, they moved about among the villages examining the mark-stones put down by Sub-surveyors at theodolite stations and giving injunctions to the headmen of villages concerning the protection of these stones.

237. During the field season, 317 skeleton plots on the 16-inch scale were supplied to the Settlement Officer for the field survey by *patwaris*, and 403 more were sent during the recess. The remaining plots will be supplied during the next field season. Copies of the village traverse data are being prepared to be lodged in the office of the Settlement Commissioner to enable fresh plots to be issued from his office whenever new surveys are required. Statements of the areas of village traverse polygons are also being prepared for the Settlement Commissioner's office.

238. The recess office of the party was inspected at Mussooree during September by the Deputy Surveyor General in charge of the Revenue Branch, who reports most favorably of the state of the records and of the organization of the party as brought about by Colonel Wilkins' able management.*

SAMBALPUR DISTRICT, CENTRAL PROVINCES.

(DETACHMENT FROM NO. 3 PARTY, REVENUE BRANCH.)

239. This detachment left its recess quarters at Nagpur under charge of Mr. P. A. G. Cowley, Surveyor, 1st grade, on 7th November 1885, and arrived in the Sambalpur District to resume operations there on 22nd idem. Mr. Cowley remained in charge until 23rd March 1886, when, under urgent medical advice, he was obliged to leave the district on account of severe illness, making over charge temporarily to Mr. C. S. Kraal, Assistant Surveyor, 1st grade, who was relieved by Mr. A. D'Souza, Assistant Superintendent, on 10th April.

Personnel.

Mr. A. D'Souza, Officiating Deputy Superintendent, 4th grade, in charge, from 11th April 1886.
" P. A. G. Cowley, Surveyor, 1st grade, in charge, up to 22nd March 1886.
" C. W. F. Seyers, Assistant Surveyor, 1st grade, from 1st November 1885.
" C. S. Kraal,* Assistant Surveyor, 2nd grade.
" E. F. Berkeley, Assistant Surveyor, 2nd grade, up to 31st October 1885.
18 Sub-surveyors and others.

* Was in temporary charge from 23rd March to 10th April 1886.

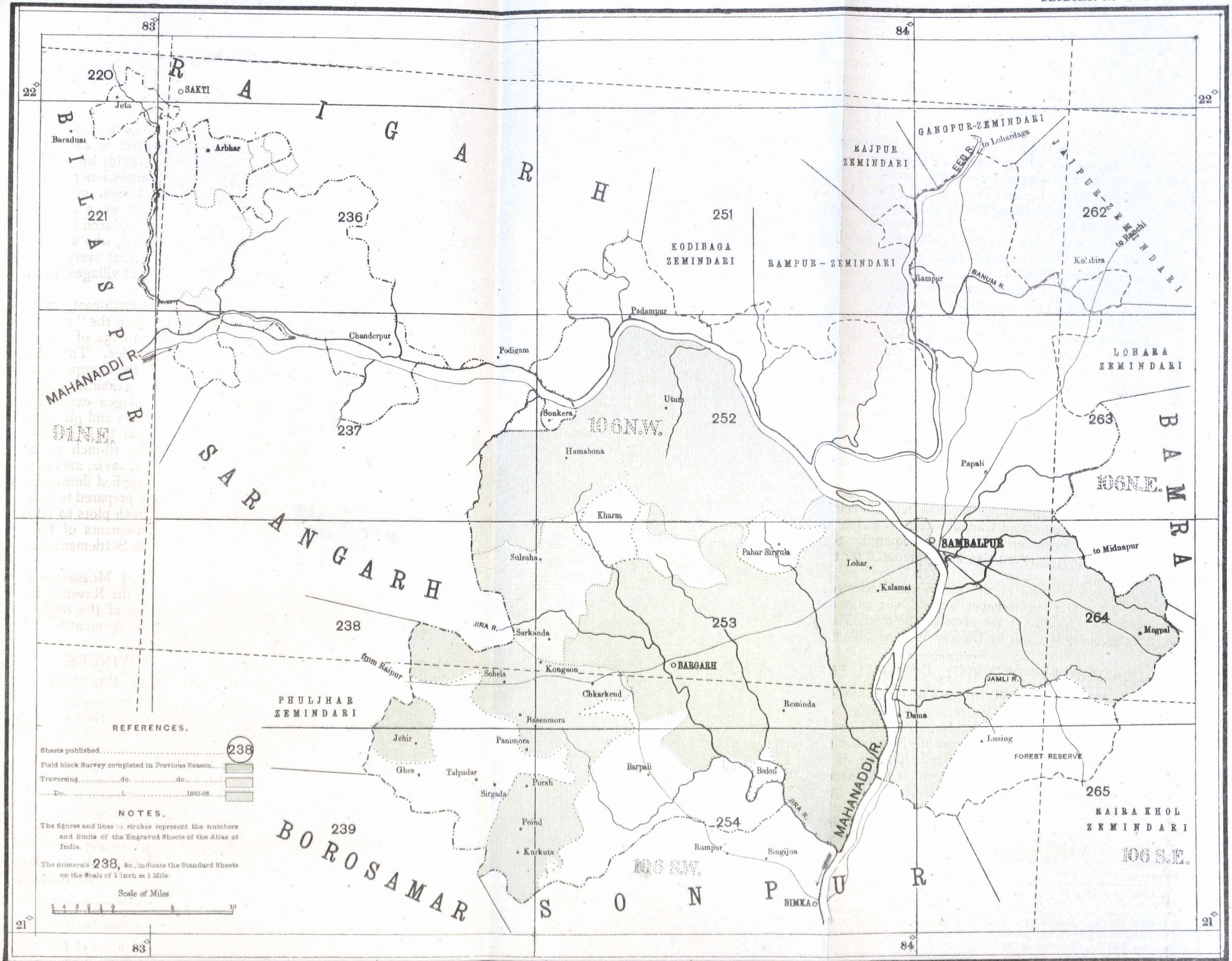
* Colonel Wilkins, mentioning the names of his senior assistants, Messrs. Buttress and Christie, states that they have given him great satisfaction; and regarding the juniors, Messrs. Vanderbeck, Berkeley and Babonau, that they have also worked satisfactorily.

Of the native establishment, Colonel Wilkins mentions favorably the names of English Writer, Bhagobutty Churn Chuckerbutty, Head Computer Kedar Nath, Draftsman Surfraz Khan, Sub-surveyors Mahomed Zakaria and Alladad Khan, and of Hospital Assistant Golam Mahomed Khan.

CENTRAL PROVINCES SURVEY.

INDEX TO THE CADASTRAL SURVEY OF DISTRICT SAMBALPUR.

DETACHT. No. 3 REV. PARTY.


RAIGARH
BILASPUR
SARANGARH
BOROSAMAR
SONPUR
BAMRA
GANGPUR-ZEMINDARI
RAJPUR ZEMINDARI
JAIPUR-ZEMINDARI
KODIBAGA ZEMINDARI
RAMPUR-ZEMINDARI
LOHARA ZEMINDARI
PHULJHAR ZEMINDARI
RAIRA KHOL ZEMINDARI
FOREST RESERVE
MAHANADDI R.
JIRA R.
BANUM R.
JAMLI R.
EEB R.
to Lohardaga
to Ranchi
to Midnapur
from Raipur
SAKTI
Jeta
Baradual
Arbhar
Chanderpur
Podigam
Padampur
Sonkera
Utum
Hamabona
Kharsa
Sulsuha
Pahar Sirgula
Lohar
Kalamat
SAMBALPUR
Papali
Rampur
Kolabira
Megpal
Sarkanda
Sohela
Kongaon
BARGARH
Chkarkend
Basenmora
Reminda
Dama
Lusing
Panimora
Jehir
Ghes
Talpadar
Sirgada
Porah
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Bodoli
Poind
Kurkuta
Rampur
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BIMKA
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262
263
264
265
91 N.E.
106 N.W.
106 N.E.
106 S.W.
106 S.E.
83
84
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21
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Sheets published 238
Field block Survey completed in Previous Season........
Traversing .... do .... do ....
Do. .... 1885-86 ....
NOTES.
The figures and lines in strokes represent the numbers and limits of the Engraved Sheets of the Atlas of India.
The numerals 238, &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.
Scale of Miles
5 4 3 2 1 0 5 10

Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*

Survey of India Offices, Calcutta, December

1886.

240. A very important change has been introduced in the work required of this party owing to the abandonment by the Central Provinces Administration of the experimental system of "field block" survey, as reported in letter No. 226S., dated 8th April 1885, from the Junior Secretary to the Chief Commissioner, to the Secretary to the Government of India, Revenue and Agricultural Department. In place of the "field block" survey a simple traverse survey has been substituted for the purpose of furnishing skeleton maps, on which the *patwaris* will now plot all the necessary field measurements, instead of, as formerly, fitting their measurements of single fields within the field blocks.

241. Under the new system, the theodolite stations corresponding with the points on the skeleton maps, are required to be marked in a permanent manner, which has been accomplished most inexpensively by utilizing stones which had been laid down to mark bends of the village boundaries, while special stones had only to be fixed at the sub-traverse stations in the interior of large villages. These survey stations were all counted and delivered to the charge of the headmen of villages, from whom receipts were obtained, so as to fix the responsibility for the proper preservation of the marks.

242. The season's out-turn comprises 436 villages of Tahsils Bargarh and Sambalpur and covers an area of 885 square miles. Besides the village boundary traverses, there are, in all, 601 sub-traverses in large villages; and the number of skeleton sheets is 735. The sheets of 124 villages, covering an area of 190 square miles, were furnished to the Settlement Officer during the field season, and the remainder at the end of the recess. Observations for azimuth were taken at 55 traverse stations. Connections were made on 9 G.T.S. stations, enabling 8 comparisons to be made between triangulation and traverse distances which show the latter to have an average error of 1·45 feet per mile.

243. The Assistant Superintendent now in charge of the detachment reports as follows on the unhealthiness of the district:—

"Although the precaution had been taken not to enter the district too early, owing to the malarious character of the country, yet the party suffered very much from sickness. Mr. Cowley was so prostrated by repeated attacks of fever and dysentery that he was obliged to apply for leave on medical certificate for 15 months, and he left the district in a very critical state. Both the European assistants suffered also very much. The average number of the sick among the native establishment throughout the field season was 30. With the exception of two men, the whole of the Sub-surveyors suffered more or less from fever, and out of the office hands only one man kept good health."

244. The total area traversed in the Sambalpur District during two seasons is 1,502 square miles, and about 937 square miles remain to complete what is required in the district.

245. Mr. D'Souza has furnished a short descriptive account of the Sambalpur District, which is printed in the appendix, page xviii. Regarding the country surveyed he writes as follows:—

"The ground under survey during the year, with the exception of a portion of Bargarh and that in the vicinity of the town of Sambalpur and along the banks of the Mahánadi River, is by no means favorable for survey operations. It embraces the forest reserves and hilly tracts which are so densely covered with forest and bamboos that it was with the greatest difficulty the surveyors cut their lines through them."*

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* Mr. D'Souza reports on the services of his assistants as follows:—

"Both Messrs. Seyers and Kraal have worked well, and I have to make special mention of Mr. Kraal (selected for the temporary charge of the party on Mr. Cowley's departure), who has fully borne out the excellent character given him by my predecessor as an intelligent and hard-working assistant."

The following members of the native establishment are named as specially deserving of mention, *viz.*, Boith Ram, Koylash Chandar, Habibulla, Changa Khan, Niladhur, Ram Dass, Ramcharan, Abdul Khalik, Mahamed Hosein, Abdul Karim, Giyadin, Sadik Hosein, and Hospital Assistant Ram Sahai, who is said to have been most attentive to the sick.

GEOGRAPHICAL AND MISCELLANEOUS.

HIMALAYA PARTY.

246. As stated at page 53 of the Annual Report for 1884-85, the *locale* of the future operations of this party being no longer confined to the vicinity of Darjeeling, its designation was altered to that above given. The several works taken up are as follows:—

Personnel.

Colonel H. C. B. Tanner, S.C., Deputy Superintendent, 2nd grade, in charge, except between 21st April and 19th August, while on duty with the Tibet Mission.
Captain R. A. Wahab, R.E., Deputy Superintendent, 4th grade, from 14th April 1886, and held charge in Colonel Tanner's absence.
Lieutenant W. H. Pollen, R.E., Deputy Superintendent, 4th grade, up to 18th March 1886.
Lieutenant J. M. Fleming, S.C., Probationary Assistant Superintendent, 2nd grade, from 21st September 1886.
Mr. H. E. T. Keelan, Surveyor, 1st grade, from 1st April 1886.
„ W. Robert, Assistant Surveyor, 1st grade.
„ E. P. S. Hill, Assistant Surveyor, 1st grade, up to 12th April 1886.
„ F. E. Warde, Assistant Surveyor, 3rd grade, from 4th September 1886.
„ G. H. Powell, Assistant Surveyor, 3rd grade.

Sub-surveyors.

Shaikh Omar, from 26th December 1885.
Atma Sing, on duty with Tibet Mission, from 21st April to 19th August.
Ram Saran, Sahai Din, and five others.

(1) The demarcation of the Nepal-Bengal boundary on the Mechi River, and on the right bank of the Bágmati in the Mozufferpore District.

(2) The bringing up of the arrears of mapping and computations connected with the Nepal Boundary Survey, the Sikhim triangulation and the Darjeeling Revisionary and Daling Lands Surveys.

(3) A topographical survey (scale depending on the character of the ground to be surveyed) of the Hill States about Simla and of the Kángra District, and *pari passú* the accurate fixing of all tri-junction and *tikka** boundary marks and other permanent points, such as wells, temples, &c., situated within them, to afford a basis for the construction of the Settlement maps of the district.

(4) The Geography of the Himalayas.

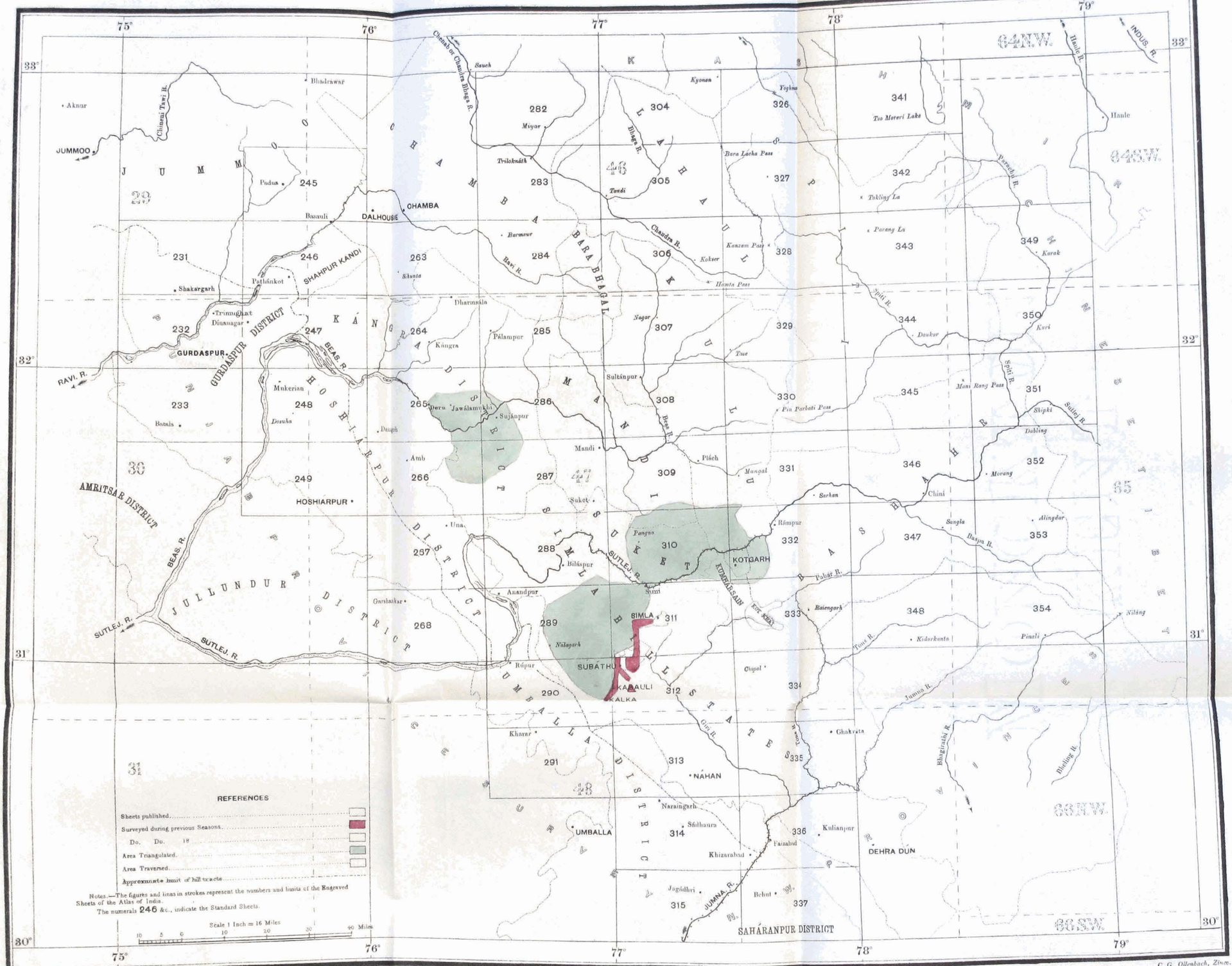
247. Regarding the Nepal-Bengal boundary, definite orders were not received till late in December, when an Assistant was immediately detached for the purpose. Twenty-four miles of boundary along the Mechi River were examined and demarcated by wooden posts erected at short intervals: of this distance, 7 miles, involving 236 acres, are disputed. After the boundary has been finally demarcated, permanent pillars (similar to those along other parts of the Nepal-Bengal boundary) will have to be erected at about one mile intervals and numbered from north to south in continuation of the Darjeeling District numbering. The demarcation near pillar No. 52 of the Mozufferpore District (left unfinished in 1884-85, see para. 269 of the last Annual Report) was also completed, and further west, a small portion of the boundary, which had been obliterated by floods in the Lál Bakia River, was relaid.

248. Of the arrears of mapping, computations, &c.; some little progress has been made with the computations, but it was not found practicable to do much more than arrange the field records and have them bound and indexed. These records however will need a great deal of time and labour to harmonize—as they pertain to different times and to works having different immediate objects in view—and as the whole strength of the party is needed for field work, they have been taken over just as they are by the Computing Section of the Trigonometrical Branch Office, where the results will be worked out in due course and published in the Synoptical Volumes of the North-East Longitudinal and the Assam Series. The whole of the sheets (Nos. 13 A to 45) of the Nepal Boundary Survey were finally examined, completed and made over for publication; the skeleton sheets of the Daling Lands Survey were also completed, but the corresponding hill-shaded sheets have still to be drawn, as have also those for the 2nd edition of the Darjeeling Revisionary Survey.

* A *tikka* is a sub-division of a *mauza*, and a *mauza* includes an area within convenient and generally natural limits and all the habitations therein. A *tikka* might perhaps be called a hamlet, but that would signify a small village subordinate to a larger one, whereas several *tikkas* go to make up a *mauza*.

INDEX TO THE SHEETS OF THE PUNJAB

CONTAINING THE SIMLA HILL STATES, KANGRA, AND PARTS OF CONTIGUOUS DISTRICTS



E. W. Foster, Photo.

C. G. Ollenbach, Zincº.

Published under the direction of Lieut.-Colonel H. R. Thuillier, R.E., *Offg. Surveyor General of India.*

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, March 1887.

249. For the topographical work the party broke ground about the middle of November 1885, in the Kángra District, in Sheet 265 (*vide* accompanying Index Map), and for the next three months was engaged in triangulating, traversing *and skeleton plane-tabling on the 16-inch scale. Experience soon proved the necessity for a change in the *modus operandi*, and instead of the 16-inch scale skeleton plane-tabling, a 4-inch survey in open style was introduced, suitable for a reduced 2-inch map, together with the fixing of the tri-junctions of *tikkas* and other suitably marked points by traversing, so as to furnish a convenient circuit of observed points in each *tikka*. The requisition for these changes is set forth in the note and letter following.

Note dated 13th February 1886, by COLONEL E. G. WACE, *2nd Financial Commissioner, Punjab, on the connection between the Survey of India and the Patwari Survey in the Kángra District.*

I have had an opportunity to-day of discussing with Colonel Tanner the connection of his work in the Kángra District with the local *patwari* survey, and I now record the system, which I am prepared to accept as meeting all local requirements—both revenue requirements and those of the general administration :—

(1) The observation of points, whether by traverse or otherwise, to be so made as to take up all known tri-junction points of hamlets (*tikkas*), and also to furnish a convenient circuit of observed points in each *tikka*. The Deputy Commissioner will arrange for all tri-junction points to be shown to the surveyor by the *patwari*.

(2) A plotted sheet showing the points so observed in each *tikka* to be made over to the Deputy Commissioner, a separate sheet for each *tikka;* the scale of this sheet to be 40 (equals 27·547 inches to the mile) local *kadams* (57½ inches each) to the inch.

(3) And also a table of co-ordinates of each *tikka*. This table will, in addition to the data, give a short description of each point.

(4) All points thus observed, which are not tri-junction pillars of *pakka* masonry, will be adequately marked on the ground, and formally made over by the surveyor to the *lambardar* and *patwari*, with a list thereof. This list will contain a topographical description of each point, corresponding with that provided above under head (3).

(5) No linear, that is to say, continuous village boundaries will be recorded by the Survey of India. *Tahsil* boundaries will be shown, also boundaries which in the Deputy Commissioner's opinion have a political importance, such as those of the *jagirs* of Siba, Goler, Lambagraon, Waigiri Rupur, &c., but in no case in minute detail.

(6) In respect of topography what is wanted is, sheets drawn in a free, open style on a scale of 4 inches to the mile, such as will be sufficient for the production of a 2-inch topographical map. All fixed points will be shown.

(7) The surveyor will show in his topographical sheets any forest boundary pillars of which a list is furnished to him. He will not be responsible for the linear boundary between pillars. A plot and table of each forest so observed will be furnished to the Deputy Commissioner, as provided under heads (2) and (3) above.

(8) The cost of the plotted sheets will be provided by the Deputy Commissioner under local arrangements, which that officer will settle in communication with the controlling revenue authorities.

(9) Copies of the 4-inch topographical sheets will be supplied to the Deputy Commissioner by the Survey of India, in the usual way.

(10) The survey will include the hill tract (Kolaba) of the Umballa District, and also the hill tract (Shahpur Kandi) of the Gurdáspur District.

(11) Colonel Tanner is at present working in the low hills of the Kángra District (Hamirpur and Dera), and will take up work in the higher mountains (Kullu Sub-division and similar tracts). This arrangement is well suited to local revenue requirements.

Letter No. C.—9 of 9th September 1886, from CAPTAIN J. A. L. MONTGOMERY, *Director of Settlements and Revenue Records, Punjab, to Colonel H. C. B. Tanner, Deputy Superintendent, Survey of India, in charge Himalaya Party.*

I am directed by the Financial Commissioner to address you in continuation of Financial Commissioner's No. 1517, dated 8th March 1886, and to request you to adopt, in lieu of the plan laid down in head (2) of the instructions therewith forwarded, the following system for plotting the traversed points of your survey on sheets intended for use as *patwari* field maps.

2. (A) For each *mauza* a plot of the traversed points is required on the scale of 80 local *kadams* to the inch.

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* Owing to the difficulty in carrying on chain measurements of ordinary traversing over hilly and broken ground, Colonel Tanner has introduced a method of determining the distances by measuring the angle subtended by a 20-foot rod, with a small portable theodolite, the intervening distance between them being of course 20 feet multiplied by the cotangent of the subtended angle which he measures with very great accuracy by the repeating process such as would be followed with the instrument known as a "repeating circle." The method has been found to answer admirably, and has been largely adopted by Colonel Strahan, R.E., in the Nicobar Survey, with very satisfactory results.

3. (B) For each *tikka* included in a *mauza* a similar plot is required on the scale of 40 local *kadams* to the inch. These large scale plots are not required for mountain areas which contain no scattered cultivation.

4. In case (A) the sheets should be ruled into squares; the side of the square measuring 15 chains. The same sheets can be used for case (B), though in this case the side of the square will represent a distance of 7½ chains only.

5. You will observe that by adopting this plan, though the sheets will be projected (that is to say engraved in squares) with reference to the local scale, the points will be plotted by the English scale.

6. On one sheet of every *mauza* (case A above), and on one sheet of every *tikka* (case B above), a printed diagram showing the correspondence between the English and local measure should be pasted. The diagram should be biglot English and Urdu, and, so far as convenient, should be placed on the sheet in each village which is numbered "1."

Diagrams for the (1) Kángra District and Shahpur Kandi. (2) Morni Ilaka of District Umballa are appended.

7. The paper for the plotted sheets should be the same as is now in use by Colonel Coddington for the Hissar Survey. The size of the sheets used by him is 30″ × 22″, and the quality is imperial hand-laid blue. A good margin is required to right and left of the sheets on which will be recorded the field numbers in the interior survey.

8. Some other matters having been settled in joint discussion between the Financial Commissioner and yourself, a note thereof is added below.

9. The table of *tikka* co-ordinates should be in the same form as is used by the Punjab Survey, and the entries should be arranged in the same manner. Columns for which data are not calculated in the Himalayan Survey will be left blank.

10. Under the co-ordinates of each *tikka's* boundary (circuit) will be added those of any "additional points" observed.

11. It will be convenient if the work can be undertaken in the following order:—

Hot weather work.	Cold weather work.
1. Kotgarh } Simla District. 2. Kot Khái }	1. Morni, Umballa District. 2. Shahpur Kandi Gurdáspur District. 3. Hamirpur 4. Dera 5. Pálampur (part) } Kángra District. 6. Kángra (part) 7. Núrpur 8. Hills of Hoshiárpur District.
3. Kullu with Seoraj 4. Pálampur (part) } Kángra District. 5. Kángra (part)	

12. The establishment required for plotting the *mauza* and *tikka* sheets will be provided on receipt of an application from you. It will be convenient if an application can be sent in September of each year, giving an estimate of the provision probably necessary during the next Financial year (commencing 1st April). The application should include the cost of the ruled sheets for plotting.

250. About 300 square miles of country was thus partially * triangulated and traversed by the end of April when the party changed its ground in order to carry out the programme arranged for the hot weather months in the higher hills. In this part of the operations, triangulation was carried on in Sheets 310 and 332, covering 308 square miles of country for detail surveying on the 2-inch scale in the Native States of Mandi, Suket, Kumhársain, and Bashahr, and 238 square miles for the 4-inch scale; besides some minor triangulation and traversing required for fixing the positions of tri-junction pillars in Kullu and Kotgarh. This being the first season, no detail survey could be undertaken, as the ground had to be first laid out with trigonometrical points.

251. The demarcation marks in the tracts which came under survey were found to be in good state of repair, but the surveyors found great difficulty in ascertaining the names pertaining to the different *tikka* tri-junctions. This was partly due to the absence of maps showing these boundaries, and partly to the tardiness of the village officials in attending on the surveyors.

252. In accordance with arrangements proposed by Colonel Wace, the party will operate in the following localities during the current field season:—Kotgarh and the Morni *taluka*, for 4-inch detail survey; Kot Khái, for triangulation and traverse preparatory to 4-inch detail survey; Shahpur Kandi (in the Gurdáspur District), for triangulation and traverse; Native States adjoining Kotgarh and Kot Khái, for 2-inch detail survey.

253. As regards Himalayan geography, nothing special was undertaken by the party during the year under review; but while the Tibet Mission was awaiting

* Equal to 150 square miles of completed work.

orders at Darjeeling, the explorer R.—N. returned from Bhután, and Colonel Tanner took advantage of the opportunity and leisure afforded him to examine the whole of the route he traversed which will make an important contribution to the basis on which to compile Sheet No. 7 of the North-East Trans-frontier Series. At the same time Colonel Tanner made arrangements for utilizing further information as to the geography of Tibet brought in by Lama U. G. and a Tibetan who accompanied the man that had been sent some years ago by the late Captain Harman to float timber down the Sanpo,* but of whom nothing had been heard since.

254. Owing to the inexperience of the hands in the novel character of the field-work, as well as to the changes in the *modus operandi* of the same, and to the other varied occupations of the party, no cost-rates can be deduced. The total cost of the party for the year amounted to ₹52,529.†

UPPER BURMA PARTY.

255. Early in the year 1886, after the military occupation of Upper Burma, a survey party was asked for by the Military Department to undertake a reconnaissance survey of the country round Mandalay and to collect and compile the numerous reconnaissance sketches which had been executed by officers attached to the army, of the country traversed by the troops.

Personnel.

Captain J. R. Hobday, S.C., Officiating Deputy Superintendent, 4th grade, in charge.
Mr. T. M. Kennedy, Assistant Surveyor, 2nd grade, from 1st July 1886.

Sub-surveyors.

Mr. J. F. McCollough, from 6th August 1886.
Ahmad Sayad, from 16th April to 17th July 1886.
Faida Ali, from 1st May 1886.
Gobardhun Dass and Shiv Charan, from 11th September.

256. As all the survey parties were at that time engaged in their several field operations, the services of a topographical party could not be then given. The Coast Triangulation Party, however, which was employed under Mr. E. C. Ryall, on the coast of Madras, was offered to commence the trigonometrical work in Upper Burma at once, and the Andaman Party was promised to follow in October when it was expected that the survey of those islands and all the mapping and records connected therewith would be completed.

257. The Military authorities, however, considered that the triangulation party would be of little use this season and urged the immediate despatch of a competent officer with a small staff, who would suffice for the present requirements. This proposal was acceded to, and Captain Hobday, who was in charge of the Andaman Party, was by special request of the Military authorities selected for this duty.

258. Captain Hobday left Port Blair on the 8th March with a small establishment from the Andaman Party, which was subsequently increased by additions from the Burma Topographical Party, and arrived at Mandalay on 2nd April 1886. During the month of April he completed the preliminary triangulation for the survey of the city of Mandalay, determined the latitude and longitude thereof astronomically, and ascertained the elevation barometrically by simultaneous observations at Mandalay and Rangoon. A preliminary map of the country round Mandalay on the scale of 2 miles=1 inch was compiled from the reconnaissances done by officers with the Burma Field Force and submitted to Calcutta for publication.

259. In May, Captain Hobday and Sub-surveyor Ahmad Sayad accompanied the Military expedition to the Kachin Hills, south-east of Bhamo, and surveyed an area of about 150 square miles on the $\frac{1}{2}$-inch scale. A much larger area would have resulted and a coveted view into Yunnan obtained had not the force been stopped after ascending the first spur of the hills.

260. At the end of June Captain Hobday accompanied an expedition to the south-east of Mandalay, taking Ahmad Sayad with him. The triangulation was thus extended southward as far as latitude 21°, when Captain Hobday returned and the Sub-surveyor was left to carry on the detail survey from the

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* To ascertain its identity with the Brahmaputra or Irrawaddy.
† The Officer in charge reports favourably of all his assistants.

post of Kyouksé. On 17th July Ahmad Sayad, while at work, was attacked by Shan dacoits, some 8 miles east of Kyouksé, and being wounded by a bullet, was overtaken and killed; the escort and menials managed to effect their escape. The loss of this promising Sub-surveyor is much regretted.

261. During the rains, the establishment was further strengthened by an Assistant Surveyor and 3 Sub-surveyors. The opportunity of a telegraph party being sent to lay out a line from Mandalay to Bhamo was availed of to attach an assistant, Mr. Kennedy, to extend the triangulation and topography northwards up the Irrawaddy. From July to the end of September Captain Hobday was engaged in compiling a general map of the country on the $\frac{1}{4}$-inch scale between the parallels of 19° and 26° N. latitude and the meridians of 94° and 98° E. longitude. This is comprised in 14 sheets and is based on the various maps, routes and sketches lately obtained from all sources and on local information supplied by the natives of the country. These sheets were reproduced as soon as they were received in the head-quarter office, Calcutta, and a large number of copies have been supplied for the use of the troops now operating in Upper Burma.

262. During this period, portions of the establishment were engaged, as the weather permitted, on the survey of the City of Mandalay, on the 6-inch scale and on the extension of the Mandalay triangulation southwards.

263. The city survey, which covers an area of about 50 square miles, has been completed. This work was much impeded by the inundation of the country caused by the bursting, on 16th August, of the embankment which surrounds the city. A sketch map of the new cantonment site at Bhamo on the scale of 12 inches=1 mile was also executed. The total area triangulated during the period under review amounts to about 5,200 square miles.

264. The amount of work that has been effected by Captain Hobday and his small staff is highly creditable, and their services have been most favourably acknowledged by the Chief Commissioner of Burma, who has intimated that Captain Hobday's work has been of the greatest value to the Military and Civil authorities, and that his industry has been remarkable.

265. It had been arranged to commence a regular survey of the new province during the current season with two topographical parties, working up the Irrawaddy and Sittang Valleys, but as it was found that the country was in too disturbed a state for systematic survey operations to be carried on without risk, it was determined to defer this programme and to retain the services of Captain Hobday and his small staff for military reconnaissances. The party has now been strengthened up to the complement of an ordinary topographical party, so that the opportunities afforded by the movements of the troops, on which the survey operations depend almost entirely at present, may be utilized to the full to obtain as much additional geographical information of the country as possible, and Captain Hobday's object during the current season will be to attach survey officers to the different expeditions. Another small party under Colonel Woodthorpe, R.E., will operate with the column under General J. J. Gordon, C.B., advancing into the Chindwin Valley from Manipur, and it is hoped that the triangulation executed by Captain Hobday, which is at present "*en l'air*," may thus be connected with the main triangulation of India, and a more satisfactory knowledge of the geodesy of Upper Burma arrived at.

TRANS-HIMALAYAN EXPLORATIONS.

266. The explorer M—H, who had just returned to India when the last Report was sent in (see page 79 of Annual Report for 1884-85), has furnished information along the route from Dagmára Thana (in the Bhágalpur District) along the Dúdhkosi to Dingri in Tibet; thence westwards *viâ* the Pálguchho Lake to Jongkhajong; then southwards *viâ* Kirong and the Tirsúli River to Arughát on the Búri Gunduk; and from the last-named place northwards to Nubri, and southwards down the Naráini to Tribeni. Thus he has furnished 400 miles of entirely new traverse besides confirming the details of 100 miles of ground previously travelled over. It is a great pity that the explorer brought back no determinations of height which would have been most interesting, for he crossed the main ridge of the Himalayas by one of the highest passes (the

Pángula), 24 miles west-north-west of Mount Everest, his route actually approaching that peak within 15 miles.

267. Another explorer, R—N, was despatched, in October 1885, to start from Darjeeling across Bhután and the mountains to the east, and to reach Gyala Sindong, the lowest point yet reached on the Sanpo; and starting from the left bank of the river to find his way back to India by *any* practicable route *without re-crossing the river*. The object of this was to set at rest the *vexata quæstio* as to whether the Brahmaputra or the Irrawaddy was the recipient of the waters of the Sanpo. The explorer met with bad luck at first from the fact of there being at the time a great dispute between Tibet and Bhutan, in consequence of which all the passes into Tibet were closed. He therefore had to find his way back to India down the Hachhu and Wongchhu rivers to Baxa, having been detained and kept under surveillance for ten days by the *jongpon* of Chukhajong. His next attempt was made from Dewangiri, whence he proceeded by a pretty direct route to the Monlakachung Pass and thence to Suphuk cave about 8 miles south-west of Seh, a very large monastery on the Lhobrak River, a value of the position of which had been previously obtained from the north by Lama U—G's traverse referred to in the Annual Report for 1883-84. Here, in consequence of the rumours regarding the advance of the Tibet mission from the south and of a party of Russians from the north, the officials absolutely stopped his further progress and kept him in custody for nine days and then conveyed his party under escort to Seh. From here he managed to escape during the night with his party and, keeping away from the routes usually followed, found his way to Menchuna (lat. 28° long. 92°), and thence *viâ* Tawang to Odalguri (along the route formerly traversed by Pundit Nain Sing). The work, which furnishes about 280 miles of new route survey, is valuable so far as it goes, inasmuch as it opens up the general geography of Bhutan and forms a connection with the work of Pemberton, (1838) from the south, and of the Pundit and the Lama from the north.

Neither the reports nor the maps are yet ready for publication.

TIDAL AND LEVELLING OPERATIONS.

268. The direction of these operations remained in the hands of Major Baird until the 20th January 1886, when, having been appointed to officiate as Master of the Calcutta Mint, he was relieved by Major Hill, who had joined the party with that object on the 29th of the preceding month.

Personnel.

Major A. W. Baird, R.E., F.R.S., Deputy Superintendent, 3rd grade, in charge till 20th January 1886.
Major J. Hill, R.E., Officiating Deputy Superintendent, 2nd grade, in charge from 20th January 1886.
Lieutenant F. B. Longe, R.E., Officiating Deputy Superintendent, 4th grade, joined the party on 23rd October 1885, transferred to South Maratha Survey on 21st December 1885.
Mr. G. Belcham, Surveyor, 3rd grade.
" E. J. Connor, do. 4th do.
" H. Corkery, B.A., L.L.B., Assistant Surveyor, 1st grade.
" P. F. Prunty, Assistant Surveyor, 1st grade, transferred, 1st September 1886.
Sub-surveyor Narsing Das.
" Dhondu Vennyak; 1 watch-maker, and 18 recorders and computers.

TIDAL OPERATIONS.

269. The recording of the tidal curves by the self-registering tide-gauges, their reduction, and the publication of tables of predicted heights, have been continued during the year as usual. Of the 16 observatories, which were in operation at the end of the last year, 3 have been closed during the year under report, on completion of the usual period of registration, *viz.*:—Diamond Harbour, Amherst and Moulmein, the period having been extended indeed to six years in the case of Moulmein, owing to certain peculiarities in the tides of that port. Four new observatories have been started during the year, *viz.*:—Cochin, Cocanada, Chittagong and Bhávnagar,—the instrumental equipment for the first three having been obtained from the observatories of Beypore, Vizagapatam and Moulmein respectively, and that for Bhávnagar having been provided, as stated in last year's report, by the Durbar of that place. The

instruments set free by the closing of the Amherst Observatory are intended to be employed at Akyab so soon as the arrangements for establishing a tidal observatory there can be made. The 17 observatories, which are now in regular work, with the dates of commencement, are here given :—

Aden	3rd	March	1878
*Kurrachee	1st	May	1881
Bhávnagar	1st	January	1886
Bombay	1st	January	1878
Mormugão (Goa)	16th	March	1884
Cochin	25th	January	1886
Colombo	1st	February	1884
Galle	1st	April	1884
Negapatam	6th	December	1881
Madras	1st	February	1880
Cocanada	1st	April	1886
Dublat (Saugor Island)	22nd	April	1881
Kidderpore	22nd	March	1881
Chittagong	6th	June	1886
Elephant Point (new site)	1st	January	1884
Rangoon	1st	March	1880
Port Blair	19th	April	1880

270. In order to present the scheme of tidal operations in a connected form, it appears desirable to give below a list of the observatories which have been closed on the completion of their registration since they were systematically established in 1877, prior to which year the only observations taken by the Survey Department were those in 1873—75 at Okhá, Hanstal and Nowanar (Navánar) in the Gulf of Cutch :—

Pámban	closed	28th December	1882
Kárwár	do.	14th April	1883
Beypore	do.	14th March	1885
Vizagapatam	do.	30th March	1885
False Point	destroyed by cyclone	22nd September	1885
Diamond Harbour	closed	12th April	1886
Moulmein	do.	24th April	1886
Amherst	do.	October	1886

271. The stations at which the establishment of new tidal observatories is contemplated are Akyab, Diamond Island at the mouth of the Bassein river, and Tuticorin. It may be mentioned here that the ordinary period over which observations have to be taken, is five years, but in the case of permanent observatories, such as Aden, Bombay, &c., this period may be extended indefinitely.

272. All the observatories, with the exception of Cochin and Cocanada (only recently established) and of Kurrachee and Port Blair, have been inspected during the past year either by the officer in charge of the party, or by one of his assistants ; that at Aden having been inspected last August by Major Hill on his way to India when returning from leave.

273. The usual account of the working of each observatory will be found in the appendix. Owing to the causes mentioned in paragraph 282 of the last Annual Report, it was unfortunately found necessary to reject the registrations at Negapatam for the period 6th December 1883 to 20th December 1885; at Madras, owing to the bottom of the float-box giving way, no registrations were secured for a period of three weeks ; and at Rangoon, in consequence of the upsetting of the tide-gauge by the steamer *Zephyr*, there is a break in the diagrams from 24th June to 5th July ; otherwise the observatories have worked satisfactorily, excepting, of course, the usual trivial interruptions. An exceptional and interesting tidal disturbance is reported from Mormugáo.

274. The reductions of the observations have made very good progress during the year, considering the increased labor of computation consequent on breaks in the tidal registrations as above mentioned. The observations at 13 ports have been reduced, and the tabulated values of the tidal constants and the discussion of the results, will be found in detail in the appendix.

275. The usual work in connection with the timely issue of the Tide Tables for 1887 has been satisfactorily got through. These tables will contain the

* The tidal observations prior to 1881 which have been used in combination with the above in calculating the Tide Tables for this port were taken by Messrs. Parkes and Price.

predictions of the heights and times of high and low water for 23 ports. For the first time, the heights in these tables have in the case of 11 of the ports been referred to a scientific datum which has been adopted after discussion with Professor Darwin and Captain Wharton, R.N., Hydrographer to the Admiralty. This new datum is termed "The Indian spring low-water mark," and it will be the *final* datum for all tidal observatories, except where special reasons or local considerations exist for retaining another datum; the latter will, however, not be materially different from the former, and will always be capable of reference thereto, as the difference of height will in each case be carefully ascertained.

276. The predictions for 1885 may be summarised as follows :—

Percentage of predictions within 15 minutes of actuals.

	High water. Per cent.	Low water. Per cent.
Open coast stations	70	67
Riverain ,,	61	53

Percentage of predictions within 8 inches in height of actuals.

	High water. Per cent.	Low water. Per cent.
Open coast stations	93	92
Riverain ,,	60	54

277. These percentages are all lower than those for 1884; but an examination of the detailed lists of comparisons given in the appendix will show that the comparative differences would be reduced by more than 4 per cent. if the results at Negapatam and Elephant Point were not included therein.

LEVELLING OPERATIONS.

278. During the year under report, another very satisfactory out-turn of spirit-levelling has been obtained, amounting to 526 miles of double levelling, in the course of which the heights of 394 permanent bench-marks and of 24 Trigonometrical Survey stations have been determined. It consists of main lines as follows :—(1) along the railway line from Madras tidal station *viâ* Tanjore to the tidal station of Negapatam; (2) from Tanjore *viâ* Ramnad to the tidal station of Pámban; (3) from Ramnad to Tuticorin tidal station; with the usual branch lines for connecting with stations of the Trigonometrical Survey, &c. Assuming the heights of the mean sea-level to be identical at the tidal stations above named, the generated errors of levelling in the three sections are ·0021 feet, ·0019 feet, and ·0013 feet per mile; or if the error be calculated between the extremities of the line, it is represented by only ·0004 feet per mile. Pairs of test bench-marks, for detection of secular change of relative level between the land and the sea by periodic determinations thereof, have been embedded on suitable sites in the vicinity of Negapatam, Pámban, and Tuticorin tidal observatories, and connected therewith.

279. Confidence being wanting in the heights of the South Konkan Series, determined over 40 years ago, without precautions having been taken for overcoming the uncertainties of terrestrial refraction, especially necessary in this case, where one flank of the series rests on the elevated *ghâts* and the other skirts the sea coast, a revision was considered a *desideratum* before their incorporation in the Professional Volumes. These heights have all been revised by trigonometrical levelling; and on account of the uncertain refraction on rays between the top of the *ghâts* and the sea coast, *simultaneous* reciprocal observations were taken on such rays in order to reduce error from refraction to a minimum; the resulting heights may therefore be accepted as exceptionally accurate and probably true to within 2 or 3 feet. A comparison between the new heights and the old exhibits discrepancies with a range of 43 feet. The revision may therefore be considered to be fully justified by the result. As one of the southernmost stations of this series is in the immediate vicinity of Mormugáo tidal station, a short line of spirit-levels will be run to it in the coming season, and a comparison with the value as brought down by the trigonometrical levelling will furnish the means for dispersing any small residual error that there may be in the latter. Opportunity was taken

to protect all the principal stations observed at, and to hand them over for safe custody to local native officials.

280. The extracts from Major Hill's narrative report will be found at page xix of the appendix.*

GEODETIC.

LATITUDE OPERATIONS.

281. These operations were suspended during the year under review, as there are only two Astronomical Parties, and these were both engaged, on the Telegraphic Longitude operations, but as explained in paragraph 295, page 59, of last year's Report, no comment could be made on the results of the Latitude operations during 1884-85, conducted by Major Heaviside, R.E. These results are now given in tabular form and will be found, together with extracts from that officer's report, at p. lviii of the appendix.

282. There being only one officer, Lieutenant S. G. Burrard, R.E., available for astronomical work during the current field season, the Longitude operations have been suspended and the Latitude observations have been resumed, and are being continued on meridian 80° southwards from Sarandi Pát Station, Latitude $22\frac{1}{4}°$. Major Heaviside closed work in 1885 at Potenda Station, having worked on practically the same meridian from north to south over about 4° of latitude. On the arc of $1\frac{1}{2}°$ between Potenda and Sarandi Pát, there are already two stations at which Latitude observations were taken some years previously. The present intention is to have a series of Latitude stations on or near meridian 80° from the Himalayas to Madras, embracing nearly $15\frac{1}{2}°$ of latitude.

ELECTRO-TELEGRAPHIC LONGITUDE OPERATIONS.

(ASTRONOMICAL, PARTIES Nos. 1 & 2.)

283. These operations were continued during the past season, nine arcs having been measured — the largest number yet completed in one season—and, besides these, observations were taken on an experimental arc at Dehra Dun, the necessity for which, and the results obtained will be detailed below. The two Astronomical Parties were engaged in these operations.

284. As explained in paragraph 247, page 55 of the General Report for 1883-84, the two transit instruments were sent to England at the close of the field season of that year, to be examined by the makers and to have certain defects, if possible, remedied. Major G. Strahan, who was on furlough, was invited to inspect the instruments when the makers should report their work complete. Major Strahan was detained in England for six months on duty, in extension of his furlough, for this work, which he carried out in the enclosure of the Observatory at Greenwich. Here, through the kindness of the Astronomer Royal, a site was placed at his disposal and shelter afforded for the telescopes and chronograph, as well as an electric communication with the standard sidereal clock, and assistance of all kinds was received from Mr. Christie and his co-adjutors, which Major Strahan gratefully acknowledges. He completed his task in time to admit of the instruments being sent out to India for the resumption of operations at the commencement of the field season

PERSONNEL.

No. 1 Astronomical Party.

Major W. J. Heaviside, R.E., Deputy Superintendent, 2nd grade, in charge up to January 24th, 1886.
Lieutenant S. G. Burrard, R.E., Assistant Superintendent, 1st grade, from January 24th, 1886.
Mr. W. W. MacNair, Surveyor, 3rd grade, Sub-surveyor, Dhondu, Bulwant, Jhoshi.

No. 2 Astronomical Party.

Major G. Strahan, R.E., Deputy Superintendent, 1st grade, in charge.
Babu Harsahai.

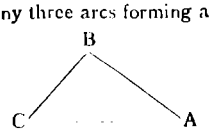
* Major Hill reports very favourably of Messrs. Belcham, Connor, Corkery, and Prunty, and also of his native assistants, making special mention of Ganesh Sadasheo, a most promising Sub-surveyor, who, after eight years' good service, died during the past season from an illness brought on by exposure.

under review.* Colonel Haig, the Officiating Deputy Surveyor General, in charge Trigonometrical Branch, reported however, to the Surveyor General that while having all confidence in the completeness and excellency of the makers' work, and in the ability of Major Strahan to satisfy himself of the same, nevertheless he was not enabled by Major Strahan's careful and elaborate report to pronounce decidedly as to the fact of the defects having been remedied. On this account Colonel Haig, with the Surveyor General's concurrence, went to Agra, where the operations were to commence, and there, after consultation with Major Heaviside, decided on having the series of experimental observations taken, which were mentioned in paragraph 295, page 59 of last Annual Report. These observations afforded the strongest reasons for considering the instrumental defects to have been completely removed, and the regular operations were at once resumed. The behaviour of the instruments throughout the season was such as to give every confidence in their perfection; yet, strange to say, when the results came to be reduced and compared in the recess season, it was found that there was still a mysterious source of very appreciable error; and, in spite of all the thought and care bestowed on the subject by the executive officers and the Superintendent of the Trigonometrical Branch, it remains undiscovered.

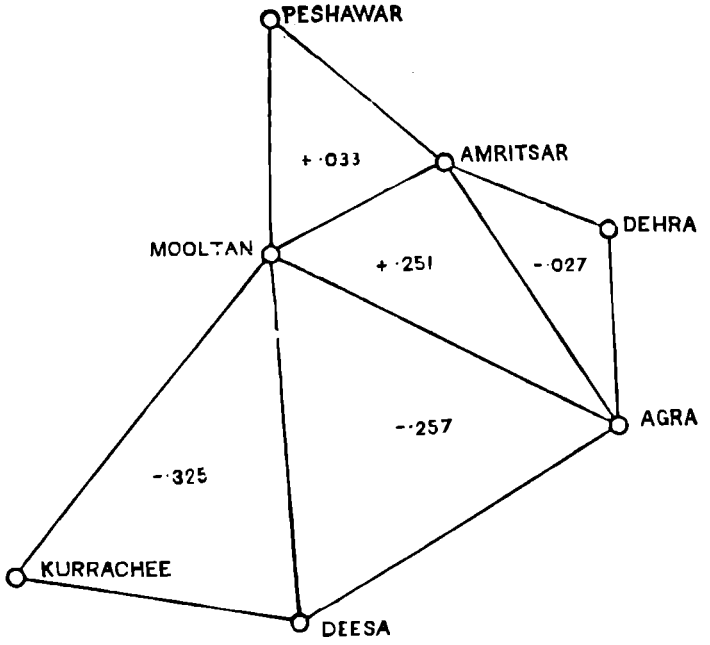
285. Out of five verificatory circuits,† three exhibit large errors between a quarter and a third of a second of time. If the theoretical probable error of each arc were determined separately from the small discrepancies between the many measures obtained for the arc by the system of simultaneous observations at each end on several nights to between 20 and 30 stars, it would, in any case, not exceed one hundredth of a second of time; so that we have to deal with the phenomenon of errors as large as $0^{s}\cdot33$ appearing in the combination of three arcs, the theoretical probable errors of which, if added together, would not exceed $0^{s}\cdot03$; and we have also the experimental arc at Dehra Dun (the two ends o fwhich were only a few yards apart, and one due north of the other), proving that there may be an error of $0^{s}\cdot18$ in a single arc, the accordant measures of which would give a theoretical probable error of $0^{s}\cdot01$. Large circuit errors have occurred before, and have occasioned the re-measurement of three arcs, the theoretical errors of which were also very small, but then it was thought that the cause lay in an instability in the relations between the visual and rotatory axes of the telescopes, due to a weakness in the joints between the three parts, which was thought to have been detected; but in the present instance, all the experiments that have been made specially for the purpose, have failed to show up any such instability. This mysterious source of error tends to throw suspicion on the accuracy of all the arcs hitherto measured, because that accuracy is assumed on the evidence of the small probable error of each arc and the small circuit errors; but it has now been demonstrated that there may be in a single arc an error, out of all proportion with the probable error and larger than most of the accepted errors of circuits of three arcs combined, and therefore that a circuit which apparently closes well, *i.e.*, with a small circuit error, may have in each of its component arcs an error possibly in excess of the circuit error which may be fortuitously small owing to the arc errors not having the same sign. Hence it is considered imperatively necessary to make, on the Dehra Dun experimental arc, a further and exhaustive series of experiments, in the course of which there

* The work of the makers consisted in the construction of new bearings or Ys of a different kind from the original; the complete overhauling of all the parts of the telescopes leading to the removal of the micrometer screws, which were thought to be faulty; the introduction of new ones, and the providing of a new Bohnenberger eye-piece to one of the telescopes in place of one of lower power, in order that the optical powers of both instruments should be similar, which before was not the case: besides other minor alterations. The original bearings were of a novel pattern and self-adjusting, each accommodating itself to its pivot, and therefore to the common axis of rotation by means of a universal joint, advantage of which was taken to give the bearing surfaces a hollow cylindrical form so as to fit the pivots and receive the weight of the telescope distributed over four surfaces (two to each bearing), about $1\frac{1}{2}$ square inches each: in the ordinary Y pattern the surfaces are slightly convex, and so require no very exact adjustment to the axis of rotation, but the weight of the telescope is received on four *points* (two to each Y), which of course, get worn by work. The original bearings were very beautifully made, but as it was suspected that they might afford shelter to a hidden source of error, additional new Ys of the ordinary pattern were supplied and were used through the past season and in all the experimental observations.

† Any three arcs forming a triangle offers a verificatory circuit: thus, the sum of the arcs A B and B C is equal to the arc A C: therefore, if the sum of the *measured* arcs A B and B C differs from the *measured* arc A C the difference is due to error of measurement in one, two, or all three arcs.



shall be every possible interchange of observers, telescopes, electrical apparatus, clocks and stations. A programme for these experiments has been arranged by Colonel Haig, and it is intended to carry them out during the current field season by slightly curtailing the Latitude operations and bringing the Astronomical Parties to Dehra Dun in March, in order that a recess season may intervene between the observations, and the subsequent resumption of the regular Longitude operations. In this way time will be afforded for a patient investigation of all the results of the experiments, and the chance of the mysterious source of error escaping detection will be reduced to a minimum. It may be regretted that the observations on the experimental arc were not extended last season according to the present project, but the existence of such error as has now been shown up was never suspected or thought possible, and the arc was measured for the purpose of establishing the extreme accuracy with which the operations might be credited. It is hoped that the cause of error will be discovered, and that all the steps taken in the discovery, including the experimental observations at Greenwich and Agra, will afford an interesting chapter for the next Annual Report.



286. The nine arcs measured during the past season are shown in the accompanying diagram, combined with the two arcs Agra-Deesa and Deesa-Kurrachee previously measured, but here included to present the circuit errors, which are printed within each triangle or circuit.

Summary of the Out-turn of field work of the Parties of the

Scale of Survey.	Name and *locale* of Field Operations.	Triangulation.																
		Instrument used.	Area triangulated in square miles.	Number of Stations at which observations were taken.	Number of square miles to each point trigonometrically fixed.	Number of square miles to each height.	Secondary—in which each angle is usually observed on two zeros.					Tertiary—in which two angles of each triangle are observed.				Number of extra heights determined.	
							Number of Stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.		
Trigonometrical	Coast (Godávari and Kistna Districts).	12″	378	94	3·5	3·6	101 (*a*)	95	5	0·1	100	7	14	0·2	6	...	1
	Spirit Levelling (Madras)	Spirit levels	...	...	...	...	...	...	...	...	..	...	...	...	...	...	
	Trigonometrical Levelling (South Konkan).	14″	...	19	...	...	...	...	...	...	..	...	...	...	...	...	
26·4 inches = 1 mile	Baroda City	...	...	..	..	..	...	...	...	..	...	...	...	...	...	...	
16 inches=1 mile	Ajmere	...	...	..	...	...	...	..	...	..	...	..	...	...	...	...	5
	Akyab	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Basti	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Biláspur	...	...	..	...	...	...	..	...	...	...	...	...	...	...	...	
	Gorakhpur	...	...	...	...	...	...	...	...	...	...	...	...	...	..	...	
	Jubbulpore and Damoh	...	...	...	...	...	...		...	...		...	...	...	...	...	10
	Kámrúp	...	...	...	...	...	...	...	...	...	..	..	...	...	...	...	
	Mozufferpore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Raipur	...	...	...		...	..	...	...	...	...	...	...	...	...	...	
	Sambalpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
8 inches=1 mile	S. Marátha (Belgaum Forests)	...	...	...	...	...	..	...	...	...	...	...	...	...	...	...	15
6 inches=1 mile	Mandalay City	..	...	..	...	...	...	...	...	...	...	...	...	...	...	...	
4 inches=1 mile	Andaman (Port Blair)	...	...	.	...	...	...	...	...	...	..	...	...	...	..	...	
	Basti	...	...	..	...	...	...	..	..	...	...	...	...	...	...	...	
	Burma (reserved Forests)	8″, 6″, 5″	263	21	12	12	6	10	17	0·5	6	12	19	0·6	12	88	
	Himalaya (Kángra and Simla Hill States).	5″ and 12″	688	123	1·0	1·7	123	157	12	0·4	44	420	740	0·9	278	2	20
	Himalaya (Nepal Boundary, Mechi River).	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
2 inches=1 mile	Baluchistan	6″	740	39	4·2	5·0	42	86	11	0·6	34	146	249	0·8	130	...	
	Burma (unreserved Forests)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Cutch	5″	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Deccan	12″ and 6″	568	31	7	18	13	56	15	0·7	12	58	116	1·5	...	12	25
	Gujarát	7″, 6″, 5″	740	50	2·7	4·7	26	83	4·7	0·30	31	230	399	0·8	132	...	
	Himalaya (Kángra and Simla Hill States).	7″	308	17	4	4·3	17	48	12	0·3	16	58	98	1·3	55	...	
	Mirzapur	6″	194	15	2·6	11	13	43	21	0·3	12	63	110	0·4	5	...	
	Punjab	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	South Marátha	5″	1,210	144	3·85	4·15	144	200	14·3	0·54	144	193	399	1·16	162	14	30
1-inch=1 mile	Mysore	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Rajputana (Jodhpore and Pálanpur)	8″	1,040	24	5·2	7·7	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	
inch=1 mile	Andaman	6″	955	18	16·2	64	14	26	4	1·7	5	49	69	4·1	11	...	
	Baluchistan	...	4,350	20	38	40	23	35	11	0·3	20	88	131	0·7	80	..	
	Rajputana (Jodhpore)	7″ and 2″	4,810	08	12	18	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	(*e*)	35
Reconnaissance. ½-inch and ¼-inch	Baluchistan, N.-W. Frontier	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
¼-inch	Upper Burma	...	5,200	...	...	...	...	...	...	...	...	...	...	...	...	...	37

Survey of India Department during the year 1885-86.

	SPIRIT-LEVELLING OPERATIONS.				TRAVERSING.					TOPOGRAPHY.						REMARKS.
	Number of miles levelled over.	Number of permanent bench-mark stones embedded.	Number of Trigonometrical Stations connected with lines of level.	Number of other permanent points fixed as bench-marks.	Number of stations at which theodolite was set up.	Linear miles.	Average angular error per station in seconds.	Average error per 1,000 links in links.	Square miles, main circuit and boundary survey.	Area completed during the season in square miles.	Average number of plane-table fixings per square mile.	Number of linear miles of test line.	Number of villages.	Number of fields.	Average size of fields in acres.	
1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	(*a*) Observations taken on 4 zeros.
	526	51	24	343	...	...	...	...	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	6·2	...	39	...	...	...	
5	...	...	...	...	2,638	656	...	...	243	...	...	...	57	...	...	
	...	...	...	...	(*b*)	(*b*)	1·5	·1	794	661	...	...	337	694,056	0·29	(*b*) Not tabulated.
	...	...	...	...	17,940	3,739	3	·1	782	783	...	2,216	2,276	1,126,230	0·44	
	...	...	...	...	18,622	6,264	2	·3	1,793	763	..	1,524	751	474,296	1·03	
	...	...	...	...	18,339	3,306	2	·1	1,025	820	...	1,712	1,251	894,028	0·58	
10	...	...	...	...	41,949	6,380	2	·3	2,215	...	...	...	1,383	...	..	
	...	...	...	...	7,770	1,722	3	·1	481	468	...	1,058	319	147,818	2·03	
	...	...	...	...	(*b*)	(*b*)	2	·1	803	414	...	...	656	582,200	0·45	
	...	...	...	...	(*b*)	5,958	5	·5	2,169	...	...	...	1,117	...	...	
	...	...	...	...	(*b*)	(*b*)	2	·4	885	...	...	...	436	...	...	
15	...	...	...	...	1,593	152	...	...	6	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	50	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	28	139	...	...	...	...	
	...	...	...	...	...	...	...	...	...	36(*c*)	...	...	48	...	...	(*c*) Riverain.
	...	...	...	...	8,099	507	6	4·1	...	199	201	28·8	...	...	...	
20	...	...	...	...	405	99	18	2·4	...	...	...	...	...	...	...	
	...	...	...	...	...	24	...	...	...	...	...	...	...	...	...	
	...	...	...	...	...	...	...	...	...	620	2·3	138	...	...	...	
	...	...	...	...	...	...	...	...	...	131	90	...	...	...	...	
	...	...	...	...	1,132	449	9·4	1·4	...	3,805	6	303	...	...	...	
25	...	...	...	...	2,360	650	1·8	0·6	...	1,676	20·5	14	...	...	...	
	...	...	...	...	2,585	422	16	1·1	...	2,524	22·5	470	...	...	...	
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	...	...	...	...	6,599	1,211	4·5	0·01	...	487	37	*in situ*	...	...	...	
	...	...	...	...	(*b*)	8,076	·8	...	3,770	2,624(*d*)	...	4,030	...	...	...	(*d*) Area tested only, and the maps compiled from the Patwari Survey.
30	...	...	...	...	3,231	1,164	7	0·6	...	1,672	...	124	...	...	...	
	...	...	...	...	...	...	...	...	...	2,570	9·6	207	...	...	...	
	...	...	...	...	...	...	...	...	...	256	6·3	17	...	...	...	
	...	...	...	...	...	...	...	...	...	1,464	2·1	*in situ*	...	...	...	(*e*) Work not computed.
	...	...	...	...	...	...	...	...	...	514	1·4	...	...	...	...	
35	...	...	...	...	...	...	...	...	...	3,540	2·7	157	...	...	...	
	...	...	...	...	...	...	...	...	...	30,000	...	...	...	...	...	
37	...	...	...	...	...	...	...	...	...	150	...	...	...	...	...	

Statement showing the Cost-rates of work executed by the several Field

Names and *locale* of Field Parties.	Cost-rate per square mile in Rupees.							Rate in annas for traverse and detail and preparation of Maps.	
	Triangulation.	Traversing.	Detail Survey on scales of					Scale 16″=1 mile.	
			1/8″	1″	2″	4″	16″	Per acre.	Per field.
								a. p.	a. p.
Topographical Surveys.									
Andaman	7·0	...	8·9	...	...	276·6	...	...	...
Baluchistan	0·5	...	11·4	...	149·1	...	...	..	...
Cutch	...	22·6(*a*)	...	...	12·3	...	...	...	...
Deccan	11·7	6·9	...	...	22·4	...	...	...	...
Gujarat	...	2·5(*a*)	...	...	16·9	...	...	...	...
Mirzapur	7·6	10·8(*a*)	...	...	68 7	...	...	...	...
Mysore	...	...	...	22·1	...	...	...	...	...
Rajputana	3·3	...	2·9	20·9	...	...	...	...	...
South Maratha	13·3	3·7	...	...	13·4	...	...	...	...
Forest Surveys.									
Lower Burma	37·2	129·4	...	...	102·8	220·4	...	...	...
Traverse Surveys.									
Ajmere	...	46·2	...	...	...	...	..	...	...
Jubbulpore	...	31·8	...	...	...	...	...	...	...
Punjab	...	9·4(*b*)	...	...	9·2(*c*)	...	...	...	...
Raipur	...	32·5	...	...	...	...	...	...	...
Sambalpur	...	36·0	...	...	...	...	...	...	...
Cadastral Surveys.									
Akyab	...	60·2	...	...	...	...	183·9	6 4	1 10
Basti	...	22·6	...	...	...	...	83·4	2 7	1 2
Bilaspur	...	16·1	...	...	...	...	70·1	2 2	2 3
Gorakhpur	...	20·5	...	.	..	...	70·5	2 3	1 4
Kamrup	...	33·4	...	...	...	...	94·2	3 3	6 7
Mozufferpore	...	28·8	...	...	...	...	97·1	3 2	1 5
Trigonometrical Surveys.									
Astronomical Parties, Nos. : and 2	...	...	...	...	...	...	...	...	...
Coast (Godáveri and Kistna Districts)	...	...	...	...	...	...	...	...	...
Himalaya	(*s*)	(*s*)	...	...	...	...	...	..	...
Tidal and Levelling Operations	...	...	...	...	...	...	...	...	...

Parties of the Survey of India Department during the year 1885-86.

Cost-rates.					Total cost of Party.	Remarks.
Stone embedding.	Records (Khanapuri.)		Completion of Nagri &c., Records, Assessment, Statistics, &c.			
Per square mile.	Per square mile.	Per field.	Per square mile.	Per field.		
₹	₹	a. p.	₹	a. p.		
...	...	...	...	...	27,540	(a) Per linear mile.
...	...	...	...	...	1,03,633(d)	(b) Traversing limited to fixing village trijunction boundary marks.
...	...	..	...	...	53,753	
...	...	...	...	...	50,924	(c) Topography not surveyed, but obtained by reduction from Settlement Survey Maps: the reduced maps are tested.
...	...	...	...	...	58,078 (e)	(d) Includes ₹2,388 for Nushki Explorations.
...	...	...	...	...	55,243(f)	(e) ,, ₹12,312 for Baroda City Survey and ₹3,191 for Baroda State Boundary Surveys.
...	...	...	...	...	57,005	
...	...	...	...	...	45,875(g)	(f) Includes ₹7,685 expended on Dudhi survey.
...	...	...	...	...	54,817 (h)	(g) ,, ₹11,000 expended on Ajmere-Merwara Revision Survey.
						(h) Includes R1,695 expended on mapping of 4″ sheets of District Thana and ₹5,861 expended on Forest Survey on 8″ scale.
...	...	...	...	...	1,15,138(i)	(i) Includes ₹3,300 for purchase of elephants and ₹90 demarcation expenses.
						(k) Includes R1,384 expended on Kashmir and Sialkot Boundary Survey and ₹370 on plotting traverse sheets for Hissar Settlement Survey.
...	...	...	...	...	11,247	
2·5	...	...	...	...	76,012	(l) Includes R1,350 expended on Revision Work.
...	...	...	...	...	64,530 (k)	(m) ,, ₹3,505 expended on the completion of Benares records and ₹5,924 on 2″ and 4″ mapping.
...	...	...	...	...	70 548	
...	...	...	...	...	31,893	(n) Includes cost of transporting the party to Bilaspur (about ₹5,500) and R6,763, cost of tent equipment—Rates of first season in a new district.
						(o) Includes ₹524 expended on completion of Diwara sheets on 4″ scale. Includes R1,387 expended on survey and mapping of an overlap in District Sarun on 2″ scale. Includes ₹2,650 expended on work done elsewhere.
10·2	...	...	...	...	1,78,890 (l)	
3·7	40 5	0 5	47·0	0 6	1,63,723(m)	(p) Includes R1,220 expended on Revision Survey and ₹1,748 on 2″ mapping.
1·5	82·0	2 2	...	...	1,34,940(n)	
10·3	30 5	0 5	38·5	0 7	1,57,986 (o)	(r) Includes R4,906 expended on salaries and travelling allowances prior to commencement of operations at Mozufferpore and R5,633 cost of tent equipment—Rates of first season in a new district.
...	68·6	3 5	...	...	95,285(p)	
14·2	59·5	0 8	69·5	0 9	1,23,566 (r)	
						(s) Not deducible.
...	...	...	...	...	52,620	
...	...	...	...	...	30,264	
...	...	...	...	...	52,529	
...	...	...	...	...	60,464	

Tabulated Statement of the principal Records prepared in the several Recess Offices of the Field Parties of the Revenue Branch for the year ending 30th September 1886.

Province and District.	Survey Party.	Mapping.						Traverses.		Field Books.		Area Books.		For Settlement Department.		Remarks.
		Original field Sections.	Cadastral 16-inch sheets.	Sheets 4 inches = 1 mile $7\frac{1}{2}' \times 3\frac{3}{4}'$.	Quarter sheets 2 inches = 1 mile $15' \times 7\frac{1}{2}'$.	Index Maps.	Triangulation Charts.	Main circuit with azimuth computations. Vols.	Village or sub-circuit. Vols.	Main circuit. Vols.	Village or sub-circuit. Vols.	Villages.	Fields.	Sheets or traces.	Village areas or khasras.	
North-West Provinces.						Cadastral Surveys.										
Basti	No. IV	5 on 4"	1,535 on 16" 49 on 24" 24 on 32"	10	13	1	...	1 1 Az.	7	1	7	2,276	1,126,230	2,276	2,276	
Gorakhpur	No. V	...	1,447 on 16"	...	...	...	...	1 1 Az.	8	1	14	1,251	894,221	1,251	1,251	
Central Provinces.																
Bilaspur	No. II	...	854	...	...	2	...	2 1 Az.	7	2	7	647	370,569	649	649	
Burma.																
Akyab	No. VII	...	915	...	30	...	...	2	4	2	8	337	694,056	337	337	Also 288 Nisf Kheraj area statements. 66 Lakhiraj area statements. 2 Waste land Grants. 3 Reserved Forest. 70 Jungle Sections.
Assam.																
Kámrúp	No. VI	...	653	...	17	1	...	1 1 Az.	2	1	3	319	147,818	319	319	
Bengal.																
Mozufferpore	No. VIII	...	734	...	...	3	...	1	7	2	15	656	582,200	656	656	
Central Provinces.						Traverse Surveys.										
Jubbulpore and Damoh	No. IX	...	...	...	...	1	...	4	10	6	18	...	...	...	..	
Raipur	No. III	...	...	...	...	...	...	2	5	1	18	...	...	.. (a)	...	(a) Skeleton traverse sheets on the 16" scale are being furnished for the use of the Settlement Surveys, number not yet known. Copies of village traverse tables are also being furnished. (b) Skeleton traverse sheets. (c) Skeleton traverse sheets of 57 villages. (d) Details obtained by reduction from Settlement Survey maps. (e) Copies of village traverse data. (f) Index charts to traverses.
Sambalpur	Detacht.	...	...	...	...	1	...	1	3	1	9	...	...	735(b)	..	
Rajputana.																
Ajmere	Detacht.	1 on 4" Forest	...	...	10 (Skeleton Plots)	...	...	...	1	...	2	...	...	266(c)	...	
Punjab.						Topographical Surveys.										
Hoshiárpur	No I	135 on 2" (d)	...	...	24	2	...	2	...	1	3	...	...	1,325(e)	33(f)	
Gurdáspur								...	...	1	.	...	...	..	..	
Jullundur								...	...	...	1	...	...	557(e)	2 (f)	
Kapurthala State								1	...	1	2	...	...	..	.	
Ludhiána								..	...	...	...	...	...	424(e)	32(f)	
Umballa								2	...	1	2	...	...	690(e)	17(f)	
Bombay.																
Belgaum, Dhárwár, and Savantvádi State	No. X	21 on 2"	...	6 Forest on 8"	16	...	3	...	1	...	2	...	...	...	...	Vols. Horizontal Angle Books . 5 Abstract of ditto . 4 Vertical Angle Books . 5 Abstract of ditto . 4 Computation of co-ordinates, triangles and heights . . . 5
Kolába, Ratnágiri, Sátára and States under Southern Marátha Agency	No. XI	26 on 2"	...	...	14	2 Trav. Charts.	2	...	3	...	4	...	...	...	...	

Abstract of Area and Cost of the Revenue Branch Parties according to Jurisdictions.

Provinces.	Scale of Survey.	Area in square miles.	Cost.	Remarks.
			£	
North-West Provinces	16 inches = 1 mile	1,603	3,21,709	
	4 do. = 1 do.	36		
Bengal	16 do. = 1 do.	414	1,23,566	
Punjab	2 do. = 1 do.	2,624(*a*)	64,530	(*a*) Topography tested only on maps compiled from the Settlement Survey Maps.
Assam	16 do. = 1 do.	468	95,285	
Lower Burma	16 do. = 1 do.	661	1,78,890	
Bombay	2 do. = 1 do.	3,348	1,05,741	
Central Provinces	16 do. = 1 do.	763	1,34,940	
	. . . . .	5,269(*b*)	1,78,453	(*b*) Traverse Skeleton Survey. Maps are plotted on 16-inch scale.
Rajputana	Ditto	243(*c*)	11,247	(*c*) Traverse Skeleton Survey with village boundaries.
	Total	15,429	12,14,361	

Note.—The areas of preparatory boundary traversing executed by cadastral survey parties have not been included in this statement.

PART III.

THE OPERATIONS AT THE SEVERAL HEAD-QUARTERS OFFICES.

1. These offices comprise—

(1) The Survey of India Offices at the Presidency.

(2) The Trigonometrical Branch Offices at Dehra Dun.

There has been little or no change in the general arrangement of these offices during the year under report, except that on the transfer of Lieutenant-Colonel W. H. Wilkins, S.C., the permanent charge of the Map Record and Issue Office was assigned to one of the Assistant Surveyors General. The work in all the offices has continued to increase.

Personnel.

Lieutenant-Colonel H. R. Thuillier, R.E., Deputy Surveyor-General, in charge Revenue Surveys, up to 10th March 1886.

Colonel J. Sconce, S.C., Deputy Surveyor-General, in charge Revenue Surveys, from 11th March 1886.

Colonel D. Macdonald, S.C., Officiating Deputy Superintendent, 1st grade, on duty from 9th March 1886, and Officiating Assistant Surveyor-General, from 21st March 1886.

Major C. Strahan, R.E., Deputy Superintendent, 2nd grade, Assistant Surveyor General, up to 16th April 1886.

Lieutenant-Colonel W. H. Wilkins, S.C., Officiating Deputy Superintendent, 2nd grade, up to 2nd November 1885.

Major M. W. Rogers, R.E., Deputy Superintendent, 3rd grade, Assistant Surveyor General, up to 20th March 1886.

Lieutenant-Colonel R. Beavan, S.C., Officiating Deputy Superintendent, 3rd grade, on duty from 10th April 1886, and Officiating Assistant Surveyor General from 17th April 1886.

Lieutenant G. B. Hodgson, S.C., Officiating Deputy Superintendent, 4th grade.

SURVEY OF INDIA OFFICES.

Mr. T. W. Babonau, Registrar.

SURVEYOR GENERAL'S OFFICE.

Mr. M. Francis, Head Clerk.
Babu Banee Madhub Banerjee.
„ Chuni Lall Dey, and one other.

Accounts Section.

Mr. E. D. Algar, Head Accountant, up to 16th July 1886.
Babu Bama Churn Chuckerbutty, Officiating Head Accountant, from 17th July 1886.
„ Raj Krishna Mookerjee.
„ Okhoy Coomar Dutt, (died 29th September 1886) and six others.

General Section.

Mr. J. A. Vallis, Examiner, up to 16th July 1886.
„ T. E. Ware, ditto, from 17th July 1886, on furlough.
Babu Doorga Narain Ghose, Officiating Examiner, from 17th July 1886.
Mr. H. R. D'Mello.
Babu Bheecum Singh.
„ Gopal Chunder Doss, and eight others.

REVENUE SURVEY BRANCH OFFICE.

Mr. A. C. Cunningham, Head Clerk, retired 17th July 1886.
„ E. D. Algar, ditto. from 17th July 1886.
Babu Kalipodo Banerjee.
„ Ram Kristo Chunder.
„ Raj Coomar Dutt.

TOPOGRAPHICAL SURVEY BRANCH OFFICE.

Mr. T. E. Ware, Head Clerk, up to 16th July 1886, furlough from 1st April 1886.
„ J. A. Vallis, Head Clerk, from 17th July 1886.
Babu Doorga Narain Ghose, up to 10th July 1886.

MAP RECORD AND ISSUE OFFICE.

Mr. A. E. Byrn, Head Assistant.
„ H. R. Vallis, Map Curator, and thirteen others.

DRAWING OFFICE.

Mr. G. A. McGill, Chief Draftsman.
„ S. M. Smylie, Head ditto, up to 26th June 1886.
„ P. J. W. Doran, Draftsman, from 1st August 1886.
„ W. Green, Draftsman.
„ J. R. Adels, ditto.
„ A. J. Musgrove, ditto.
„ R. Sinclair ditto.
„ A S. Bateman, ditto.
„ G. Gill, ditto, and two others.

Native Draftsmen.

Munshi Sonaullah.
„ Nabi Buksh.
Babu Harihur Sen.
„ Mohesh Chunder Shaw.
Munshi Muttiullah.
Babu Purna Chunder Sen.
„ Gopal Chunder Roy, and 36 others.

Surveyors and Assistant Surveyors on duty.

Mr. S. M. Smylie, Surveyor, 1st grade, from 27th June 1886.
„ F. Adams, Surveyor, 2nd grade.
„ A. G. Wyatt, do, 3rd do
„ S. O. Madras, Assistant Surveyor, 1st grade.
„ E. J. Martin, ditto, do.
„ B M. Wilson, ditto, 2nd grade.
„ J. A. Higgs, ditto, do.
from 1st July 1886.

Sub-surveyors on duty.

Babu Modhu Sudun Dutt, and one other.

Additional Establishment.

Mr. W. Stotesbury, Draftsman.
„ P. J. W. Doran, ditto, up to 31st July 1886, and seven others.

ENGRAVING OFFICE.

Mr. C. W. Coard, Superintendent.
„ W. Donaldson, on furlough, from 6th June 1886.
„ G. G. Palmer.
„ D. L. Mitchell.
„ J. Fulford.
„ T. B. Rodger.
„ A. G. Palmer.
„ S. M. Coard.
„ A. W. N. James.
„ A. R. Coard.
„ A. D. M. Chamarett, on leave, from 8th May 1886
„ E. C. Ollenbach, on leave, from 19th July 1886.
4 Apprentices and 25 Native Engravers, and 1 Storekeeper.

Copper-plate Printing Section.

Mr. W. T. Collins, Copper-plate Printer, and 15 Native Printers, and Pressmen

2. The duties of the Surveyor-General's and the Topographical Branch Offices were carried on by Major M. W. Rogers, R.E., up to the 20th March 1886, and thereafter by Colonel D. Macdonald, S.C.

3. The Revenue Survey Branch Office was supervised by Lieutenant-Colonel H. R. Thuillier, R.E., up to the 10th March 1886, and subsequently by Colonel J. Sconce, S.C., on his return from furlough, who carried on the duties connected with the accounts as well as the correspondence of this Branch.

The Drawing, Engraving and Map Record and Issue Offices were supervised by Major C. Strahan, R.E., up to the 16th April 1886, and thereafter by Lieutenant-Colonel R. Beavan, S.C.

Lieutenant G. B. Hodgson, S.C., has continued to hold the post of Personal Assistant to the Surveyor-General.*

MAP RECORD AND ISSUE OFFICE.

4. From the 1st October 1885 up to the 15th April 1886, Major C. Strahan, R.E., Deputy Superintendent, 2nd grade, and Assistant Surveyor General, held charge of the Map Record and Issue Office. He was relieved by Lieutenant-Colonel R. Beavan, B.S.C., Deputy Superintendent, officiating 3rd grade, who has since superintended it.

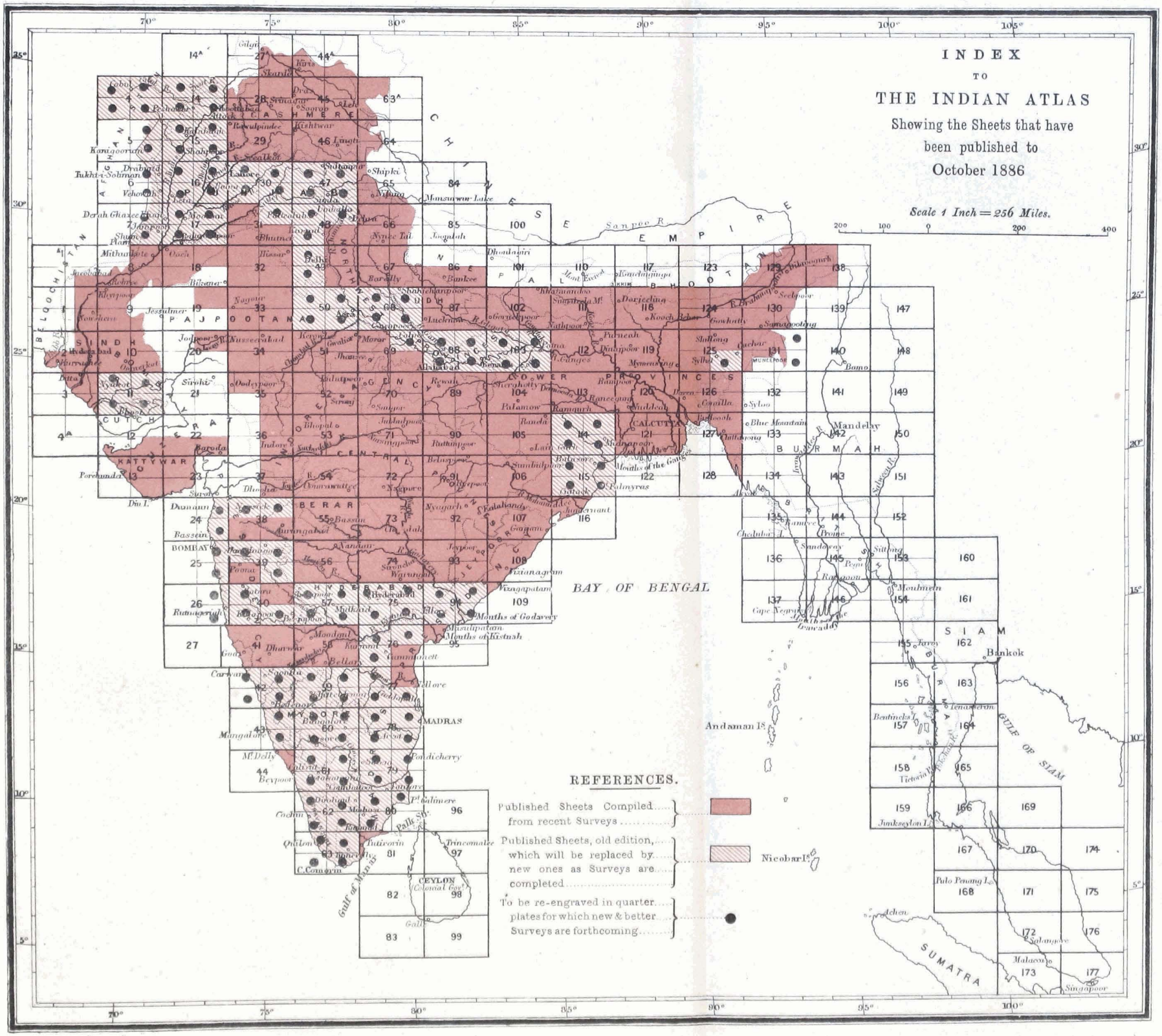
5. The number of maps issued during the year under review is shown in the following statement :—

Maps issued.	Number.	Value.
		₹
General maps to Government officials	64,028	51,410
Ditto to India Office, London	4,084	6,028
Ditto to Agents	2,748	4,740
Total .	70,860	62,178
Cadastral maps to Government officials	1,39,428	1,04,571
Grand Total .	2,10,288	1,66,749

6. As compared with the previous year, there is a decrease in the number of maps issued to Government officials, both general maps and cadastral, but owing to the increased number of maps sent to England and to agents for sale, the total number of general maps issued is somewhat larger than was issued in 1884-85. Since April, a new system has been introduced of debiting other departments with the value of all maps issued on public service. This may be expected to have the effect of reducing for a time the numbers of maps indented for by officials, but at the same time it increases materially the clerical work of this office.

7. The number of applications for copies of maps is almost the same as during the previous twelve months. In the Revenue section of this office, 617 applications were received for extracts from the original records of the Revenue surveys, and 2,638 copies of village plans were supplied at a cost of ₹5,494, which was recovered from the applicants.

* Colonel Macdonald reports as follows :—
The Registrar of the Survey of India Office, Mr. Babonau, has, as usual, performed his duties in a very satisfactory manner.
Mr. Francis, Head Clerk, Surveyor-General's Office, Mr. E. D. Algar, Head Accountant, and Mr. J. A. Vallis, Head Clerk, Topographical Branch, have all worked hard and steadily.
Babus Bance Madhub Banerjee, Doorga Narain Ghose, Bamachurn Chuckerbutty, Bheecum Singh, Chuni Lall Dey, Rajkrishna Mookerjee, and the remaining clerks have been regular in their attendance, and attentive to their duties.
In the Revenue Branch Office, the Deputy Surveyor General reports most favourably of Mr. E. D. Algar and Babu Kali Podo Banerjee, and names Babus Ram Kristo Chunder and Raj Coomar Dutt as deserving of mention.
Mr. A. C. Cunningham, late Head Clerk of the Revenue Branch Office, retired on a pension on 17th July 1886, after a total service of over 30 years, but he lived to enjoy his pension for only three months.



Published under the direction of Lieut. Colonel H. R. Thuillier, R.E., *Officiating Surveyor General of India,*
Survey of India Offices, Calcutta, January 1887.

8. The following statement gives the income from map sales:—

	R	a.	p.
Realised from map sales and paid into the Government Treasury	7,741	0	0
Realised from map agents	991	14	0
Total	8,732	14	0

9. The following figures show briefly the details of work:—

Applications received for maps by letters, indents and telegrams	2,387
Letters issued in reply	2,788
Invoices and receipts issued for published maps	1,773
Ditto ditto for cadastral do.	290
Ditto ditto for extracts from original records	210
Packets, parcels and town despatches	2,685
Packages despatched by rail and steamer	254
Published maps, coloured for sale and issue	20,396
Ditto ditto for other departments	2,630

10. The publication of the new Catalogue of Maps published by the Department is being proceeded with. Two parts, those of the Atlas of India and the Punjab, have already been issued, and those of the remaining Provinces are in various stages of progress. Mr. J. P. Doran has been employed chiefly on this work, besides attending to the arrangement and sorting of the maps and the completion of the racks. The latter, as reported last year, are practically complete, that is, in their present state, they are sufficient for all probable requirements for some time to come, but still there are some minor additions which will have to be carried on by degrees as money is available from time to time: a considerable amount of work has been done in this direction during the past year.*

DRAWING OFFICE.

11. Up to the 15th April 1886, the duties connected with the Drawing Office were supervised by Major C. Strahan, R.E. Since that date they have been under the superintendence of Lieutenant-Colonel R. Beavan, B.S.C.

12. This office is divided into three Sections—Section I dealing with new compilations and all maps connected with the Topographical Surveys; Section II with the maps connected with Revenue Surveys, other than Cadastral; and Section III, which deals with Cadastral maps only. A statement in detail is given in the appendix, of the amount of work turned out in the various sections.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILATION.

13. Section I has been kept fully occupied during the past year. A great deal of work has been done for the Indian and Colonial Exhibition in London. A map of the world on Mercator's projection was prepared, showing the import and export trade of India with other countries during 1884-85. A series of maps was also prepared with a view to showing at a glance the percentage of various crops grown in different districts of India. These were coloured by hand on the 64-mile outline map of India. The maps to illustrate the Density of Population, Emigration, External trade, Land settlement and revenue, Geology, &c., of India have been completed, as well as the Religion map which was described in last year's report.

14. The model of India in relief, which was alluded to in last year's report as being then under preparation by Major C. Strahan, was completed and sent to the London Exhibition; it was prepared in plaster-of-paris and coloured by hand. Another cast has been taken, and this will be completed for His Excellency the Viceroy, by special request.

* Colonel Beavan reports that Mr. A. E. Byrn has worked hard, and that Messrs. H. R. Vallis and B. M. Wilson have discharged their duties most efficiently. Mr. Doran has worked well and steadily; Sub-surveyors Madhu sudan Dutt, Babu Ashutosh Kar, Mr. S. Hazrah and the other clerks employed in the office have all worked hard and rendered good service.

15. Three small skeleton maps have been drawn, showing (*a*) the Burma and Assam Frontier, (*b*) the Punjab and Afghanistan Frontier, (*c*) the Sind and Baluchistan Frontier. These maps are intended for attachment to official reports, for the illustration of political questions dealing with large areas of country, on which any routes for transfrontier railways or expeditions can be readily sketched in by hand.

16. Several large maps of India on the 32-mile scale have been prepared for general use, similar to the well-known "Railway map"; one showing Canals, another Feeders to Railways, Roads, &c., and a skeleton map for lecture rooms and schools. The last has also been published on a smaller scale.

17. The small District maps for Administration Reports have all been completed, excepting those of two districts in Assam and two in the Central Provinces. These maps have entailed a great deal of work in the Drawing Office, and it is to be hoped that they will be appreciated by the District officials for whose use they have been prepared.

18. Several quarter-sheets of the Indian Atlas have been specially prepared by hand for the purpose of experimenting in different methods of reproduction, one having been drawn for reproduction by photo-zincography and others in different styles for heliogravure, with a view to ascertain which is the best method.

19. The regular work of the section has progressed well; 25 Atlas Sheets are in hand, in different stages of progress, under preparation for the Engraving Office. Several odd jobs have also been done for Government and various officials.

20. Twelve District maps on the $\frac{1}{4}$-inch scale have been prepared from Atlas Sheets or corrected to date, and the Provincial maps on the 16-mile scale have been proceeded with. Additions have been made to the new 32-mile map of India which is being engraved. It is intended to have this map transferred to stone, and the small portion that still remains unengraved, will be drawn on the stone by hand, so that a preliminary edition of this beautiful map will be available for issue to the public in a few months.

21. As usual, the fair standard sheets received from field parties have been examined, and passed on to the Photographic Office for reproduction. A great deal of work had to be done on these sheets in many cases before they could be published, but steps have been taken to have them prepared in the field party offices in a strictly uniform manner, so that in future the amount of this kind of work will be very greatly reduced.

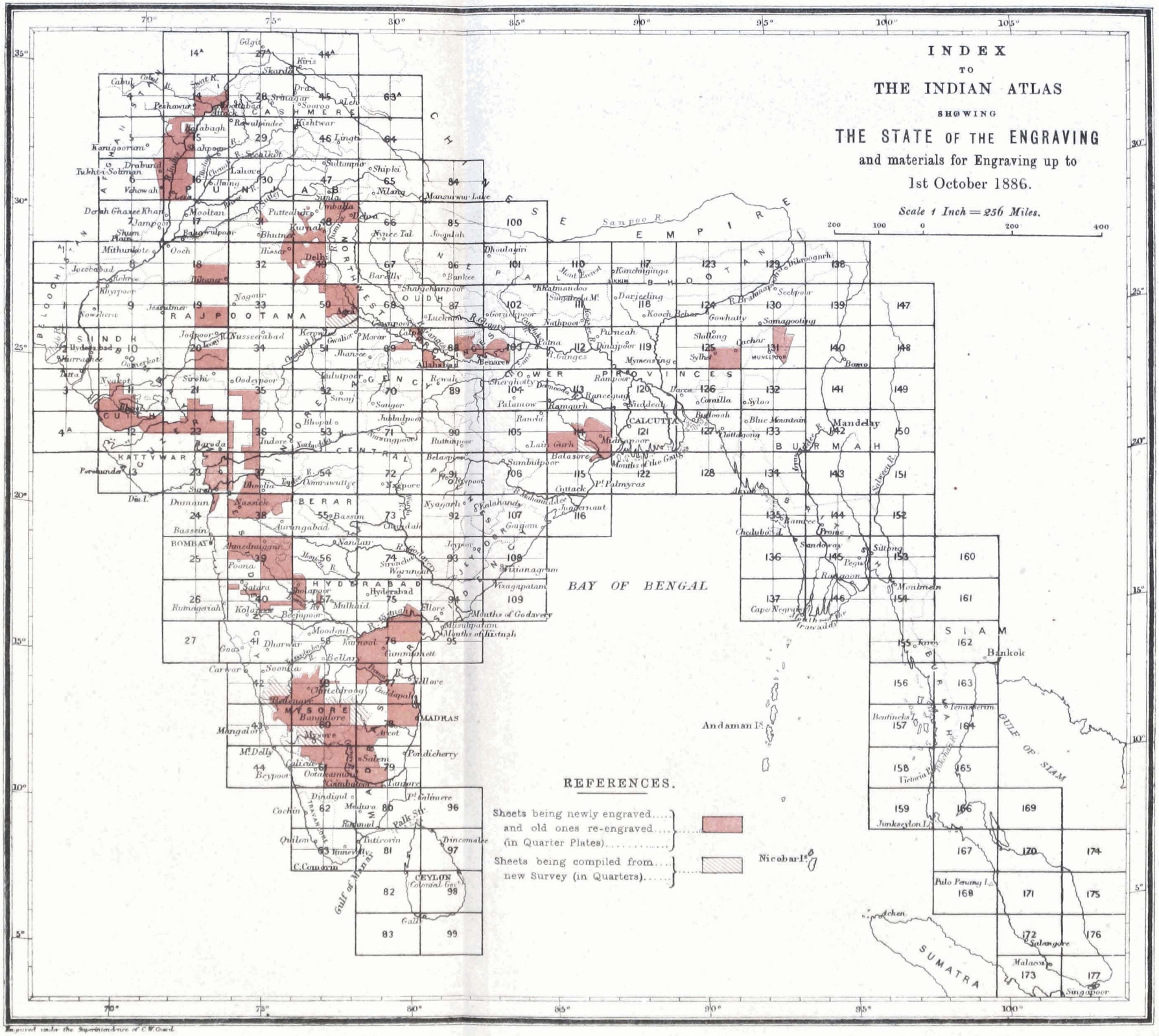
22. The preparation of the Index maps for the Annual Report has been comparatively simple this year, as in most cases those used for last year's Report have sufficed, with the necessary additions, to bring them up to date.

SECTION II.—REVENUE MAPPING.

23. In this section much work has been done for various Government officials in preparing copies of Revenue records as shown in the appendix. A considerable number of maps have also been coloured. All the fair maps sent in by the field parties have been examined, and the headings, foot-notes, &c. have been rectified and made complete for photo-zincography. Part of the special work performed during the year by this section is the preparation of the maps of Districts Prome, Tharawaddy and Henzada on the 2-inch scale for reduction to 1-inch, as well as those of Districts Gorakhpur and Mirzapur. A new map of the city and cantonment of Benares has been taken in hand. It is to be drawn on the scale of 8 inches to the mile by reduction from the cadastral sheets.

SECTION III.—CADASTRAL MAPPING.

24. The work in this section has proceeded steadily. The number of sheets sent to press is somewhat less than during the previous year, but this is entirely due to the fact that the supply from field parties was smaller; on the other hand, a large number of volumes (46), containing original survey sheets, have been arranged and bound up for record, and 150 volumes containing sets of printed sheets have been prepared for the Government of Burma.



Published under the direction of Lieut. Colonel H. R. Thuillier. R.E., *Officiating Surveyor General of India, Survey of India Offices, Calcutta, January* 1887.

25. The publication of the cadastral maps of Districts Benares and Ballia was completed during the year; also of the districts of Prome, Bassein and Henzada in Lower Burma, and of Pooree District (Khorda Estate) in Bengal: of Dehra Dun, a few sheets only remain unpublished.

26. The map of the city of Benares on the 32-inch scale occupies 5 sheets. The *mohulla* names were given on separate sheets with a view to their being printed in red, but this was found impracticable, as the blocks of buildings had been shaded with fine lines, and the names could not be printed clearly on the face of the map. The only alternative was to give the names in a separate reduced index map on the margin of each sheet.

27. The large scale plans of the towns of Akyab, Prome, and Henzada, (scale 64 inches = 1 mile) have also passed through this office. In addition to the number of copies of cadastral maps that are usually ordered, a few extra copies of these city plans have been printed for stock, as they will probably be wanted by the local officials, or private individuals, in the future.*

THE ENGRAVING OFFICE.

28. During the year, three of the European engravers have been on long leave—two letter engravers and one hill etcher: the native hill etcher, who was taken by Colonel Waterhouse last year for heliogravure work, has been employed by him during the whole of this. The amount of outlining and lettering is slightly below last year's out-turn, consequent upon the absence of the engravers on leave. The hill etching is above last year's out-turn, while the engraving of other details is below it; still the aggregate work in this branch is slightly above last year's amount.

29. The out-turn of work of the Printing Section is much above that shown in last year's report, and is the largest ever accomplished by this branch; it continues to increase very rapidly and great want of space is felt as the work grows.

30. The new map of India in six sheets, on the scale of 1 inch = 32 miles is well advanced; the hill work in sheet 3 is being completed from recent surveys, and railways, &c., to date are being engraved in sheets 4, 5 and 6. Duplicate plates of sheets 1 and 2 have been prepared by the electrotype process, and the remaining sheets will be treated in the same manner in order that one set of plates may contain only material derived from actual survey, while the other set will be completed from any geographical information that may be available, such as route surveys and reconnaissances and will be kept up to date and corrected year by year. The two maps of India on the scale of 1 inch = 64 miles (with and without hills) have been brought up to date.

31. The provincial map of Bengal in two sheets on the scale of 1 inch = 16 miles is making good progress. Sheet 1 is nearly completed, but the hill etching of sheet 2 remains to be done. Rajputana, on the 16-mile scale, is complete so far as surveys have yet extended, but a small portion of country is still unsurveyed. Meanwhile, the map will be printed from stone in the Lithographic Office. A map of the Punjab on the same scale is being engraved, and one of the North-West Provinces and Oudh has been commenced. Additions have been made to the maps of Assam, the Central Provinces, the Central India Agency, and the Patna Division, and several miscellaneous plates have been completed, among which are a map of Berar, a form of Commission for Native Officers, the Viceroy's Arms, six plates ruled for Tints, and numerous Scales of different kinds.

32. Of the sheets of the Atlas of India, which are engraved on a uniform scale of $\frac{1}{4}$ inch = 1 mile, sixteen new quarter-sheets have been projected during

* Section I has been under the immediate charge of Mr. G. A. McGill, Chief Draftsman, who has conducted the duties of his post in a most efficient manner; the Revenue Section has been in charge of Mr. S. M. Smylie, Head Draftsman. Both of these officers are old and well-tried surveyors and have, during the past year, fully kept up their previous reputation. Mr. Stotesbury is also a reliable and hard-working surveyor who has had charge of the cadastral section. Mr. F. Adams has had charge of the Examining Branch of Section I, which is located in a separate room, and almost forms a separate section. Here every topographical, general, or engraved map has to undergo a strict scrutiny before it is published, and the press of work is usually very heavy.

The following Surveyors and Assistant Surveyors have also been employed in the Drawing Office, *viz.*:—Mr. A. G. Wyatt, Mr. S. O. Madras, Mr. E. J. Martin, and Mr. J. A. Higgs. They have all worked steadily and well. The European and native draftsmen have done good work.

the year, thirty-eight have been repaired and added to, and nine have been completed and published. At present there are sixty-one plates in hand in various stages of progress. During the past twelve months 253 plates have been worked upon in this office. The hill etching done covered 1,552 square inches of copper plate, 324,589 letters were cut and 2,727 square inches of topographical detail. In the Printing room 19,305 impressions were pulled. The detailed statement of work done during the year will be found at page lxxix of the appendix.*

THE PHOTOGRAPHIC OFFICE.

33. Lieutenant-Colonel J. Waterhouse remained in charge of the office until the 21st March, when he was obliged from ill-health to take short furlough to Europe, and Lieutenant-Colonel W. F. Badgley officiated for him until the close of the year. Lieutenant J. M. Fleming remained attached as Assistant Superintendent until 9th August, when he was transferred to the Baluchistan Topographical Party. As it was considered desirable to have a second officer in training in the Photographic and Lithographic Offices, Mr. T. A. Pope of the Madras Revenue Survey, who had been very favourably reported on as likely to prove well qualified for the post, was transferred from the Madras Survey, and appointed to the Survey of India as Assistant Superintendent. He joined the office on 14th October 1886.

Personnel.

Lieutenant-Colonel J. Waterhouse, B.S.C., Assistant Surveyor General in charge, on furlough from the 21st March 1886.
Lieutenant-Colonel W. F. Badgley, B.S.C., Officiating Assistant Surveyor General, in charge, from 21st March to 30th September 1886.
Lieutenant J. M. Fleming, Assistant Superintendent, from 1st October 1885 to 9th August 1886; transferred to the Baluchistan Topographical Party.

NEGATIVE SECTION.

Normal Establishment.

Mr. J. Mackenzie, Photographer.
„ C. DeCruze, Assistant ditto.
Ismail Khan, „ ditto.
2 Negative retouchers, 2 glass-cleaners, and 1 bhistie.

Cadastral Establishment.

Mr. C. Marshall, Photographer.
„ L. Lagnier, ditto.
„ T. Lloyd, Assistant ditto.
3 Assistant Photographers, 3 Negative retouchers, 5 glass-cleaners, and 1 bhistie.

PHOTOGRAPHIC TRANSFER PRINTING SECTION.

Normal Establishment.

Mr. J. Harrold, Photographer.
Habibul Hossain, Asst. ditto.
2 labourers.

Cadastral Establishment.

Mr. R. George, Photographer, in charge Silver Printing Section, from 1st October to 15th December 1885, in addition.
2 Assistant Photographers and 2 labourers.

SILVER PRINTING SECTION.

Normal Establishment.

Mr. G. G. Dempster, Photographer, working in the Negative Section (Normal Establishment).
1 Assistant Photographer and 1 labourer.

HELIOGRAVURE SECTION.

Normal Establishment.

Mr. A. W. Turner, Photo-Engraver.
Babu Joy Kristo Shaw, Engraver, drawing his pay from the Engraving Office.
1 Assistant Photographer, 1 copper-plate printer, and 4 pressmen.

COLLOTYPE SECTION.

Normal Establishment.

1 Printer, 1 glass-cleaner, and 2 pressmen.

ZINC PRINTING SECTION.

Normal Establishment.

Mr. B. Mackenzie, Zincographer.
1 Writer, 4 zinc-correctors, 5 zinc-printers, 4 spongemen, 3 zinc-grainers, and 17 pressmen.

Cadastral Establishment.

Mr. J. Watson, Zincographer.
„ E. A. LeFranc, ditto.
„ J. B. Mackenzie, Assistant Zincographer.
9 zinc-correctors, 1 writer, 9 zinc printers.
6 spongemen, 11 zinc-grainers, and 30 pressmen.

GENERAL OFFICE ESTABLISHMENT.

Normal Establishment.

Mr. W. Moore, Store-keeper.
Babu Kanny Lall Sen, Clerk and Accountant.
Babu Gopal Chunder Mookerji, Clerk.
1 Clerk.

Cadastral Establishment.

Mr. H. Haward, Head Assistant, in charge Collotype Section and also in charge Silver Printing Section, from 16th December 1885 to 30th September 1886.
1 Clerk and 1 extra Clerk.

APPRENTICES.

Normal Establishment.

Mr. C. Meade, working in the Silver Printing Section.
„ J. T. Meade, working in the Collotype Section.
„ U. S. Ravenscroft, working in the Zinc Printing Section (Cadastral), from 1st October 1885 to 31st August 1886. Transferred to the Lithographic Office, 1st September 1886.
P. C. Michael, working in the Negative Section.

34. The out-turn of the office, as shown in the annexed abstract, has again been very large, and in the Zinc Printing Section shows a considerable increase. In the Normal Sections, engaged in the ordinary departmental and extra-departmental work, the number of subjects reproduced shows a falling off, though still much above the average, being

* Mr. C. W. Coard, Superintendent, has conducted the duties of this office in a very satisfactory manner. His tenure of the appointment has been further extended for another twelve months. During Mr. Coard's absence on privilege leave Mr. G. G. Palmer officiated for him. The work turned out by this office is of the usual high quality, and the amount done proves that the engravers and printers have worked well and steadily. The Europeans and, with few exceptions, the natives have done very well.

1,518 (892 departmental and 626 extra-departmental), while last year it was 1,702 (853 departmental and 849 extra-departmental). The number of negatives taken has risen, from 2,573 to 2,671, including 70 reversed negatives and transparencies. The number of zinc-plates printed is less by 103 than it was last year, but the number of press pulls, which is the real criterion of the work done, exceeded that of last year by 29,892, while the number of complete copies was larger by 108,619; this is due to the comparatively large amount of small subjects, several going on one plate.

35. The amount of silver printing is again comparatively large and shows an increase of 1,493 over last year, due to a large order for copies of the sketches done by Major E. L. Durand, attached to the Afghan Boundary Commission, as well as for photographs taken in connection with the Indo-Colonial Exhibition. The out-turn of the heliogravure and collotype prints has not been quite so large as last year, but the processes are progressing satisfactorily. A very large increase of electrotyping work has been done during the year in duplicating the engraved copper-plates of the Atlas of India and Standard Maps.

36. In the Cadastral Sections the out-turn has been well up to the average, the number of sheets printed off being 122 more than last year, though the number of pulls is 16,008 less, owing to smaller numbers being printed.

General Abstract of Out-turn and Value of work done between 1st October 1885 and 30th September 1886.

Description of Work.	Number of Sheets, Sections, or Subjects.	Negatives.		Photo-zincographic Printing.					Silver and other Printing.			Heliogravure and Electro-typing.					Photo-collotype.		Value.
		Number of Negatives, (Direct).	Number of Negatives (reversed) and transparencies.	Number of Photo. transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies	Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Plates, Photo-electrotyped.	Heliogravure Plates, Photo-etched.	Heliogravure Prints.	Photo-Blocks.	Electrotypes.	Photo-collotype Plates.	Photo-collotype Prints.	
																			R a. p.
Departmental Maps and Plans .	892	1,901	11	1,848	602	612	96,361	150,219	170	152	39	3	7	...	2	13	21	845	52,502 12 11
Cadastral Maps	5,203	3,387	...	3,492	5,245	5,282	154,898	144,760	...	...	...	...	...	...	...	...	...	...	73,615 14 0
Extra-Departmental Maps and Plans	626	700	59	472	208	211	55,440	117,770	5,229	20	48	9	11	...	1	...	22	4,035	27,749 7 0
Total . .	6,721	5,988	70	5,812	6,055	6,105	306,699	412,749	5,399	172	87	12	18	...	3	13	43	4,880	1,53,867 1 11

37. The total cost of the office amounted to ₹1,66,122-9-9, as far as can be estimated, while the value of work done and other credits amounted to ₹1,58,149-14-6, thus showing a balance against the Department of ₹7,972-11-3. This, however, is explained by the fact that owing to supplies of paper for 1885-86, arriving later than usual, their cost, amounting to ₹40,531-13-0, is included in this year's accounts instead of last year's, unduly increasing the balance in favour of the office last year and against it this year.

38. Under the orders of Government a strict system of book-debit for work done for other departments was introduced from the 1st April. A system of noting the value of all work done for other departments had already been in existence for some time past and fixed rates had been established for all classes of the work ordinarily done in the office. The rates were carefully revised and the charges for zinc and litho. printing modified, so as to enable one set of rates to be used by the Photographic and Lithographic Offices here and by the Photo-zincographic Office at Dehra Dun. The new system entailed a good deal more work, and the appointment of an additional clerk was sanctioned for this purpose. As far as can be judged at present, after a few months' experience, the new system has worked well and the rates seem to be about correct, but they will be revised, if necessary, before the commencement of the new financial year.

39. There is nothing specially worthy of note in connection with the ordinary work of the office during the year. The departmental publications have been larger than usual and include, among the General maps, a Map of India showing Feeders to Railways, on the scale of 1 inch = 32 miles, and a reprint

of the Railway Map on the same scale. Among the Provincial maps, a Map of the Central Provinces on the scale of 1 inch=32 miles. A very large number of the District maps on the scale of 1 inch=8 miles was printed off. These maps have been specially prepared for the illustration of Administration Reports, and should be very useful for that purpose. The detailed list of the districts published will be found in the appendix.

40. Three hundred and fifty-nine sheets of standard maps have been printed, including 6 sheets of the Andaman Survey; 38 sheets of the Burma Survey in Districts Pegu and Hanthawaddy, Tharrawaddy and Bassein; 40 sheets of the Gujarát Survey; 23 of District Hissar; 52 sheets of the Hooghly River Survey; 21 of the Kathiawar Survey; 42 of the Konkan Survey; 16 of District Montgomery and 14 of the Mysore Survey. Among City and Cantonment plans may be mentioned—the City of Mysore on the scale of 12 inches = 1 mile, Ajmere City and Environs; City and Cantonment of Bhuj. Of the extra-departmental work may be noted maps of Burma and regions adjacent for the Quartermaster General's Department and maps, for the Camp of Exercise, of the country between Umballa and Delhi. Several military maps of country 10 miles round various cantonments, have been reproduced in this office, as well as in the Lithographic Office, under the direction of the Intelligence Branch of the Quartermaster General's Department. These maps are from special surveys made by officers of the garrisons, and in many cases are fit for reproduction by photo-zincography; in other cases they are lithographed. Three river charts have been reproduced for the Port Officer. The campaign in Burma has not given so much work as might have been expected, but a good deal has been done in the way of reproducing sketches and maps for the use of the force. For the Meteorological Department a series of Wind Charts of the Bay of Bengal were reproduced. For the Telegraph Department an extensive series of diagrams of telegraph stores was reproduced, besides a Telegraph Map of India.

41. The Photo-collotype process has been making good progress during the year and has been utilised in various ways for extra-departmental work. Some plates of very small coins have been reproduced for the Asiatic Society, also some plates of microscopic sections of tree fungi, from the original negatives by Dr. A. Barclay. Prints were also made of some enlargements of maps of the Ordnance Survey for the use of draughtsmen and engravers. Experiments have been made with fair promise of success in transfer from photo-collotype plates to stone.

42. The heliogravure processes have also made fair progress, though the out-turn has not been so large as last year. Some very successful transfers to stone were made from specially prepared photo-electrotype plates, and though more expensive and slower, this method appears likely to offer the most satisfactory solution of the problem how to break up the delicate photographic image sufficiently to print clearly from stone or zinc without destroying fine details.

43. The electrotyping arrangements have been greatly extended during the year with the object of duplicating incomplete Atlas sheets and standard maps, so that they may be temporarily completed for issue pending the engraving of the final results. This is a very valuable addition to the capabilities of the office and will prove of great utility, especially as no difficulty has been found in duplicating sheets up to the size of double-elephant.

44. During the early part of the year under review the final plans and estimates for the new Photographic and Lithographic Offices were completed by the Government Architect, and after approval by the Surveyor General were returned to the Public Works Department, Government of Bengal. Urgent representations were again made to the Government of India regarding the early provision of suitable accommodation for these offices in one block of buildings—a question which has now been under consideration for the last 16 years. The Hon'ble Sir S. C. Bayley, K.C.S.I., visited the Offices in January 1886, to see the state of things. Owing, however, to financial difficulties it was found impossible to make any provision for this purpose in the Budget for the current year and nothing has since been done.

45. Lieutenant-Colonel Waterhouse has forcibly represented the evils and inconvenience of the present arrangements in a memo. prepared for Sir S. C. Bayley (printed in the appendix, p. lxxxv).

46. They may be summarised as follows:—

I.—The loss of money in house rent: the total amount paid yearly in rent for the three houses—No. 1, Camac Street (lower floor), occupied by the Lithographic Office, and Nos. 1 and 2 Wood Street, occupied by the Photographic Office, is ₹10,980, besides taxes, amounting to ₹943, or in all a sum of ₹11,923. Taking the cost of the new offices, as estimated, at about ₹2,16,000, the interest on this sum at 4 per cent., would amount to ₹8,640. It is clear, therefore, that the erection of the new building would effect a large saving in rent alone, while further savings would also accrue by the greater economy with which the offices could be worked when concentrated together, besides the increased efficiency, convenience, and other advantages in working that would be gained.

II.—The division of the Lithographic and Photographic Offices into three separate houses, the former at some distance from the latter, necessitates references and visits to and fro, and renders efficient supervision difficult. The zincographic and lithographic presses, all doing similar work, are distributed between the three houses and scattered in small rooms. Were they brought together in one large room, as proposed in the new buildings, there would be less loss of power, and better work could be done by the use of stone or zinc, as might be best suited to the particular class of work. The printing staff, being concentrated, could work together with greater advantage and economy, and the whole could be more effectively and easily superintended.

III —The present accommodation in private houses is quite unsuitable for technical offices—requiring special arrangements for water-supply, for washing negative plates and prints, and heating apparatus for drying sensitised papers and plates, also for working heavy presses and machinery. The want of proper permanent arrangements lowers efficiency.

IV.—The Photographic glass-house, originally built in 1869, in a light way, quite as a temporary measure, is very dilapidated and otherwise unsuitable for the work with large plates as now carried on. The touching up and finishing of negatives has to be done in an open tiled shed, exposed to all weathers. There is no proper place for storing negatives that are required for further use.

V.—The accommodation of the Silver-printing Section in an old cook-house, very damp and close to a drain is quite unsuitable for such work.

VI.—For want of proper store rooms the photographic chemicals, apparatus, and stores are scattered between Nos. 1 and 2 Wood Street, causing great inconvenience and making it exceedingly difficult to keep things in order and guard against loss and waste by spoiling.

VII.—In the Lithographic Office, besides the inconveniences of separation from the Photographic Office already noticed, the arrangements for the type printing are very cramped and unsuitable: there are no proper rooms for keeping stores or the fast-accumulating records and file proofs, and the printing machines cannot be worked by steam power.

47. The fact that the provision of new buildings for these offices has been under consideration for so many years with the constant prospect of something being done at an early date, has, in many ways, prevented better working arrangements being made, as it has always seemed undesirable to incur expenditure for temporary buildings or fixtures in these hired houses. Work has been regularly carried on and has largely increased in both offices in the face of many grave disadvantages and inconveniences, but the need for some better arrangements is none the less urgent, and it is to be hoped that the settlement of this important question may not be any longer delayed.

Further details of the working of the office and the different processes employed are given in the appendix.

48. While on furlough Lieutenant-Colonel Waterhouse visited, with the sanction of the Secretary of State, various establishments in England and on the Continent, with the object of acquiring information on the latest improvements. His report, which was submitted to the Secretary of State, has not yet been received.*

THE LITHOGRAPHIC OFFICE.

49. This office was in charge of Lieutenant-Colonel J. Waterhouse till the 20th March, when he proceeded on furlough, making over charge to Lieutenant-Colonel W. F. Badgley, who held it for the remainder of the survey year.

Personnel.

Lieutenant-Colonel J. Waterhouse, S.C., Assistant Surveyor General, in charge, from 1st October 1885 to 20th March 1886.
Lieutenant-Colonel W. F. Badgley, S.C., Officiating Assistant Surveyor General, in charge, from 21st March to 30th September 1886.
Lieutenant J. Fleming, S.C., Assistant Superintendent, from 1st October 1885 to 9th August 1886.
Mr. H. L. Lepage, Head Assistant.
Babu Ambica Churn Mookerji, Examiner.
Munshi Sobhan Buksh, and 24 others. } Draftsmen.
Mr. D. Deas, Head Lithographic Printer.
„ B. Wilson, Assistant Lithographic Printer, and 74 others.
„ E. DePyvah, Head Type Printer, and 25 others.
6 clerks and 12 others.
Mr. G. A. Lefranc, „ E. Dowling, } Apprentices.

50. The out-turn of lithographic work performed during the year, as shown in the annexed abstract, was again very large. The number of subjects printed off amounted to 677, of which 190 (including 75 forms) were departmental and 487 extra-departmental. Reckoned by the total number of pulls, 424,872, the number of impressions printed off was 92,654 more than last year, though the number of complete copies, 356,877, was 11,099 less than last year. This large increase is due to the larger number of departmental forms printed. The type work has again increased, the number of items set up being 5,566, and the number of copies printed off being 488,796, as against 5,687 items and 464,976 copies last year.

General Abstract of Out-turn and Value of work done between 1st October 1885 and 30th September 1886.

Description of Work.	Lithographic Printing.				Type Printing.		Total number of pulls.	Number of copies.	Value.	Remarks.
	Number of sheets or subjects.	Number of Stones.	Number of coloured copies.	Number of uncoloured copies.	Number of pages or items.	Number of copies.				
Departmental Work.									R a. p.	
General maps	22 / 7	42 / 14	612 / ...	1,262 / ...	... / ...	... / ...	9,221 / ...	1,874 / ...	2,710 8 0 / 383 15 0	Not yet printed.
Provincial maps	10	14	...	1,275	...	...	1,975	1,275	369 6 0	
District maps	4 / 5	4 / 5	... / ...	450 / ...	... / ...	... / ...	450 / ...	450 / ...	279 13 4 / 541 12 0	Ditto.
Plans of Cantonments and Cities	3	5	100	100	...	...	500	200	69 5 0	
Atlas sheets	2 / 1	2 / 1	... / ...	200 / ...	... / ...	... / ...	200 / ...	200 / ...	180 4 2 / 249 9 0	Ditto.
Standard sheets	14 / 5	14 / 5	... / ...	3,210 / ...	... / ...	... / ...	3,210 / ...	3,210 / ...	3,282 0 10 / 1,988 12 0	Ditto.
Index maps	5	11	2,500	500	...	...	5,550	3,000	315 14 8	
Miscellaneous	37	45	100	12,698	...	...	14,583	12,798	661 5 4	
Departmental forms	75	75	...	178,905	...	...	230,814	178,905	10,846 13 2	
Total	190	237	3,312	198,600	...	...	266,503	201,912	21,859 6 6	
Work done for other departments	487	420	20,845	134,120	...	...	158,369	154,965	27,226 7 5	
Total of Drawing and Printing in Lithographic Office, Survey of India Department	677	657	24,157	332,720	...	...	424,872	356,877	40,085 13 11	
Work done in Type Section	...	...	...	...	5,566	488,796	928,114	...	13,573 0 0	
Total Rupees	...	...	...	...	...	...	...	...	62,658 13 11	

51. The Military and Railway map of India, on the scale of 32 miles = 1 inch, in four colours, of which the commencement was noticed in last year's Report, has made good progress during the year. Four sheets have been completed and proofs forwarded for approval; 4 other sheets are in progress, and the whole map will probably take about eighteen months more to complete. It will be a very good specimen of chromo-lithography.

* Lieutenant-Colonel Waterhouse continues to report very favourably of his European assistants, Messrs. H. Haward, A. W. Turner, J. Mackenzie, B. Mackenzie, J. Watson, H. Harrold, C. Marshall, R. George, L. Lagnier, E. A. Lefranc, G. G. Dempster, T. Lloyd, and W. Moore, as well as the Head Clerk, Babu Kanny Lall Sen, who have all performed their duties very satisfactorily; also of the native clerks, draughtsmen and photographic assistants.

52. A great deal of work was done in the preparation and printing of a series of maps for the Statistical Atlas of India, prepared by Sir E. C. Buck for the Colonial and Indian Exhibition in London. Further progress was also made with the series of chromo-lithographed maps illustrating the material and physical state of India. A map showing the Density of Population, on the scale of 80 miles to the inch, was prepared but not printed. Also an External Trade Route Map, on the same scale, was prepared and printed. The Contour Map, on the 32-mile scale, and Religion Map, on the 80-mile scale, were printed off, and a Canal Map was prepared on the 32-mile scale.

53. Of the regular departmental work, the map of the Nizam's Dominions, in two sheets, on the scale of 1 inch = 16 miles, of which the completion was noticed in last year's Report, has been printed off. Three of the new standard sheets of Oudh, on the scale of 1 inch = 1 mile, have been drawn and 6 printed: 2 sheets of District Mymensingh were drawn, but none printed.

54. With the exceptions noted above, the extra-departmental work has been of the usual varied character, but shows a slight falling off in quantity, the outturn for the year being 158,369 pulls, or 154,965 complete copies of 487 subjects, as against 171,696 pulls or 201,770 complete copies of 522 subjects last year. The value of the work done has, however, increased, being R27,226-7-5, as against R24,266-12-0 of the previous year.

55. The expenditure of the office for the year was R65,824-6-2, including cost of all materials and plant supplied, and the value of the work performed R63,236-7-2, showing a balance against the Department of R2,587-15. This is partly due to increase in the cost of superintendence, as one-third of Lieutenant Fleming's pay has been debited against this office.

56. Under the orders of Government a strict system of book-debit account of work done for other departments was introduced from the 1st of April last, and the rates of cost of drawing and printing were carefully revised in order to simplify the system of accounts by assimilating the rates of the three printing offices in Calcutta and Dehra Dun. As the old rates were in force from October to March, and the new ones for the rest of the year, the above figures can only be considered approximate as regards the results for the year. No difficulty has been found in working the system and it will no doubt tend to economy. The experience gained in the working of the new rates has shown that a few modifications are desirable and revised rates will be prepared before the commencement of the next financial year.

57. The tabular statements and report showing the details and cost of the work done will be found at page cvii of the appendix.*

MATHEMATICAL INSTRUMENT OFFICE.

58. During the financial year 1885-86, the usual activity has prevailed in all branches of this office. The work has been incessant and shows a tendency to increase year by year. This is evidenced by the figures, which show an increase over the past year under the heads "Receipts," "Issues" and "Repairs."

Personnel.

Major M. W. Rogers, R.E., Assistant Surveyor General in charge, to 20th March 1886.
Colonel D. Macdonald, B.S.C., Officiating Assistant Surveyor General in charge, from 20th to 31st March 1886.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument-maker.
„ F. Marshall, Assistant do. do.
64 Artificers on permanent establishment.
125 Artificers on an average on the temporary establishment.
3 Eurasian Apprentices.

Store Branch.

Mr. C. O. Gray, Instrument Store-keeper.
Babu Woomesh Chunder Chowdry, Material Store-keeper.
1 Packing Sircar.
2 Packers.

Office Establishment.

Mr. M. O'Brien, Head Clerk.
„ W. Campagnac, 2nd clerk, and 6 other permanent clerks.

59. The total increase to the serviceable stock consists of 52,128 instruments of sorts, valued at R1,70,179, the principal details of which are as follow:—

9,038 instruments, valued at R33,615, were received on indent from England; 16,151 instruments, valued at R13,467, were purchased in the local market; 13,453 instruments were manufactured in the workshop at a cost of R21,454; 949 instruments were returned to store in a serviceable condition by various departments,

* Colonel Waterhouse reports that Messrs. Lepage and Deas have performed their duties very satisfactorily. Mr. DePyvah has worked very well and the apprentices have made good progress. The native assistants and clerks have all worked well. Babu Ambica Churn Mookerji. Munshis Abdul Hamid, Abdul Mujid, Mahomed Yasin, Draftsmen, and Babus Russick Lal Shaw, Kedar Nath Ghose, Rajani Kanto Chatterjee, clerks, deserve special mention.

value ₹17,492; 9,197 instruments were received from various manufacturing offices for stock, value ₹5,867; 3,103 instruments were received from the repairable stock, after having been repaired at a cost of ₹21,378 and brought on the books at a valuation of ₹76,039; finally, 237 instruments, valued at ₹2,246, were received from other sources.

60. The total issues from serviceable stock amounted during the year to 41,643 instruments, costing ₹1,77,864.

61. The repairable stock received an addition of 6,320 instruments, valued at ₹69,860; 3,103 instruments, valued at ₹54,660, were repaired in the workshop and transferred to the serviceable stock. The total issues from repairable stock amounted to 3,745 instruments, costing ₹61,328. The value of repairable stock in hand therefore has been increased by ₹8 532.

62. Table A at page cxii of the appendix shows the values of the issues to, and receipts from, the various departments of the State during the year under review. The receipts show an increase over the previous year of ₹45,967 and the issues an increase of ₹6,978, representing a corresponding increase of work in the Store branch.

63. The value of instruments purchased in the local market amounts to ₹13,467 as against ₹8,695 in the previous year. The details will be found in Table B, page cxiii of the appendix.

64. Tables C and D at pages cxv and cvii of the appendix give details of the principal instruments manufactured and repaired in the Workshop, and the Profit and Loss Account of the Workshop will be found at page cviii. The profit amounts to ₹3,887.

65. The value of repairs under all heads shows a nett increase of ₹2,600 over last year, but the value of manufactures has diminished by ₹3,700. The total value of work turned out has diminished by about ₹1,100, as compared with the previous season's out-turn.

66. It is to be noted that last year a reduction was made in the value of repairable stock by nearly ₹20,000. This year, however, the reverse is the case: the value of repairable stock in hand has been increased by ₹8,531. This is accounted for by the immense increase in the value of repairable instruments returned to store. The figures for the year under review are ₹69,650 against ₹29,509 in 1884-85, being an excess of over ₹40,000.

67. The building occupied by the Mathematical Instrument Office is old and dilapidated and in a very shaky condition, and the accommodation is altogether inadequate to the growing wants of the office. It is to be hoped that the Government will not defer any longer the commencement of the new building which is so urgently required for this office.*

THE TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

68. The sections under which the work of this office will be reported on are as follows:—

(1) Superintendence, Correspondence, Accounts, Stores, &c.
(2) Computing.
(3) Type-printing.
(4) Drawing and Compiling.
(5) Photo-zincography.
(6) Solar-photography.
(7) Miscellaneous, Meteorology, &c.

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* Major Rogers reports very favourably of the skill, industry, and general good management of Mr. T. Bolton, Mathematical Instrument maker, and of his Assistant, Mr. F. Marshall. Mr. Gray, the Instrument Store-keeper, is reported to be very pains-taking and efficient. The clerical establishment generally are favourably commented on.

69. (1) SUPERINTENDENCE, CORRESPONDENCE, ACCOUNTS, STORES, &c.—The principal work of this office is the final reduction and publication of the triangulation in all parts of India, including the principal and secondary operations of the Great Trigonometrical Survey. Most of the publications being necessarily of a technical nature and the office being located at a considerable distance from Calcutta, it has been found a great advantage that it possesses small printing, drawing and photo-zincographic establishments, without which the accuracy of the technical details could not have been well maintained, while inaccuracy would have rendered the publications worse than useless. The office has also a depôt of instruments (chiefly of the higher class) and stores attached to it, appertaining to the Great Trigonometrical Survey, of which it was the head-quarters. Among the instruments are, besides several large theodolites, the Colby compensation bars and microscopes for the measurement of base-lines.

Personnel.

Colonel C. T. Haig, R.E., Offg. Deputy Surveyor General, in charge of (1), (4), (5), (6) and partly of (7).
Mr. W. H. Cole, M.A., Deputy Superintendent, 3rd grade, in charge of (2) (3) and partly of (7).
Mr. J. Eccles, M.A., Offg. Assistant Superintendent, 1st grade.

(1) Correspondence, Accounts, Stores, &c.

Mr. J. Bond, Surveyor, 4th grade (1st October 1885 to 31st July 1886).
„ F. A. D'Rozario, Head Clerk.
Babu Mirzaji Lal.
And 4 other native writers.

(2) Computing Section.

Mr. C. Wood, Surveyor, 1st grade.
„ H. W. Peychers, Surveyor, 3rd grade.
Babu Gunga Pershad, Computer.
„ Kally Mohun Ghose, „
„ Kally Kumar Chatterji, „
And 14 other Computers.

(3) Type-printing Section.

Mr. B. V. Hughes, Printer.
12 Compositors and apprentices.

(4) Drawing and Compiling Section.

Mr. A. J. Wilson, Surveyor, 1st grade (posted to this Section, 1st October 1885).
„ G. W. E. Atkinson, Surveyor, 1st grade.

Drawing and Compiling Section—continued.

Mr. J. A. May, Surveyor, 1st grade (posted to this Section, 1st November 1885; died 26th June 1886).
„ C. H. McA'Fee, Surveyor, 3rd grade.
„ W. J. Cornelius, Assistant Surveyor, 1st grade.
„ F. E. Warde, Assistant Surveyor, 3rd grade (1st October 1885 to 31st August 1886).
„ H. Sindon, and 7 other Draftsmen, 22 Assistant Draftsmen, Apprentice Draftsmen and Colorists.

(5) Photo-zincography Section.

Mr. C. G. Ollenbach, Zincographer.
„ C. F. Guthrie, Photographer.
2 Assistant Photographers, 2 Native Draftsmen, 1 Assistant Draftsman and 1 Map-keeper.

(6) Solar-photography Section.

Mr. L. H. Clarke, Surveyor, 2nd grade, and Solar Photographer to 1st January; (retired 30th June 1886).
Sergeant B. Rowland, R.E., Solar Photographer (transferred to this Section, 1st January 1886).

70. Owing to the completion of the principal triangulation, there was the danger of these beautiful instruments and apparatus deteriorating from disuse, and of the way to use them being forgotten; steps therefore have been taken to avert this double danger. One of the rooms in the smaller photo-heliographic observatory, though originally built for a transit room, had never been used as such, but only as a store-room for the printed Professional and Synoptical volumes in stock. This was equipped with instruments mounted on isolated pillars, built at a small cost, *viz.*—

A 3-foot meridian circle, for which the double vertical circle of one of the two astronomical alt-azimuths (No. 2) was mounted between two masonry piers, to which 8 micrometers, 4 to each face, were firmly attached, besides another for an index. One of the two Russian pattern* transit instruments: two collimators, one north and one south; and an astronomical clock by Frodsham, with mercury compensation pendulum.

71. A meridian mark, consisting of a masonry structure, presenting an isosceles face, 10 feet high and 8 feet broad at base, was also erected on Vincent's Hill at Mussoorie for the setting of these instruments to the meridian. A little to the east of the larger photo-heliographic observatory a new shed observatory, with corrugated iron roof, capable of being opened up in parts as required, was

* The characteristic feature of this pattern is that the telescope, instead of being straight from object glass to eye-piece, has a diagonal reflector in the centre of the horizontal axis, deflecting the rays to the eye-piece, which is fixed in one of the pivots, the advantage being that the eye is always placed at the same point irrespective of the altitude of the stars. The ordinary eye-end of the telescope is accordingly replaced by a counterpoise to balance the object-end, and this arrangement admits of very low and therefore stable piers for the bearings. There are, however, disadvantages which need not here be enumerated.

erected at small cost accommodating six large instruments, five collimators and a clock, all on isolated pillars, viz.—

A Browning's reflecting telescope, with 9-inch reflector.
A telegraphic-longitude transit instrument, with its two collimating telescopes—north and south.
A (Strange's) zenith sector, with its collimating telescope.
A 3-foot theodolite.
A 2-foot do.
A 3-foot astronomical alt-azimuth (No. 1) with two collimators—north and south—the former being Everest's "phantom" (*vide* p. li of that officer's Account of the Meridional Arc of India), and the latter being an old 24-inch transit instrument by Dollond.

The clock is an old one by Jones, with a gridiron compensation pendulum, and formed part of the equipment of one of the astronomical alt-azimuths.

72. A meridian mark similar to that built at Mussoorie on the meridian of the transit room was built on another part of the same hill on the meridian of the longitude transit instrument. The meridional positions of both these meridian marks were determined by careful series of observations of the Pole Star; one by Major G. Strahan, with a longitude transit instrument, and the other by Colonel Haig, with the Russian pattern transit. The method of determination is described in detail by Major Strahan and will be found in the extract from his narrative report on the Longitude operations in the appendix. In the transit room the instruments (excepting of course the clock) are all on the same meridian. The transit circle can be readily lifted by a system of pulleys (with wire rope), slings, and guides devised for the purpose. It is necessary to raise it about a foot when the mutual collimator readings are taken, and then lower it into its Ys as before, but in order to change pivots east for west, it has to be raised nearly 3 feet, swung round and lowered. The Russian pattern transit horizontal axis is pierced with a circular opening on either side to admit of mutual visibility between the collimators, but the reflector inside the axis intercepts so much of the aperture that it affords more comfort in the mutual reading of the collimators to lift the transit out of its bearings and place it for the while in its box.

73. A working catalogue of 678 stars, derived from the Greenwich 9-year Catalogue, was prepared for Dehra Dún, giving each star's magnitude, right ascension, and setting reading of the circle to the next lower 5-minute division, both for altitude and zenith distance. The catalogue covers a complete belt of the heavens from the equator to north declination 60°, so that no star has a greater zenith distance (north or south) than 30°, and the average interval in time between two successive stars passing is about 2 minutes.

74. A series of observations to determine the latitude of Dehra was taken by Messrs. Wood and McA'Fee to 11 pairs of stars during the months of March and April. The observations indeed included more than that number, but cloudy weather prevented the observations in part or whole to the second stars of several pairs, to the first stars of which complete observations had been taken.

The resulting latitude was:—

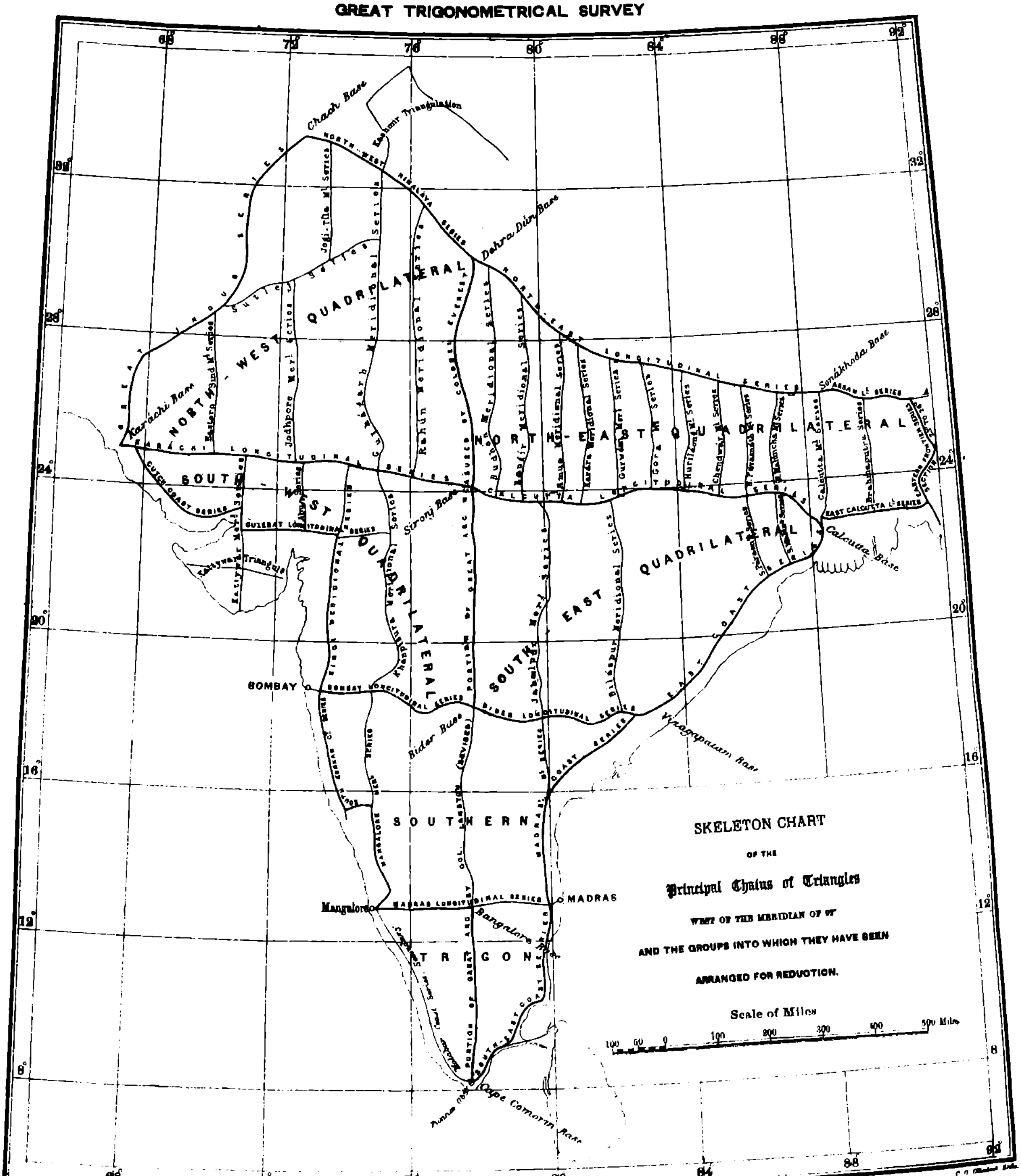
By North Stars	30°	18′	54″·5
By South Stars	30	18	54·3
Mean	30	18	54·4 with a theoretical

probable error of ± 0″·29

75. The latitude determined by the triangulation in conjunction with the astronomical latitude of Kaliánpur is 30° 19′ 29″·1, the excess (=34″·7) of geodetic over astronomical being due to local attraction. Two other surveyors observed 14 pairs of stars for latitude with the same instrument, but the observations were not reduced. The astronomical clock in the transit room is now constituted the standard time-keeper of the office, and is rated by astronomical observations every day or as often as the weather permits.

76. The new shed observatory has windows on the north side admitting of the observation of three principal stations, Banog H. S., Sirkanda H. S. and Mussooree Observatory, by the two large theodolites, so as to familiarize officers of the department with the use of this class of instruments. All the large class

GREAT TRIGONOMETRICAL SURVEY


SKELETON CHART
OF THE
Principal Chains of Triangles
AND THE GROUPS INTO WHICH THEY HAVE BEEN
ARRANGED FOR REDUCTION.
Scale of Miles
NORTH - WEST QUADRILATERAL
NORTH-EAST QUADRILATERAL
SOUTH - WEST QUADRILATERAL
SOUTH EAST QUADRILATERAL
SOUTHERN
TRIGON
Chach Base
Dehra Dūn Base
Karāchi Base
Sironj Base
Sonākhoda Base
Calcutta Base
Bidar Base
Vizagapatam Base
Bangalore Base
Cape Comorin Base
BOMBAY
MADRAS
Mangalore
Kashmir Triangulation
North-West Himalaya Series
North-East Longitudinal Series
Great Indus Series
Sutlej Series
Karāchi Longitudinal Series
Calcutta Longitudinal Series
Guzerat Longitudinal Series
Bombay Longitudinal Series
Bidar Longitudinal Series
Madras Longitudinal Series
East Coast Series
Cutch Coast Series
Assam Longitudinal Series
East Calcutta Longitudinal Series
Kattywar Triangulation
Jodhpore Meridional Series
Gurhagarh Meridional Series
Rahun Meridional Series
Budhon Meridional Series
Rangir Meridional Series
Amua Meridional Series
Karara Meridional Series
Gurwani Meridional Series
Gora Meridional Series
Hurilaong Meridional Series
Chendwar Meridional Series
Brahmaputra Series
Calcutta Meridional Series
Jabalpur Meridional Series
Bilaspur Meridional Series
Khanpisura Meridional Series
Madras Meridional Series
Mangalore Series
South Konkan Coast Series
Great Arc Series
South-East Coast Series
68
72
76
80
84
88
92
32
28
24
20
16
12
8

Sukha Ram, Photo.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dūn, March 1887

of theodolites in the Dehra store (altogether four), besides the two astronomical alt-azimuths and a Repsold 14-inch alt-azimuth, have been thoroughly cleaned and put into working order.

77. In order to preserve the knowledge of measuring base-lines in the department, a short base-line (231 yards) was measured in the Survey office estate with the Colby apparatus. The direction of the measurement was entrusted to Mr. Cole, and the details are given in his report, at page cxxi of the appendix, from which it will be seen how various are the labours required in this delicate operation, and how necessary it was (in view of the prospect of having to measure probably a base-line in Burma and in the Malay Peninsula), that it should be undertaken. A staff quite sufficient to undertake the measurement of an actual base-line have now been familiarized with the various duties involved.

78. The correspondence and accounts of the Trigonometrical Branch call for no special mention, beyond stating that the work in connection with the protection of the stations has continued to be carried on as before. During the year under report 975 stations have been repaired by district officers at a cost of ₹3,912. Of the 328 districts from which reports are due, those for 34 were not received; but reminders were sent out, and the reports for 5 districts have since come to hand.

79. (2) COMPUTING SECTION.—During the past year the final reduction and publication of the various operations of the Great Trigonometrical Survey have steadily proceeded under the superintendence of Mr. Cole who has been ably assisted by Mr. Eccles. Among the items specially worthy of note may be mentioned the South-West Quadrilateral, of which the simultaneous reduction of the circuit triangles has been finished. Not much remains to complete the final reduction of the *principal* triangles of this Quadrilateral, and with it that of the whole of India west of meridian 92°. The final reduction of the Latitude observations from Colonel Lambton's time up to season 1884-85 is now complete; the preparation of the results for the press is well advanced, and the printing of them has been commenced for publication in one of the series of Professional volumes, which will now progress steadily towards completion. A very considerable portion of the *secondary* triangulation of the Southern Trigon, also embracing much of Colonel Lambton's triangulation in Southern India, has been reduced to final terms, but a large amount still remains for treatment. Good progress has been made with the preparation of the new edition of the Auxiliary Tables for facilitating the calculations of the Department. The book, which will be published during the next few months, will be a much larger work than the old edition: those tables of which latitude is the *argument* have been extended for application from the equator to 40°, and many new tables and improvements have been introduced, which will largely extend the scope of its usefulness and render it a great boon to the Department and probably a valuable work of reference to others. Considerable assistance has been rendered to the two Astronomical Parties in bringing up their last season's work; and towards bringing up the arrears of the Khándesh Survey. Large help was given over a period of seven months to an officer, who had been exploring in foreign parts, in the reduction of his astronomical and meteorological observations. The remaining work of the computing section is of a miscellaneous character as will be seen on reference to the appendix.

80. (3) TYPE-PRINTING SECTION.—Professional Volume IVA., containing the reductions and details of the Jodhpore and Eastern Sind Meridional Series of the North-West Quadrilateral, has been completed and issued; so that the whole of the details of the *principal* triangulation of the North-West Quadrilateral have now been published. The Synoptical Volume of the Jodhpore and Eastern Sind Meridional Series is also in the press, but very little progress has been made owing to other work of a more pressing character. This is the last of the series of Synoptical Volumes of the North-West Quadrilateral. The Synoptical Volume XIIIA., containing the reductions and details of the South Párasnáth and the South Malúncha Meridional Series appertaining to the South-East Quadrilateral, was issued, which completes the publication of the whole of the principal and secondary triangulation of this Quadrilateral. The printing of the details of the principal triangulation included in the Southern Trigon is in hand, but has not been pushed on rapidly owing to the necessity for giving precedence to the Electro-longitude operations, the new addition of the Auxiliary Tables, and the Spirit-levelled Heights in the Bombay and Madras Presidencies;

of these, the first includes the work of seasons 1881-84, and is about two-thirds printed; it will probably form the next issued volume of the Professional series; the other two will be brought out within the next few months.

81. (4) DRAWING SECTION.—A detailed statement of the work done in this section is given in tabular form on page cxxx of the appendix.

82. A complete set of plotting scales (4, 8, 16 and 32 miles) for parallels 0° to 40° have been drawn and published on a card about 20 inches square: this, it is believed, will be found very useful in the projection of graticules.

83. (5) PHOTO-ZINCOGRAPHY.—The details of the work performed by this section during the year will be found in tabular form at page cxxxiv of the appendix, but some remarks appear necessary in explanation of the money value (R16,661-8) of the outturn for this year, as compared with that for 1884-85 (R26,672-13); the expenditure for 1885-86 being R17,922-10, as against R16,845-1 for the previous year. To make the value R16,661-8 of 1885-86 strictly comparable with the figures for the year previous, the following should be added to the former:—

		R
(*a*)	For superintendence (not now included in value) . .	2,400
(*b*)	For lower rates ordered to be charged from 1st April 1886	1,700
(*c*)	For professional and office forms, the bulk of which are now done at Calcutta, and which were previously printed in this office at intervals when the map-printing work was slack	2,400
	TOTAL .	6,500

But for the deficiencies noted as (*a*), (*b*), (*c*), the money value of maps, &c., turned out would have been R23,161-8, against an expenditure of R17,922-10. Endeavours will be made to find suitable work for the presses during spare intervals in place of the forms, so that next year, even with the reduced rates charged for our maps, &c., it is expected there will be a much more favourable comparison between expenditure and outturn.

84. Among the maps published by this section the following may be specially mentioned:—The final prints of 18 of the Nepal-Bengal Boundary Survey Sheets, as well as 4 sheets of the Mechi River Survey and 7 skeleton sheets of the Daling Lands Survey; Map of Jeypore and Environs in 8 sheets, printed in two colours: and the map of the country between Umballa and Delhi, of which no less than 2,250 copies were required by the Quartermaster General's Department within a limited time, for the Camp of Exercise.

85. The amount realized during the year and paid into the Treasury on account of maps sold is R663-7: and the value of the work done by this section for other departments is R5,583-7, as shown at page cxxxiii of the appendix.

86. (6) SOLAR-PHOTOGRAPHY.—Photographs of the sun for the Solar Physics Committee, South Kensington, have been continued daily throughout the year, except on 75 days when the sun was invisible. With the large photo-heliograph 115 pictures (12-inch) of the sun have been taken during the year, and with the smaller instrument 525 pictures (8-inch) have been taken. As stated in the Report for 1884-85, these latter are used for the measurement of the areas of spots and faculæ, while the former are specially suited for the study of the mottling or granular appearance of the normal photosphere and structure of the penumbra of the spots. From the Greenwich observations for 1884 just to hand it is gratifying to find that photographs of the sun taken in India on no fewer than 161 days were employed to supplement those taken at Greenwich, thus bringing up the available total for that year to 315 days.

87. The usual tables of working facts, percentages of daily visibility of the sun, and statements of cost will be found at page cxxxvi of the appendix. The cost of this section for the year under report was R9,820-13.

88. (7) METEOROLOGY.—Besides the usual tabulated results of the meteorological observations usually given, there will be found in the appendix a table giving the average rainfall to date in inches from 1st June to 30th September, deduced from 21 years' observations, 1866-86.

Explorations.—The account of the Trans-Himalayan explorations that have been made under the superintendence of the Deputy Surveyor-General, Trigonometrical Branch, is given in Part II of this Report.

Colonel Haig and Mr. Cole make special mention of the services rendered by Messrs. Wood, Wilson, Atkinson, Peychers, and McA'Fee, and by Babus Gunga Pershad, Shiv Nath Saha, and Shoshee Bhushan Shome; and report favourably on all the other assistants attached to the Trigonometrical Branch Office.

APPENDIX.

EXTRACTS

FROM

THE NARRATIVE REPORTS OF THE EXECUTIVE OFFICERS

IN CHARGE OF

SURVEY PARTIES AND OPERATIONS.

Extract from the Narrative Report of COLONEL A. PULLAN, S.C., *Deputy Superintendent, in charge Cutch Survey,—Season 1885-86.*

The country surveyed this season is generally sterile, mingled "Ran" and grass land, but here and there well cultivated spots occur, notably the oasis of Antarnes, a rich and well-watered village in the middle of the Ran. The little peninsula of Nagar Párkar is too stony and sandy to be productive.

The principal towns which fall in the season's work are :—

NAGAR, the principal town of Párkar, situated at the foot of a group of granite hills rising abruptly to a height of 1,100 feet above sea level. A *Mukhtyár* is resident here, and the place contains a hospital, post office and police barracks. Population 1,822.

SANTALPUR, the principal town of Chorar, situated on the edge of the Ran. The *Thanadar* of the district resides here. Population by last census 1,664.

ADESIR, the principal town of the small portion of Cutch proper, which is included in this season's work, has a population of 3,133. The *Thakur* is the most important of the Cutch *Bhayads*.

VARAHI, the head-quarters of the *Wahiwatdar* of the sub-taluka, is about 1½ miles north of one of the mouths of the Banás River. It has a post office and jail and a population of 3,233.

SINGAM, with a population of 2,765, is a principal station of the salt preventive line, and has a Salt Inspector's bungalow, police barracks and post office.

The granite range of Kalinjar is the principal feature in the peninsula of Nagar Párkar, rising to a general height of 1,100 feet, and in abruptness of outline and rich warmth of colour affords a striking contrast to the trap and basalt of Cutch and Káthiáwár.

The few small hills in the other remaining sheets are of trap formation, but are insignificant and call for no special notice.

Extract from the Narrative Report of LIEUTENANT-COLONEL D. C. ANDREW, S.C., *Deputy Superintendent, in charge Deccan Survey,—Season 1885-86.*

DESCRIPTION OF THE COUNTRY.

Towns.—The principal towns met with are Ratnagiri, Sangameshvar and Devrukh. Ratnagiri is the chief town of the district with a population of about 11,000 people; as the head-quarters of the Sub-division, it has buildings for all the various offices of the different officials, a nice Club, and a large Lunatic Asylum lately built, which it is proposed to make the principal one in the Presidency. This town has also been selected by the Imperial Government as the abode of Thebaw, the ex-king of Burma, who lives there with his two queens. To the north-west on a point jutting out into the sea is a large fortress, the origin of which is doubtful: in fact very little is known about Ratnagiri for certain, prior to its being taken over by the British in 1818. Sangameshvar can only be called a small village on the Shástri River, which of late years has considerably declined owing to the Kumbhárli Ghát road having turned the Deccan traffic to Bombay *viâ* Chiplún from it; again upon the destruction of the Mámlatdár's Court it was rebuilt at Devrukh, thus reducing its importance still more. Devrukh at present is a small village, consisting chiefly of Brahmins; it is healthily situated on a high plateau and shows signs of daily increasing importance. This is due to the new road that has been made connecting the Amba and Kumbhárli Ghát roads. A small bazar has also sprung up owing to all the traffic from the Koondee Ghát passing through this village to Sangameshvar. Also, houses for the head-quarters of the Sub-divisional, Revenue and Police Officers, Subordinate Judge and Executive Engineer have been built.

Rivers.—The Sávitri and Váshishti are the two largest rivers, on which small tugs ply in connection with Messrs. Shepherd and Company's coasting steamers, one running daily from Bánkot to Máhad and from Dábhol to Chiplún on the latter, the journey being of a most uninteresting nature, the scenery consisting of bare hills and low shelving muddy banks covered with mangrove or weeds; the appearance of these rivers varies considerably, in some places being nothing more than large ponds, whilst in others, the current is very strong, their courses also being most circuitous: this can be accounted for as they are formed from thousands of water-courses or hill torrents flowing down from the Sahyádri Range and falling into these large rivers which flow through this narrow strip of country until they empty themselves into the Arabian Sea. The waters of all the rivers are brackish, being affected by the tide for several miles inland. Besides the rivers above-mentioned, there are the Shástri Bhatya and Muchkundi, but these are not nearly so deep as the two before-mentioned, although a very large traffic in country boats of small draught is carried on between Sangameshvar and Jaygad on the Shástri—more so than on any of the others.

Brief Description of Features.—The country is about 40 miles in width, lying between the Sahyádri Range and Arabian Sea and consists of innumerable flat-topped hills varying in height from 200 to 800 feet, which have a monotonous appearance, as they are either bare or covered with rank grass that soon dries up after the rains; the hills are intersected by small valleys, dotted over with little hamlets and temples under clumps of large mango, jack and tamarind trees, and this is the only relief to the eye of the official who has to work in a tract destitute of all *shikar* or anything likely to lessen the dreariness of his leisure hours. The coast all along the sea has a steep, rocky appearance with several small bays, at the head of which, as a rule, villages are found peopled by fishermen, who earn their livelihood by bartering dry fish for grain; this they carry in their boats to the large towns on market days. At the mouths of the rivers or large creeks are bays sufficiently large to make harbours for small vessels, but unfortunately most of them are dangerous of navigation excepting in fair weather. The country is a very difficult one for survey operations owing to the features being so very irregular and intricate, consisting of innumerable steps and precipices, necessitating great care and accuracy to delineate correctly on paper.

Population.—The population chiefly consists of Maráthas and Brahmins, the latter being to a great extent well-to-do, whilst from the former, a large portion of the Bombay army is recruited, the best soldiers coming from this district. The ineligible, or undersized men, finding it impossible to support their families out of the produce of this impoverished country, have to gain a livelihood as labourers by going to Bombay, where thousands flock yearly. It is from this district that the labour supply of Bombay chiefly comes, it being estimated that over 100,000 men, women and children proceed there annually during the busy export season.

Climate.—The climate, although healthy, is moist and relaxing and very trying to those whose constitution requires a dry heat, particularly during the months of March, April and May, when the excessive heat makes survey work very harassing: the temperature in the shade sometimes exceeds 108° at midday, and this is intensified by the heat refracted from rocks, of which the country chiefly consists, and the glare from the hills. The rainfall is plentiful, varying from 100 to 110 inches along the coast, and increasing as you get nearer the Sahyádri Range.

Extract from Narrative Report of MR. J. NEWLAND, *Surveyor in charge Gujarát Survey, Season, 1885-86.*

The survey comprised Sheets 72, 73, 75, 4, parts of 47, 52, 53, and 54. Sheets 72 and 73 comprise parts of Baroda, Rádhanpur and Kánkrej States, and also a few petty States under the Pálanpur Agency. Rádhanpur State has an area of about 833 square miles, a population of 91,579 souls, or an average of 109·9 to the square mile. Its south-western extremity abuts on the Rann of Cutch, from which a considerable portion of the soil is said to have been reclaimed. Sandy and black soil are also met with which yield good crops of wheat, cotton and rape seed. The trade in these has been greatly stimulated by the opening of the Rajputana Railway. The crops are almost entirely dependent on the monsoon, irrigation being confined to the vicinity of streams, which are few.

Kánkrej State stretches for about 35 miles along both banks of the Banas River; it has an area of about 507 square miles, a population of 37,771 souls, or on an average of 74·5 to the square mile. The Banás runs through the district, and though during the hot weather its bed is usually dry, water is plentiful in most places from 30 to 40 feet below the surface. The soil, sandy in some places and black in others, yields the usual rain and irrigated cold-weather crops.

The general aspect of the country in Sheets 72 and 73 is that of a flat, open plain, whose blankness is only relieved by the few trees which shelter the villages. Owing to the scarcity of water in the country the necessity of excavating large tanks for storing the rainfall has been forced upon the people, so that one or more tanks are to be found in almost every village. Many have been dug at the cost of private individuals. These tanks invest the country with a charm for the European visitor, whose eye rests with pleasure on their cool depths in the midst of a thirsty land. A great number and variety of ducks and water-fowl are usually found on them. Two rivers, namely, the Banás and the Sarasvati, flow through these sheets in a south-westerly direction and lose themselves in the Rann. The breadth of the Banás varies from 800 yards to a mile and-a-half and is split up into numerous narrow channels which interlace in the sand, forming miniature islands, the latter producing rich crops of wheat, vegetables and melons. Close to the Banás the land is liable to be flooded, but the floods do not at furthest pass more than a mile from either bank. The principal towns are Radhanpur, with a population of 14,722, Sami, with 5,306 inhabitants and Thara with 2,114.

The town of Rádhanpur stands in a wide open plain, mostly under water during the rains. It is surrounded by a part-stone, part-brick loopholed wall, 15 feet high, 8 feet broad, and about two and-a-half miles round, with corner towers, eight bastioned gateways, outworks and a ditch now filled up. Against modern arms the wall gives little shelter, and it could easily be taken by escalade or battery; there is also, surrounded by a wall an inner fort or castle, called Rajghadi, where the Nawab lives. Except a wide and clean main street, the town roads, little better than lanes, are narrow and rather dirty. The water-supply, taken from tanks and wells becomes a little brackish in the hot weather. Though subject to very great extremes of heat and cold, the climate of Rádhanpur is, except in September and October, healthy. The town of Sami stands in a low plain under water during the rains. It is surrounded by a brick wall, about one and-a-half mile in circumference, 24 feet high and 12 wide, now partly in ruins. To the east is a strong stone and brick court, and on the west a building of Nuransha Pir, with a lake called the Pir Talao. Besides these, there is a mosque and the tombs of some of the Nawab's families. There are no other buildings of brick and cement. The houses are irregularly built and the streets narrow and dirty. There is no river in its vicinity, the supply of water being obtained from tanks and wells.

Sheet 75 comprises portions of Baroda and Pálanpur States. Pálanpur State has a total estimated area of about 8,000 square miles, a population of about 500,000 souls or 62·5 to the square mile. The general aspect of this sheet differs little from that described above towards the south, but in the northern half it is more sandy and undulating. South of the River Banás, which flows through the sheet from north-east to south-west, the soil is a clayey loam, varying in color from whitish-yellow to pale-red, resting on a sub-soil containing a considerable quantity of carbonate of lime, nodules of which are to be picked up in quantities along the banks of the river. In the neighbourhood of old Deesa the ground rises from the river in terrace-like fashion which seems to mark the periodic recessions of the water from their ancient bounds. Most of the villages have a patch of grazing land varying in extent from a few acres to two or three square miles according to their requirements. This land is in most cases overgrown with a dense jungle of stunted trees of sorts, which, besides fuel to the villagers, furnish food for the camel and goat, both of which animals abound. The inhabitants are mostly Koli Thakoras, of mixed Rajpoot and Koli origin who were the original proprietors of the soil and are still exempt from land-tax. Rabaris (shepherds) are also numerous and own great flocks and herds of sheep, goats, cattle and camels. The principal towns are Pálanpur, with a population of 17,547, old Deesa with a population of 3,828, and Kanodar with 3,426. The town of Pálanpur is surrounded by a brick and mortar wall from 17 to 20 feet high, 6 feet thick and about three miles round, with seven bastioned gateways, and at the corners, round towers, armed with guns. Though in fair repair, the defences are useless against the attack of a

modern army. The houses are irregular and closely packed, and, with few exceptions, the streets and lanes are narrow and dirty. It is the head-quarters of the Pálanpur Political Superintendency and the seat of the Chief or Diwan of the Pálanpur State,—a Musalman of the Jhalor family. The railway station of Pálanpur is the nearest one to the military cantonment of Deesa, which is eighteen miles distant in a westerly direction.

Sheet 4 comprises portions of Baroda, Idar and Pálanpur States, and also parts of a few petty States under the MAHIKANTHA Agency. With the exception of a small portion in the north-east corner of the sheet, which is hilly and covered with scrub jungle, all the sheet is flat or slightly undulating, and tolerably well covered with fruit trees. The soil is for the most part sandy, with patches of rich black soil which allow of three crops being produced during the year. Grains of various sorts are produced, including a very superior description of rice. Large quantities of wheat and rape-seed are yearly taken away by the Rajputana Railway for exportation to England. The principal river in the sheet is the Sábarmati, which takes its rise in the Meywar hills and runs through the sheet in a southerly direction towards the Gulf of Cambay. A smaller river, called the Amerdeshi, crosses the north-west corner of the sheet on its way to the Kanu. This river gets quite dry during the summer months although water is always obtainable a few feet below the surface of the ground. The chief towns are Vadnagar, with a population of 15,424; Kherálu, with a population of 11,030; Umtu, population 5,805, and Sipor, with 5,643 inhabitants. Vadnagar is a very old town, said to have been founded in A.D. 144. The town, says Burgess, has produced many of the men who have played a prominent part in Gujarát. It is encompassed by a strong masonry wall, and, being on a rising ground, has a rather picturesque appearance; to the north-east is the large Sarmishta tank, of a circular shape with an island in the middle of it. The water is flanked with stone walls and steps; trees fringe it; and here and there a small temple has been erected; the houses of the town are often perched above the walls, and steep stone stairs, one numbering 360 steps, lead to the water. In the neighbourhood are the remains of Badshahi Bagh which commemorates the Musulman rule. Towards the north-east part of the sheet are situated the celebrated Jain temples of Shri Ajitnathji and Shambhavnathji—the resort of numerous pilgrims from all parts of India. The temples are on a hill which bears the name of Taringa, probably from a shrine that has long been there dedicated to a local deity Taran Mata. The temples are of no very great size, the enclosures measuring 250 feet round, and the temples 125 feet high. The main temple was built by Kumar Pal of Anhiloada about 1143-1174. The special times of pilgrimage are during the full moon in the months of November and April.

Extract from Narrative Report of LIEUTENANT H. M. JACKSON, R.E., *Officiating Deputy Superintendent, in charge Mysore Survey,—Season 1885-86.*

The portion of the Kolar District plane-tabled this field season is all that to the east of meridian 78°. It is generally undulating, partly covered with cultivation, partly with scrub jungle, in many places with nothing but stones. The valleys, of which the streams are mostly dammed so as to form lines of large tanks, hold rich fields, where rice and vegetables are largely grown. Almost everywhere, but chiefly on the bare ridges, are strewn masses of boulders of every shape, and around these generally a skirt of smaller rocks and stones. Here and there bare rocky hills rise, some suddenly from the plain, others with skirts of gravel and detritus rain-cut into numerous water-courses. Along the western edge of this tract runs a much broken line of hills, entering the district north of Gumnayakanpalya and trending nearly south, where it appears only at intervals in the peaks of Murugamale, Ambajidurga and Rahmandurga, thence again south near Kolar town, finally merging in the Tyakal hills and the *ghâts*. From the northern end of this range, flowing to the north-east rises the Vandaman River; and from near Ambajidurga, flowing south and west, the Palar supporting in its much-interrupted course a very flourishing cultivation. The Papaghini rising from under the skirts of Nundydroog, flows about north and west into the large tank of Vyasa Samudra and out through it to the north. There are also two smaller streams, affluents of the Pinakini to the south, which rise from either side of the southern portion of this range and flow out of the district, the one nearly due south, the other south-east, and then south; their names are doubtful.

A line of low hills rises near Shrinivaspur, and running fairly parallel with the first described passes to the east of Kolar and southwards to the *ghâts*. Still more to the east are several groups of hills, irregular in formation, sub-buttresses of the Mysore plateau, in some instances enclosing elevated valleys. The central and eastern parts of the country in question, valleys of the Palar and Papaghini, are undulating and well cultivated. The northern, western and southern portions are more broken up by the hills just detailed, and less fertile. The third range of low hills mentioned above consists of clayey slate with veins of quartz, in which is found the gold worked to a considerable extent in olden times, and again recently the object of much busy enterprise.

In the south-east corner of the Betmangala *taluk* is a patch of small tree jungle, and clumps of acacias are common; but, generally, where the land has remained uncultivated, if there is any vegetation at all, it is merely bush.

The revenue of the Kolar District generally has been increasing steadily. The latest "Mysore Administration Report" shows it to be about R10,55,955.

The means of communication may be said to be generally good. The following roads cross this part of the country :—

No. of sheet.	Name of road.	Imperial.	District.	Remarks.
70	Dadahalli, Yelandur . . .	...	District.	
„	Chamrajnagar, Hasnur . . .	Imperial.		
43 & 44	Bagenhalli, Chelur	...	Do. .	Under construction.
44 & 45	Hookote, Madanepalli . . .	...	Do.	
45	Bagenhalli, Chintamani . . .	...	Do.	
45 & 46	Sidlagatta *viâ* Shrinivaspur to Mulbagal	...	Do.	
45, 46 & 66	Bowringpet *viâ* Kolar and Shrinivaspur to Targol	...	Do.	
46	Jangamkote *viâ* Kolar and Betmangala to Venkatgiri Kote . . .	...	Do.	
46	Hoskote *viâ* Kolar and Mulbagal to Chittur	Imperial.		
46	Mular, Narsapur	...	Do. .	Ditto.
46	Malur, Kolar	...	Do.	
46 & 66	Bowringpet *viâ* Betmangala to Mulbagal	...	Do.	
66	Malur Barki	...	Do.	
66	Bowringpet, Budikote . . .	...	Do.	
66	Ditto *viâ* Gold Mines to Kansandra	...	Do. .	This road is in use, but is not quite constructed.
66	Kansandra to Fuel Forest . . .	...	Do. .	Under construction.
65	Kankanhalli to Kodihalli . . .	...	Do. .	Ditto.

Fairs are held at the towns detailed in the following list arranged in order of importance, *viz.* :—

Kolar, Bowringpet, Mulbagal, Chintamani, Shrinivaspur, Kyasamballi, Kamsandra, Budikote, Masti, Narsápur, Vemgal, Vakkaleri, Sugatur, Somayajalpalli, Nelavanki, Yallur, Ryálpád, Adgal, Betmangala, Tailur, Utnur, Bairkur, Malinaikanhalli, Bilur, Pichpalli, Uriga, Forlakki, Tádigol, Yerkálve, Bhairganpalli, Nangali, Pulagal, Korlaparti, Pályakeri, Batlahalli, Tambihalli and Mittur.

There are no remarkable hill forts in this part of the district, except that of Ambajidurga, built by Tippu Sultan. In some of the old Palagar *jagirs*, however, to the north and east there are still to be seen a few remains of their robber strongholds.

The country comprised in Sheet 70, consists mostly of the Yelandur Jagir, held now by Krishna Murti, the grandson of the Minister Purnaiya, to whom the grant was originally made. The low lands of the *jagir*, watered by the Suramavati and Honnu Hole and the tanks that these streams feed, are among the most fertile rice-lands in Mysore. One-third of their area is held by Brahmans. Besides rice, much sugar-cane is also grown.

The temple of Billigiriranganbetta, about 4 miles from the town of Yelandur, attracts numerous worshippers The temple itself is in a poor style, but it is imposingly situated on the edge of a precipice crowning a hill that rises about 2,000 feet from the plain. The approach is by rough stone steps, so disposed as to render the ascent more difficult than it would be without them. Near the temple is a plantation kept up by the *jagirdar*, in which coffee cultivation has been attempted with but poor success and is now giving place to cinchona and tea: most excellent fruit is grown here.

In these hills are several settlements of the Sholegars. They are of apparently "Non-Aryan" race, live invariably in the jungles in lean-to's or in bamboo huts, in the middle of little temporary clearings, in which they grow their scanty supply of *ragi*, to be supplemented in the dry season by roots, and at all times by the wild honey which they are very clever in finding. By this indeed, and by finding different gums and lacs of certain market value they manage to clothe themselves, unless they earn pay for odd jobs from forest officer or planter. But they are an independent race, preferring to do things in their own time and way, and they are too conservative in disposition to accept the benefits of the civilization around them. They are skilful trackers, but are by no means courageous, and towards the elephant and tiger they evince the profoundest respect.

Extract from the Narrative Report of Lieutenant W. H. Pollen, R.E., *Officiating Deputy Superintendent, in charge Rajputana Survey,—Season 1885-86.*

With regard to the nature of the country triangulated in Degree Sheet VII, the ground in the south-east is level, with sand-hills. Towards the west there are rocks and rocky hills, some running up to 1,200 feet above the sea. In the north-east is a plateau some 600 or 700 feet above the sea and 100 feet above the general surrounding level: the surface of this plateau is pebbly and covered with *karil* (*capparis aphylla*) jungle; in it is a large depression, about 6 miles long and 1 wide, the surface of which is encrusted with

salt. In the south-east the water was not good and had to be taken from the *pakka* cisterns (*tanke*) near the villages.

The northern part of Degree Sheet VI is sandy with high sand-hills (*dhure*), and the water is generally bad. In this portion, too, there are hardly any villages, but numerous collections of huts (*dhani*), which are used by the cultivators in the rainy season and are deserted at other times. At Ramdera, about 6 miles north of Pokaran, there is a large annual fair. Some two years ago there was great mortality from cholera there, and the ground is strewn with human skeletons. In the south the ground is hard and rocky. At Loharki there are some stone quarries, and at Bhadra in the south-west a small fair is annually held.

As regards the country surveyed in detail, the River Lúni runs through the east portion of Degree Sheet VIII. In the north-east the ground is level, with sand hills; and in the north-west there are rocky hills running up to over 2,000 feet above the sea. There is a curious out-crop of rock running up from Kalinjar in Cutch, to the north of Jeysulmere; it appears in the west portion of the sheet. On each side of the Lúni is the *nayar* land, an alluvial soil brought down by the river. This land is 14 miles in width near the Ran of Cutch.

The sand hills rise to about 100 feet above the surrounding country. The water in the western portion is generally good in the wells, but towards the east, among the *dhure*, the water is mostly brackish even in the wells. The country is covered with *dhuni*, every house has perhaps 2 or 3 *tanke*, circular cisterns 8 to 10 feet in diameter and 10 to 12 feet deep, lined with *chunam*, for storing rain-water. The water is good when boiled, but the inhabitants do not like parting with it.

There are no forts in the country surveyed, though it has been the scene of much lawlessness in earlier years.

The chief towns are :—

Balmer or Bármer—the head-quarters of the district; Maláni—where a *hakim* resides, built on the slope of a hill; Guranagar on the Lúni—the chief of this place has a remarkably fine breed of horses—and Sindri on the Lúni.

There are some clusters of hills near Bármer of igneous rock. The largest hills are those of Jesai and Taratra, of both of which the slopes are very steep. There is an easy pass in the hills between Geu and Drura villages, the road is hard and good, and there is only an ascent of some 50 feet. The chief roads are from Bármer north to Jeysulmere, *viâ* Jalipa, Kapuri and Bharko. Also from Bármer south to Sachor, crossing the Lúni at Chitalwána. The only river worth notice is the Lúni, in the bed of which pools of brackish water are frequently met with during the cold weather; by digging a few feet down in the bed, however, good fresh water is obtained, but during the rains the river water is undrinkable. The inhabitants are chiefly Rajputs: there are no Bhils, but there is a proportion of Jat cultivators. They have fine herds of cattle, sheep, &c., and good camels. There is a sprinkling of Mahomedans, some Sindis and some Baluchis, locally known as "Sarhai." The land produces *bajra* in all parts, and wheat in the *nayar* land on the Lúni. There are some villages occupied by the *Mali* caste, who cultivate vegetables, such as radishes, onions, pepper, &c., and tobacco.

Fuller's-earth is found in parts.

The soil generally is sandy, with the exception of the *nayar* land, which is black and fertile.

Report by MR. G. P. TATE, *Assistant Surveyor, Rajputana Survey.*

The country triangulated during the past season comprises Sheets 43 and 58 of Central India and Rajputana, and consists of a part of the Sáchor Pargana of Marwar or the Jodhpore State, and the northern portions of the territories of petty chiefs of Tharád and Váv, both of which are under the orders of the Political Agent of Pálanpur, and lie on the northern boundary of Gujarát. The chief of Tharád, and the Rájput landholders are a remnant of the Bhagela dynasty which succeeded, in 1193, the Chaluk or Solanki clan in Anhilwára Patan.

The chief of Váv is descended from the Nadol branch of the Chauhán clan, which, in ancient times, had extended its several branches from Delhi and Hariána in the north to Golconda (in the Nizám's dominions) in the south; and from Chotan in the Bármer desert in the west to the plateau of Meywar in the east. Sáchor, according to the traditions of the local bards, was the possession of the Kálam, or Kálma Rájputs. This tradition is verified by the translation of a part of an old record of the early Kings of Chitor, contained in the "Annals of Rajputana," by Colonel Todd: in which the "Kálam from Sáchor" is mentioned as one of the allies of the King of Chitor, who had summoned his adherents to resist an invasion of the Mahomedans from Khorasan. The date of the above-mentioned record lies between 824 and 836 A.D. The date of the acquisition of Sáchor by the Chauháns could not be obtained even approximately; but the exploit of the Chauhán chiefs, Apa and Vikran, who introduced their retainers in disguise into the stronghold of the Kálam chief on the occasion of a marriage festival, affords a theme for the bards, who wander from village to village, and gain a livelihood by recounting the achievements of heroes of ancient

days. These bards are the possessors of all the genealogies and traditions of the country, oral as well as recorded. Sáchor was acquired by the Ráhtor Princes of Jodhpore over 100 years ago, since when it has been one of the *parganas* of that State. The Ráo of Chitalwána, who has a *jagir* (free-hold grant) on the banks of the Lúni, about 15 or 20 miles north and north-west of Sáchor, is a descendant of the last of the Chauhán Ráos of that place. Sáchor is a well built village of considerable size, and possesses a post office and dispensary. The mails are sent from the Cantonment of Deesa about 60 miles to the south-east.

Dhárnidar, about 20 miles south by west of Sáchor, is a large village of the Váv Pargana, and contains a shrine, which is visited by Hindu pilgrims. A battle was fought near this village between the forces of the Jodhpore Rája Bhím Singh and those of the Amir of Hyderabad, in which the latter were defeated.

At Batki, about 20 miles west of Sáchor and near the Ran of Cutch, is a station of the Northern India Salt Revenue Department, two officers of which and a subordinate establishment are stationed there.

The surface of the country triangulated consists of gentle undulations, and as it is nearly all under cultivation, and has numerous villages, each surrounded by large trees, a reconnaissance had to be effected before the observations could be commenced.

The soil is sandy; but water is not at a great depth from the surface, and is generally good. The crops are entirely dependent on the rainfall, and nothing which requires irrigation is cultivated. An area of about 180 square miles of the Ran of Cutch was included in the triangulation.

The word "Ran" is a modification of a Sanskrit word and means a swamp or depressed plain: it is frequently met with in Western Rajputana, where any depressed plain is called a Ran which during the rains is flooded, and where, after the accumulated waters have evaporated, there is an efflorescence of saline matter. One of these Rans occurs about 30 miles north-west of Bármer, and it is said that Pokaran, a large and important town of Jodhpore on the borders of Jeysulmere, takes its name from five such depressions which unite at or near the site of the town. The Lúni River flows through a strip of alluvial soil which is sometimes under a mile in width and at others as much as 10 or 12, and falls into the Ran of Cutch about 2 or 3 miles south of the Trigonometrical Survey station of Akoria, of the Karáchi Longitudinal Series. The Lúni bifurcates at about 30 miles from the Ran, the main branch flowing about 100 yards to the west of Akoria station.

During the cold weather the surface of the Ran is a glittering expanse of white salt, forming a crust about 3 inches in thickness, under which lies the briny ooze of the swamp. At this time of the year it is capable of affording a passage to foot passengers, and there is one well-known foot-path which crosses diagonally from the village of Kandalia on the eastern shore to that of Churia at the foot of the Vorawa hill on the west. Near the shore the salt crust can support a man easily, and horses and even camels in some places. During the rains, when the Ran is flooded, it is impassable. The course of the waters of the Lúni can be traced for some distance by the deposit of mud, which being mixed with the salt, is of a dark-grey color. It is said that the annual deposit of mud is encroaching on the salt. Just south of the spot where the main branch of the Lúni falls into the Ran, there are small islands of saline earth, distant from the northern shore about 3 to 6 miles. On one of these islands, about 6 miles south of Akoria, a station was selected, and reciprocal vertical angles were observed for determining its height. The platform is flush with the level of the island.

The islands near the shore are covered with tamarisk and the *Salsola* plant. The latter resembles the *Portulacca* in appearance and is very plentiful along the margin of the Ran. It is known locally as the "*Saji*" plant. The color of the *salsola* is a dark brown.

The salt is not fit for use immediately it is taken out of the Ran. It consists of about 96 per cent. of pure salt, about 3 per cent. of chloride of magnesia, and the balance of other foreign matter. Looking across the salt deposit beyond a distance of 2 or 3 miles, the white salt seems to be lost in what appears to the eye to be an expanse of blue water; and to make the illusion complete, the rocky hills towards the west and the higher sand hills on the western shore appear as islands in a vast sheet of water. This is also noticeable in the broad grassy plains to the north of the Ran. Small bushes are magnified to the size of trees and appear as wooded islets, and as trees fringing large sheets of water.

The margin of the Ran, where the sand hills do not come down to it, is covered with a grass, locally known as "*Mottra*," which resembles that well-known variety "*Dub*" in the way it grows. The root is a small bulb, about $\frac{1}{16}$th or $\frac{1}{10}$th of an inch in diameter, and is eaten by the poorer classes.

At the commencement of the summer when evaporation increases, the fish inhabiting the large pools of water which remain in the bed of the Lúni, die and float to the shore in large numbers; for the pools then become merely large salt pans. Fresh water can be obtained along the edges of the Ran by digging holes a few feet deep.

On the north-west of the Ran the sand hills come right down to the shore, and are fairly well covered with *Komta* jungle. The *Komta* is a thorny tree with white bark, and grows to a height of 20 to 25 feet. This part of the country has a very desolate appearance. There is fairly good shooting about the Ran, and to the east of it are to be found floriken, bustard (great and lesser), sand-grouse, partridge, hare, *chinkara*, or ravine deer and black buck.

Extract from the Narrative Report of LIEUTENANT F. B. LONGE, R.E., *Officiating Deputy Superintendent, in charge South Marátha Survey,—Season 1885-86.*

The country surveyed was of a most varied description. There are the forest-clad *ghâts* on the west and the densely-wooded country south of Khánápur, then the quartzite plateau to the north of the Belgaum Valley, thickly covered with thorny bushes, and at Murgod again flat hills of conglomerate overlying quartzite beds, and covered in parts with cactus bushes, as well as large open tracts of grass land and country suitable for dry crops. The geology of the district, as well as all other information, is most fully given in the Belgaum Gazetteer.

In the hilly west, the rugged hills, the ravines and the abundance of trees and brushwood render the country interesting and beautiful. The upper slopes and scarps, which are of trap, resemble those of the Bor and Tal passes in Thána, and the scarps are so high and continuous that the country presents great difficulties to the surveyor, who often has to go miles to reach a spot not more than a few hundred yards from him in a direct line. Each village in the *ghâts* has a little watered rice land, on which two crops of red rice are grown yearly. In the hot weather, there is not much water except low down in the valleys, and in one or two of the bigger streams, in which the water is banked up at intervals and the intermediate space is sown with rice. In February, the trees are almost bare and the grass is bleached or burnt—a few *ráis* or sacred groves, as for instance that of Parli in Sheet 243, alone relieve the general barren appearance. These *ráis* are evergreen and in many cases are almost impenetrable. In May, after a few showers, the country begins to freshen up wonderfully, the grass soon appears, and everything seems to take a fresh lease of life. Eastwards, towards Belgaum, the valleys become flatter, broader and more suited for tillage, while near Belgaum itself are large tracts of undulating grass land on which flocks of goats and sheep are reared.

The Belgaum District may be said to be divided into three belts,—by the Malprabha River in the south, the Ghatprabha in the centre, and the Krishna in the north. The latter area does not concern us, as it lies far north of the scene of operations this year, and only a portion of the middle belt falls within the area allotted for survey to this party.

The hills north and east of Belgaum form the water-shed of the Ghatprabha and Malprabha Valleys, those to the north from Kákti towards Nésargi, are scarped and covered with thorny bushes; further east they are replaced by comparatively low sandstone ranges, while at Murgod in the extreme east of the country topographically surveyed this year, the hills rise again abruptly to the height of some 250 to 320 feet above the surrounding country, and are chiefly composed of conglomerates, with sandstone overlying a bed of quartzite, forming a largish plateau, greatly broken by weathering and covered in places with cactus bushes, in which partridges, quail and hares abound. There is also a tank in the hills near Murgod, to which grouse in very large numbers betake themselves every morning to drink. The rest of the country south of this is open grass or cultivated land, (the product being chiefly cotton) more or less undulating, while in Sheet 276, the country is much more broken and is fairly covered with forest. The hills near Khánápur are rugged, high and of striking outline, and the forests thence southwards and to the west are admirably placed for supplying fuel to the Southern Marátha Railway which runs through this portion of the district.

The chief towns and places of interest falling within the area surveyed this season are :—

Belgaum.—The head-quarters of a brigade,—consisting of 3 regiments of infantry, 1 battery of artillery—and also of the district, is a pretty station well-wooded and situated at an altitude of from 2,100 to 2,260 feet above, and 50 miles from, the sea, with a population of about 25,000 souls. The town stands on one of the laterite hills which form the eastern slope of the Márkándeya River which flows south-west to north-east, about 3 miles, and of its feeder, the Belari, which is about 2 miles south of Belgaum. The city is situated between the British infantry and artillery lines, and the fort, while to the south-west, are the Native infantry lines. About half a mile to the south is the town of Sháhápur belonging to the Sángli State. Water is obtained entirely from wells, which afford a plentiful supply throughout the year, but in Sháhápur the water is brackish and unpalatable. The roads are numerous and good.

The fort of Belgaum, which is about 1½ miles in circumference, is surrounded by a wall about 35 feet high, pierced by two gateways, one protected by a large outwork. Round the wall is a deep ditch, about 70 feet wide, which, except during the hot weather, is generally full of water. The fort is kept in a fair state of repair and contains an arsenal depôt, a church, some barracks, and a number of private houses surrounded by gardens: it is well-wooded and has an ample water-supply from wells.

Belgaum is an old town, and is called Venugram, or the Bamboo Village, in inscriptions of the twelfth and thirteenth centuries. The fort is said to have been built by a Jain king, and both it and the town appear to have often changed hands. In 1472 the fort was captured after a vigorous defence by one Mujahid Shah Bahmani. About 1488 it was seized by the Governor of the Konkan Bahádur Giláni. In 1498 it was assigned to Bijápur, and in March 1510 the Hindus rose and driving out the garrison resumed their former allegiance to the Vijaynagar kings. In 1511 it was granted to a Persian named Khosru Turk as a reward for saving the young king Ismail Adil Shah from the treachery of his guardian, and he reigned under the title of Asod Khan till 1549,

during which he was the mainstay of the Bijápur power. His is the greatest name in Belgaum history, and he is looked upon as a saint whose power keeps cholera from the place. There were many attempts to wrest his power from him but he frustrated them all and eventually died at Manoli, 3 miles south-west of Belgaum in 1549, and was succeeded by his son. In 1593 Ismail, brother of the Bijápur king, possessed himself of the fort; but though he withstood a siege, he was eventually induced to march on Bijapur and was captured and shortly afterwards put to death. In 1673 Shivaji, on his way to Hubli plundered Belgaum. In the third Marátha war in 1818, Munro attacked Belgaum on 22nd March having arrived on the 14th, and on the 11th April a practicable breach having been made, the garrison surrendered and were allowed to march out with their arms and private property.

Khánápur.—Situated on the Malprabha River at the point of crossing of the Southern Marátha Railway, is the head-quarters of the *taluka* of that name. It has revenue, police, and post offices, a rest-house, &c. It has a small trade in rice and plantains. It was formerly, in about 1720, a large entrepôt for Goa merchants who exchanged drugs, China goods, metals and spices for cotton and saltpetre with the Hubli, Nargund and Navalgund merchants: this trade was afterwards removed.

Nandgad.—A village 7 miles south-east of Khánápur, with a population of some 9,000 or 10,000 souls, a post office, weekly market and three schools.

Bidi.—Formerly the head-quarters of a sub-division, afterwards transferred to Khánápur.

Murgod.—About 15 miles north-west of Saundatti has a fair trade in cotton and grains. There are revenue, police and post offices and a Canarese school. It has a yearly fair lasting six days, in November—December; the village is partly enclosed by a wall and ditch, now ruined, and in rear by hills. There is a ravine about half a mile from the village, frequented by panther, and I had a shot at one within 50 yards of the village in the dusk of the evening last February.

Nésargi.—On the Belgaum-Kaládgi road, about 7 miles north of Sampgaon, has a dâk bungalow. It has a weekly market on Monday, and weaving and bangle-making industries.

Sampgaon.—The head-quarters of a *taluka*, has the usual offices, a post office and two schools. There is a weekly market on Sundays, where cattle, grain, cotton and cloth are sold. The first mention of Sampgaon is in 1683 when Aurangzeb's son, Mahomed Muazzam, is mentioned as besieging and capturing the fort after a gallant attack. It lapsed to Government after the Kittúr outbreak in 1824.

Halshi.—An old town about 10 miles south-east of Khánápur, the chief capital of the early Kadambas (A.D. 500); it has no trade or manufactures. It has three large temples, two of which are in the town,—one to Varáhvarsinh and the other to Suvarneslvar.

Mugatkhán Hubli.—Is a large village on the Dhárwár road, 18 miles south-east of Belgaum; it has a travellers' bungalow. It is so called after a Bijápur officer, named Mugat Khán whose tomb is in the village.

Kittúr.—On the Belgaum-Dhárwár road, is a large village with a ruined fort and citadel. An inscription of about the close of the twelfth century is the earliest known mention of Kittúr. In 1785 Tipu seized Kittúr and placed a strong Mysore detachment there, which held out against Holkar with a large force for more than a month, when the siege was raised. Tipu in 1787 handed the place over to the Maráthas. Under the treaty of Seringapatam, Kittúr became again a part of the Marátha country.

The Duke of Wellington (then General Wellesley) in his pursuit of Dhundia Vágh in 1800, reached Kittúr on 5th August and was delayed for six days, making boats to cross the Malprabha. Subsequently Mr. Mackray, the Collector at Dhárwár, sent by Government in 1824, to take charge of the Kittúr Estate, was murdered, and his two assistants were imprisoned. The place was invested in November and the prisoners released, the garrison surrendering at discretion. The State thus lapsed to Government.

In 1828 Kittúr fort is described as being a heap of ruins but still worth seeing, as the ruins showed it to have been a place of great strength.

The chief hill forts and hills of special mark in the area surveyed during the season under review are:—

Yellurgad.—A ruined fort at the west end of a high trap ridge, about 7 miles south-east of Belgaum. It is 3,288 feet above sea-level. This hill and fort are the most conspicuous objects in the neighbourhood of Belgaum.

Shamshergad.—Once a fine old fort, is situated near the apex and on the highest part of a sort of V shaped ridge; its altitude is 3,001 feet above sea-level and about 700 feet above the plain. It was built of stone and earth, but now is quite ruined. The spurs springing from it run north-east and east for about 3½ to 3 miles, and at their feet are the town of Nandgad and the village of Bijgarni. There is a well and a good mango grove in the fort. The ascent is easy from the east.

Máchigad.—A small fort above the village of Bijgarni.

Kalánidhigad and Gandharvagad, both hill forts, fell within the area surveyed this year, but as the sheet is not complete, they will be described in next year's Report.

The Malprabha River—rises in the eastern spurs of the Sahyádri range, about 8 miles west of Jámboti in Khánápur. Of the origin of the river the following story is told:—

In Kankumbi, on the eastern slope of the Sahyádris, lived a man, with a beautiful and virtuous wife. In spite of her goodness, he was jealous, and gave her neither rest nor

peace. At length driven to despair, she sacrificed to the gods, and offering a prayer to Basava, the patron of the Lingayats, threw herself into a mountain tarn. The pool on receiving this sacrifice overflowed its banks and formed a river which was called Malprabha or Malápahari "the cleanser from sin."

From its source it runs east for some 13 miles, when it turns south-east for 8 miles and then to the north-east past Khánápur and Lokodi. Though shallow, its flow is continuous throughout the year. The chief ferries in the portion of its course under review are at Khánápur, Mugatkhán Hubli—Turmuri—Sángoli and Virapur.

The Malprabha, entering Sheet 276 at the village of Mansápur, is joined at Lakhibail by the Chor Nala, an inconsiderable stream; close by at Kodchivad it receives the waters of the Khumbar Nala, which drains a largish area rising as it does in the hills near Kánvikarvinkop in Sheet 275 S. W., and further on it is joined from the north by a large *nala* rising in the hills near Siddanbhavi and Basápur in Sheet 275, and from the south by the Satti Nala, also a biggish stream which has a large drainage area rising as it does in the hills near Nandgad, of which Shamshergad is the highest, flowing south-west past Halshi near which it bends north-east to Bidi, and, continuing in this course, flows past Kasmalgi and Chikangroli to the Malprabha.

A fairly large *nala* flows into the Malprabha at Hira Mulkur, and the next important one is the Dod Nala which rises near Shigihalli and flows past Belvadi and Lingadhalli and joins the Malprabha at Budihal. From the north the Kiadgi joins it at Vakund rising near Hongal.

In Sheet 275 the Hira Nala rises in the hills near Sutgatti, and flows north-east past Nésargi and Chik Badnur, and so out of the season's work.

The Bándan, which rises in this sheet near Harngop, flows through Markumbi, where it is joined by the Bagnáth Nala, and eventually meets the Chilár Nala at Chikkop and the three combined flow into the Malprabha River at Ingalgi.

The Márkándeya River which rises in the hills near Bailur in Sheet 243 and enters Sheet 275 at the village of Ambevádi is a biggish stream and flows north-west past the villages of Alitgi and Honga, where it enters the hills and continues its course east by north through the hills, widening as it goes past Kenchanhatti, and so out of the work; it eventually flows into the Ghatprabha at Gokák.

The Mogitar Nala and one which joins the Malprabha at Khánápur are the only other streams of importance in the country under report.

The Hari Nala rises in the hills south of Belgaum, of which Yellurgad is the highest point—flows in an easterly direction past Marikatti, Tigdi and Sampgaon, whence turning in a south-easterly direction it flows past Naginhál and so on to the Malprabha. At Naginhál it is joined by a biggish *nala* from the north.

Sheet 243 not having been completely surveyed, is not reported on, as no maps are submitted this season.

The Belgaum District is well known to be particularly well supplied in the way of roads.

From Belgaum as a centre, made roads run to Poona on the north; eastwards *viâ* Aukalgi to Gokák and through Nésargi to Kaládgi; south-east, through Bágevádi to Dhárwár and a branch from Bágevádi to Murgod, and so on to the Kaládgi road; southwards to Khánápur and thence to Canara and south-west to Jámboti, leaving the Khánápur road near Yalúr, and westwards to Chandgad, Amboli, and so on to Sávantvádi.

The Southern Marátha Railway from Poona runs through the work, entering Sheet 275 at the village of Budihal, it runs to Belgaum with a station at Kangaon and from Belgaum through Yalúr to Khánápur, and thence on to Londa, where it joins the Dhárwár-Goa branch.

There are numerous cart-roads throughout the district.

Extract from the Narrative Report of MR. H. HÖRST, *Deputy Superintendent, in charge Burma Forest Survey,—Season 1885-86.*

In order to show why the out-turn was so small in comparison with the previous season's, it will be as well to remark that, the field season closed 25 days ealier than usual, and that the work met with several serious interruptions. On the 24th January, owing to the disturbed state of the country, particularly that of the reserved forest tracts in which two large bands of dacoits had been plundering the Karen villages, the detail surveyors had to be withdrawn from the Yoma, and fresh work allotted to them on the 2-inch scale. More than a week was thus lost in plotting fresh boards, in marching to new ground, and making fresh arrangements. During February the work was interrupted on two occasions by dacoits, and the aggregate number of days lost was 126. During March the Tharrawaddy and Prome Districts were more or less disturbed, and it was considered unsafe to allow small parties to work on the higher hills. Of the two, the Tharrawaddy District was most disturbed, and troops were placed at most of the stations on the Irrawaddy line of railway. In April matters came to a crisis: both districts were infested with dacoits, and it was positively dangerous to move about beyond a strip of country 5 miles wide on either side of the railway. The Local Government was then urgently solicited by telegram to permit the recall of the party from the field; but the sanction did not reach

till four days after. Meanwhile a large gang of dacoits, estimated at from 300 to 400 strong, was driven by the troops from Zigon into the ground which was under survey. The result was that three Sub-surveyors, with 40 *klassies*, narrowly escaped being massacred at Nyoung-le-bin, and Mr. Gibson's camp was attacked at Peinzaik on the 26th April. Four men fell into the hands of the dacoits who tortured them to death in the most barbarous manner, a fifth man was never heard of again and it is believed he too was killed. The loss of both Government and private property was considerable; Mr. Gibson and a Sub-surveyor escaped only with the clothes they wore, through their knowledge of the ground which was intricate and covered with jungle, and the work was abruptly brought to a close and several gaps were therefore unfortunately left. The Traverse and Triangulation Sections were similarly retarded although no casualties occurred, but Mr. Wilson had a very narrow escape and so had Mr. Ewing. The work was further retarded by the transfer of two good Sub-surveyors to Mandalay early in April and by an unusually unhealthy season, during which Mr. Wilson and several Sub-surveyors (one of whom was sent away to India on departmental leave early in March) suffered much from malarious fever.

The following forests are comprised in the area traversed and triangulated:—South Naweng, Middle Naweng, Gwaicho, Quaimeedo, Nabai-byo, Chaung-zouk, Pwaygin, and Shwelaung. The South Naweng is drained by the Taung-Naweng Chaung. At the south-east portion of this forest is a large Karen area containing two *Tes* or hamlets, Nashi-te at the north on the Litwa Chaung and Nga-to-te, about the middle of the area, on the Taung-Naweng Chaung. Through this tract a fair road runs from Prome to Toungoo, *viâ* Paukkaung and Taungle. From the latter village it goes to Satbyu village, then along the Kyoukgyi Chaung and up the Litwa Chaung to Nashi-te, thence across the Yoma to Shwe-ye-te in the Toungoo District. In the Middle Naweng Forest, which is drained by the Alay Naweng Chaung, there are no Karen areas, nor are there any passes into Toungoo. There is a difficult path passing from Nashi-te to Dabi-te in North Naweng. The other forests contain no Karen areas, nor are there any paths passing through, save one from Paukkaung *viâ* Kadin-gna-sin and Bambwe Taung to Kangyin *thana*. The isolated forests of Nyoung-Ben-det and Htonyea were also traversed. The former lies about 10 miles south of Paukkaung and the latter about 8 miles north of Prome. The Fuel Reserves of Sinmizwé and Pauktaw close by the railway line were also traversed.

The country surveyed on the 4-inch scale had the Pegu Yoma range running through it, but the backbone of the range from which the drainage flows east and west is not a very marked feature. There are other parallel ridges and spurs of considerably greater elevation than the main ridge or watershed, which are very striking at first. The features are generally small and the labor of surveying them very great in consequence of the heavy jungle. With the exception of a few Karen *Tes*, which were burnt down by dacoits, the country is totally uninhabited, which is probably the reason why the detail surveyors were not more frequently molested by dacoits. The country surveyed on the 2-inch scale consisted of low intricate hills covered with dense jungle which retarded the progress of the plane-tablers quite as much as that in the reserved forests.

The principal streams met with were the Taungnyo, with the Thayet, Panyo-gyi, Mwe-gyi, Kyauk-Myaung, Sinzwé, as tributaries; and the Shwelé with the Le-zé and Peinzaik as its tributaries.

The following forest reserves were taken up:—Taungnyo, Bwet, Sha-baung, Kadin-zauk, Padin-ben, Tapun, Pazingye, Kanni, Nyanle, Shwele, Kyauk-kyi-Taung, Padit Myaung, Kyibyu, Inma-Tayokmaw, as well as 5 interlying or adjacent Karen areas.

Routes.—From Paungdé in the Prome District *viâ* Tantabin, Nyounghla and Nyoung-le-bin to Ngapan-te in the Toungoo District, 6 marches. First march to Tantabin, where there are 5 *pakka* wells, 15 miles, a good cart track; second march to Nyounghla, 8 miles, cart track traversing low hills and along the Taungnyo Chaung for 1½ miles near Nyounghla; third march to Nyoung-le-bin, 10 miles, village of Thumba-di half way, road crosses Taungnyo Chaung, a fair cart road in dry weather. From Nyoung-le-bin there is only a footpath practicable for elephants lightly laden. For about half a mile the path runs along the bed of the Taungnyo Chaung, skirts the Maung-de Chaung for 1½ miles, crosses a low hill and again follows course of Maung-de Chaung ascending afterwards Sobyu Taung ridge 880 feet. From this point a succession of ridges and streams have to be crossed till the Yoma is reached near the hill, called Makupya. The descent on the eastern face of the Yoma is gradual, and the path, after keeping along the Yoma ridge for a short distance, runs along a stream till Nga-pan-te is reached; distance about 24 miles, 3 marches, with water at the halting places; no supplies procurable anywhere.

From Paungdé (Prome) to Aunghla-te (Toungoo), four marches.

First stage Ngapaw, a *thana* and large village; by a good cart track 16 miles; second march to Peinzaik, 11 miles; a small village with little water; fair cart track. From Peinzaik for the third march of 10 miles, there is only a footpath which follows the Peinzaik Chaung for 4 miles, then crosses water-shed to source of the Le-ze Chaung along which it runs to the junction of the Thaing Myaung, where there is a perennial spring and a suitable halting place The fourth march of 10 miles commences with the ascent up the Pandaung range which is crossed at the hill, called Thitpok Taung; ascent 500 feet; hence the path goes along a gradual slope to Kathit Myaung, along which it runs as far as Kywe-de-te, leaving which the Yoma ridge is crossed near a point called Thon-mye-zaing, and thence Aunghla-te is reached without much trouble.

Paungdé to Aunghla-te *viâ* Yoksaing, four marches. First march as above. Second march Ngapaw to Yoksaing; fair cart track; distance 14 miles. Shwele stream frequently crossed. From Yoksaing, which is a small Burman village, there is a good cattle track for the third march practicable for elephants lightly laden. It first skirts the Shwele Chaung to Bam-bwe-gante, 4 miles, whence the path runs along a low ridge for 2 miles up to Wun-din-byit Chaung, and along this stream for 3 miles to where the Yem-hen Chaung joins it. At this halting place there is a good perennial spring. Starting from this point the Pandaung range is crossed on the fourth march, ascent 750 feet, then the Thon-mye-zaing ridge, after which Kywe-de-te is reached. From here the Yoma is crossed to reach Aunghla-te; distance 10 or 12 miles. This path is better than the one *viâ* Peinzaik above described.

With two exceptions, the quality of work executed during the past field season is equal to the previous season's, and the drawing is superior. Owing to the abrupt termination of the field season at the end of April, several gaps have been left in the work, and the portion surveyed has only been partially checked. Unfortunately during the coming field season, it will not be possible to fill up more than two of these gaps as the others lie on the Yoma, which will not be accessible for a season or two, or until the country is quieter. Had it not been for the frequent interruptions already described, there would have been a most satisfactory out-turn, as the party was properly organized, the equipment was sufficient in every respect, and every ordinary contingency had been carefully considered.

Much credit is due to the Assistants and to several of the Sub-surveyors for standing firm at their work in spite of the dangers they were exposed to from dacoits, by whom they were constantly threatened.

Extract from the Narrative Report of LIEUTENANT-COLONEL H. S. HUTCHINSON, S. C., *Deputy Superintendent, in charge, Akyab Cadastral Survey,—Season 1885-86.*

The country known as the Arakan Coast in which Akyab is situated, in many ways closely resembles that of the "Konkan" of Western India. Both lie at an average elevation of a very few feet above the sea-level, both are long narrow strips of country of an average width of 40 or 50 miles, bounded on the east by a chain of mountains and on the west by the sea, and being situated in the same latitudes, their climates also are very much alike. The main difference between them consists in the magnificent wide tidal creeks, which penetrate Arakan far inland, extending even into the hill tracts, and which are navigable for river steamers and large sailing craft for long distances, whilst there are no rivers of importance in the Konkan in any way to compare with them. This is probably the reason why Arakan is so much the damper climate of the two, and its scenery also differs very much on this account. The main rivers of the Akyab District, *viz.*, the "Kaladan" and "Mayu," are some miles wide and maintain a width of 1 to 3 miles for a long distance inland. The Arakan hills, though not dissimilar in outline and formation to the *ghâts* of Western India, are not so bold, and do not form the same peculiar wall or step of 2,000 feet high, whilst they are more rounded and more densely covered with forest. The timber, however, in the Akyab District is not considered valuable, and in consequence there are no forest reserves, though some timber is under especial protection. The Arakanese are a slothful, indolent people, and the labour for cultivation of the country is mainly imported from Chittagong. Indeed, the Chittagonians are, I believe, gradually dispossessing the aborigines of the country; settlers are found all over the Akyab District. The Arakanese are seen most to advantage during their water festival, when they turn out in crowds for boat races, and the country seems alive with excitement. A description of a boat race by Mr. Jarbo, Surveyor, with this party, is given below, as nearly as possible in his own words.

The villages of "Wagun" and "Kyauktaw" lie in a picturesque position, facing and immediately on the left bank of the Kaladan River: they are some 3 miles apart; the portion of the river between them has a high bank and is fringed with lines of jack, marian and other fruit and jungle trees; behind the jungle, and running almost parallel with the river, there are ranges of hills, some of whose peaks reach a height of 3,000 feet, and are for the most part covered by bamboo jungle with here and there a gigantic gurgan tree, many of which are festooned with long sprays of purple orchids, or clothed with graceful ferns. The gaps that occur in the jungle are caused by clearings for cultivation, called *taungya*, and the crops are claimed by the semi-civilized, and more than semi-nude tribe of "Khwaymes" or dog-eaters. Many of the lower spurs are capped with white pagodas, conspicuous in contrast with the green background of the foliage on the higher hills. The pagodas are bell-shaped masses of solid masonry, erected in order to merit *Nekban* (heaven), of no use but ornament. Between the hills and the villages are fields after fields, bearing at the proper season teeming crops of rice, the staple on which alone as yet depends the prosperity of the surrounding country. For the front view our villages have low detached hills with very precipitous sides abutting on to the river whose waters under the shadows of the grey rocks, look but are not unfathomable, for in the water at the mouth of a small rivulet may be seen a herd of buffaloes lying dosing each one with its nose, eyes, and the tips of its horns just visible above the surface of the water, enjoying a mid-day nap in which we cannot afford to join them at present for the day promises to be

a busy one; what with woods and rivers and hills and herds the population of the country have much to be grateful for, and they are as a rule a very contented race; but just at present their thoughts are occupied with other things than the beauties of their surroundings—Who will win at the approaching boat races? and pose as athletes and heroes before the world in general? (and their sweethearts "Thā zan Phyoo" and "Mah Thā loung" in particular).

It is to see the races and to describe the contest of the day between the boats of the two villages above named, that we are now concerned, and to do so with advantage we had better climb the low hills on the opposite bank of the river from which we shall get a bird's eye view of the whole proceedings whilst sitting in the shade of a mutilated torso of an herculean figure of Guadama (unless we sink into an endless reverie and our features, like his, become fixed with the expression of eternal meditation).

Now we have recovered breath after the climb, let us take a good look around. Ah, the first arrivals have reached the wharf, abreast of which is to be placed the winning flag—among them is a podgy figure balanced on a very fat little bay pony, this is the "*Myoôk*" or petty Magistrate and Revenue Collector; he wears the gayest of "*loongyees*" (waist cloth), of the richest and thickest silk, woven with very bright colours into an exceedingly intricate maze of squares, triangles, and zig-zag twisted, turned, and interlaced, called, I believe, the dog-tooth pattern; his iron-grey hair glossy with exuberant oil tied into a compact knot and brought to the very top of his head like the knob of a teapot cover, is encircled with a wisp made of the whitest of white cambric handkerchiefs, and there is no mistaking him for being other than the great man of the country. As he slides off his nag, he is surrounded by a crowd of sleek men whose self-importance will at first only allow them to mumble greetings and hint suggestions, but as arguments wax warmer, dignity is laid aside and then they shout and gesticulate like very schoolboys. At last something has been decided on for a muscular middle-aged man, tucking his *loongyee* high up above his thighs and canting his head on one side to get hold of, and tie up his long back hair which has got loose and hangs to his waist, rushes along the wharf, as if having been worsted in the discussion he is determined to bring it and his life to an end together; but as he nears the edge he evidently thinks better of it, for he turns to his right, and goes deliberately down the steps placed there and draws forth a dug-out (a country skiff, made of one solid bit of wood) from under the wharf, out of which he proceeds to dislodge the water by rocking it to and fro half a dozen times, then taking up the paddle he squats himself on the extreme end of the canoe, dangling one leg in the water, and awaits events; meanwhile others are not idle, for a bamboo raft about 2 feet square has been made, and this a youth now places in the dug-out whose helmsman with a few strokes of his paddle, carries it some 50 or 60 yards away from the wharf and then stops and calls out to know if he has gone far enough; the *Myoôk* decides this knotty question favourably, and the bamboo raft is set afloat at that spot and moored with large stones for anchors, so that it may not be carried away by the tide, and now arises a discussion as to the best way of fixing the winning flag on the raft; for in Arakan the boat, whose crew secures the winning flag and can show it as a token, wins the race, and it is necessary that both should have an equal chance of laying hold of it. One therefore suggests that a hollow bamboo tube be tied horizontally to two posts on the raft with a cane through it which could be easily withdrawn from either end, breadthwise to the river, and that whichever crew succeeded in withdrawing the cane should be declared to have won; this is objected to by others, who say, "No," for perhaps the leading man of the boat which is ahead may miss taking hold of the cane, and that then the leading man of the second boat, and the second and third man of the first boat may seize the cane simultaneously and that then the boats will upset, this will lead to a dispute and doubtless end in a riot as happened in a former year; let there be two flags quite independent of each other." To this there are also objections, but now the old *Myoôk* hits upon a plan which meets the wishes for fair play of all parties. It is this,— a bamboo, about a foot long, is fastened in the centre of the raft in an upright position, and the staff of the flag rests in this as in a socket, the winning boat is to be that one whose crew takes out the flag from the socket. A large rice boat is anchored out in midstream in a line with the wharf and raft, this is for the judges and umpire, besides this, "dug-outs" are stationed at intervals along both sides of what is to be the course to see that each racing boat keeps to its own side of the river, and that there is no foul play. Whilst all this has been going on, sight-seers have been coming in increasing numbers, first in ones and twos, then by the half dozen, till now they form a continuous stream of people dressed in all the colours of the rainbow as well as in others not to be found in it. She who is the happy wearer of a pink *thamine* or petticoat, a delicate, canary scarf over a plum colored velveteen *aengyee* or bodice, and a large bunch of yellow orchids in her hair, is considered quite the star of the day; and he who is dressed in a yellow and black-checked *loongyee* with an elaborate border, a blue cloth jacket, with gold buttons and a light pink head-kerchief or *gaung boung* with a magnolia blossom behind one of his ears, is looked upon as the cream of gentility. As the boat races are to be followed at night by a *zat pwav* or dramatic performance by male and female artists of famed excellence and beauty, whole families may be seen bringing with them the wherewithal to make themselves happy and comfortable for two or three days and nights, should the entertainment last so long; this consists of loads of cooking utensils, bundles of mats, and trays upon trays of sweets and other edibles of sorts, not the least important being bowls of roasted beetles, and grasshoppers, fried snakes, pickled tea leaves, and the inevitable *ngapi* or fish-paste, fra-

grant to the nostrils and delicious to the palate of the true Arakanese. There is an old grandmother with the mats, the mother with a tray of cigars and a baby—without this latter appendage a Burman woman would be ashamed to appear in public; the father heads the procession with the pet of the family on his shoulder—a boy of four or five years—decked out as an exact miniature of himself, the rear is brought up by a grown-up son, preceded by his sisters, his cousins and his aunts, chattering, laughing with, and at times teasing each other, their whole manners and actions indicative of the spirit and delight with which they intend to enter into the business of entertaining and being entertained. It is now 3 o'clock and time that the racing boats should appear, for it is very nearly high tide. What is that coming up stream? It looks like a procession of canoes, for surely it is not one boat. Yes, it is, now that it is closer we see it is but one, and that by its flag, an English blue ensign with the design of a white pagoda worked on the blue ground, it is the racing boat of Kyauktaw. As regards length, it is an enormous boat, being fully 120 feet long, but barely 3 broad; it is in fact nothing more than a very long dug-out made of one tree, and so shallow and light is it that it looks a mere straw on the water. In the centre is a platform flush with the top of its side, on this is slung a large gong, around which are gathered some half dozen musical performers, whose notes are expected to instil and keep alive the spirit of emulation in the crew of eighty rowers, or rather paddlemen; these are seated two abreast, twenty pairs being on each side of the orchestra. Each rower is armed with a paddle made of a dark-coloured wood, nicely polished, and wears a pink head-dress. The boat is steered by a very long flat-bladed oar, fixed over the stern of the boat, and projecting some distance beyond it; with this powerful lever the boat can be steered to a nicety and turned completely round in its own length.

Here comes a second similar boat bearing the Wagun flag, an English red ensign with a black *Beloo* or demon embroidered on the red ground, lilac coloured head-kerchiefs being the distinguishing head-dress of its rowers. These are the great rivals, though there are eight other racing boats now present they are smaller editions of the above, differing from them in the number of paddles, the devices on the flags, and in the colour of the uniforms. The crowds lining the river banks begin to evince signs of impatience, the friends and sympathizers of one boat constantly call out to their crew to know when the start is to be made, and remind them that they have to pull for the honor of their village, and the smiles of its girls, whilst those of the other chaff and criticise their appearance and prospects with the ladies, very much after the style of an English mob on a like occasion.

At last the race is to come off, the boats are brought up parallel to each other near midstream, and they are to start by mutual consent. The coxswain in each boat now chants what sounds like an invocation, "*Maungdoo Maungdoo-yee yee,*" which is repeated by the crew who are holding their paddles upright poised in the water; he then intones "*Ngado Hlay-go-pyin ya lay-gyee,*" to this his crew taking up his note respond with "*Nindoo Souk Kyoo Nga ya lay gyee*" followed by—"*Hlaytuga, Hlaybaw, Hlaybaw thait Ka,*" from the coxswain, answered by the rowers with "*Taung Loong Gyawdthey, Taung Loong Gyaw.*" The gong is now struck with a pause of slow time at first between each stroke; this serves to mark the time and get the rowers into the correct swing, as it is accompanied by each of the crew making a sweep of his paddle, passing it in a circle above his head, and down into the water, shouting his war cry of "*Hayla Heela,*" "*Hayla Heela*" with each dip of it.

The strokes on the gong become more rapid, the paddles keeping time with it. Suddenly the helmsman of one boat throws up his arm and gives a loud shout, and both boats literally dart forward like birds. The beats of the gong and the *hayla heela* of the rowers are repeated now as fast as hand can strike and tongue articulate, the whole eighty paddles of each boat keeping exact time in dipping, with the precision of a machine: so true are the movements that it is almost incredible that the motive power furnished by no less than eighty pairs of arms, and as many distinct wills can conduce to a result which rivals in accuracy the motions of the nicest mechanism prompted by but one motive engine. Soon after the start has been made the band strikes up, and some of them begin to dance on the centre platform, some imitate the flying of birds by flapping their arms, others the swimming of fishes balancing themselves the while so as not to interfere with the trim of the boat, but keeping time to the music. At the prow one performs a *pas seul*, the movements of his arms and hands representing capitally the beating of a bird's wings through the air. The clean dip of the paddles, the rapid but smooth gliding of the boat, and the graceful actions of the dancers may well be called the poetry of motion. As the winning flag is neared, the rallying cry becomes a succession of shrieks. The Wagun canoe leads by a foot or two, but the Kyauktaw coxswain gives a shout of encouragement to his men, and makes two rapid sweeps with the oar which serves as a rudder, this, acting like the screw of a steamer, brings both boats level. They are now within six inches of the end of the flag-platform, and it seems as if they will run down it and each other. There !!!, the dancer on the prow of the Kyauktaw boat has made a grab at, and succeeds in grasping the coveted flag; this he waves in trimuph over his head, and a perfect roar of applause arises from the spectators on the banks; all discipline on board is now at an end, for the whole crew are capering about at the risk of upsetting their craft, dancing, shouting, singing, kicking up their legs behind and before, and slapping themselves and each other in excess of joy; paddles, long hair, and handkerchiefs flying about in all directions, testify to the delight of their owners at having, after a very severe

struggle, won the race; so equal a contest was it, that had the man at the prow of the Wagun boat had an arm and fingers but two inches longer the result would probably have been different, for he made his grab for the flag simultaneously with that of the Kyauktaw man: in fact to English ideas the race ended in a dead heat.

Miss Thā-zan Phyoo, or "White orchid," is all smiles and tears as she offers her swain from the Kyauktaw boat the choice of her tray of cigars; this is by no means refused, nor is the further favour of lighting it for him, which she proceeds to do after giving it a caressing lick with her tongue which is doubtless appreciated. Beautiful "Mah Tha loung" of Wagun fame affects an indifference, we dare say she does not feel, unless indeed having no partiality for any of the crew she can afford to keep her sympathies for another occasion.

And now the chief event of the day is passed and the greater portion of the crowd have already left the river bank and are engaged in regaling with divers dainties the recent competitors who have each been presented with a gaudy handkerchief by the *Myoôk*; so we will descend the hill and leave the holiday makers to complete their day's sport without our presence, hoping it may end as peacefully as it has begun.

Extract from the Narrative Report of LIEUTENANT-COLONEL S. H. COWAN, *Deputy Superintendent, in charge Basti Cadastral Survey,—Season 1885-86.*

As the Benares records are now all complete, and no further charges against that district will appear in the accounts of the party, a final statement is here given of the cost of the survey and of the *pargana* areas, &c.:—

District Benares.

Nature of Survey.	Scale.	No. of villages.	No. of fields.	Square miles.	Cost.	Remarks.
	Inch.				₹ . p.	
Field Survey	16	2,272	951,919	988·48	1,63,331 14 7	Includes the amount of ₹4,365 expended on marking theodolite stations.
City Survey	32	44	40,899	10·98	9,772 0 0	
TOTAL .		2,316	992,818	999·46	1,73,103 14 7	

The following Comparative Statement shows the Benares rates and the rates for two adjoining Districts.

	Ghazipur.	Ballia.	Benares, Including City.	Benares District (not City.)	Benares City alone.
	₹ a. p.	₹ a. p.	₹ a. p.	₹ a. p.	₹ a. p.
Rate per square mile	167 2 6	157 5 9	172 6 9	165 4 4	890 0 0
,, Village	66 1 9	72 4 10	75 0 4	72 8 1	
,, Acre	0 4 2	0 3 11	0 4 4	0 4 2	...
,, 100 Fields	12 4 9	12 5 7	17 7 11	17 4 9	...
Average size of Village	253	294	278	280	...
,, Field	·48	·50	·65	·67	...

In these amounts and areas, the Pargana Kaswar Raja is included (305 villages, 211 sheets, 125,661 fields, 118·25 square miles); for the survey, records and maps of which, the Maharaja has paid ₹22,000. Of this sum ₹3,200 is the cost of printing cadastral maps, being at the rate of about ₹15 per sheet, leaving ₹18,800 for survey and records. The cost may be estimated in three different ways, *viz.*:—

	₹ a. p.	₹ a. p.
118·25 square miles	@ 165-4-4 per square mile	= 19,543 4 5
305 villages	@ 72-8-1 per village	= 22,118 0 0
125,661 fields	@ 17-4-9 per 100 fields	= 21,735 6 9

so that whichever calculation is adopted, the Maharaja is a gainer.

The Maharaja's Settlement Officer (styled Additional Principal Revenue Officer), Munshi Krishna Chandra, M.A., has favoured me with the following extract from the Report of the Deputy Superintendent, Family Domains, Maharaja Benares, on the Gangapur Settlement.:—

"The total cost of survey and printing the maps, as paid by the Maharaja to Government, amounts to ₹22,000. This, on a corrected area of 118·7 square miles, amounts to about ₹186 per square mile. This is considerably in excess of the estimate, which was for about ₹140. The excess is probably owing to the minute sub-division of the cultivated area. The cost of attestation, settlement of disputes, and fairing the papers, irrespective of the Maharaja's personal expenditure in the employment of agents to look after his interests, amounted to a further sum of ₹10,740 or about ₹91 per square mile."

Particulars of District by Parganas.

Pargana.	Villages.	Sheets.	Fields.	Acres.	Square miles.	Average size of	
						Villages.	Fields.
						Acres.	Acre.
Narwan	201	162	79,875	67340·50	105·22	335	0·84
Barhwal	131	95	62,994	41282·01	64·50	315	0·65
Majhwar	185	140	64,973	48534·05	75·83	262	0·75
Dhus	84	71	37,981	29098·08	45·47	346	0·77
Mahuari	78	67	25,614	22657·20	35·40	290	0·88
Mawai	51	38	13,516	12234·82	19·12	240	0·90
Ralhupur	80	60	19,238	19638·33	30·68	245	1·02
Barah	94	91	28,176	31577·08	49·34	336	1·12
Athgaon	164	89	42,910	22996·63	35·93	140	0·54
Kolasla	147	136	126,800	55926·32	87·38	380	0·44
Pandraha	103	85	64,347	30833·82	48·18	299	0·48
Sultanipur	31	22	15,653	7626·83	11·92	246	0·49
Katehir	215	193	104,892	66179·17	103·40	308	0·63
Jalhupur	62	81	24,920	28906·18	45·17	466	1·12
Shiupoor	111	71	33,574	21049·08	32·89	190	0·63
Dehat Amanat	142	141	76,847	36268·46	56·67	255	0·47
Kaswar Sirkari	132	81	44,847	28233·38	44·11	214	0·63
Kaswar Raja	305	211	125,661	75680·00	118·25	248	0·60
TOTAL	2,316	1,834	992,818	646061·94	1009·46	279	0·65

The *bigha* in Benares is equal to 3,136 square yards nearly, 1 acre being equal to 1 *bigha* 10 *biswas* 17·3445 *dhurs*.

Extract from the Narrative Report of MAJOR J. E. SANDEMAN, S.C., *Deputy Superintendent, in charge Gorakhpur Cadastral Survey,—Season 1885-86.*

The Hata Tahsil contains the following *parganas;* the names of the *tappas* within the latter, their area and the number of *mouzahs* are also given :—

Number of Mouzahs.	Names of Tappas.	Parganas.	Area.
	Agaya	Haveli	4906·98
	Bandwar	Hata	14072·14
	Bharsand		19685·72
	Dedupar		17653·85
	Padkhori		9192·46
	Parwarpar		36159·74
Totals . 229			101670·89
	Bachauli	Sháhjahánpur	13106·31
	Bhainsadabar		8085·26
	Bhitni		5101·70
	Chak Daia		9412·25
	Majhana		1960·64
	Nagwan		19503·80
	Padiapar		4683·52
	Patnan		11478·36
	Tarkulwa		14240·71
Totals . 258			87 572·55
	Bakhra	Silhat	3577·90
	Banchara		15089·25
	Barnai		3223·07
	Binack		3160·25
	Chariaon		6972·52
	Dhatura		12192·46
	Donth		2143·72
	Gaura		1910·05
	Idrakpur		1664·16
	Indupur		15002·05
	Kataura		4394·80
	Madanpur		6522·13
	Nagwa Tikar		72543·19
	Narainpur Chiuraba		6762·02
	Paharpur		2207·26
	Singhpur		13163·38
	Sirjam		6116·19
Totals . 507			176644·40
GRAND TOTAL . 994			365887·84

An exception to the usual dead level of the country is a sand ridge, about 30 feet high, which runs south through Haveli Pargana and is continued along the border of Silhat and Sháhjahánpur and which crops up at intervals in both *parganas*.

The proprietary tenures of the *mouzahs* are as follows:—

	Zamindari Wahid.	Biljmel Zamindari.	Patidari na-mukammal.	Patidari mukammal.	Total.
Haveli	44	114	64	7	229
Shahjahanpur	36	72	142	8	258
Silhat	55	150	291	11	507

In this *tahsil*, as in all others in the district, the shares of proprietors when they are numerous, as is often the case in coparcenary villages, are recorded in the following divisions of an anna:—

20 phens = 1 rehn.
20 rehns = 1 dant
3 dants = 1 kant.

3 kants = 1 kaurie.
4 kauries = 1 ganda.
20 gandas = 1 anna.

The sizes of the *pargana bighas* are as follows:—

	Square yards.		Square yards.
Silhat	3,161	Haveli	3,164
Sháhjahánpur	3,600		

The total amount of cultivation and of irrigated and dry cultivation in the *tahsil* is as follows, in acres —

	Irrigated		Total.		Total of cultivation.
	From wells.	From other sources.	Wet.	Dry.	
	Acres.	Acres.	Acres.	Acres.	Acres.
Haveli	6,322	24,938	31,260	41,792	73,052
Sháhjahánpur	11,623	16,335	27,958	40,490	68,448
Silhat	38,062	45,089	83,151	54,944	138,095
				Total	279,595

The areas of land cultivated by proprietors and tenants in the various *parganas* of this *tahsil* are as follows:—

	Sir and Khud-kasht.	Tenant's land.
	Acres.	Acres.
Haveli	6,633	65,335
Sháhjahánpur	11,150	55,469
Silhat	36,003	100,024

The numbers of and the areas cultivated by occupancy tenants and tenants-at-will are contrasted below:—

	Occupancy tenants.		Tenants-at-will.	
	No.	Acres.	No.	Acres.
Haveli	12,793	40,001	17,706	25,334
Sháhjáhanpur	20,583	40,892	15,957	14,576
Silhat	31,740	63,668	33,096	36,355

The number of rent-free-tenants and areas cultivated by them—

	No.	Acres.
Haveli	391	887
Sháhjahánpur	968	1,683
Silhat	769	1,847

The average sizes of the two kinds of holdings in this *tahsil* are—

	Acres.
Occupancy tenants	2·22
Tenants-at-will	1·14

The areas of culturable and barren land in the three *parganas* are as follows :—

Culturable.

	Fallow.	Groves.	Grass.	Bush.	Total.
	Acres.	Acres.	Acres.	Acres.	Acres
Silhat	18,494	4,018	1,239	839	24,590
Sháhjahánpur	9,994	1,566	474	166	12,200
Haveli	16,802	2,030	1,171	73	20,076

Barren.

	Sites.	Water.	Otherwise barren.	Total.
	Acres.	Acres.	Acres.	Acres.
Silhat	3,265	7,655	3,039	13,959
Sháhjáhanpur	1,948	3,061	1,916	6,925
Haveli	1,831	4,149	2,562	8,542

The cultivated areas under the various soils are as follows :—

	Sháhjahánpur.	Haveli.	Silhat.
	Acres.	Acres.	Acres.
Dorus (loam)	57,606	52,919	66,818
Matyar (clay)	9,839	19,153	14,394
Balua (sand)	1,004	980	7,088
Bhat (a cretaceous soil)	...	...	312
Kachhar (lands inundated in the rains)	...	...	407

The conventional tracts, as divided for assessment purposes, and to which the rates of rent often conform, have the following areas :—

	Haveli.	Sháhjahánpur.	Silhat.
	Acres.	Acres.	Acres.
Goend (Home-lands)	7,023	8,642	24,106
Manjhar (middle tracts)	15,139	17,303	53,679
Palo (out-lying)	50,891	42,504	60,311

The following is an abstract of the agricultural statistics, which were collected, by *parganas* :—

	Wells.			Ploughs.								
	Masonry.	Earthen.	Total.	2 bullocks.	4 bullocks.	Total.	Plough cattle.	Other cattle.	Sheep and goats.	Horses.	Sites.
Sháhjahánpur	1,546	900	2,446	9,608	100	9,708	21,792	34,853	12,988	216	594
Haveli	1,130	790	1,920	10,565	26	10,591	23,565	44,438	10,053	120	558
Silhat	3,658	2,658	6,316	21,953	89	22,042	45,695	60,050	16,637	711	19,33

There are 5·48 sites of villages in each square mile.

The following are the areas in the three *parganas* under some of the principal crops in the autumn and spring harvests—

KHARIF.

KHARIF.	Haveli.	Sháhjahánpur.	Silhat.	TOTAL.
	Acres.	Acres.	Acres.	
Rice (Aghani and Bhadain)	45,177	24,524	37,371	
Kodo	838	2,822	10,723	
Arhar, with jowar and bajra	287	6,100	17,030	
Arhar	3,045	140	821	
Makai	94	1,648	568	
Jowar	258	497	1,911	
Garden food crops	70	152	60	
Other food crops	890	1,271	4,463	
Total food crops of the Kharif harvest	50,659	37,454	72,947	161,060
Sugarcane	5,272	6,911	5,080	
Cotton	13	88	15	
Indigo	15	13	275	
Garden non-food crops	...	2	13	
Other non-food crops	620	663	419	
Land prepared for sugarcane	4,293	5,640	2,483	
Total non-food crops in the Kharif harvest	10,213	13,317	8,285	31,815
RABI.				
Wheat	8,826	5,666	11,850	
Barley	1,001	2,979	29,565	
Gojai, wheat and barley	3,448	10,446	15,406	
Bijra, wheat or barley and gram	152	2,112	1,313	
Gram	3,740	...	6,790	
Kiran	11,563	9,229	19,917	
Potatoes	25	42	54	
Masur	1,095	746	205	
Garden food crops	50	108	157	
Other food crops	11	30	653	
Total food crops in the Rabi harvest	29,911	31,358	85,910	147,179
Opium	7	325	1,416	
Tobacco	27	13	50	
Tisi	9,698	4,802	9,749	
Sarson	...	3		
Garden non-food crops	...	...	44	
Other non-food crops	1	17	26	
Total non-food crops in Rabi	9,733	5,160	11,285	26,178

The double-cropped areas are,—in Sháhjahánpur 18,842, in Haveli 27,465, and in Silhat 40,336 acres.

The numbers of cultivators of each caste and the areas cultivated by them in the three *parganas* are given below:—

	HAVELI.		SHÁHJAHÁNPUR.		SILHAT.	
	No.	Acres.	No.	Acres.	No.	Acres.
Mahomedans	896	2,768	2,678	5,735	1,598	3,406
Brahmans	2,212	6,683	2,935	7,826	7,193	21,963
Rajputs, Thakurs or Chatris	840	3,742	1,988	6,913	4,818	18,392
Banyas	370	1,045	705	1,257	963	1,851
Kayats	291	1,388	498	1,273	491	2,507
Chamar or Dusadh	2,792	5,252	2,153	3,262	3,570	6,741
Ahir	1,840	4,350	3,187	6,353	6,581	15,597
Koeri	492	1,301	1,749	3,854	1,547	3,753
Kurmi	6,094	22,723	3,524	10,094	5,392	18,032
Kahar, Malla or Gondh	537	1,027	660	1,094	4,385	9,847
Dhobi	434	885	506	766	459	717
Teli	897	2,387	963	1,795	1,293	2,694
Julaha	535	1,089	945	1,429	943	1,685
Nanera	394	943	598	1,083	1,728	3,821
Barai	202	514	312	586	396	850
Kalwar	178	493	518	921	358	813
Nai	406	739	496	703	606	873
Other castes	6,355	15,725	6,897	13,504	10,068	22,653
TOTAL	25,765	73,054	31,312	68,448	52,389	137,095

Sugar boiling is extensively practised in all three *parganas* of this *tahsil*. The areas under sugar cultivation, as is apparent from the crop statement given above, are very large, and there are sugar-mills (*Kolhu*) in almost every village. The juice is extracted and boiled and the *gur* is taken to the nearest factory. The factories generally advance money to the cultivators. There are sugar factories at many of the large villages.

Ancient monuments are scattered over the *tahsil*, notably at Rudarpur. Some are the remains of Budhist convents and relic temples. At Rudarpur are the remains of a quadrangle, about 350 yards square, enclosed by a mound of brick which rises 40 feet above the surrounding country, which is strewn with bricks.

Extract from the Narrative Report of MR. A. D'SOUZA, *Officiating Deputy Superintendent, in charge Sambalpur Traverse Survey,—Season 1885-86.*

Sambalpur is the most eastern district of the Chhattisgarh Division of the Central Provinces. The Khálsa portion of the district is divided into two *tahsils* or sub-collectorates by the River Mahánadi, the one on the right bank being called Bargarh, and that on the left the Sambalpur Tahsil. These positions are also locally known as the Dakhintir and Utartir from their positions with respect to the river; that which is south of the river is called Dakhintir and that to the north the Utartir.

The portion surveyed in the Utartir or Sambalpur Tahsil embraces the tract of country between latitude 21° 5′ and 21° 35′ and from the River Mahánadi to the eastern boundary of the district. The country surrounding the town of Sambalpur and that along the bank of the river is highly cultivated. To the east and south where there are mostly forest reserves and hilly tracts, the country is undulating, with some clumps of hills more or less rugged, and occasionally an isolated hill to break the monotony of the undulation. The most notable among the mass of hills to the south is the Bodapali range which attains the height of 2,331 feet above sea level. The country is so densely covered with forest trees and under-growth, combined with bamboos, that it was a source of great difficulty to the surveyor who surveyed the portion last season. The country besides is notoriously unhealthy, poorly inhabited, and the villages are very few and far between; those met with, are composed of three or four huts only, and as the field season advances, there is a great scarcity of water and the few inhabitants of these parts leave the place for the cultivated plains near the larger streams. It is difficult therefore to procure coolies and guides to point out the boundaries of the forest reserves and villages. The tract abounds in large game, *viz.*, elephants, bison, tiger, panthers, deer, &c.

The portion surveyed in the Bargarh Tahsil consists of 550 square miles of level open country, similar to that surveyed last year, and the Bara Pahar—a range of hills situated at a conspicuous bend of the Mahánadi River which flows on three sides of it. The highest point of this range is Dabrugarh, which attains the height of 2,267 feet above sea level. This hilly tract is densely wooded and presents most formidable obstacles to the traverse surveyor who has to follow up the village boundaries which run through them.

Sambalpur is the only town of the district. It is situated on the left bank of the River Mahánadi $\frac{\text{Latitude } 21^\circ\ 28'\ 14{\cdot}9''}{\text{Longitude } 84^\circ\ 0'\ 20{\cdot}5''}$. It is about a couple of miles in length, having about 2,500 houses and a population of 13,939 inhabitants. There is nothing very remarkable in it but a few tottering bastions of an old fort and a dilapidated palace which still remains to speak of its past history, when it was in the possession of a Garjat Chief. It was annexed by the Government of India in 1849 on the demise of the Raja who left no male issue to succeed him on the throne. The river here is about a mile broad and is sometimes full during the monsoon from bank to bank, but after the rains, the channel of the river is about 50 to 60 yards in breadth and in some places of considerable depth. It is crossed by a ferry. The bed of the river is covered with boulders of rocks, by the sides of which grows the *jhow* tree forming little green islets here and there, which adds much to the beauty of the scenery.

Bargarh, the head-quarters of the *tahsil* $\frac{\text{Latitude } 21^\circ\ 19'\ 50''}{\text{Longitude } 83^\circ\ 39'\ 33''}$ is a small town on the road to Raipur. It has a subordinate Magistrate's *kacheri*, police station, post office and school.

The Mahánadi is the only large river in the whole district, it takes its rise in the Bastar District and flowing in a northerly direction, it reaches the Biláspur boundary where it receives the waters of its great affluent, the Seonáth, and taking an easterly course, enters the Sambalpur District and passes the town of Sambalpur. It then flows south and south-easterly to Cuttack and then branching out into its numerous estuaries, flows towards the coast and empties itself into the sea. It is navigable by boats as far as Seorinárayan, for the greater portion of the year, when a very large quantity of grain and other produce of the country are conveyed to Cuttack for shipment to other ports.

Gold dust has been found in the Mahánadi and the Ib Rivers, and diamonds in an island called Hira Kund, which is about 6 miles north of the town of Sambalpur.

Extract from the Narrative Report of CAPTAIN R. A. WAHAB, R.E., *Officiating Deputy Superintendent, in charge Himalaya Party,—Season 1885-86.*

The country triangulated lies in the Sutlej Valley, between the outer Himalaya range which forms the Sutlej-Beas water-shed and the high range, which running eastwards from Nárkanda, forms the southern water-shed of the Sutlej. Several G. T. S.

secondary stations and points fall within this area, but few of them could be identified. South of the Sutlej, Hatúgarh h.s. and Tumru h.s. were satisfactorily identified, and form the basis of the triangulation; north of the Sutlej only Núnúkanda h.s., and Ghamain h.s., out of six or seven stations visited, were found.

The ranges which enclose the part of the Sutlej valley under survey, average from 9,000 to 11,000 feet above sea-level; from them steep spurs, divided by deep valleys, run out to the river, from the level of which (about 2,500 feet) up to an average height of perhaps 6,000 feet the hill sides are bare, and wherever the slope admits, dotted with villages and patches of cultivation. Above that height they are generally thickly clad with forest, chiefly *Kail*, or blue pine (*Pinus excelsa*) and *Rai* or Himalayan spruce (*Abies Pindrow*): Deodar is also found in places near the lower limit of the forest tract and on the warmer and drier slopes; at a still lower elevation patches of *Chir* (*Pinus longifolia*) are met with.

The only places of any importance in the country under survey are Kotgarh, in the British State of the same name, and Rampur, the residence of the Raja of Bashahr, and a well-known market for shawls, *puttoo* and all kinds of woollen manufactures. At Kotgarh there is a Mission church and several European residents.

The Hindustan-Tibet road passes through Kotgarh and Rámpur, from each of which places roads run north into Kullu. From Kotgarh a road leads by Suket and Mandi into Kangra.

The party reached their ground rather later in the season than was desirable, the operations in Kangra having occupied them until late in April, and as no preliminary work, such as selecting stations or erecting marks had been done beforehand, the work of observing was not commenced till late in May when hazy weather set in and greatly delayed work. The heat in the low, shut-in valleys was very great and the labor of climbing the steep, bare hills of the Sutlej valley under a June sun was very trying. The health of the party was, however, on the whole good; one death from pneumonia among the Hindustani *klassies*, and several cases of fever occurred. Work was closed on the 4th July when the Rains had fairly set in, and the party reached Simla and commenced recess work by the 15th idem.

During the recess the computations of the triangulation have been taken in hand. That of Kotgarh, the detail survey of which is to be shortly commenced, is completed, and copies of the trigonometrical data required by the Forest Survey in and around Kotgarh have been made for that department. The remainder of the computations are well advanced, and a large area will be ready for detail survey at the end of the recess.

Extract from the Narrative Report of MAJOR J. HILL, R.E., *Deputy Superintendent, in charge Tidal and Levelling Operations,—Season 1885-86.*

The working of each observatory, commencing with Aden and Kurrachee and following the order of the stations round the coast, will now be briefly described.

Aden.—The self-registering tide-gauge has worked very satisfactorily throughout the year; there have been only six unimportant interruptions in the working of this instrument, occasioned as follows. On the 24th October 1885 the float band was removed to clear out the cylinder and pipe, the accumulation of mud in which had been causing a slight discrepancy between the reading of the pencil and the graduated staff; on the 4th December the driving clock stopped for three hours; on the 20th February the pencil broke, causing a break of three hours; on the 8th April the wire at the clock end, to which the counterpoise weight of the pencil is attached, broke at 8 P. M., but it was repaired at 7-30 the following morning, when the clerk in charge of the observatory went to his duties; on the 2nd July the wire at the clock end broke again, and 13 hours' registration was lost; and finally on the 6th August the clock stopped for six hours.

The self-registering anemometer had only three interruptions in its registration caused by the stoppage of the driving clock, *viz.*, on the 20th October for 3 hours, on the 16th November for 6 hours, and on the 17th November for 23 hours.

The self-registering aneroid by Adie has worked without a single failure throughout the year.

The self-registering aneroid by Légé is in good order and is kept working, although its diagram is not renewed, while the instrument is kept only in reserve.

Accompanied by Sub-surveyor Dhondu Venayak and the watch-maker of the party, I inspected the observatory between the 18th and 24th August 1886. The cylinder was cleaned out, and it was discovered that the rose and bent pipe had disappeared and could not be found; it was also plain that for some time there had been a direct flow of water into the cylinder. The well was found to be quite clean, and as the curves on the diagrams had been satisfactory, there was no necessity to attach a new rose, and the direct communication was allowed to remain. The instruments had not been cleaned since the inspection made in November 1883, or nearly three years ago, and though after so long an interval they were found to want cleaning badly, their performances had remained very good. They were thoroughly cleaned and oiled, and a new float band was substituted for the old one which was nearly worn out.

The several instruments were left in thorough good condition.

Captain Thyne, the Port Officer, continues his kind co-operation, and has rendered valuable assistance to the operations by his supervision of the clerk in charge.

Kurrachee.—The self-registering tide-gauge registrations at this port are very good; there were five interruptions of from 1 to 5 hours' duration, each caused by the communication holes in the cylinder getting choked with shell-fish; there were also three more from the imperfect working of the driving clock; one of these was on the 5th February when the clock was removed to be cleaned, it was however replaced on the following day and thereby only 19 hours' values were not registered, and on the other two occasions the clock stopped for 3 hours; in addition to these interruptions there were three failures in the working of the pencil from accidents to the cord attached to the counterpoise weight, by which a few hours' work in each case was lost. The whole of the interruptions being only for a few hours each, the breaks in the curves were easily filled up.

The self-registering anemometer had only two breaks in its registration—one on the 20th July last of thirteen hours, and another of six days between the 13th and 19th August, during which time the driving clock was being repaired and cleaned.

The self-registering aneroid had only one break in its registration of four days when the clock was removed to be cleaned on the 12th November and not re-started till the 16th of the same month.

Acknowledgments are again due to Mr. Price, the Port Engineer, for his continued interest and co-operation in the work, and for the prompitude with which he has caused all necessary repairs to be made, and so saved the registration from any serious interruptions.

Bhávnagar.—A description of this observatory having been given last year and incorporated in the General Report for 1884-85 (p. liv), it need not be repeated here.

The instruments for use at this port were erected in December last in the observatory house, which had been prepared for their reception during the previous month, and the work may be said to have commenced from the 1st January 1886, since which time the self-registering tide-gauge has worked satisfactorily; on the 19th and 20th February the tidal curves were not registered owing to an accident to the pipe leading into the cylinder; on the 27th and 28th February the instrument stopped work for twenty-one and six hours respectively, owing to a piece of cloth choking up the pipe; and on the 23rd March and 24th June the clock stopped for about twelve hours. In addition to the above there were several minor interruptions of a few hours each, caused by the flushing out of the cylinder which requires cleaning very frequently.

The self-registering anemometer and aneroid have worked very well since they were put up, there having been only two failures in the registration of each of these instruments caused by the stoppage of the driving clock for a few hours on each occasion.

All preliminary arrangements having been very satisfactorily made by Sub-surveyor Dhondu Venayak, the observatory was inspected and started by Mr. Belcham in December, when the several instruments were left in excellent working order. All the instruments belong to His Highness the Thakore Sahib of Bhávnagar. In addition to their cost the cost of construction and maintenance of the observatory, the salary of the clerk and all expenses connected with the tidal registrations at Bhávnagar are generously borne by His Highness. Mr. Proctor Sims, the State Engineer, devised all the special arrangements necessary for the erection of the observatory, the difficulties of which were considerable owing to the great rise and fall of the tide at Bhávnagar. Warm thanks are due to him for the great interest he has been taking in the work, and for the skill with which he has, after several years of experimental work, overcome all difficulties connected with the establishment of the observatory.

Bombay (Apollo Bandar).—The registration throughout the year by the self-registering tide-gauge at the Apollo Bandar is perfect, not a single break having occurred. There is no anemometer or barometer at this observatory.

The observatory was inspected in December last by Mr. Belcham, who reported that the float band was rusty and nearly worn out, and that it should be changed. This will be done at an early date. The clerk continues to perform his duties most satisfactorily. Thanks are due to Mr. Ormiston for his continued interest in the work.

Mormugáo.—The registration of the tidal curves at this port by the self-registering tide-gauge has been perfect, not a single failure having taken place throughout the year.

A tidal disturbance at this place is noticeable on the diagram of the 23rd May last, on which date at 9-15 P.M., the water, after having risen 6 inches above low water which occurred about half an hour previously, suddenly began to fall and in half an hour had fallen 18 inches or about a foot lower than the point at which it stood at low water. The tide then turned and rose with equal rapidity to the height from which the abnormal fall began, from which point the rise continued without any further irregularity. This disturbance seems to have been merely local. The wind at the time was very variable, as between 8 P.M. and 11 P.M. it veered almost completely round the compass, *viz.*, from north-east through east and south right round to north with a velocity of 20 miles an hour.

Up to the date of the last General Report the self-registering anemometer was working well. About the middle of March last the clerk was sick for a few days, and the diagram consequently could not be changed From that time the working of the instrument has been unsatisfactory. On the 23rd March, the cord attached to the driving weight of the clock broke, but was repaired by Mr. Belcham on the 3rd April. The clock stopped

again on the 9th June and was re-started on the following day, but on the 28th July it failed again and since that date it has not been working, for it cannot be re-started until the watch-maker can be sent to repair it.

The old pattern self-registering aneroid by Adie, modified by Légé, continued to work very satisfactorily, there being only two interruptions of 14 hours each, until the 7th May, when the gold wire attached to the pencil broke. Its readings, however, are registered daily at 7 and 10 A.M. and 4 and 6 P.M., and this will be continued until the watch-maker repairs the breakage.

The new pattern self-registering aneroid by Légé and Co., which was set up as a reserve instrument last year, worked very well for a few months, but when the observatory was inspected in April last, Mr. Good, the Executive Engineer of the Harbour Works, brought to Mr. Belcham's notice that the instrument had stopped working in September. Mr. Belcham then carefully examined and re-started it, but it soon stopped again and is not now working.

The observatory was inspected in the beginning of April by Mr. Belcham, but the several instruments and clocks could not then be cleaned, as the watch-maker attached to the party was away on duty at other tidal observatories. He will accompany the inspecting officer at the next inspection, which will be made as soon as possible after the beginning of the coming field season.

Acknowledgments are again due to Mr. Good for his continued assistance.

Cochin.—This new observatory, at which tidal observations were started for the first time on the 25th January 1886, is situated in the storeyard of the Marine Department, on the eastern side of the Cochin river. The observatory house and float cylinder were sent from Beypore when observations were discontinued there in March 1885. The house however was very dilapidated, and a great part of it had to be removed, and all the piles on which it rests are new. Communication with the water is effected by means of a pipe, 36 feet long and 3 inches in diameter, terminating in a rose. The pipe leaves the cylinder 2 feet above its bottom and enters the water 2 feet below lowest low water.

The instruments also are those which had been at work at Beypore and had been sent to Messrs. Légé and Co. in April 1885 for modification. They were received in Bombay and trans-shipped to Cochin in December 1885.

The self-registering tide-gauge worked, with a few interruptions of from two to seven hours' duration, from the 25th of January to the 8th July; but on the 9th July the clock stopped and all attempts to make it work proved fruitless: on receipt of a telegram from the Port Officer, the watch-maker of this party was sent down to repair the clock. He put it into order on the 22nd of the same month, from which time the instrument has been working satisfactorily, and in two instances only the error in the clock has exceeded three minutes.

The self-registering anemometer has only stopped twice since being set up; on the 20th March for seventeen hours and on the 24th idem for three hours. The watch-maker cleaned and repaired the clock on the 24th July, after attending to the tide-gauge clock, since which time the registration has been continuous.

The clock of the self-registering aneroid stopped for six hours on the 9th February, after which it was found to be working badly, but it was cleaned by the clerk in charge of the observatory on the 27th February, and since then its registration has been continuous.

The erection of this observatory was carried out under the immediate superintendence of Captain J. E. Winckler, the Port Officer, whose experience of our tidal observations at Vizagapatam, while he was Port Officer there, was a great advantage in the present instance, and whose kind co-operation deserves warm acknowledgment. The instruments were put up and the work started by Sub-surveyor Dhondu Venayak, and all the details of a full inspection were carried out by him before leaving the port, but the inspecting officer's visit has yet to be made. This will be done at an early date.

Colombo.—The registration of the tidal curves has been continued without a single failure in the working of the clock, but the curves between the 1st November and 5th December were untrustworthy, as Lieutenant Longe who inspected the observatory noticed a difference of over a foot between the readings of the level of the water inside and outside of the float cylinder, from which it was apparent that the pipe admitting water into the cylinder was blocked: the pipe was immediately detached, and it was found that, with three exceptions, the whole of the perforations in the rose at the end of the pipe were completely blocked with a rusty deposit. The blockage must have been gradual, and consequently the level of the water inside and outside the cylinder must have been gradually reaching the startling difference of a foot, but notwithstanding this the clerk in charge had recorded daily that the water inside and outside the cylinder was the same, which was palpably false.

On examining the tidal diagrams, the curves from the 1st November to the 5th December were found to be very much compressed, and consequently they were rejected. To avoid similar occurrences the Master Attendant, Captain Donnan, who takes great interest in the work, has very kindly undertaken to see that the pipe is removed and cleaned every fortnight, and also to have independent comparisons of the height of the water inside and outside the cylinder taken daily by some person other than the clerk in charge of the observatory as a check on the work.

The observatory was inspected by Lieutenant Longe between the 5th and 8th December, during which time the gauge was thoroughly cleaned in all its parts by the watch-maker of the party and left in perfect order.

The anemometrical and barometrical data are supplied by the office of the Surveyor General of Ceylon.

Galle.—The tidal observations have been very satisfactory, not a single failure in the observations having taken place.

The anemometer clock has failed to work on six occasions, twice in December for 17 and 21 hours and four times in January for about a day at a time. All these stoppages occurred shortly after the instrument had been cleaned by the watch-maker and the cause of them is not known; but since January the performances of the anemometer have been satisfactory.

In the old pattern self-registering aneroid by Adie, modified by Légé, there have been only two failures throughout the year, the first occurring on the 2nd March, when the clock stopped for four hours, and the second on the 16th June, when the clock again stopped for twelve hours.

No interruptions in the working of the new pattern self-registering aneroid by Légé and Co. have been reported.

An inspection of the observatory was made in the early part of December by Major Baird, accompanied by Lieutenant Longe, when the instruments were all thoroughly cleaned by the watch-maker and left in excellent working order.

At this port the operations have been much facilitated by the kindness of Captain D. Blythe, the Master Attendant, who takes great interest in the work and superintends the clerk.

Negapatam.—In the last Annual Report the very unsatisfactory nature of the tidal registrations at this port was mentioned, and it was found that the results deduced from the observations between the 5th December 1883 and 11th December 1884 were useless. Owing to the imperfect communication also mentioned therein, trustworthy observations were not obtained until the 20th March 1885, and the Negapatam tidal year has accordingly been changed so as to commence on the 20th March, and not on the 6th December as formerly. The observations for the year ending in March 1886 are satisfactory and the gauge has worked uninterruptedly, but since the beginning of the current tidal year a small but increasing difference is noticeable between the readings inside and outside of the float box which, at this observatory, is the substitute for a cylinder. Up to the present time this difference has only attained to 0·1 feet, and until the results of some special measurements which have been ordered have been received, it would seem to point rather to a subsidence of the graduated staff than to faulty communication. At latest this will be cleared up at next inspection. At a former inspection the Port Officer was requested to take check readings to a graduated staff unconnected with the observatory and he has forwarded the readings he took, but unfortunately they have not been found of a nature calculated to fulfil their object.

The self-registering anemometer and aneroid have not had a single break in their registration throughout the year.

The observatory was inspected conjointly by Major Baird and Lieutenant Longe in November last and all the instruments were cleaned by the watch-maker and left in good working order.

Madras.—The performances of the self-registering tidal gauge were satisfactory up to the 13th May last when the clock stopped working and was removed for repair by Messrs. Orr and Sons of Madras, who repaired it on the 18th, but the repairs were not properly executed, as it continued to stop very frequently. On the 23rd May there was very heavy rain and strong wind from the north-east which broke the float pipe, and the registrations were consequently stopped. Two days afterwards the instruments were removed into the Master Attendant's Office and the repair to the pipe was taken in hand. On the 4th June the pipe was re-fixed and the work was re-started the following day. On the 26th June the clerk in charge of the observatory, while flushing out the pipe, found that water had got into the float and that its bottom had given way. At the request of the Master Attendant, Sub-surveyor Dhondu Venayak and the watch-maker were sent to rectify the float. They found it necessary to repair the clock also, and on the 18th July the registration of the curves was resumed, and the instrument continued to work on till the 28th July, when the clock began to stop again, and on the 29th it stopped completely. Messrs. Orr and Sons examined and repaired the clock and on the 10th of August it was re-fixed, since which date no stoppage has been reported. They have reported that the vibration of the pier during the loading and unloading of cargo is so great that it may cause the clock to get out of order at any time. It was also noticed in the General Report for 1884-85, that the heavy traffic on the pier seriously interfered with the proper working of the clock.

The self-registering aneroid was brought away to Poona on the 4th June 1885. It was repaired by the watch-maker of the party, taken to Madras and set up on the 17th November, since which time there have only been two short interruptions in its registrations of 12 and 6 hours each, on the 26th March and 25th June.

There is no anemometer at work here, as the records of the Madras Observatory will be available when required.

Major Baird and Lieutenant Longe made an inspection of the observatory in November 1885 when the tide-gauge clock was taken off and cleaned and the self-registering aneroid was put up. I also inspected the observatory in February 1886, and Sub-surveyor Dhondu Venayak, when he went in July to repair the float, made a very full and complete inspection.

Cocanada.—The self-registering tide-gauge, anemometer and aneroid, which had been in use at Vizagapatam, were sent to Messrs. Légé and Co. for alteration and modification, and on their receipt from London were set up at Cocanada in March last, and the tidal registrations were commenced on the 31st of the same month. The Vizagapatam observatory house was also transferred to Cocanada. It has been set up on the eastern bank of the Godávari Canal, 20 feet from the bank, near the Master Attendant's landing jetty, and its floor is 3 feet above high water mark. The float cylinder from Vizagapatam being found too short, a box 3 feet high was added to it according to Major Baird's instructions, and let in through the floor of the observatory. A small bent pipe carrying a rose is attached to the float cylinder at about 9 inches from the bottom and about 2 feet below the lowest tides.

Since the starting of the work not a single interruption has taken place in the registration of the curves by the self-registering tide-gauge, and nothing remarkable occurred except on the 14th June last, when between 2 and 3-30 A.M., about low water, the diagram showed that there was a rush of water up the canal, and a similar occurrence took place between 10-45 and 11-45 the same morning also at low water.

The self-registering anemometer was set up on the roof of the Master Attendant's office, well above the surrounding buildings and trees; before this was done it was necessary to repair the toothed wheel of the barrel which was found broken when the instrument was opened. This was done by the watch-maker and it began working on the 8th April last, and had only one break of a day in its registration when the clock stopped on the 18th April. The watch-maker being on the spot it was attended to by him and no further stoppages are noted.

There is a small defect in its construction, which however does not affect the correctness of its registration, the pointer having been set by Messrs. Légé and Co., when repairing the instrument, to point from, instead of towards the quarter from which the wind is blowing.

The self-registering aneroid was set up in the Master Attendant's office, and although so recently repaired and modified by Messrs. Légé and Co., it was found in an unsatisfactory state—the gold band was broken and the hair-spring, which appeared to be the old one, was coated with rust and was not able to act properly. The watch-maker of the party repaired the instrument and it has since been working well, but a new hair-spring ought to be substituted for the present one at the next inspection.

The observatory was erected under the supervision of Captain Baker, the Port Officer, who, when he was at Pámban in the same capacity, greatly assisted the tidal observations there, and he is now continuing his kind co-operation. Finding a great part of the timber, screws and bolts of the Vizagapatam observatory so much worn away as to be useless, he replaced them by proper materials and had the structure properly erected, which owing to its distance from the bank was a troublesome business. The instruments were put up and the work started by Sub-surveyor Dhondu Venayak. The inspecting officer has to visit the observatory as soon as possible during the coming field season, but the Sub-surveyor carried out all the details of a full inspection before leaving the port.

Dublat.—The tidal registration at this port by the self-registering tide-gauge has been most satisfactory, not a single break or interruption in the work having taken place.

The self-registering anemometer also has worked very well. With the exception of a break of 10 hours on the 5th June and another of 4 hours on the 31st August, both due to the stoppage of the clock, the registration has been continuous. The old self-registering aneroid by Adie has worked very unsatisfactorily; there have been frequent stoppages of the clock, and scarcely a diagram is without breaks. The clock of this instrument being a pendulum one, is easily affected by the vibration in the observatory and any sudden shock stops it. It was cleaned in June last by the watch-maker of the party, but the record still continues to be very unsatisfactory.

The self-registering aneroid by Légé and Co., which was set up in December 1884, worked continuously up to the 13th January 1886 when it stopped, and as the observatory clerk had no way of getting at the balance wheel of the clock he could not re-start it. It was, however, cleaned by the watch-maker of the party last June, since which time it has been working well.

Mr. Belcham inspected the observatory last June, when the instruments and clocks were all thoroughly cleaned by the watch-maker and left in good working order A settlement of 0·225 feet has taken place in the observatory since the last inspection in February 1885, which no doubt is due to the extra weight of 4 sets of braces formed of old rails, which had been fixed to the piles in June 1885 to strengthen the observatory.

Diamond Harbour.—The tidal registrations at this port by the self-registering tide-gauge have been unsatisfactory for the past year. No less than 33 stoppages of the clock of the gauge were noted; these, however, lasted only from 3 to 13 hours on each occasion, and the breaks can therefore be interpolated. The copper band attached to the float stuck on 4 different occasions for about 6 hours at a time, and the breaks thus occasioned can also be interpolated.

The self-registering anemometer has registered continuously without a single interruption; and there have been only three interruptions in the registration of the self-registering aneroid caused in each case by the driving clock ceasing to work.

For a considerable time past the observatory had been in a very unstable and dilapidated condition, and used to sway according to the direction of the tide. It was reported

to be unsafe, and I accordingly made an inspection of it on the 23rd March 1886, and found by levelling that during the previous 7 months a subsidence of 0·414 feet had taken place in the bed plate of the gauge. Considering the time of the year, however, I decided to allow it to remain at work until the 12th April when 5 years' observations would be completed. Work was accordingly continued to that day, when all the instruments were dismantled by Lieutenant Petley, R.N., Deputy Conservator of the River, and brought away by him. They were afterwards taken over by Mr. Belcham and stored in the Mathematical Instrument Office, Calcutta.

I take this opportunity to acknowledge the great trouble Lieutenant Petley has always taken in helping on the work at all the Hooghly tidal stations.

The kindness of Major Boughey, R.E., Manager, Eastern Bengal State Railway, also calls for acknowledgment here. When I made my inspection, I was without departmental assistance, Sub-surveyor Dhondu Venayak and the watch-maker of the party being then engaged in putting up the instruments at the new tidal observatory at Cocanada. To assist me in the necessary levelling, Major Boughey most kindly sent an Assistant Engineer, Mr. Russik Lall Roy, who was most obliging and did all that was required in the most efficient way.

Kidderpore.—From the date of the last Annual Report to the 20th December the self-registering tide-gauge has worked well. The clock of this instrument stopped on nine different occasions, but as they were only of a few hours' duration each, the broken curves were easily filled up, and since December there has been only one stoppage of three hours which occurred on the 16th June. During the time under report the wire attaching the counterpoise weight to the pencil broke on three occasions; the first two breakages caused no interruption in the work, but the last one occurred about midnight and consequently the wire could not be renewed until the clerk came to his duties next morning, and 7 hours' work was lost.

Up to the 4th September 1886 the self-registering anemometer has worked with only five short breaks in its registration, which were all due to the stoppage of its clock. But from the 5th to the 11th of the same month the instrument stopped daily, and on the latter date it had to be removed by Lieutenant Petley, R.N., for repair.

The self-registering aneroid clock stopped ten times during the past year, but only for a few hours at a time.

The observatory was inspected by Sub-surveyor Dhondu Venayak in the beginning of May last when all the instruments were cleaned and left in good order; and a second inspection was made on the 14th of the same month by Mr. Belcham.

Chittagong.—The tidal registration at this port began on the 6th June last. The instruments set up in the observatory, with the exception of the mercurial barometer, are those that had been working at Moulmein up to the 24th April last.

Since the starting of the work and up to the present time, no failures of the self-registering tide-gauge have occurred. On two occasions the error of its clock was allowed to exceed three minutes. This was due to the circumstance that the observatory clerk had not a proper watch with which to note the time at the telegraph station. He has now been provided with one.

The self-registering anemometer and aneroid are working very well. Some hours' work was lost on the 27th June, owing to the barrel of the anemometer not gearing with the clock, and on the 22nd July the clock of the aneroid stopped for two hours.

The observatory house at this port is the one which formerly contained the Diamond Harbour instruments. Captain Stiffe, the Port Officer of Calcutta, who also exercises supervision over the port of Chittagong, arranged for the purchase of the structure by the Port authorities of the latter place from the Calcutta Port Commissioners. He also had a float cylinder constructed for the Chittagong gauge at the Government dock-yard at Kidderpore, and he selected the site for the observatory. It is due to him that it has been possible to commence tidal registrations so soon at Chittagong.

The observatory has been erected on the west side of the head of the iron jetty, and a special arrangement of chains has been devised to protect the cylinder from the timber, &c., brought down the river by the ebb tide, which here flows with great rapidity. The town and pier are situated on the right bank of the river, at a distance of about 9 miles from its mouth.

The observatory was erected and the instruments placed in position and started by Sub-surveyor Dhondu Venayak and the watch-maker of the party. Mr. Good, the Port Officer, took the greatest interest in the erection of the observatory, and engaged an observatory clerk whom he has promised to supervise. Although none of the fittings had arrived before the 20th May, by the end of the month all the instruments were in position. Sub-surveyor Dhondu Venayak remained at the observatory teaching the clerk his duties until the arrival of Mr. Belcham on the 26th June, who made a complete inspection of the observatory and left everything in perfect working order.

Elephant Point.—From the date of the last report until the 23rd December there were sixteen short breaks in the registration of the tidal curves by the self-registering tide-gauge, owing to the faulty working of the clock: these, however, can be easily interpolated, and since the latter date only three breaks of a few hours each have been noted. On the 23rd December the bed-plate was found to be out of level, and was set right by Mr. Jennings, the Port Engineer. Between the 9th and 11th January the observatory was somewhat neglected owing to the illness of the clerk in charge, and the clock was allowed to run into error to the extent of 6 minutes 16 seconds.

On the 3rd February, the wire attaching the counterpoise weight to the pencil, broke, but was renewed after three hours. On the 7th March, the tide-gauge clock and barrel were removed to be cleaned, thus occasioning an unavoidable loss of four hours' work; and finally, on the 13th July, the wire of the counterpoise weight again broke and five hours' readings were not registered.

The self-registering anemometer is in position on the top of the look-out house near the Telegraph Office. Since the date of report it has only worked for ten days. On the 16th November the clock broke, and was sent to Rangoon for repair, but the watch-maker to whom the work was given, after keeping the clock for almost four months, said he could not repair it, so I brought it away to Poona last March, where it has been repaired by the watch-maker of the party, and it is now ready to be sent back to Elephant Point.

The registration of the self-registering aneroid has been almost continuous, its clock having only stopped once on the 6th February last. The instrument remains for safety in the Telegraph Office and is attended to by Mr. Duckworth, the Telegraph Master, who has also the immediate charge of the anemometer, and exercises supervision over the tidal observatory clerk. Mr. Duckworth has shown himself interested in the work, and takes good care of the instruments entrusted to him, which could not have been said of his predecessor.

I inspected the observatory in March last, when the tide-gauge, the self-registering aneroid and the machinery of the anemometer, with the exception of its clock, were all thoroughly cleaned. I was accompanied and assisted by Sub-surveyor Dhondu Venayak and the watch-maker of the party.

Acknowledgments are again due to Mr. Jennings, the Port Engineer of Rangoon, for the assistance he still continues to give at this observatory in spite of its distance of 25 miles from Rangoon. It was mentioned in the Annual Report for 1884-85 that it would give some trouble to prepare the diagrams for July and August 1885 for the measurements; this is due to an uncertainty regarding the relative level of the bed-plate of the gauge and bench mark of reference during those months, consequent on a serious movement of the observatory on the 17th July, which was reported to Mr Jennings, who, according to the report of the observatory clerk, restored the observatory to its original level on the 1st September 1885. Mr. Jennings has been asked to furnish the levels he took in connection with this movement of the observatory, without which data the registrations from the 17th July to the 1st September cannot be used, but as yet he has not sent them.

Rangoon.—The self-registering tide-gauge worked very well until the 24th June last, up to which date there were only a few trivial interruptions in the registration curves caused by the clock failing to work. Also the band slipped off the stud wheel on one occasion, and thrice it got entangled in the float box. But on the above-mentioned date a serious accident happened to the observatory. In a letter dated 24th June from Mr. Jennings, the Port Engineer, which was forwarded by the Port Commissioner, it was stated that on the 24th June "the house on Latter Street wharf containing the tide-gauge was upset by the S. S. *Zephyr* this morning." The damage caused was considerable—the pendulums of the self-registering tide-gauge and aneroid clocks were broken, also the gold wire attached to the pencil marker of the latter, and the copper band of the float; the rain gauge, together with two tin cases, one empty and the other containing aneroid diagrams, were lost, and the roof of the observatory was broken. The repairs were immediately taken in hand by Mr. Jennings, who also got a watch-maker to attend to the instruments and clocks. On the 5th July the tide-gauge was re-started, there being thus a break of eleven days in the registration of the curves due to this accident; but until an inspecting officer can visit the observatory and take the necessary measurements, there is the fear that should a second mishap occur, all the registrations between the 5th July and the possible future interruption would be rendered useless.

The self-registering anemometer was stated in the last Annual Report to have been working unsatisfactorily, and from that time only seven weeks' continuous work has been registered by it, namely, until the 1st January, when, owing to the fly wheel of the clock being broken and worn out, it became quite useless, and a few days afterwards the clock was sent for repair to the same watch-maker who had undertaken the repair of the Elephant Point anemometer clock, and with a like result. He was unable to repair it, and I brought it away to Poona, where it has been recently repaired by the watch-maker of the party.

The self-registering aneroid worked continuously from the date of the last report up to the 24th June last, when the accident to the observatory, which has already been mentioned, occurred. The gold wire attached to the pencil marker and the pendulum of the clock broke on that occasion; but they were repaired by the 6th July, since which time no stoppages have occurred.

Accompanied by Sub-surveyor Dhondu Venayak and the watch-maker of the party, I inspected this observatory in February last. The instruments were thoroughly cleaned, and with the exception of the anemometer, which could not work without its clock, they were all left in good working condition.

Acknowledgments are again due to Mr. Darlington, the Vice-Chairman of the Port Commissioners, for his continued assistance, and to Mr. Jennings, the Port Engineer.

Amherst.—There have been no stoppages in the registration of the self-registering tide-gauge throughout the year, with the exception of the brief but necessary interruptions caused once a fortnight by the flushing of the float cylinder.

In the registration of the self-registering anemometer there have been only four

interruptions, one of a day and the other three of a few hours each, all owing to the stoppage of the clock.

The self-registering aneroid has worked continuously throughout the year.

This observatory was inspected in February and March 1886 by myself, accompanied by Sub-surveyor Dhondu Venayak and the watch-maker of the party, and all the instruments were cleaned thoroughly and left in good order.

This observatory was originally started on the 30th July 1880, and the calculations of the tidal constants commenced from the 5th of the following month, that being the date of new moon. In the Annual Report for 1881-82 it was remarked, with reference to the first year's observations :—"The present co-efficients are deduced from the observations taken during eight complete lunations from 5th August 1880 to 29th March 1881, and they are therefore not of the same value as if they had been derived from a year's good work." After a break of upwards of four months, the second year's registration began on the 5th August 1881, and it has been thought well to have a complete series of five years' observations from that date before closing the observatory. The period was completed last month, and Captain Dodd, the Port Officer at Moulmein, has accordingly been requested to close the observatory, and directions have been sent him as to the packing and present disposal of the instruments, which are intended to be sent to Akyab when the arrangements regarding the establishment of a tidal observatory there have been made.

Moulmein.—The self-registering tide-gauge worked continuously since the date of last report, with the exception of one short interruption of seven hours on the 8th October, when the clock stopped.

The tides at this riverain port are very peculiar, and it was thought well to extend their registration over a period of six years This period was completed on the 24th April 1886, and all the instruments were then dismantled by Captain Dodd, the Port Officer, and sent to Chittagong for erection there.

The self-registering anemometer and aneroid have both worked very satisfactorily since the dates of last report, not a single failure having occurred.

An inspection of the observatory was made last February and March by myself, accompanied by Sub-surveyor Dhondu Venayak and the watch-maker of the party, when all the instruments were found in good order and working most satisfactorily. As a preliminary to their removal they were thoroughly cleaned, and Captain Dodd, the Port Officer, arranged to dismantle them on the period of the observations coming to an end, and after packing them carefully to forward them to Chittagong. As the wharf on which the observatory stood was undergoing demolition, he arranged that the outer part, supporting the observatory, should remain undisturbed until the instruments were removed; and he also had boats moored in such a way as to avoid all danger of shocks to the observatory from floating timber, &c. Special thanks are due to him for the great interest he has always taken in the work, and for the assistance he has so freely given it. The success of the observations at both the Moulmein and Amherst observatories is mainly due to his untiring supervision.

Port Blair.—There have been several breaks in the registration of the tidal curves by the self-registering tide-gauge since the date of the last report. The first of any importance occurred between the 16th and 18th November, when the float cylinder was being repaired, and a second of four days' duration between the 8th and 12th December, when, owing to the condition of the old cylinder, it had to be removed and a new one fitted. In addition to these there were twelve brief interruptions due to the stopping of the clock, but these were of no importance.

The self-registering anemometer and aneroid have both worked continuously since the date of last report.

No inspection of this observatory has been made since December 1884, and no occurrences worth mentioning beyond those already noted, have taken place since the date of last report, except that a slight shock of earthquake was reported to have been felt at 1-45 P.M. on the 26th September 1885, and another at 4 P.M. on the 12th January 1886, but neither of these caused any disturbance of the tidal curves.

BENCH-MARKS.

Up to the present time only three standard bench-marks giving planes of reference accurately determined by the tidal and levelling operations of this department, for general use in engineering undertakings in the large towns, have been established in India. The one first laid down is in Madras, on a stone at the north-east corner of the plinth of the light-house : it is described in Madras Government Order, dated 24th March 1885, No. 737 W. Public Works. The other two are in Bombay ; one in front of the Public Works Offices on the Esplanade, and the other on the sill of the Prince's Dock. The former is described in Public Works Notification No. 57, dated 24th July 1886, published in the Bombay Government *Gazette* of the 27th July 1886, Part I, page 629. The erection of the standard bench-mark for Bombay was reported in the last Annual Report (see p. lx). It was examined by Mr. Belcham last January, who found it to be 0·27 feet too high. After the level of its surface had been reduced by that amount, it was verified by him on the 5th July, and on his reporting that it was quite correct, the Government Notification was published.

In the last Annual Report it was mentioned that a standard bench-mark for Rangoon had been built in the vicinity of the tidal observatory there; but it has not been connected by spirit-levelling with the observatory, nor has any inscription been placed upon it as yet. When I made my inspection of the Rangoon tidal station in February last, I found that the standard bench-mark, which consisted of a large block of masonry, had been built too high, and I considered that a change in its design would be an improvement. It was explained to me that the height had been given to render it difficult for people to climb on to the block, and consequently as a protection to its upper surface, which was to be the plane of reference; but I hope that the change I have made in the design will with a less height afford increased protection to the level surface of reference. Mr. Jennings, the Port Engineer, kindly carried out the alteration. The inscriptions on the standard bench-mark, and its connection with the tidal observatory, will be arranged for at next inspection.

In September 1884 the Deputy Superintendent, in charge, Trigonometrical Branch, ordered the establishment of "permanent bench-marks on reliable ground within a few miles of each tidal observatory in connection with the question of subsidence of land." A pair of such bench-marks were laid down during the past field season at each of the following tidal stations, *viz.*,—at Negapatam, Pámban, and Tuticorin. During the preceding field season pairs of bench-marks of this kind, which for convenience have been termed "test bench-marks," were laid down at Beypore and Madras, so up to the present time five pairs of test bench-marks have been established.

At the new tidal stations at Bhávnagar, Cochin, Cocanada and Chittagong, the usual bench-marks of reference were laid down and connected with their respective tidal observatories; and in addition to them 45 embedded bench-marks, 332 minor bench-marks, 11 Railway bench-marks, and 24 Trigonometrical Survey stations were connected in the course of the levelling operations of last field season.

At Tuticorin a new bench-mark has been laid down to serve as a substitute for bench-mark No. 2 to which the zero of the tide-gauge had been originally referred, and which was the initial point of the line of levels between Tuticorin and the Cape Comorin base-line. This appeared necessary in case the latter bench-mark, which is inconveniently situated and liable to damage, should ever become displaced. The new bench-mark was embedded by Mr. Corkery at a distance of about a chain from the old one, in the verandah of the Port Office, in a convenient and safe position immediately under the staircase, and was connected on the 20th June: its level is 2·518 feet above that of bench-mark No. 2.

While connecting the old bench-marks at Tuticorin, Mr. Corkery found that bench-mark No. 4, which was denoted by a stone post at the north-west corner of the pedestal of the cross in front of the Goa church, had disappeared.

When the Amherst tidal observatory was inspected in February last, it was found that a considerable subsidence had taken place in bench-mark B, which had been cut on a wooden post forming one of the supports of a small timber *Ziyat* or rest-house. This structure is in a rather dilapidated and unstable condition, and bench-mark B is quite useless for reference. There appeared to have been also a slight settlement in bench-mark C at the same observatory, and the position in which it lies may account for this. The other two bench-marks (A and D) at the Amherst tidal station are, however, good for reference.

LEVELLING OPERATIONS.

The programme of the season's work was as follows:—To carry a line of spirit levels from Madras skirting the coast to Negapatam tidal station and thence to Tuticorin tidal station, touching at Pámban tidal station, after which the line was to proceed northwards *viâ* Madura and Trichinopoly (with a branch line from the latter station to Negapatam) to Erode, where a connection had to be made with the levels run during 1884-85. Permanent bench-marks had to be established a few miles inland from each tidal observatory, where not already done, with as many connections as could conveniently be effected between the new lines of levelling and the triangulation, in order to make the heights of the latter as perfect as possible before publication. This programme would have involved an out-turn of close on 900 miles.

Although the levelling was started by Lieutenant Longe and Mr. Belcham, who did the first few miles in Madras, the total out-turn may be credited to Mr. Corkery, who was placed in charge of the levelling detachment, and who had as his assistant Sub-surveyor Narsing Das. Mr. Corkery took the field on the 3rd November 1885, preceded by Narsing Das, who had to meet at Sholápur the *khalassies* (carriers) who had been sent on leave at the end of the previous field season and take them on with him to Madras; and they returned to Poona on the 26th June 1886. During this exceptionally long field season, in spite of delays at its commencement from bad weather, and consequent sickness among the native establishment, a proportionately large out-turn of work was accomplished. It amounts to no less than 526 miles of double levelling, in doing which the instruments were put up at 3,709 stations, and in the course of which 394 bench-marks and 24 Trigonometrical Survey stations were connected. This is the largest out-turn on record with the exception of Mr. Belcham's out-turn of 533 miles during the previous season. Mr. Corkery's work was completed in three sections. The first section was from Madras *viâ* Tanjore to Negapatam; the second section from Tanjore *viâ* Ramnad to Pámban with a branch line to Rámesvaram; the third section from Ramnad to Tuticorin.

There now remains as a progamme for the coming field season the completion of the programme above mentioned, together with work on the west coast of India, all of which may be divided into sections as follows :—

	Miles.
From Tuticorin to Madura	99
„ Madura *viâ* Trichinopoly to Tanjore	127
„ Trichinopoly to Erode	87
„ Shoranur to Cochin Tidal Station	80
„ Kárwár to Mormugáo Station	50
„ Branch lines to Trigonometrical stations of the Great Arc and Konkan Meridional Series	25
Total	468

The results of Mr. Corkery's work do not tend to show that there is any appreciable difference between the mean level of the sea at his stations along the eastern coast. According to his results the mean sea-level at Negapatam is higher by 0·573 feet than the mean sea-level at Madras which by the line of levelling is 268 miles to the north, and it is also 0·270 feet higher than the mean sea-level at Pámban, which by the line of levelling is 191 miles to the south. Also, the mean sea-level at Tuticorin is higher by 0·169 feet than that of Madras, the distance between these two places being 408 miles. Such small discrepancies as these may be due to other causes than differences in the sea-level. If distributed over the lines of level in question, they would give, in the first section, an error of only ·0021 feet per mile, while in the other two the error per mile would be still less.

The following extracts are taken from an interesting report on his work submitted by Mr. Corkery :—

"Mr. Belcham and I left Poona on the 3rd November, and were obliged to stay at an hotel in Madras, pending the arrival of our kit, which reached us on the 8th."

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"On the 8th November the instruments were overhauled and tested, and the staves compared with the standard bar. On the 9th levelling operations began from the tidal observatory at the end of the pier; Lieutenant Longe and Mr. Belcham worked the cylindrical level, and Narsing Das and I the rectangular. Progress was slow at first; the portion between the Madras pier and St. Thomas' Mount, a distance of 10½ miles, and a visit to the Trigonometrical station on the summit of the Mount, occupied us for five days; each day we left camp at 3-A.M., returning at 1 or 2-P.M., and on one occasion at 5-P.M. The difference between the closing values of the two instruments over this short distance was as much as $\frac{9}{100}$ of a foot, or a little over one inch."

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"Incessant rain for a week from the day after Mr. Belcham left us, retarded work; and what was worse, sowed the seeds of disease in many of the men, which hampered the work at times. No house accommodation could be obtained, and as we were encamped in low-lying country—the only available spot near the Railway line—I set the men to work to drain the place, and to raise the flooring inside their tents to a height of 8 inches; they were also provided with mats to keep out the cold and damp.

"On the 20th November we resumed work, and with the exception of an occasional break of a day or two on account of rain, and four days at Christmas, work went on steadily, the first section, along the Railway line *viâ* Tanjore, closing at Negapatam on the 4th March. The distance levelled in this section was 283½ miles, including 15½ miles of branch lines to Trigonometrical stations. The height of G. T. S. Bench Mark *A*. at Negapatam, the closing point of the 1st section, was found to be 10·156 feet above mean sea-level at Madras: its height above mean sea-level at Negapatam is 9·583 feet. This either shows Negapatam mean sea-level to be 0·573 feet above Madras mean sea-level, or, if the error lies in the levelling operations, it is an error of ·0021 feet per mile. In this section 28 bench-marks were embedded, including two test bench-marks: 230 minor bench-marks inscribed on advantageous positions were connected, also 9 Trigonometrical stations of the Madras Coast Series and of the Negapatam Minor Series: test bench-marks were laid down near Kivalur Railway station, 7 miles from Negapatam, one on each side of the line of levels and respectively one mile north and 50 chains south of the main line.

"Section II was started on the 8th March and completed on the 13th May It emanated from the embedded bench-mark at Tanjore, of Section I: proceeding *viâ* Arantángi and Mimisal to Ramnad where a bench-mark was embedded; the section closed at Pámban, on bench-mark *A*. The closing value of this bench-mark is 7·774 feet above Madras mean sea-level, and 7·471 feet above Pámban mean sea-level. The value of Pámban mean sea-level so deduced is therefore 0·303 feet above Madras mean sea-level, and 0·270 feet below Negapatam mean sea-level. The distance levelled in this section, including 12 miles of branch lines to Trigonometrical stations, was 154½ miles. The total distance from Madras to Pámban *viâ* Tanjore and Ramnad is 361 miles; the error in levelling =0·303 feet or 0·0008 feet per mile. A branch line 8¼ miles long was run from bench-mark *C* at Pámban to the extreme end of Rámesvaram island, closing on a bench-mark inscribed at west entrance to Rámesvaram temple. Gandhamána Temple station and 11 other Trigonometrical stations of the Madras Coast and Ceylon Connection Series were also connected.

"Test bench-marks were embedded near Perapanvalasai Chattram, 10 miles from Pámban, one on the line of levels, and the second 32 chains north. Twelve embedded bench-marks, and 74 minor inscribed bench-marks were connected by levelling in this section.

"Section III, emanated from the embedded bench-mark at Ramnad of Section II, and closed at Tuticorin on a new bench-mark near G. T. S. B. M. No. 2 ⩚A. D. 1869. The distance levelled in this section was 78⅓ miles, including 4 miles of branch lines; it occupied the party from the 17th May to the 20th June. The value of B. M. No. 2 above Madras mean sea-level is 4·569 feet, and above Tuticorin mean sea-level is 4·400 feet, showing Tuticorin mean sea-level to be 0·169 feet above Madras mean sea-level. The distance from Madras to Tuticorin along the line of levels is 408 miles; the error per mile of levelling is therefore 0·0004 feet, if the mean sea-level at Tuticorin, as determined by Colonel Branfill in 1871-72, may be accepted as its present value.

"Nine embedded bench-marks, including two test bench-marks, and 36 minor points were connected, also 3 Trigonometrical stations of the Ramnad Longitudinal Series. The test bench-marks for Tuticorin were laid down 12 miles inland from Tuticorin, one on each side of the line of levels and 1¾ and 1¼ miles respectively from the main line.

"The districts traversed were very healthy, but owing to the heavy rain which we had at St. Thomas' Mount at the commencement of the work, many of the men suffered severely during the early part of the

season. I regret exceedingly to have to record the death of Sub-surveyor Gunesh Sudasheo early in the season. He was the most intelligent Sub-surveyor I have met; in addition to being a rapid recorder and accurate computer, he was able to work both levels.

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He was a great favourite in camp, and every one regretted to hear of his premature death.

"Four *Khalassies* (carriers) also were seriously ill early in the year, and at one time there was very little between them and death."

"Every man but one in camp had his turn of illness."

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"I beg to acknowledge the great courtesy shown, and the help given, by every one of the officers of the S. I. Railway with whom I came in contact; it enabled the work to proceed without a hitch We were equally well treated when we left the Railway line and levelled from Tanjore to Tuticorin: there was one notable exception, and that was in the Zemindari lands of Ramnad. Carts were refused us, and every obstacle thrown in our way when buying supplies. *Dasturi* was demanded in Ramnad itself from the cartmen who had voluntarily agreed to come with us. As they declined to pay, they were prevented from coming to my camp.

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"With one exception I experienced no difficulty in the levelling operations of the season; the exception was in crossing the Pámban channel. Luckily we hit upon the most favourable time of the year as regards lowness of tides. The rocks on which the instruments were set up by the previous leveller, near the deepest part of the channel, no longer exist, and we had much difficulty in securing a favourable spot; at one station the staves were 32 chains apart. Narsing Das was unable to observe to his satisfaction a staff 16 chains distant, so I worked both instruments, taking half a dozen sets of observations with each instrument, using the usual staves; and two or three more with each instrument when using Colonel Strange's pattern staves, divided to tenths of a foot. Every chance of error was eliminated by the number of sets of observations. The width of the channel is a mile and a half, and it took us three days of hard work to level across. Our difficulty lay in measuring distances; for this purpose ropes, previously divided into chains and half chains, were used. It took us two days to circumvent the deep water channel, which is about 18 chains wide. The tide was so terrific that no boat succeeded in carrying the measuring rope across. On the second day when we almost despaired of success, a boatman gallantly swam across with the rope. The distance from the platform of the Toni Turai Chattram on the mainland to the nearest point of Pámban island, as measured this year, is *m.* 1, *ch.* 39, *l.* 46, the previous record was *m.* 1, *ch.* 40, *l.* 90. The height of Toni Turai G. T. S. B. M exceeded the value obtained in 1879 by nearly half an inch."

"No sign of the letters G. T. S. B. M. inscribed on the Toni Turai platform in 1879, could be found when visited this year: they had apparently been covered with a coating of lime. I was not permitted to remove this, and my levels were taken to the surface; but as the coating of lime was nearly half an inch thick, the difference of half an inch between the values of 1879 and 1886 disappears. A bench-mark was embedded in the Chattram and connected.

"Gib's monument, which is within 10 yards of the water's edge, was connected on both occasions, the value for 1879 was — 1·674, and for 1886, — 1·912, or a difference of — 0·238. The monument is visibly sinking; it is already ten degrees out of the perpendicular; this explains the difference in value of — 0·238 feet."

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"An abstract of the season's work is attached to this report: it shows that 526½ miles of double levelling were completed, including 42 miles of branch lines, which I may add are more troublesome than main lines. The total of rises and falls was 7,276 feet: 24 Trigonometrical stations were connected, 51 bench-marks were embedded, and 332 minor bench-marks were inscribed on prominent points; 11 Railway bench-marks also were connected.

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"It is superfluous to attempt a description of the country passed through I may mention, however, that, during the months of April, May and June, large quantities of pumice were washed ashore, first making their appearance at Rámesvaram and Pámban, and gradually finding their way up towards Madras. I collected a few specimens, some of them with coral growths on them. I offer as a conjecture that they are the remnants of the upheaval at Krakatoa some three years ago.

"A visit to Pámban and its neighbourhood will well repay the naturalist. Living corals are found in abundance 4 miles south-west of Pámban Light-house; their glorious colourings are beyond my powers of description. It is not often that the living coral is to be found so near the mainland, as a condition of his existence is a pure sea, free from the pollution of rivers, &c. There are not many varieties of coral; I saw but five or six, and of these the Meandrina, or Brain coral, and Oculina predominate.

"The following is a rough classification of those found:—

Actinozoa . { 1. Zoantharia, comprehending Sclerodermic forms
2. Alcyonaria „ Sclerobasic „

Of Sclerodermic forms the Brain coral and Oculina were found in abundance. Of Sclerobasic forms I picked up a couple of specimens of the handsome Organ-pipe coral (Tubipora).

"At Pámban I was presented with a piece of coral called the "Biscuit coral," but which I believe is not indigenous. My impression is that it has not as yet been classified, and I am sending the specimen to a specialist for information. Echinoderms are also found in abundance; the common star-fish, and the Ophiurid, or brittle star, but neither calls for remark.

"At the Rámesvaram end of the island, during the course of a couple of sea-side rambles, I picked up eleven varieties of sponges, washed up from their ocean homes. They are said to grow within a few hundred yards of the island. One of the sponges has in all probability a market value. Like the ordinary sponge of commerce, it has a horny support of true spongiolin, its pores and oscula are smaller than those of the bath sponge, though not comparable with the Turkey sponge. I have kept this specimen for further enquiry. The other sponges were the usual simple oceanic forms with Siliceous supports.

"At Rámesvaram an extensive and very profitable trade is carried on in '*chanks*'. These shells are brought up by divers from considerable depths; they are trans-shipped to Calcutta whence they are distributed throughout Northern India. They play an important part in the religious ceremonies of the Hindu; any water, however impure, becomes purified and sacred, from the fact of its having been poured into the shell. I found to my surprise that the Mahomedan also uses it here as a 'Konch' and blows his blast with it to summon the faithful to prayer.

"Early in January I found the sea-shore covered with jelly-fish-like forms, the size of a large cherry; they had evidently been washed up after a storm. They belonged to the group of 'physophoridæ', genus

Porpita. The disc was marked with concentric rings, intersected by radiating bars, the latter cutting it into wedge-shaped chambers: each chamber was filled with the gas which gives this genus its peculiar light-blue tint. Attached to the float (pneumataphore) was a long tentacle crowded with thread cells.

"I beg to draw attention to the disappearance of Porto Novo chimney on the 11th January of this year: it is given on the charts as an intersected point of the Trigonometrical Survey."

Tabular Statement of out-turn of work for the Field Season 1885-86, by the Levelling Detatchment under Mr. H. Corkery.

During the month of	Number of miles, double levelling.			Total number of feet.		Number of Stations at which the instrument was set up.	Number of Bench-marks embedded, inscribed and connected.				
	Main Line.		Branch Line.				Ordinary Embedded.	Test B. Ms. Embedded.	Inscribed.	G. T. Survey Stations.	Railway B. Ms.
	Ms. Chs. Lks.		Ms. Chs. Lks.								
				Rises.	Falls.						
				Feet.	Feet.	No.	No.	No.	No.	No.	No.
November 1885	39 40 84		1 38 10	561·1	216·8	288	4	...	37	1	...
December ,,	65 0 88		6 39 23	1068·7	415·4	458	7	...	53	2	...
January 1886	90 62 38		. . . .	217·9	261·5	550	9	...	72	...	4
February ,,	73 45 90		4 78 62	505·7	331·9	543	6	2	68	4	7
March ,,	55 79 78		11 57 78	658·4	601·5	528	5	...	23	7	...
April ,,	76 51 24		2 1 16	465·8	526·7	566	5	...	31	5	...
May ,,	49 14 66		12 41 6	552·7	397·4	517	5	2	22	5	...
June ,,	33 44 58		2 64 20	240·9	253·5	259	4	2	26	...	...
Totals	484 20 26		42 0 15	4271·2	3004·7	3,709	45	6	332	24	11
Total number of miles double levelling	526 20 41			Total of rises and falls.	7275·9						

Revision of the heights of the South Konkan Meridional Series.

In his sanctioned programme for the field season 1885-86, the Deputy Surveyor General, in charge Trigonometrical Branch, remarked:—

"The heights of the South Konkan Series (from Bombay to Goa), determined trigonometrically over 40, years ago, being unsatisfactory and defective from the circumstance of the observations being confined to only certain rays of the triangulation, and not having been made in such a manner as to overcome the uncertainties of terrestrial refraction (more especially necessary as one flank of the series skirts the sea coast while the other rests on the *ghâts*), it is necessary to re-measure the heights of this Series—some 270 miles in length—before the final publication of the heights of the Southern Trigon."

He subsequently gave instructions that Lieutenant Longe and Mr. Prunty should be employed on this work and added—

"They will be required to observe *simultaneous* verticals on each *cross* ray of the series, and ordinary verticals on the flank rays."

As Lieutenant Longe had to leave the party in December to take the charge of the South Marátha Survey, it became necessary to employ Mr. Belcham in his place on the revision of the heights, in addition to his other duties.

Mr. Belcham left Poona for Madras on the 2nd November and remained with the levelling detatchment, starting the work until the 14th November, when, according to Major Baird's instructions, he took a set of zero measurements at the Madras tidal observatory and then made all possible haste back to Poona, arriving there on the morning of the 15th November, and commenced his preparations to take up the revision of the heights of the South Konkan Meridional Series in conjunction with Mr. Prunty. Mr. Prunty, whose establishment preceded him into the field, left Poona on the 20th November, but Mr. Belcham was unable to leave so soon, as the instruments intended for his use, sent from the Mathematical Instrument Office in Calcutta, did not arrive in Poona until the 21st November. After some delay in Poona through having to repair the stand of his 14-inch theodolite which had been broken in transit, and a further short delay after arriving on his ground in arranging a code of flashing signals with Mr. Prunty, simultaneous observations were commenced on the 27th November.

A few days at Christmas were employed by Mr. Belcham, according to his instructions, in making inspections of the tidal observatories at Bombay and Bhávnagar, and in verifying the standard bench-mark in Bombay; those days Mr. Prunty was consequently able to take as holidays. An inspection of the tidal observatory at Mormugáo was also made by Mr. Belcham while Mr. Prunty was making an exceptionally long march between two of his stations. Fifteen days were lost in consequence of a dense haze which set in about the middle of February—so that the two observers did not complete their vertical observations until the latter end of April. They then returned to recess quarters, arriving in Poona on the 1st May, since which time Mr. Prunty has been employed in the office on the computations connected with the height revision, together with the other work mentioned above. Mr. Belcham, on arriving in Poona, received instructions to go on to Calcutta on the tidal duty mentioned in paras. 32 and 33, and he returned to Poona in time to relieve Major Hill on the 25th May.

The work done conjointly by Mr. Belcham and Mr. Prunty consisted in revising the heights of the 18 principal stations which form the South Konkan Meridional Series, and the height also of one secondary station of that series which had to be visited and used as an auxiliary station in the course of the work. According to the Deputy Surveyor General's orders, simultaneous vertical observations were taken on the cross rays, and ordinary reciprocal vertical observations on the flank rays. Most of the cross rays were from 35 to 40 miles in length, seven of them exceeded 40 miles, and the ray between Kumbhárli H. S. and Kanta H. S. was 54½ miles long. The flank rays ranged in length from 23 to 39 miles.

The stations of the east flank of the series, which rests on the *ghâts*, were observed at by Mr. Belcham; and those of the west flank, which skirts the sea coast, were observed at by Mr. Prunty. The following table gives the heights of the stations as originally determined, and as now deduced from the recent observations; the latter values cannot, however, be considered final until the height of a station near the southern end of the series has been connected with the spirit-levelling. It is proposed, as stated in para. 53, to have this done during the coming field season :—

Name of Station proceeding from North to South.		Original height given in Preliminary Chart.	Height by Revision, 1885-86.	Error in Original heights.
		Feet.	Feet.	Feet.
East Flank.				
Mándwi	H.S.	4'123	4119·0	+ 4·0
Torna	„	4,605	4600·2	+ 4·8
Mahábaleshvar	„	4,717	4712·8	+ 4·2
Kumbhárli	„	3,435	3437·5	— 2·5
Manoli	„	3,348	3351·9	— 3·9
Valvan	„	3,240	3237·2	+ 2·8
Chaukola	„	2,778	2776·7	+ 1·3
Salili	„	2,019	2006·1	+12·9
Kumbhári	„	2,889	2880·5	+ 8·5
West Flank.				
Karanga	H.S.	997	*996·5	+ 0·5
Titvi	„	1,302	1315·8	—13·8
Kanta	„	1,100	1125·3	—25·3
Adhúr	„	352	371·3	—19·3
Mirya	„	464	463·8	+ 0·2
Ghirya	„	319	320·3	— 1·3
Bhutoba	h.s.	367	371·2	— 4·2
Parule	H.S.	517	512·5	+ 4·5
Agoada	S.	256	238·2	+17·8
Pil	H.S.	1,568	1551·0	+17·0

* Derived directly by reciprocal vertical observations to and from Trombay H. S. whose height was determined by spirit-levelling.

Considering the age of the stations of the South Konkan Meridional Series, and that none of them had been closed by protecting pillars, the condition in which they were found last season was better than might have been expected. Only four of them showed signs of dilapidation or of having been tampered with—these are Valvan on the east flank, and Kanta, Ghirya and Parule on the west flank. At Valvan H. S., the upper mark-stone, and all the masonry portion of the station had been destroyed; and Mr. Belcham found a pole and brush signal standing on the circle and dot which are engraved on the rock *in sitû*. He built the station up to the level of the existing mark only. At Kanta H. S., Mr. Prunty found a '*kacha*' (stone and earth) circular pillar, 2 feet in diameter and 3½ feet high, containing no mark-stone and surrounded by a platform of loose stones. On removing it, he found the mark whose height is given on the preliminary chart, and which consists of a circle and dot engraved on the rock *in sitû*. After completing his observations at the station he built a solid masonry pillar of the same dimensions as the one he removed, with a new mark-stone in the centre of its upper surface, exactly over the old mark. This was unnecessary, and confusion may afterwards arise unless care is taken, when the final heights are published, that the height of the new mark is given. The values entered in the foregoing table refer to the old mark on the rock *in sitû*. At Ghirya H. S., Mr. Prunty found at the spot formerly occupied by the circle and dot, a hole 19 inches deep and 12 inches in diameter, bored in the solid rock, in which was standing a staff, 20 feet high, which he conjectures may have been erected for Marine Survey purposes. He also found three rubbed surfaces on the rock, the lines joining which, 2 feet in length, formed an equilateral triangle, having the hole at its centre — these evidently marked the positions for the feet of the stand of the theodolite. He further verified the position of the mark by means of the azimuths of the surrounding stations, and being satisfied of its correctness, he then filled in the hole and placed a new mark-stone in the exact position of the original mark, flush with the top of the hill. At Parule H. S., there was no upper mark, and Mr. Prunty built the protecting pillar over the lower mark-stone.

All the principal stations observed at by Mr. Belcham and Mr. Prunty were regularly transferred to the custody of the village officials in accordance with departmental regulations, after they had been closed with the usual protecting pillars. Bhutoba h. s., which was used as an auxiliary station, has been left protected by a cairn of stones.

The following are some extracts from Mr. Belcham's report on his season's work :—

"I observed at the stations on the east flank of the Series, they were nine in number and were visited in succession beginning at the north, and were as follows :—Mándwi H. S., Torna H S., Mahábaleshvar H. S., Kumbhárli H. S., Manoli H. S, Valvan H. S., Chaukola H. S, Salili H. S., and Kumbhári H. S.; of these Mahábaleshvar and Chaukola were very convenient as I was able to encamp within a short distance of each, but the remaining ones being on peaks, very remote from any habitation and devoid of water and being the haunts of wild beasts, such as tigers and bears, I considered it more prudent to remain at the foot of them, which necessitated a two hour's climb every morning as long as the observations lasted at each, and a run down the hill in the evening. Even at the foot of these stations, bears on several occasions paid my camp nocturnal visits and dug up ant-hills within a few yards of the tents, and the roar of a tiger often disturbed our slumbers.

"On the last day of the observations at Kumbhári H. S., I determined upon bivouacking on the hill for the night so as to get on with the closing pillar early the following morning, and we had scarcely retired to our impromptu huts, constructed of timber and grass, when we first heard a tiger and then followed a stampede of very large animals quite close to our bivouac; probably they were bison, which are said to abound in the hills immediately above the Konkan plain."

"The stations I visited are all very easy of approach, though the routes taken from one to another were very circuitous, and in most cases three times the direct distances owing to the absence of roads."

"The march to Kumbhárli from Mahábalesvar occupied six days: there being only a path across the hills, I had to follow the more circuitous road *viá* Sátára, Tárla and Pátan, by which it was over 90 miles, whereas in a direct line the distance was not more than 35 miles. On ascending the *ghát* at Tarla, the road suddenly narrowed and was only about 9 feet in width, and having camels for the carriage of my baggage, the distance between Tárla and Pátan was accomplished with the greatest difficulty and risk. The camels got into the gorge at the top of the *ghát*, but they could not pass through laden. Fortunately there was a village close by whence I got a number of coolies to carry the things down till the road became safer, but even then the camels cost me many an anxious moment as the road was very much cut up and the slightest slip on their part would have hurled them down a precipice some hundreds of feet below; however they got safely down to Pátan, where I got on to the high road to Chiplún, and reached Helvak, a village of some importance, immediately at the foot of Kumbhárli H. S.

"At Valvan H. S. the observations were not completed till the 3rd March, owing, in the first instance, to the introduction of another station (Bhutoba h. s.) between Ghirya H. S. and Parule H. S. as the signal on this ray was not visible, though it had been observed when the triangulation was first carried out; and then to the very hazy state of the atmosphere, the like of which had never come under my experience before. The introduction of Bhutoba h. s. entailed the observing of the horizontal as well as the vertical angles, and though I had observed to Ghirya on the 18th February, when not only the heliotrope but the hill itself was distinctly seen, I did not again see the signal until the 26th, owing to haze, which was so thick that the hill tops within 8 or 10 miles became obscure: a sudden change, however, in the weather brought on a few clouds which, combined with a change in the direction of the wind, dispelled the haze, and on the morning of the 26th the distant objects became as clear as possible, and it was a welcome sight to see the signals at the surrounding stations after so many days of, I may say, darkness and anxiety. From Bhutoba h. s. Mr. Prunty proceeded to Parule H. S., while I remained at Valvan H. S. for the simultaneous observations, and, to our great annoyance, the haze again set in as dense as ever, and we saw nothing of each other's signals until the 3rd March, when it cleared up, and we were able to get through the observations the same afternoon.

"The hill of Salili being detached from the line of *ghâts*, I had to get down into the Konkan *viá* the Rám-ghát pass, which, though a good width, is very steep and stony, and the descent quite knocked up the camels, which necessitated a halt of a couple of days at the foot of the pass. The observations at Salili H. S. were started on the 22nd March, and by the 30th the vertical angles to Chaukola, Parule, Agoada, and Kumbhári were completed with great difficulty, as hazy weather, similar to that which retarded the observations at Valvan, was experienced. The signal at Parule appeared as a star of very small magnitude, and could only be distinguished by setting the instrument both in azimuth and altitude, and then it was a very flickering object; this ray was over 46 miles in length; for four days we could not exchange any signals, and neither observer knew whether the other had been successful in getting any observations, so that messengers had to be employed for communicating with each other. After this the villagers began burning the jungle on the low hills in the Konkan which made the atmosphere very much more hazy, so it was fortunate that we finished with this long ray as early as we did, or it might have been left unobserved.

"The observations at Kumbhári H. S. extended over a week, as after the observations to Pil H. S., Mr. Prunty had to return to Agoada S., but before he reached it, the haze, combined with the smoke from the burning of the jungle, made the atmosphere almost impenetrable for observing; however by dint of patience and perseverance the observations on the ray Kumbhári-Agoada, over 41 miles in length, were completed on the 24th April, and these brought the revision of heights of the South Konkan Series to a successful close.

"The work progressed very favourably till the 18th February, after which the observations were very much retarded by hazy weather, which shut out the signals for days together and caused Mr. Prunty and myself very great anxiety.

"The traffic along the *ghát* roads leading into the Konkan from the Deccan is enormous, especially on the Kumbhárli *ghát* road to Chiplún—a large town in the Ratnagiri Collectorate. While I was marching on this road, hundreds of carts, laden with molasses, grain, earth-nuts, cotton, &c., were met daily, and on enquiry at some of the toll-houses I learned that in the cold weather as many as 600 carts are registered daily on their way to Chiplún, and from 200 to 300 more on their return from Chiplún to the Deccan country.

"The health of the party throughout the season was excellent, not a single man having been ill."

"I have to acknowledge the very great assistance I received from the native officials of the Poona and Satára districts; from those of the Native States of Bhor, Kolhapur and Sawantvadi, and from the Portuguese Government at Goa, while carrying on the revision of heights of the South Konkan Series."

The extracts which follow have been taken from a report on his work submitted by Mr. Prunty :—

"On the 24th November I visited Karanja H. S. which is situated on the highest part of the hill of that name, and as this hill rises nearly 1,000 feet immediately above the coast line, it proved a pretty stiff ascent—the way up consists of the remains of a series of steps constructed by the Portuguese many years

ago, when this part of India belonged to them. On the 25th November the theodolite and tents reached the top of the hill, and by the 29th observations to Mandwi H. S. and Titvi H. S. were completed.

"While encamped on the top of Karanja, on the night of the 27th November, I was disturbed from my sleep by the agonized howling of a small fox-terrier tied to the foot of my bed. I got up to ascertain the cause of the disturbance, but I had no sooner alighted on the ground than I felt my feet stung by a myriad of large black hairy ants, causing intense pain and great irritation. I found out next morning that these invaders were a detachment from a colony of ants that had passed over the hill a short distance from where my camp was pitched.

"On the 3rd December I reached Murúd on my way to Titvi H. S., and was detained there for two days. The town was in mourning for the Nawab of Janjira's wife, and out of respect for the deceased lady all business was suspended until the 5th December, when I managed to procure sufficient coolies for the carriage of the instrument and camp equipment to Titvi H. S., situated on a range of hills 7 miles inland. The march occupied the greater part of the day as the circuitous track was over hilly and undulating country covered with dense scrub jungle.

"While at Ghirya, the haze for the first time during the season presented a formidable barrier to the progress of the observations, and for several days shut out the luminous signals on the diagonal rays effectually. I have never encountered such dense haze in other parts of India as I experienced this season, towards the end of February and the early part of March. At Parule H. S., too, the haze was very similar to what I had met with at Ghirya H. S., and caused great delay in the observations taken there: in fact, I may say until the close of the season's work on the 22nd April, the haze was a constant attendant on the observations, and it was with the greatest difficulty that the last ray, Agoada-Kumbhári, was observed.

"The most expeditious way of getting from station to station on the western flank of the Series was by country boats, and I adopted this mode of transit, though fraught with great inconvenience and no little danger in a rough sea. On several occasions, while travelling in this way, the boats threatened to capsize, and when going to Parule H. S. towards the end of the season, we escaped being wrecked by the merest chance.

"The health of the party, on the whole, was very fair. Towards the end of March three-fourths of the men were attacked by itch of a virulent type, and some cases were so bad as to present the appearance of scurvy. After it had been stamped out, three of the men were laid up with guinea-worm, and for a time were entirely unfit for any work."

"The aspect of the coast line from Karanja to Goa, as it stretches along the blue sea, presents the appearance of low ranges of rugged hills folded inextricably together, with stretches of grey sand beach on which the foam of the sea lightly touches, streaking it like marble, but the stretches of sand are comparatively few and hardly disturb the continuity of the rock-bound coast. As one sails along, there is scarcely a sign of life perceptible. Here and there an island fortress a short distance from the coast, attracts attention.

"The trade carried on by native craft is very brisk, and the wealth of the people on the sea-board is essentially derived from maritime pursuits."

REDUCTION OF THE TIDAL OBSERVATIONS AND COMPUTATIONS CARRIED ON IN THE HEAD-QUARTERS OFFICE, POONA.

A very large amount of work in connection with the tidal calculations has been done in the Poona office during the past year. The observations at 13 ports have been reduced, and the tabulated values of the tidal constants at these stations, together with the usual discussion of the results will be found appended to this report. Although less by one than the number discussed in the preceding Annual Report, the labour of the reductions has been greater than what was then described. This is due to the breaks in the tidal registrations which occurred at various stations. When the registrations at a tidal station are broken, modifications are necessary in the calculations of the summation and means of all the 20 series of short period tides, and the 5 long period tides have in the first instance to be fully calculated out approximately, ignoring the breaks, and the results so obtained are treated according to Professor Darwin's method, in order to arrive at the most probable values to interpolate on the days when the breaks occurred. Having filled up the blanks in this manner, the long period tides have to be calculated afresh in order to obtain the final values.

The present state of the ordinary tidal computations is shown in the following table, together with their state at the end of October 1885, extracted from the Annual Report for 1884-85. The actual amount of work done in the period embraced by the table, which in the present instance is only eleven months, can thus be easily seen. The extra tidal work is not entered in it. This consisted in preparing tracings of five months' tidal diagrams of the Kidderpore observatory, which were sent last April to the Calcutta Port Commissioners according to their request. All the work also connected with the tide tables will be separately mentioned.

State of the ordinary reductions of the yearly tidal registrations at the beginning and end of the survey year 1885-86.

Observatory at work during the year.	State at end of October 1885.	State at end of September 1886.
ADEN	1884-85. Summation of series ready .	1884-85. Calculations completed. 1885-86. Diagrams not read off.
KURRACHEE . . .	1884-85. Additions of hourly heights of each series ready.	1884-85. Calculations completed. 1885-86. Diagrams completed and all read off, and the hourly readings being copied from the S series into the other series.
BHAVNAGAR . . .	. . . . .	Newly started observatory. No diagrams read off yet.

State of the ordinary reductions of the yearly tidal registrations, &c.—contd.

Observatory at work during the year.	State at end of October 1885.	State at end of September 1886.
Bombay . . .	1885. Year incomplete, so the readings from the diagrams are not read off.	1885. Diagrams completed, and all read off, and computations completed.
Mormugao . . .	1885-86. Year incomplete, so the readings from the diagrams are not read off.	1885-86. Diagrams completed, and all read off, and computations completed.
Cochin . . .	. . . . .	Newly started observatory. No diagrams read off yet.
Colombo . . .	1885-86. Year incomplete, so the readings from the diagrams are not read off.	1885-86. Diagrams completed, and all read off, and summations of series ready.
Galle	1885-86. Year incomplete, so the readings from the diagrams are not read off.	1885-86. Diagrams completed, and all read off, and summations of series ready.
Negapatam . . .	1885-86. Year incomplete, so the readings from the diagrams are not read off.	1885-86. Diagrams not yet read off.
Madras . . .	1884-85. Additions of hourly heights of each series in hand.	1884-85. Calculations completed. 1885-86. Diagrams not yet read off.
Cocanada . . .	. . . . .	Newly started observatory. No diagrams read off yet.
Vizagapatam (closed March 1885).	1884-85. Additions of hourly heights of each series in hand.	1884-85. Calculations completed.
False Point (closed September 1885).	1884-85. Additions of hourly heights of each series in hand.	1884-85. Calculations completed.
Dublat . . .	1884-85. The hourly readings being copied from the S series into the other series.	1884-85. Calculations completed. 1885-86. Diagrams not yet read off.
Diamond Harbour (closed April 1886.)	1884-85. The hourly readings being copied from the S series into the other series.	1884-85. Additions of hourly heights of each series ready. 1885-86. Diagrams not yet read off.
Kidderpore . . .	1884-85. The hourly readings being copied from the S series into the other series.	1884-85. Calculations completed. 1885-86. Diagrams completed, and all read off, and the hourly readings copied from the S series into the other series.
Chittagong . . .	. . . . .	Newly started observatory. No diagrams read off yet.
Elephant Point . .	1884. Summations of series ready.	1884. Calculations completed. 1885. Diagrams completed, and all read off, and the hourly readings from the diagrams in hand.
Rangoon . . .	1884-85. The hourly readings being copied from the S series into the other series.	1884-85. Calculations completed. 1885-86. Diagrams completed, and all read off, and calculations as far as the end of additions of the hourly heights of each series ready.
Amherst . . .	1884-85. Diagrams ready; but the hourly readings not yet completed.	1884-85. Readings of diagrams completed, and the additions of the hourly heights of each series ready. 1885-86. Diagrams not yet read off.
Moulmein (closed April 1886).	1884-85. Diagrams ready; but the hourly readings not yet complete.	1884-85. Readings of diagrams and computations completed. 1885-86. Diagrams not yet read off.
Port Blair. . .	1884-85. Diagrams ready; but the hourly readings not yet complete.	1884-85. Readings of diagrams and computations completed. 1885-86. Diagrams not yet read off.

The Tide Tables.

In addition to the tidal calculations reported on above, the usual amount of work was done in connection with the issue of the Tide Tables which will contain the predicted heights and times of every high and low water during the year 1887 and January 1888, for twenty-three ports. As was done last year, the values of the constants have been sent to Mr. Roberts in London ready for use. The mode of calculating them was described in the Annual Report for 1884-85, and need not be repeated here; and the method employed for

the riverain tides will be found described in the Tide Tables in the prefaces to the several riverain ports. In connection with these riverain tides, and in addition to the data furnished in previous years, the daily values of the actual and predicted heights and times of high and low water at Kidderpore, Dublat, Rangoon and Moulmein were sent every month to Mr. Roberts, together with similar data for the whole of the year 1885 at Elephant Point, according to an arrangement made by Major Baird.

An important improvement has been introduced into the Tide Tables for 1887 by the employment of a scientific datum which has at last rendered it possible to fix finally the datum for each of the tidal observatories. The following extract from Major Baird's preface to the Tide Tables for 1887 describes the new datum, which has been termed "The Indian Spring low water mark:—"

"The datum line for soundings adopted by the Admiralty is the 'mean low water of ordinary spring tides.' This term does not appear to have a scientifically accurate meaning with reference to tidal theory, but the datum line is usually determined by taking the mean of such spring tide observations as are available.

"It is desirable that a datum line should possess the following qualifications:—(1) it should be rigorously determinable from tidal theory, when complete observations are at hand; (2) it should be sufficiently low to preclude the occurrence of a large depression of the water, at any spring low water, below the datum even at ports where there is a considerable diurnal inequality; (3) it should, for rough navigational purposes, be practically the same as the Admiralty datum.

"After discussion with Professor Darwin and Captain Wharton, R. N., the Hydrographer to Her Majesty's Admiralty, it has been agreed to adopt a datum line to be called "The Indian Spring low water mark." This datum is defined as the sum of the semi-ranges of the principal lunar (M_2) and principal solar (S_2) semi-diurnal tides, and of the uni-solar diurnal (K_1) and the lunar diurnal (O_1) tides below mean sea-level, that is to say A_0—[H of M_2+H of S_2+H of K_1+H of O_1] above the zero of the gauge."

At some ports the old datum has been retained as differing very slightly from "the Indian Spring low water mark." At others, including the riverain ports, local considerations have forbidden the adoption of the new datum. The following table has been prepared to show the datum finally adopted at each of the tidal observatories.

Final Datum for each of the Survey of India Tidal Observatories.

Name of Tidal Observatory.	Datum to which the heights in the Tide Tables for 1887 are referred.	Datum below Mean Sea-level.
		Feet.
Aden	Mean low water ordinary spring tides	4·226
Kurrachee	Kurrachee Harbour Works Datum	5·183
Okha	Indian Spring Low Water Mark	7·149
Kathiwadar (or Shiyalbet)†	Do. do. do.	6·508
Bombay	Mean of the lowest Ordinary Spring Tides, *viz.*, 72 feet above the "Town Hall Datum"	8·223
Mormugao	Mormugáo Harbour Works Datum, or the same level as low water ordinary springs	3·512
Karwar	Indian spring low water mark	3·867
Beypore	Do. do. do.	2·328
Pamban	Do. do. do.	1·366
Galle	Do. do. do.	1·092
Colombo	Do. do. do.	1·238
Negapatam	Do. do. do.	1·310
Madras	Do. do. do.	1·874
Vizagapatam	Do. do. do.	2·623
False Point	Lowest low water recorded by the self-registering tide gauge between 1880-85	5·081
Dublat	Level of the zero of the Kedgeree gauge—Datum for River Survey Charts of Saugor Island	9·608
Diamond Harbour	Level of Sill of Kidderpore Dock	*8·995
Kidderpore	Do. do. do.	*10·686
Elephant Point	Datum to be adopted by River Surveyor, corresponding very nearly to the lowest recorded low water and 24 feet exactly below B. M. *A.* at the observatory	*7·686
Rangoon	Zero of the graduated staff at Brooking Street Wharf—Datum used by the River Surveyor	*10·641
Amherst	Mean low water ordinary spring tides	9·145
Moulmein	2 feet 8 inches lower than the mean low water ordinary Spring Tides	*7·667
Port Blair	Indian Spring low water mark	3·546

* Note.—These are reckoned from Mean River Level—not Sea Level.
† " This is not an observatory of the Survey Department, but appertains to the Bhavnagar State.

No. 1.

Statement showing the Percentage and the amount of the Errors in the Predicted Times of High Water at the various Tidal Stations for the year 1885.

Station.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	705	80	20	...	...	...
Kurrachee	705	43	39	8	7	3
Bombay	705	42	41	11	5	1
Negapatam	614	22	37	14	17	10
Madras	705	17	16	13	29	25
False Point	469	29	37	14	11	9
Dublat	705	25	40	15	15	5
Diamond Harbour	705	30	35	13	16	6
Kidderpore	706	24	37	12	18	9
Elephant Point	705	15	32	10	20	23
Rangoon	692	22	37	14	18	9
Amherst	664	52	21	10	9	8
Moulmein	705	20	37	14	19	10
Port Blair	692	32	37	10	9	12

No. 2.

Errors in the Predicted Times of Low Water.

Station.	Number of comparisons between the actual and predicted values.	Errors of 5 minutes and under.	Errors over 5 minutes and under 15 minutes.	Errors over 15 minutes and under 20 minutes.	Errors over 20 minutes and under 30 minutes.	Errors over 30 minutes.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Aden	706	81	19	...	...	...
Kurrachee	707	37	40	11	9	3
Bombay	705	38	40	9	9	4
Negapatam	614	17	28	9	21	25
Madras	705	21	18	11	26	24
False Point	470	31	36	13	12	8
Dublat	705	23	35	12	20	10
Diamond Harbour	705	21	31	15	21	12
Kidderpore	705	22	35	15	18	10
Elephant Point	705	9	14	7	13	57
Rangoon	691	21	33	13	20	13
Amherst	663	37	21	12	16	14
Moulmein	705	30	41	14	9	6
Port Blair	690	27	36	12	10	15

No. 3.

Statement showing the Percentage and the amount of the Errors in the Predicted Heights of High Water at the various Tidal Stations for the year 1885.

Station.	Number of comparisons between the actual and predicted values.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
		Per cent.	Per cent.	Per cent.	Per cent.
Aden	705	92	8	...	...
Kurrachee	705	82	15	2	1
Bombay	705	67	25	7	1
Negapatam	614	31	44	16	9
Madras	705	63	32	3	2
False Point	469	55	38	7	...
Dublat	705	57	29	10	4
Diamond Harbour	705	42	26	16	16
Kidderpore	706	27	25	19	29
Elephant Point	705	1	1	1	97
Rangoon	692	50	29	12	9
Amherst	664	37	29	18	16
Moulmein	705	41	25	15	19
Port Blair	692	89	11	...	...

No. 4.

Errors in the Predicted Heights of Low Water.

Station.	Number of comparisons between the actual and predicted values.	Errors of 4 inches and under.	Errors over 4 inches and under 8 inches.	Errors over 8 inches and under 12 inches.	Errors over 12 inches.
		Per cent.	Per cent.	Per cent.	Per cent.
Aden	706	88	12	...	...
Kurrachee	707	75	20	4	1
Bombay	705	66	28	5	1
Negapatam	614	21	49	22	8
Madras	705	85	14	1	...
False Point	470	64	27	8	1
Dublat	705	56	24	12	8
Diamond Harbour	705	47	33	13	7
Kidderpore	705	34	24	13	29
Elephant Point	705	10	9	9	72
Rangoon	691	27	26	26	21
Amherst	665	11	10	12	67
Moulmein	705	34	31	17	18
Port Blair	690	81	14	3	2

VALUES OF THE TIDAL CONSTANTS, ADEN, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Aden; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations :—

Short Period Tides.

A_0=5·849 feet.

S_1	H = R =	0·074	M_6	R =	0·005	Q_1	R =	0·017	T_2	R =	0·081
	κ = ζ =	173°·69		ζ =	42°·44		ζ =	79°·25		ζ =	335°·74
S_2	H = R =	0·700		H =	0·005		H =	0·144		H =	0·081
	κ = ζ =	244°·76		κ =	317°·12		κ =	29°·14		κ =	275°·15
S_4	H = R =	0·004	M_8	R =	0·002	L_2	R =	0·055	$(MS)_4$	R =	0·014
	κ = ζ =	6°·95		ζ =	318°·01		ζ =	190°·36		ζ =	279°·81
S_6	H = R =	0·006		H =	0·001		H =	0·047		H =	0·014
	κ = ζ =	188°·43		κ =	84°·26		κ =	223°·65		κ =	131°·37
S_8	H = R =	0·001	O_1	R =	0·546	N_2	R =	0·449	$(2SM)_2$	R =	0·021
	κ = ζ =	265°·60		ζ =	81°·39		ζ =	11°·29		ζ =	319°·25
				H =	0·670		H =	0·434		H =	0·021
				κ =	37°·04		κ =	217°·09		κ =	107°·69
M_1	R =	0·075	K_1	R =	1·156	λ_2	R =	0·038	$2N_2$	R =	0·111
	ζ =	138°·15		ζ =	139°·92		ζ =	83°·93		ζ =	336°·71
	H =	0·084		H =	1·303		H =	0·037		H =	0·107
	κ =	35°·62		κ =	34°·24		κ =	258°·74		κ =	176°·75
M_2	R =	1·639	K_2	R =	0·156	ν_2	R =	0·161	$(M_2N)_4$	R =	0·038
	ζ =	13°·42		ζ =	265°·42		ζ =	145°·42		ζ =	277°·38
	H =	1·581		H =	0·206		H =	0·156		H =	0·036
	κ =	224°·98		κ =	233°·53		κ =	213°·74		κ =	334°·74
M_3	R =	0·015	P_1	R =	0·399	μ_2	R =	0·089	$(M_2K_1)_3$	R =	0·031
	ζ =	74°·78		ζ =	283°·29		ζ =	129°·78		ζ =	297°·26
	H =	0·014		H =	0·399		H =	0·083		H =	0·033
	κ =	212°·12		κ =	31°·75		κ =	192°·91		κ =	43°·14
M_4	R =	0·003	J_1	R =	0·083	R_2	R =	0·019	$(2M_2K_1)_3$	R =	0·006
	ζ =	262°·65		ζ =	155°·64		ζ =	1°·85		ζ =	113°·46
	H =	0·003		H =	0·099		H =	0·019		H =	0·006
	κ =			κ =	57°·30		κ =	242°·44		κ =	282°·26

Long Period Tides.

		R	ζ	H	κ
Lunar Monthly	Tide	0·044	47°·57	0·039	53°·33
„ Fortnightly	„	0·008	275·50	0·012	35·75
Luni-Solar „	„	0·020	116·43	0·019	264·87
Solar-Annual	„	0·367	14·51	0·367	356·05
„ Semi-Annual	„	0·102	195·66	0·102	158·75

The value of (A_0) the mean level of the sea for 1884-85 is 5·849 feet above the zero of the gauge, and is the highest yet obtained; last year it was 5·800 feet.

The mean amplitude (H) of the main lunar tide (M_2) is 1·581 feet; it is almost identical with the value obtained last year, *viz.*, 1·588, which is the highest value obtained at Aden. The epoch of this tide is 224°·98 and corresponds very closely to that of the previous year.

The main solar tide (S_2) has an amplitude of 0·700 feet and agrees well with the values obtained in previous years; its epoch, too, is about identical with that of the past year.

The main diurnal tide (K_1) has a mean amplitude of 1·303 feet, which is almost exactly the mean of the values obtained in the previous five years. Its epoch is 34°·24 and is the smallest value yet obtained.

The proportion of the main solar tide (S_2) to the main lunar tide (M_2) is again 44 per cent.; theoretically it should be 47 per cent.

The principal diurnal tide (K_1) is 82 per cent. of the main tide, somewhat lower than the proportion obtained last year, *viz.*, 83 per cent.; theoretically it should be 58 per cent., but at Aden this tide has always been found to be very large.

The proportion of the smaller lunar elliptic tide (L_2) is this year 0·030, and accords well with the theoretical value 0·028; the larger elliptic tide (N_2) is 0·275 of the main tide, which is slightly larger than the proportion obtained last year, 0·266, and approaches the values of 1879-80 and 1880-81; the theoretical proportion being 0·194.

The smaller evectional tide (λ_2) is this year 0·023 of the main tide, and approaches the 1881-82 proportion, the largest yet obtained; theoretically it should be 0·007, last year it was 0·009 of the main tide.

The larger evectional tide (ν_2) has a proportion of 0·099, which is identical with the value obtained in 1879-80 and is nearly three times the theoretical proportion 0·038.

With regard to the diurnal tides the proportions to the main tide are as follow :—

		Aden, 1884-85.	Theoretical.
Luni-Solar	K_1	0·824	0·584
Lunar	M_1	·053	·036
Solar Declinational	P_1	·252	·193
Lunar „	O_1	·424	·415
Lunar Elliptic	J_1	·063	·033
Solar „	Q_1	·091	·080

From which it will be seen that the largest component (K_1) is nearly half as large again as its theoretical value; that the next larger component (O_1) agrees well with the theoretical proportion; and that the remaining diurnal tides are from 1 to 6 per cent. greater than the theoretical value—a result which accords well with the proportions hitherto obtained; the value of (M_1) however is the largest yet obtained at this port.

As usual at this port, the overtides are all quite insignificant, with the exception of the ter-diurnal lunar tide (M_3), which, though barely appreciable, seems clearly to exist, as year by year this overtide is found to have an amplitude of 0·01 of the main tide, a value which agrees with theory: its epoch, as determined from six years' observations is about 209°.

The compound tides $(M_2K_1)_3$, $(MS)_4$, $(2\,M_2K_1)_3$, $(M_2\,N)_4$, $(2SM)_2$ are as usual very small, and are almost identical with last-year's values.

Of the long period tides, the solar annual has the greatest amplitude, and is again this year 23 per cent. of the main tide; its time of maximum is 10 days later than was obtained last year, *viz.*, the 17th March.

The solar semi-annual tide is again 7 per cent. of the main tide, and its epoch continues to be variable.

The lunar monthly tide is 0·025 of the main tide, and just about half the theoretical value, 0·046.

The luni-solar fortnightly tide is 0·012 of the main tide, and this is the largest value yet obtained of this tide: theoretically it is 0·007 of the main tide.

The lunar fortnightly tide has this year the smallest proportion to the main tide that has yet been obtained, *viz.*, 0·008 of the main tide: theoretically it should be 0·086 of the main tide: the mean of the last five years is 0·031.

VALUES OF THE TIDAL CONSTANTS, KURRACHEE, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Kurrachee; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations:—

Short Period Tides.

$A_0 = 7{\cdot}198$ feet.

S_1	H = R =	0·055	M_6	R =	0·050	Q_1	R =	0·090	T_2	R =	0·126
	$\kappa = \zeta =$	182°·90		ζ =	282°·74		ζ =	200°·29		ζ =	80°·00
S_2	H = R =	0·963		H =	0·045		H =	0·111		H =	0·126
	$\kappa = \zeta =$	323°·13		κ =	206°·00		κ =	45°·76		κ =	321°·33
S_4	H = R =	0·011	M_8	R =	0·002	L_2	R =	0·089	$(MS)_4$	R =	0·026
	$\kappa = \zeta =$	44°·23		ζ =	183°·81		ζ =	227°·80		ζ =	124°·84
S_6	H = R =	0·005		H =	0·001		H =	0·076		H =	0·025
	$\kappa = \zeta =$	323°·57		κ =	321°·50		κ =	315°·51		κ =	339°·26
S_8	H = R =	0·001	O_1	R =	0·541	N_2	R =	0·618	$(2SM)_2$	R =	0·018
	$\kappa = \zeta =$	240°·26		ζ =	146°·02		ζ =	116°·64		ζ =	327°·65
				H =	0·666		H =	0·596		H =	0·017
				κ =	47°·29		κ =	275°·26		κ =	113°·23
M_1	R =	0·036	K_1	R =	1·151	λ_2	R =	0·067	$2N_2$	R =	0·087
	ζ =	202°·37		ζ =	94°·08		ζ =	165°·65		ζ =	128°·62
	H =	0·042		H =	1·300		H =	0·065		H =	0·084
	κ =	111°·46		κ =	45°·87		κ =	290°·31		κ =	231°·44
M_2	R =	2·640	K_2	R =	0·232	ν_2	R =	0·185	$(M_2N)_4$	R =	0·072
	ζ =	79°·60		ζ =	232°·97		ζ =	195°·95		ζ =	28°·54
	H =	2·546		H =	0·308		H =	0·179		H =	0·067
	κ =	294°·02		κ =	316°·14		κ =	320°·14		κ =	41°·59
M_3	R =	0·029	P_1	R =	0·395	μ_2	R =	0·044	$(M_2K_1)_3$	R =	0·019
	ζ =	207°·30		ζ =	356°·07		ζ =	218°·85		ζ =	347°·51
	H =	0·027		H =	0·395		H =	0·041		H =	0·020
	κ =	348°·93		κ =	46°·43		κ =	287·69		κ =	153°·72
M_4	R =	0·031	J_1	R =	0·059	R_2	R =	0·019	$(2M_2K_1)_3$	R =	0·022
	ζ =	311°·71		ζ =	71°·23		ζ =	12°·83		ζ =	249°·67
	H =	0·029		H =	0·071		H =	0·019		H =	0·023
	κ =	20°·56		κ =	80°·19		κ =	311°·51		κ =	6°·72

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·031	63°·08	0·027	118°·88
,, Fortnightly ,, ...	0·037	161·93	0·058	33·82
Luni-Solar ,, ,, ...	0·038	51·29	0·037	196·87
Solar-Annual ,, ...	0·139	4·18	0·139	43·81
,, Semi-Annual ,, ...	0·137	81·28	0·137	160·55

The mean level of the sea (A_0) is 7 198 feet above the zero of the gauge, and very slightly higher than last year's value, 7,192.

The main lunar tide (M_2) has a mean amplitude of 2·546 and is 0·02 foot less than the value obtained last year: its epoch is almost identical with the values obtained for the previous 4 years.

The main solar tide (S_2) has an amplitude of 0·963 foot, or just 0·01 foot more than it was last year, and almost identical with the value obtained in 1880-81, 1881-82, and 1882-83: its epoch too compares very well with those of the previous six years.

The main solar tide (S_2) is 0·378 of the main tide—a proportion which accords well with those of former years: its theoretical proportion is 0·465.

The luni-solar semi-diurnal tide (K_2) has again this year a proportion nearly equal to the theoretical.

The two lunar elliptic tides (N_2 and L_2) are respectively 23 and 3 per cent. of the main tide; these proportions are similar to what generally obtained at Kurrachee: the theoretical proportions of these tides are 19 and 3 per cent.

The larger evectional tide (ν_2) is this year nearly double the theoretical proportion, being 0·07, while the theoretical is 0·038; last year it was only 0·01, but that was the lowest value obtained at Kurrachee.

The smaller evectional tide (λ_2) is this year 0·026 of the main tide; this is the largest value obtained since 1878-79, and is about four times the theoretical value, which is 0·007.

The lunar elliptic tide of the second order ($2N_2$) is 0·033 of the main tide; last year it was 0·043: the theoretical proportion is 0·026.

The variational tide (μ_2) has a proportion of 0·016 to the main tide, a value very similar to what was obtained in 1882-83, *viz.*, 0·015: the theoretical proportion is 0·024. Since 1878-79 it is noticeable that the proportions are alternately about 0·016 and 0·03..

The solar elliptic semi-diurnal tides (T_2 and R_2), which are only evaluated every alternate year, were calculated: the former is found to be 5 per cent. of the main tide and nearly double the theoretical proportion, and the latter is insignificant as usual.

The principal diurnal tide (K_1) is as usual 51 per cent. of the main tide, while the theoretical proportion is 58 per cent.

The lunar declinational tide (O_1) and the solar declinational tide (P_1) are respectively 26 and 16 per cent. of the main tide, and accord well with the previous values: the theoretical proportions of these tides are respectively 42 and 19 per cent. of the main tide.

The remaining diurnal tides (Q_1, J_1, M_1) are 4, 3 and 2 per cent. of the main tide; theoretically they should be 8, 3 and 4 per cent. So that (Q_1) and (M_1) are each half of what they should be; and (J_1) is identical with the theoretical value. (S_1) is slightly lower in its proportion to the main tide than it was last year; but there is no theoretical value to compare it with.

The overtides (M_3), (M_4), and (M_6) are respectively 1, 1, and 2 per cent. of the main tide; and these proportions are generally obtained. Of the remaining overtides (S_4), (S_6) are insignificant; and (M_8) and (S_8) have altogether vanished this year.

The compound tides are all insignificant, the greatest being $(M_2\,N)_4$.

The lunar monthly and lunar fortnightly tides agree in their proportions to the main tide with the values obtained last year; they are both less than the theoretical proportions, but this is usually the case at Kurrachee.

The luni-solar fortnightly tide is this year 0·015 of the main tide and double the theoretical value.

The solar annual tide is 0·055 of the main tide, and just 2 per cent. more than it was found to be last year.

The solar semi-annual tide is 0·054 of the main tide, or about one per cent. more than the theoretical value and 2 per cent. less than last year.

With regard to the epochs of the luni-solar fortnightly, the lunar monthly and the lunar fortnightly, they are all as usual very divergent. The epoch of the solar annual is 44°, or about 5° later than last year; and that of the solar semi-annual is 160°, or 10° earlier than last year.

VALUES OF THE TIDAL CONSTANTS, BOMBAY, 1885.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1885 observations at Bombay; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1885 observations:—

Short Period Tides.

$A_0 = 10{\cdot}304$ feet.

S_1	H = R =	0·053	M_6	R =	0·011	Q_1	R =	0·106	T_2	R =	0·237
	κ = ζ =	168°·44		ζ =	93°·01		ζ =	242°·35		ζ =	349°·63
S_2	H = R =	1·627		H =	0·010		H =	0·132		H =	0·237
	κ = ζ =	2°·87		κ =	95°·67		κ =	35°·75		κ =	349°·50
S_4	H = R =	0·010	M_8	R =	0·008	L_2	R =	0·047	$(MS)_4$	R =	0·140
	κ = ζ =	325°·31		ζ =	20°·27		ζ =	103°·83		ζ =	20°·13
S_6	H = R =	0·003		H =	0·007		H =	0·041		H =	0·135
	κ — ζ =	184°·09		κ =	23°·81		κ =	305°·05		κ =	21°·01
S_8	H — R =	0·002	O_1	R =	0·549	N_2	R =	1·033	$(2SM)_2$	R =	0·047
	κ — ζ =	105°·52		ζ =	237°·97		ζ =	328°·12		ζ =	100°·85
				H =	0·682		H =	0·995		H =	0·046
				κ =	47°·88		κ =	312°·50		κ =	99°·97
M_1	R =	0·044	K_1	R =	1·232	λ_2	R =	0·004	$2N_2$	R =	0·159
	ζ =	221°·23		ζ =	214°·49		ζ =	291°·80		ζ =	278°·06
	H =	0·050		H =	1·398		H =	0·004		H =	0·153
	κ =	69°·17		κ =	45°·58		κ =	95°·28		κ =	245°·94
M_2	R =	4·226	K_2	R =	0·311	ν_2	R =	0·054	$(M_2N)_4$	R =	0·140
	ζ =	328°·94		ζ =	144°·20		ζ =	354°·62		ζ =	252°·19
	H =	4·072		H =	0·415		H =	0·052		H =	0·130
	κ =	329°·83		κ =	346°·37		κ =	12°·92		κ =	237°·45
M_3	R =	0·084	P_1	R =	0·415	μ_2	R =	0·194	$(M_2K_1)_3$	R =	0·094
	ζ =	212°·93		ζ =	234°·34		ζ =	293°·61		ζ =	298°·61
	H =	0·079		H =	0·415		H =	0·180		H =	0·103
	κ =	34°·26		κ =	43°·24		κ =	295°·38		κ =	130°·58
M_4	R =	0·130	J_1	R =	0·082	R_2	R =	0·029	$(2M_2K_1)_3$	R =	0·061
	ζ =	325°·63		ζ =	238°·57		ζ =	46°·68		ζ =	240°·17
	H =	0·121		H =	0·099		H =	0·029		H =	0·065
	κ =	327°·40		κ =	86°·05		κ =	226°·82		κ =	50°·86

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·029	47°·08	0·026	63°·58
„ Fortnightly „	0·052	208·27	0·083	49·34
Luni-Solar „ „	0·054	268·93	0·052	268·04
Solar-Annual „	0·042	177·75	0·042	98·85
„ Semi-Annual „	0·042	18·95	0·042	221·16

The value of (A_0) the mean level of the sea at Bombay is this year 10·304 feet above the zero of the gauge; it is the largest value yet obtained, being 0·047 foot higher than the mean of the two preceding years, and nearly $\frac{8}{100}$ths of a foot above the mean of the seven previous years' observations at this station.

The mean amplitude (H) of the main lunar tide (M_2) is almost identical with the value obtained last year: it is 4·072 feet, while last year it was 4·071 feet. The epoch of this tide is this year 1½ degrees more than last year's value; but the greatest discrepancy between the epochs of this tide for any two years does not exceed 2°·28, or less than 5 minutes in time.

The amplitude of the main solar tide (S_2) is identical with the value obtained in 1880 *viz.*, 1·627 feet; and is only 0·003 foot less than the mean of the whole eight years' observations. The epoch (κ) of this tide is 2°·87; last year it was 1°·48, but that was an exceptionally low value; and the value now obtained agrees very well with the mean (2°·81) of the several years' observations.

The proportion of the main solar tide to the main lunar tide is 0·400, and is very accordant with the mean proportion from the several years' values, *viz.*, 0·402; theoretically it should be 0·465 of the main tide.

The luni-solar semi-diurnal tide (K_2) is this year 10 per cent. of the main tide, which proportion is generally obtained: theoretically it should be 13 per cent. The epoch of this tide is 346° and is the lowest yet obtained, but does not differ by more than 5° or 10 minutes in time from the mean of all the values of the epoch at this place.

The proportion of the larger component (N_2) of the lunar elliptic semi-diurnal tides is 0·244 of the main tide, which is identical with the 1880 proportion, and very accordant with the other years' values, which have been from 5 to 6 per cent. greater than the theoretical value.

The epoch is 312°·5 and agrees very well with the three preceding years' values; and the greatest difference between any two years' values does not exceed 4° or 8 minutes in time.

The smaller component (L_2) of the lunar elliptic semi-diurnal tides is this year only 1 per cent. of the main tide; in 1883 it was also 1 per cent.; but the value of this tide varies between 1 and 3 per cent. and in 1882 it was very nearly 4 per cent. of the main tide.

With regard to the evectional semi-diurnal tides, the larger component (ν_2) has a proportion of 0·013 of the main tide, the smallest proportion yet obtained: theoretically it should be 4 per cent. The smaller component (λ_2) is as usual quite insignificant.

The lunar elliptic tide of the second order ($2N_2$) bears very nearly the same proportion to the main tide as it did last year, and is about 1 per cent. greater than the theoretical value, 0·025.

The solar elliptic semi-diurnal tides (T_2 and R_2), which are only evaluated every alternate year, are respectively 0·058 and 0·007 of the main tide; the former is a little more than double the theoretical value and agrees with the proportion obtained in 1881; and the latter agrees with all the previous values.

The variational tide (μ_2) is 0·044 of the main tide,—a value nearly twice as great as theory gives; but this proportion has always been obtained for this tide at Bombay.

The diurnal tides are all smaller in their proportion to the main tide than the theoretical values; but the values are very accordant with those usually obtained, and the following table shows the proportions of the principal diurnal tides to the main tide for the year 1885, compared with the theoretical values:—

	Bombay, 1885.	Theoretical.
Luni-solar (K_1)	0·343	0·584
Lunar declinational (O_1)	·167	·415
Solar „ (P_1)	·102	·103
Solar elliptic (Q_1)	·032	·080
Lunar „ (J_1)	·024	·033
Lunar diurnal (M_1)	·012	·036

The epochs of the first three (K_1, O_1, and P_1) agree very well with those previously obtained, in fact they are very accordant year after year; but those of the other three tides vary as follow:—(Q_1) from 36° to 60°, (J_1) from 40° to 89°, and (M_1) from 19° to 105.

The proportions of the overtides of (S) and (M) are all nearly identical with the values found in former years.

With regard to the compound tides, $(M_2\ K_1)_3$ is this year 2½ per cent. of the main tide, while in the two previous years it was under 1 per cent.; theoretically it should be 12 per cent.; $(M\ S)_4$, $(2M_2K_1)_3$, and $(2\ S\ M)_2$ agree with the proportions hitherto obtained; and $(M_2\ N)_4$ is 3 per cent. of the main tide; last year it was 2 per cent. and theoretically it should be 4 per cent.

Of the long period tides, the lunar monthly and the luni-solar fortnightly agree with the proportions obtained last year, and are each 1 per cent. of the main tide: the latter is very nearly the theoretical proportion, but the former is about 3 per cent. less than it should be, and this is generally found to be the case.

The lunar fortnightly tide has this year a proportion of 0·020 of the main tide, the largest yet obtained, but does not differ much from the value, 0·017 obtained in 1878; theoretically it should be 0·086 of the main tide.

The solar annual tide is 0·010 of the main tide; the proportions of this tide are very divergent, the smallest being 0·008 and the largest 0·064 of the main tide. The epoch of this tide is for this year 98°, which is 18° less than the value obtained in 1878; between these two years, however, the values were very different and varied between 285° and 355°.

The solar semi-annual tide has this year a proportion of 0·010 of the main tide, the lowest yet obtained; theoretically it should be 4 per cent. The epoch is 221°, or about 12° more than last year and very accordant with those of 1879 and 1882; the times of maxima remaining between the 11th June and 16th July, and the 11th December and 16th January.

VALUES OF THE TIDAL CONSTANTS, MORMUGAO, 1885-86.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1885-86 observations at Mormugáo; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1885-86 observations:—

Short Period Tides.

A_0=5·577 feet.

S_1	H = R =	0·041	M_6	R =	0·014	Q_1	R =	0·096	T_2	R =	0·068
	κ = ζ =	177°·47		ζ =	255°·32		ζ =	221°·06		ζ =	350°·89
S_2	H = R =	0·641		H =	0·013		H =	0·119		H =	0·068
	κ = ζ =	332°·23		κ =	245°·04		κ =	51°·56		κ =	277°·82
S_4	H = R =	0·009	M_8	R =	0·012	L_2	R =	0·060	$(MS)_4$	R =	0·029
	κ = ζ =	99°·97		ζ =	33°·69		ζ =	252°·81		ζ =	70°·65
S_6	H = R =	0·005		H =	0·011		H =	0·053		H =	0·028
	κ = ζ =	109°·89		κ =	19°·98		κ =	338°·19		κ =	67°·22
S_8	H = R =	0·004	O_1	R =	0·423	N_2	R =	0·455	$(2SM)_2$	R =	0·003
	κ = ζ =	24°·44		ζ =	315°·81		ζ =	188°·93		ζ =	135°·00
				H =	0·524		H =	0·438		H =	0·003
				κ =	49°·59		κ =	282°·22		κ =	138°·43
M_1	R =	0·053	K_1	R =	0·911	λ_2	R =	0·015	$2N_2$	R =	0·072
	ζ =	61°·09		ζ =	142°·07		ζ =	185°·95		ζ =	73°·33
	H =	0·055		H =	1·033		H =	0·014		H =	0·069
	κ =	98°·02		κ =	45°·78		κ =	102°·50		κ =	263°·34
M_2	R =	1·889	K_2	R =	0·134	ν_2	R =	0·108	$(M_2N)_4$	R =	0·062
	ζ =	303°·53		ζ =	343°·96		ζ =	357°·00		ζ =	252°·49
	H =	1·820		H =	0·179		H =	0·104		H =	0·057
	κ =	300°·10		κ =	331°·45		κ =	253°·59		κ =	342°·35
M_3	R =	0·015	P_1	R =	0·305	μ_2	R =	0·045	$(M_2K_3)_3$	R =	0·032
	ζ =	304°·33		ζ =	306°·92		ζ =	253°·20		ζ =	153°·35
	H =	0·015		H =	0·305		H =	0·042		H =	0·035
	κ =	299°·19		κ =	42°·88		κ =	246°·35		κ =	53°·64
M_4	R =	0·050	J_1	R =	0·071	R_2	R =	0·006	$(2M_2K_1)_3$	R =	0·006
	ζ =	12°·48		ζ =	237°·08		ζ =	244°·80		ζ =	300°·26
	H =	0·047		H =	0·085		H =	0·006		H =	0·006
	κ =	5°·62		κ =	43°·16		κ =	137°·86		κ =	29°·69

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·033	95°·57	0·029	358°·85
„ Fortnightly „	0·047	24·89	0·075	13·91
Luni-Solar „ „	0·059	275·88	0·057	279·30
Solar-Annual „	0·165	339·19	0·165	333·22
„ Semi-Annual „	0·055	79·43	0·055	67·51

The value of (A_0), the mean level of the sea, is 5·577 feet above the zero of the gauge, or 0·065 foot greater than last year's value.

The mean amplitude (H) of the main lunar tide (M_2) is 1·820 feet, or 0·054 foot more than last year, and its epoch is 5° less than that obtained last year.

The main solar tide (S_2) has an amplitude of 0·641 foot, which is almost the same as the preceding year's value, 0·638; the epoch of this tide is 332°·23; last year it was 336°·75.

The luni-solar tide (K_2) is this year also 10 per cent. of the main tide, while the theoretical proportion is 13 per cent.

The lunar elliptic tides (N_2 and L_2) are 24 and 3 per cent. respectively of the main tide: the former agrees with the value obtained last year, and the latter with the theoretical proportion.

The larger evectional tide (ν_2) is 0·057 of the main tide, last year it was 0·087 of the main tide; the theoretical proportion of this tide is 0·038.

The smaller evectional tide (λ_2) is insignificant and agrees well with the theoretical proportion.

The lunar elliptic tide of the second order ($2N_2$) agrees with the value determined last year; and is only 1 per cent. greater than the theoretical proportion.

The two solar elliptic tides (T_2 and R_2) have for the first time been deduced this year; the former is 4 per cent. of the main tide, while theory gives 3 per cent. and the latter is insignificant.

The variational tide (μ_2) has a proportion of 0·023, which agrees very well with the theoretical proportion, 0·024.

Regarding the diurnal tides, the luni-solar (K_1), the lunar declinational (O_1), and the solar declinational (P_1) have very nearly the same proportions to the main tide as were obtained last year. The solar elliptic tide (Q_1) is 7 per cent. of the main tide; the lunar elliptic tide (J_1) is 5 per cent. and the lunar diurnal tide (M_1) is 3 per cent.; theoretically they should be 8, 3 and 4 per cent. respectively.

The epochs of the several diurnal tides agree very well with those determined last year, the greatest difference being in (Q_1) of 12½°.

The proportions of the several overtides are almost precisely the same as those found last year, and are all insignificant with the exception of the lunar (M_4).

The proportions of the compound tides also agree very closely with those of last year.

The lunar monthly tide has a proportion of 0·016 of the main tide, whereas by theory it should be 0·046; last year it was 0·027.

The lunar fortnightly tide is 0·041 of the main tide, or about half what theory assigns as its value; last year it was 0·027.

The luni-solar fortnightly tide is 0·031 of the main tide; last year it was found to be 0·012, and by theory it is quite insignificant.

The solar annual tide is 0·091 of the main tide, or just about half of what it was found to be last year. The epoch of this tide for this year is 333°, thus the time of maximum is 26 days later than last year.

The solar semi-annual tide is 0·030 of the main tide; last year it was 0·042—a value which is almost identical with theory: its epoch is 67° against 162°—last year's value.

VALUES OF THE TIDAL CONSTANTS, MADRAS, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Madras; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations:—

Short Period Tides.

$A_0 = 2{\cdot}134$ feet.

S_1	H = R =	0·056	M_6	R =	0·008	Q_1	R =	0·006	T_2	R =	...
	κ = ζ =	99°·61		ζ =	135°·54		ζ =	215°·54		ζ =	...
S_2	H = R =	0·450		H =	0·008		H =	0·007		H =	...
	κ = ζ =	279°·79		κ =	165°·04		κ =	280°·23		κ =	...
S_4	H = R =	0·005	M_8	R =	0·002	L_2	R =	0·030	$(MS)_4$	R =	0·015
	κ = ζ =	302°·28		ζ =	99°·46		ζ =	334°·81		ζ =	7°·08
S_6	H = R =	0·001		H =	0·001		H =	0·026		H =	0·015
	κ = ζ =	63°·44		κ =	18°·81		κ =	359°·29		κ =	256°·91
S_8	H = R =	0·001	O_1	R =	0·082	N_2	R =	0·274	$(2SM)_2$	R =	0·021
	κ = ζ =	333°·44		ζ =	297°·73		ζ =	307°·65		ζ =	146°·39
				H =	0·100		H =	0·265		H =	0·021
				κ =	321°·88		κ =	238°·02		κ =	256°·55
M_1	R =	0·035	K_1	R =	0·263	λ_2	R =	0·074	$2N_2$	R =	0·064
	ζ =	11°·31		ζ =	116°·91		ζ =	212°·12		ζ =	230°·30
	H =	0·038		H =	0·296		H =	0·071		H =	0·061
	κ =	282°·99		κ =	340°·85		κ =	73°·29		κ =	201°·21
M_2	R =	1·097	K_2	R =	0·065	ν_2	R =	0·151	$(M_2N)_4$	R =	0·109
	ζ =	358°·53		ζ =	1°·88		ζ =	125°·86		ζ =	256°·74
	H =	1·058		H =	0·086		H =	0·145		H =	0·102
	κ =	248°·36		κ =	269°·19		κ =	224°·36		κ =	76°·94
M_3	R =	0·003	P_1	R =	0·104	μ_2	R =	0·068	$(M_2K_1)_3$	R =	0·023
	ζ =	173°·66		ζ =	207°·18		ζ =	55°·18		ζ =	256°·40
	H =	0·003		H =	0·104		H =	0·063		H =	0·025
	κ =	8°·41		κ =	346°·29		κ =	194°·85		κ =	10°·18
M_4	R =	0·021	J_1	R =	0·025	R_2	R =	...	$(2M_2K_1)_3$	R =	0·005
	ζ =	86°·26		ζ =	160°·92		ζ =	...		ζ =	98°·75
	H =	0·019		H =	0·030		H =	...		H =	0·006
	κ =	225°·93		κ =	346°·06		κ =	...		κ =	14°·48

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·019	40°·77	0·017	0°·23
,, Fortnightly ,, ...	0·013	3·88	0·010	25·41
Luni-Solar ,, ,, ...	0·027	18·02	0·026	128·19
Solar-Annual ,, ...	0·366	264·20	0·366	215·09
,, Semi-Annual ,, ...	0·362	235·63	0·362	137·41

The mean level of the sea (A_0) is 2·134 feet above the the zero of the gauge, which is the lowest value of all the five years' observations at this port; it differs by 0·055 foot from the mean of the three preceding years' values, which are very close to one another, and by over one-tenth of a foot from the first year's value.

The main lunar tide (M_2) has a mean amplitude (H) of 1·058, which is the largest yet obtained, but does not differ by more than 0·013 foot from the mean of the preceding four years' values. Its epoch this year is about 2° less than it was last year, and almost the same as that found in 1882-83.

The mean amplitude (H) of the main solar tide (S_2) is also higher than the values hitherto obtained, but only differs by 0·010 foot from the mean value: its epoch, however, is very nearly the same as last year, and the greatest difference in the epochs of this tide during the five years' observations is 5°, or 10 minutes in time.

The proportion of the main solar tide to the main lunar tide is 0·425; it is almost identical with last year's value and only slightly exceeds the mean of all the values previously obtained.

The luni-solar semi-diurnal tide (K_2) has a proportion of 8 per cent. of the main tide, theoretically it should be 13 per cent., last year it was 11 per cent.

The two lunar elliptic tides (N_2 and L_2) are 25 and 3 per cent. of the main tide respectively, proportions which accord fairly well with those hitherto found; the former is 6

per cent. more than the theoretical proportion, and the latter corresponds with the theoretical proportion.

The larger evectional tide (ν_2) is this year 14 per cent. of the main tide, which is almost double the proportion obtained last year, and four times the theoretical proportion.

The value of the smaller evectional tide (λ_2) is 7 per cent. of the main tide, the largest proportion yet obtained, and about 10 times the theoretical proportion.

The lunar elliptic tide of the second order ($2N_2$) is about double what theory assigns, and slightly larger than it was found to be last year.

The values of the two solar elliptical tides (T_2 and R_2), which are only evaluated every alternate year, have not been determined this year.

The variational semi-diurnal tide (μ_2) is 6 per cent. of the main tide, and about 2½ times its theoretical value; hitherto the proportions have been from 3 to 5 per cent.

The main diurnal tide (K_1) is 28 per cent. of the main tide, which has always been found to be the case at this port; theoretically it should be 58 per cent.

The lunar declinational tide (O_1) and the solar declinational tide (P_1) are each about 10 per cent. of the main tide, proportions very similar to those previously found; theoretically they should be 42 and 19 per cent.

The solar elliptic diurnal tide (Q_1) and the lunar elliptic tide (J_1) also agree in their proportions to the main tide with those previously obtained.

The lunar diurnal tide (M_1) is 0·036 of the main tide, which is the theoretical proportion, hitherto the proportions have ranged from 0·001 to 0·018.

The solar diurnal tide (S_1) has a proportion of 0·053, last year and in 1881-82 it was just half of this amount, while in 1882-83 it was 0·011, and in 1880-81, 0·035 of the main tide.

The overtides at Madras as usual are insignificant, the value of (M_4) has, however, gone up to 0·018, whereas formerly it ranged from 0·001 to 0·005.

Of the compound tides, the quarter diurnal tide $(M_2N)_4$ is the largest this year, it is 0·096 of the main tide, while last year it was 0·039, which latter is as nearly as possible the theoretical proportion.

With regard to the long period tides, the lunar monthly and the lunar fortnightly are each 0·016 and 0·019 of the main tide, which are the smallest values yet obtained at Madras; theoretically they should be 0·045 and 0·086.

The value of the luni-solar fortnightly tide agrees well with the values of the three previous years, and is considerably over the theoretical value.

The solar annual is 0·346 of the main tide, last year it was just half of the main tide, and the mean of the first three years is a close approximation to this year's value. The epoch of this tide is 215,° which would make its time of maximum about 19 days earlier than it was last year.

The solar semi-annual is 0·342 of the main tide, last year it was 29 per cent. and in the three previous years it was 25 to 36 per cent. of the main tide, while theoretically it is insignificant. The epoch of this tide is this year 137°·4, and the times of maxima are about the 25th May and 25th November.

VALUES OF THE TIDAL CONSTANTS, VIZAGAPATAM, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Vizagapatam; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations:—

Short Period Tides.

A_0 = 4·630 feet.

S_1	H = R =	0·044	M_6	R =	0·007	Q_1	R =	0·012	T_2	R =	0·036
	$\kappa = \zeta$ =	93°·63		ζ =	182° 64		ζ =	349°·56		ζ =	314°·09
S_2	H = R =	0·625		H =	0·007		H =	0·014		H =	0·036
	$\kappa = \zeta$ =	288°·28		κ =	6°·47		κ =	337° 74		κ =	282°·19
S_4	H = R =	0·003	M_8	R =	0·005	L_2	R =	0·091	$(MS)_4$	R =	0·008
	$\kappa = \zeta$ =	45°·00		ζ =	155°·90		ζ =	254°·27		ζ =	82°·09
S_6	H = R =	0·001		H =	0·004		H =	0·078		H =	0·007
	$\kappa = \zeta$ =	113°·96		κ =	241°·00		κ =	256°·26		κ =	283°·37
S_8	H = R =	0·000	O_1	R =	0·105	N_2	R =	0·309	$(2SM)_2$	R =	0·013
	$\kappa = \zeta$ =	288°·44		ζ =	359°·67		ζ =	36°·01		ζ =	60° 95
				H =	0·129		H =	0·298		H =	0·012
				κ =	333°·33		ζ =	251°·80		κ =	219°·67
M_1	R =	0·015	K_1	R =	0·318	λ_2	R =	0·041	$2N_2$	R =	0·058
	ζ =	41°·26		ζ =	116°·62		ζ =	104°·21		ζ =	347°·99
	H =	0·016		H =	0·358		H =	0·039		H =	0·056
	κ =	288°·96		κ =	342°·51		κ =	299°·35		κ =	218°·29

Short Period Tides—contd.

A_0=4 ,630 e'j

M_2	R =	1·514	K_2	R =	0·124	ν_2	R =	0·098	$(M_2N)_4$	R =	0·032
	ζ =	54°·51		ζ =	8° 00		ζ =	195°·40		ζ =	1°·48
	H =	1·402		H =	0·163		H =	0·095		H =	0·030
	κ =	255°·78		κ =	279°·20		κ =	222°·81		κ =	58°·55
M_3	R =	0·010	P_1	R =	0·109	μ_2	R =	0·039	$(M_2K_1)_3$	R =	0·020
	ζ =	259° 64		ζ =	2ω8° 34		ζ =	221°·83		ζ =	317°·95
	H =	0·009		H =	0·109		H =	0·036		H =	0·022
	κ =	21°·56		κ =	345°·49		κ =	264°·38		κ =	25°·11
M_4	R =	0·004	J_1	R =	0·020	R_2	R =	0·025	$(2M_2K_1)_3$	R =	0·014
	ζ =	184°·19		ζ =	164°·92		ζ =	216°·78		ζ =	149°·84
	H =	0·004		H =	0·024		H =	0·025		H =	0·015
	κ =	226°·74		κ =	18°·02		κ =	68°·68		κ =	326°·50

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·011	21°·52	0·010	7°·00
„ Fortnightly „ . . .	0·047	318·02	0·073	31·98
Luni-Solar „ „ . . .	0·020	240·77	0·019	39·49
Solar-Annual „ . . .	0·694	229·62	0·694	182·48
„ Semi-Annual „ . . .	0·350	222·93	0·350	128·64

The value of the mean level of the sea (A_0) is 4·63 feet above the zero of the gauge, or about 0·18 foot lower than it was in the three preceding years and double this amount lower than the 1879-80 value.

The mean amplitude (H) of the main lunar tide (M_2) is practically the same as that determined last year; the epoch, too, agrees very well with previous values.

The main solar tide (S_2) has an amplitude of 0·625 foot, which is the lowest value obtained, but it does not differ by more than 0·049 foot from the value obtained in 1879-80, which is the highest: its epoch is very accordant with former values.

The main solar tide (S_2) has a proportion of 0·427 of the main tide, the lowest yet obtained, but it does not differ by more than 0·018 from the mean of the other five years, and 0·038 from the theoretical proportion, which is 0·465.

The luni-solar semi-diurnal tide (K_2) is 11 per cent. of the main tide, which agrees very closely with the proportions of all the other years, with the exception of that for 1882-83, when it was 21 per cent. of the main tide; theoretically it should be 13 per cent.

Of the two lunar elliptic tides (N_2) the larger is 20 per cent. of the main tide, which agrees with the theoretical proportion fairly well, and also with the proportions previously determined: the smaller component (L_2) is this year just 5 per cent. of the main tide, and about double the theoretical value, 0·028; the former values vary between 0·019 and 0·061.

The larger evectional tide (ν_2) is 0·065 of the main tide, last year it was 1 per cent. greater, theoretically it should be 0·038 of the main tide; in 1881-82 it was quite insignificant, while the following year it was as much as 0·088 of the main tide. The smaller evectional tide (λ_2) is 0·027 of the main tide—just four times its theoretical value; last year it was slightly more than the theoretical proportion, and in the four years preceding it, it was double what it should be.

The lunar elliptic tide of the second order ($2N_2$) is 0·038 of the main tide, or about 1 per cent. more than the theoretical proportion, which was obtained last year.

The solar elliptic tides (T_2 and R_2) have been evaluated this year. (T_2) is 0·025 of the main tide, which is the theoretical proportion, the two former values were 0·056 and 0·014; the mean of the 3 values, however, is very close to the theoretical value: the tide (R_2) is 0·017 of the main tide, and this agrees fairly well with the other two values, 0·027 and 0·010.

The variational tide (μ_2) is this year slightly more than the theoretical proportion; and the whole of the proportions agree very well with one another.

The proportion of all the diurnal tides are very nearly the same as those found last year, and are all smaller than the theoretical proportions, which is the case in the whole of the six years' observations at this port.

The epochs of three of the diurnal tides (M_1, Q_1 and J_1) differ rather largely from the previous year's value, but those of the remaining four (K_1, O_1, P_1 and S_1) are fairly accordant.

The lunar and solar diurnal overtides are as usual all very small, and call for no special remark, which is also the case with the compound tides.

Regarding the long period tides, the lunar monthly tide is quite insignificant this year; during the other years of observations it ranged from a little over 1 per cent. to 5 per cent. of the main tide, the theoretical proportion being 0·046.

The lunar fortnightly tide is 5 per cent. of the main tide, and agrees with last year's value, the theoretical proportion is 0·086, but in the first four years the proportions were much smaller.

The luni-solar fortnightly tide is 0·013 of the main tide, a little more than the value obtained last year, but almost identical with that of 1880-81, theoretically it should be 0·007; in the first year of observation it was 5 per cent. of the main tide.

The solar-annual tide is 0·475 of the main tide, which corresponds with the mean of the other five years' values: the greatest difference in the epochs of this tide is about 21°.

The solar semi-annual tide has very nearly the same proportion to the main tide as was found last year, *viz.*, 24 per cent.; theoretically it should be only 4 per cent., but the values of this tide have never approached the theoretical, but ranged from 17 to 31 per cent.

Its epoch this year agrees with last year's and with that obtained in 1880-81 very closely; and its times of maxima appear to be about the 20th May and 20th November.

VALUES OF THE TIDAL CONSTANTS, FALSE POINT, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at False Point; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations:—

Short Period Tides.

A = $_0$7·492 feet.

S_1	H=	0·008	M_6	R=	0·004	Q_1	R=	0·004	T_2	R=	0·099
	κ=	86°·42		ζ=	214°·88		ζ=	339°·78		ζ=	38°·62
S_2	H=	1·000		H=	0·004		H=	0·005		H=	0·099
	κ=	298°·22		κ=	142°·18		κ=	187°·36		κ=	280°·00
S_4	H=	0·006	M_8	R=	0·005	L_2	R=	0·112	$(MS)_4$	R=	0·041
	κ=	306°·67		ζ=	77°·01		ζ=	197°·82		ζ=	44°·90
S_6	H=	0·005		H=	0·004		H=	0·095		H=	0·039
	κ=	158°·20		κ=	220°·08		κ=	286°·15		κ=	260°·66
S_8	H=	0·005	O_1	R=	0·140	N_2	R=	0·455	$(2SM)_2$	R=	0·029
	κ=	181°·10		ζ=	71°·03		ζ=	97°·68		ζ=	68°·50
				H=	0·172		H=	0·439		H=	0·028
				κ=	333°·70		κ=	258°·37		κ=	212°·73
M_1	R=	0·008	K_1	R=	0·359	λ_2	R=	0·069	$2N_2$	R=	0·052
	ζ=	317°·05		ζ=	29°·49		ζ=	146°·71		ζ=	134°·61
	H=	0·009		H=	0·406		H=	0·066		H=	0·050
	κ=	226°·80		κ=	341°·23		κ=	272°·09		κ=	240°·22
M_2	R=	2·320	K_2	R=	0·220	ν_2	R=	0·141	$(M_2N)_4$	R=	0·051
	ζ=	51°·29		ζ=	212°·16		ζ=	174°·43		ζ—	10°·38
	H=	2·237		H=	0·292		H=	0·136		H—	0·047
	κ=	267°·05		κ=	295°·23		κ=	300°·58		κ—	26°·84
M_3	R=	0·017	P_1	R=	0·132	μ_2	R=	0·046	$(M_2K_1)_3$	R—	0·014
	ζ=	243°·44		ζ=	293°·66		ζ=	180°·89		ζ—	59°·32
	H=	0·016		H=	0·132		H=	0·042		H—	0·015
	κ=	27°·09		κ=	344°·08		κ=	152°·43		κ—	226°·83
M_4	R=	0·031	J_1	R=	0·017	R_2	R=	0·014	$(_2M_2K_1)_3$	R—	0·009
	ζ=	161°·50		ζ=	351°·28		ζ=	345°·04		ζ—	240°·82
	H=	0·029		H=	0·020		H=	0·014		H—	0·010
	κ=	233°·04		κ=	359°·46		κ=	283°·66		κ—	0°·61

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·016	347°·83	0·014	42°·90
„ Fortnightly „	0·063	161·98	0·099	32·42
Luni-Solar „ „	0·015	97·87	0·014	242·10
Solar-Annual „	0·888	122·07	0·888	161·65
„ Semi-Annual „	0·260	78·73	0·260	157·89

The mean level of the sea (A_0) is found to be 7·492 feet above the zero of the gauge, which is exactly one-tenth of a foot lower than last year, and 0·067 foot lower than the mean value obtained from the whole four years' observations.

The mean amplitude (H) of the main lunar tide (M_2) is 2·237 feet, it is the lowest value obtained, but does not differ by more than 0·03 of a foot from last year's value, and is only 0·014 foot less than the mean of all the amplitudes. The epochs are very accordant, the greatest difference being about 4°, or 8 minutes in time.

The mean amplitude (H) of the main solar, tide (S_2) is very accordant with all the previous values; its epoch, too, is well determined there being only a difference of about 6° between the largest and smallest values, or about 12 minutes in time.

The proportion of the main solar tide to the main lunar tide is 0·447, which is precisely the same as the 1881-82 value, and also the mean of the other two years' values; the theoretical proportion is slightly greater, being 0·465.

The luni-solar semi-diurnal tide (K_2) is again 13 per cent. of the main tide, which is also the theoretical proportion. The epoch of this tide agrees with the first two, but is about 12° less than last year's.

The two lunar elliptic tides (N_2 and L_2) are 1 per. cent. greater than last year, but the former has a proportion equal to the theoretical, and the latter a somewhat greater proportion.

The evectional tide (ν_2) has a proportion of 0·061, which is close to the mean of the first two years' results, last year it was 0·016, and the theoretical proportion is 0·038.

The other evectional tide (λ_2) is 0·030 of the main tide, last year it was 0·008, which is nearly the theoretical proportion, and in the two first years the proportions were 0·020 and 0·036.

The lunar elliptic tide of the second order ($2N_2$) has a proportion very similar to that of last year's, and also agrees very well with the theoretical proportion.

The two solar elliptic tides (T_2 and R_2) are respectively 0·044 and 0·006 of the main tide, the former is about five times as large as it was in 1882-83, and one and a half times the theoretical proportion, but the latter is fairly accordant with the value determined in 1882-83.

The variational tide (μ_2) is 0·019 of the main tide, and is a closer approach to the theoretical value than any of the other three years' results, which were 0·030, 0·036 and 0·031.

Of the diurnal tide, it may be said that the proportions of all agree with those previously obtained, and are all less than the theoretical proportions, and it may also be remarked that the proportions of the three principal tides (K_1, O_1 and P_1) to the main tide are smaller than they are either at Madras or Vizagapatam. The epochs of three of the diurnal tides (O_1, K_1 and P_1) are all very accordant, but those of (S_1, J_1 and M_1) have not been well determined, while that of the remaining tide (Q_1) were for the first three years 306°, 340° and 31 :°, and this year the epoch is only 187°.

The overtides are all insignificant as usual, the largest of them is (M_4) and this is only a little more than 1 per cent. of the main tide; the several values of its epoch are very near one another, the greatest difference being 12°, or about 12 minutes in time.

The compound tides agree very well with previous values, but do not call for further remark.

With regard to the long-period tides, the lunar monthly is this year very small, it being only 0·006 of the main tide, the other three values of this tide ranged from 0·020 to 0·032, its theoretical value being over 0·045.

The lunar fortnightly tide is this year 0·044 of the main tide, or about half of what it should be, the other values of this tide were even smaller.

The luni-solar fortnightly tide is insignificant this year, which it ought to be; in former years it was about 2 per cent. of the main tide.

The solar annual tide is 0·397 of the main tide, or about 2 per cent. higher than the mean of the two preceding years' values and about 6 per cent. more than the first year's value. The greatest discrepancy in its epoch is 10° and its time of maximum is about the 3rd September.

The solar semi-annual tide is again 12 per cent. of the main tide, the two first values were 9 and 16 per cent., while by theory it should be only 4 per cent. of the main tide: its epoch is this year 158°, or about 4° more than last year, the largest difference, however, between the epochs is only about 16°, and its times of maxima may be said to be about the 4th June and 4th December.

VALUES OF THE TIDAL CONSTANTS, DUBLAT, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Dublat; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations:—

Short Period Tides.

A_0=14·379 feet.

S_1	H =	R =	0·047	M_6	R =	0·014	Q_1	R =	0·010	T_2	R =	0·175
	κ =	ζ =	124°·40		ζ =	299°·14		ζ =	118°·89		ζ =	170°·45
S_2	H =	R =	2·071		H =	0·013		H =	0·012		H =	0·175
	κ =	ζ =	326°·36		κ =	165°·08		κ =	312°·40		κ =	60°·70
S_4	H =	R =	0·015	M_8	R =	0·007	L_2	R =	0·200	$(MS)_4$	R =	0·076
	κ =	ζ =	255°·12		ζ =	0°·99		ζ =	109°·64		ζ =	101°·88
S_6	H =	R =	0·001		H =	0·006		H =	0·170		H =	0·074
	κ =	ζ =	59°·04		κ =	302°·24		κ =	299°·65		κ =	177°·20
S_8	H =	R =	0·002	O_1	R =	0·148	N_2	R =	0·907	$(2SM)_2$	R =	0·060
	κ =	ζ =	58°·39		ζ =	212°·05		ζ =	144°·80		ζ =	273°·40
					H =	0·183		H =	0·875		H =	0·058
					κ =	343°·00		κ =	282°·67		κ =	198°·08
M_1	R =		0·020	K_1	R =	0·434	λ_2	R =	0·065	$2N_2$	R =	0·208
	ζ =		246°·62		ζ =	47°·31		ζ =	33°·81		ζ =	52°·22
	H =		0·024		H =	0·490		H =	0·063		H =	0·200
	κ =		264°·52		κ =	350°·29		κ =	276°·85		κ =	252°·65
M_2	R =		4·796	K_2	R =	0·478	ν_2	R =	0·287	$(M_2N)_4$	R =	0·054
	ζ =		215°·06		ζ =	267°·24		ζ =	215°·08		ζ =	216°·96
	H =		4·626		H =	0·634		H =	0·276		H =	0·050
	κ =		290°·38		κ =	332°·77		κ =	302°·68		κ =	70°·14
M_3	R =		0·051	P_1	R =	0·156	μ_2	R =	0·115	$(M_2K_1)_3$	R =	0·048
	ζ =		19°·64		ζ =	290°·82		ζ =	204°·49		ζ =	123°·29
	H =		0·048		H =	0·156		H =	0·107		H =	0·053
	κ =		132°·61		κ =	350°·11		κ =	355°·12		κ =	141°·58
M_4	R =		0·093	J_1	R =	0·044	R_2	R =	0·095	$(2M_2K_1)_3$	R =	0·047
	ζ =		358° 31		ζ =	120°·25		ζ =	16°·94		ζ =	276° 63
	H =		0·086		H =	0·053		H =	0·095		H =	0·050
	κ =		148°·94		κ =	2°·05		κ =	306°·69		κ =	124°·28

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·030	105°·72	0·027	43°·17
„ Fortnightly „ . . .	0·055	41·07	0·086	34·48
Luni-Solar „ „	0·028	309·16	0·027	233·84
Solar-Annual „	0·930	114·80	0·930	145·51
„ Semi-Annual „	0·211	100·50	0·211	161·91

The value of the mean level of the sea (A_0) is 14·379 feet above the zero of the gauge, which is about the same as the value obtained in 1881-82; the mean value of the mean sea-level from the four years' observations is 14·422 feet

The mean amplitude (H) of the main lunar tide (M_2) is 4·626 feet and corresponds with that determined from the first year's observations, this value is only 0·03 foot higher than the mean of the other two years, which is 4·595 feet. The epochs are all very accordant, the greatest difference being less than 1°, or about 1½ minutes in time.

The mean amplitude (H) of the main solar tide (S_2) is 2·071 foot, which agrees fairly well with the value derived in 1881-82, but it is about 0·08 foot less than the mean of the other two years' results. The epochs of this tide also are all very accordant, there being no greater difference than 2½°, or 5 minutes in time.

The proportion of the main solar to the main lunar tide is 0·448. or very nearly the same as in 1881-82; the mean proportion from the four years' observations is 0·458, which is very close to the theoretical value, 0·465.

The luni-solar semi-diurnal tide (K_2) is about 1 per cent. more than the theoretical proportion, but the last three years' values are very close to one another and the first year's value agreed with theory. The epochs of this tide vary between 310° and 333°.

The results of the two lunar elliptic tides (N_2 and L_2) vary but little from those of last year, the former is just about the theoretical proportion to the main tide and was so in the two preceding years, but in the first year of observation it was about 3 per cent. greater, while the latter tide is this year 1 per cent. greater than the theoretical propor-

tion to the main tide, but agrees with the proportions found during the two first years. The epochs of these tides agree very well.

The larger evectional tide (ν_2) has double the proportion to the main tide that it had last year, *viz.*, 0·060, but it agrees with the first year's value, while for the other two years very nearly the theoretical proportion was obtained.

The smaller evectional tide (λ_2) is just double the theoretical proportion and accords with the proportion obtained last year, but in the other two years the proportions were much higher, *viz.*, in 1882-83, 0·030, which is about 5 times the theoretical value, and in 1881-82, 0·064, or 10 times as large as it should be.

The epochs of these two tides are very variable.

The lunar elliptic tide of the second order ($2N_2$) is twice as large as it was found to be last year, and nearly double the theoretical proportion, 0·026.

The solar elliptic tides (T_2 and R_2) have been deduced this year, the former is nearly 4 per cent. of the main tide, or about 1 per cent. greater than it should be by theory; the latter tide is just about half of the value found in 1882-83.

The variational semi-diurnal tide (μ_2) agrees with the theoretical value and with what was obtained in 1882-83, in 1881-82 the proportion was about double what it ought to have been, and in 1883-84 it was too great by about a half.

The proportion of all the diurnal tides to the main tide throughout the four years' observations at this place, are very accordant; those of the three principal ones (K_1, O_1 and P_1) are respectively 11, 4 and 3 per cent., while theoretically they should be 58, 42 and 19 per cent., and their epochs are well determined.

The overtides are all as usual unimportant, and the same may be said of the compound tides.

The long period tides, as is usual, at Dublat, have been found to be small. The three lunar tides (Mm, Mf, and Msf) are respectively 1, 2 and 1 per cent. of the main tide, while theoretically they should be 5, 9 and 1 per cent.

The solar annual tide is 20 per cent., and the solar semi-annual 5 per cent. of the main tide: the last-mentioned agrees very well with theory. The epoch of the solar annual tide has been fairly well determined, and the time of maximum varies between the 13th and 22nd August. The epoch of the semi-annual is not so well determined, the times of maxima being between the 15th May and 10th June and 15th November and 10th December.

VALUES OF THE TIDAL CONSTANTS, KIDDERPORE, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Kidderpore; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations:—

Short Period Tides.

A_0=10·669 feet.

S_1	H=		M_6	R=	0·174	Q_1	R=	0·028	T_2	R=	0·175
	R=	0·082		ζ=	351°·73		ζ=	45°·74		ζ=	263°·54
	κ=	200°·48		H=	0·156		H=	0·034		H=	0·175
S_2	H=			κ=	325°·37		κ=	350°·28		κ=	184°·34
	R=	1·462	M_8	R=	0·077	L_2	R=	0·178	$(MS)_4$	R=	0·647
	ζ=	103°·66		ζ=	188°·60		ζ=	242°·53		ζ=	333°·71
S_4	H=			H=	0·067		H=	0·151		H=	0·625
	R=	0·080		κ=	273°·46		κ=	62°·61		κ=	84°·92
	ζ=	118°·10	O_1	R=	0·171	N_2	R=	0·686	$(2SM)_2$	R=	0·069
S_6	H=			ζ=	186°·33		ζ=	186°·20		ζ=	123°·85
	R=	0·001		H=	0·210		H=	0·662		H=	0 066
	ζ=	194°·04		κ=	23°·30		κ=	44°·99		κ=	12°·64
S_8	H=	R =	K_1	R=	0·353	λ_2	R=	0·057	$2N_2$	R=	0·131
	κ=	ζ= 0·007		ζ=	142°·26		ζ=	144°·81		ζ=	67°·99
		235°·01		H=	0·398		H=	0·055		H=	0·127
M_1	R=	0·045		κ=	55°·02		κ=	72°·92		κ=	34°·36
	ζ=	229°·85	K_2	R=	0·369	ν_2	R=	0·330	$(M_2N)_4$	R=	0·113
	H=	0·052		ζ=	93°·10		ζ=	290°·12		ζ=	257°·60
	κ=	260°·29		H=	0·489		H=	0·318		H=	0·105
M_2	R=	3·808		κ=	98°·13		κ=	44°·43		κ=	227°·61
	ζ=	308°·65	P_1	R=	0·153	μ_2	R=	0·237	$(M_2K_1)_3$	R=	0·078
	H=	3·674		=	321°·18		ζ=	320°·22		ζ=	36°·98
	κ=	59°·87		H=	0·153		H=	0·270		H=	0·085
M_3	R=	0·046		κ=	51°·03		κ=	182°·65		κ=	60°·96
	ζ=	177°·16	J_1	R=	0·026	R_2	R=	0·123	$(2M_2K_1)_3$	R=	0·031
	H=	0·043		ζ=	243°·44		ζ=	180°·14		ζ=	14°·83
	κ=	343°·98		H=	0·031		H=	0·123		H=	0·032
M_4	R=	0·783		κ=	50°·10		κ=	79°·34		κ=	324°·49
	ζ=	177°·91									
	H=	0·729									
	κ=	40°·34									

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·325	119°·83	0·288	12°·25
„ Fortnightly „	0·152	156·43	0·238	53·71
Luni-Solar „ „	0·864	154·16	0·834	42·95
Solar-Annual „	2·361	161·75	2·361	161·90
„ Semi-Annual „	0·651	352·91	0·651	353·22

The mean level of the river at Kidderpore (A_0) is 10·669 feet above the zero of the gauge, which zero corresponds to the level of the sill of the Kidderpore Dock, the value is 0·07 foot higher than last year and 0·013 foot less than the mean of the values determined up to date.

The main lunar tide (M_2) has an amplitude of 3·674 feet, which very nearly corresponds with the 1882-83 value, but it is 0·028 foot greater than last year's value, and in the first year of observation the value of the amplitude was 3·593 feet. Its epoch is 2° more than in the two preceding years and 1°·3 more than the first year's value.

The main solar tide (S_2) is 1·462 in amplitude, or about 0·05 foot lower than in the two years immediately preceding and 0·04 foot greater than the first year's value. The epoch agrees very well with last year's and is only 3° different from that of 1882-83, which has the lowest value.

The proportion between these two tides is precisely the same as in 1881-82, *viz.*, 0·398, while in 1882-83 and 1883-84 it was slightly higher, the theoretical proportion being 0·065.

The luni-solar semi-diurnal tide (K_2) is a little over 13 per cent. of the main tide, and agrees very closely with the preceding year's proportion; the value of the other two years' observations were about 12 per cent., the theoretical proportion being 12½ per cent. Its epoch is fairly well determined, the greatest difference in any two years' observations being less than 13°.

The lunar elliptic tides (N_2 and L_2) correspond very well in their proportions to the main tide with the values previously obtained and approach the theoretical proportion, the epoch of the larger tide (N_2) has been well determined, but that of (L_2) varies about 27°.

Of the two evectional tides (ν_2 and λ_2), the former is 9 per cent. of the main tide and agrees with the first year's value, but is double that of the other two years', when the theoretical proportion was approached; the latter tide has a proportion of 0·015 of the main tide, which is just about double what it should be by theory, while in the other three years the proportions were much higher. The values of the epochs of these two tides are very irregular.

The lunar elliptic tide of the second order ($2N_2$) has a proportion similar to that obtained last year and is slightly larger than it should be.

The two solar elliptic tides (T_2 and R_2) are 0·048 and 0·033 of the main tide, values not very different from those obtained before.

The proportion of the variational tide (μ_2) to the main tide is 0·060, which was the value first obtained in 1881-82, and is 2 and 1 per cent. respectively less than in the two years immediately preceding.

With regard to the diurnal tides, the luni-solar (K_1) this year is 11 per cent. of the main tide, and so are all the other values. The lunar declinational tide (O_1) is 6 per cent. and the solar declinational (P_1) 4 per cent. of the main tide, which values have always been found. The values of the epochs of these three tides are very accordant. The other diurnal tides are all very small as usual. The proportions of all the diurnal tides to the main tide are very much smaller than they ought to be by theory, but this is noticeable in all the Hooghly ports.

The lunar (M_4) is the most important overtide, its proportion to the main tide is 20 per cent. and this value has always been obtained; the remaining overtides all agree in their proportions to the main tide with those hitherto found.

The proportions of the compound tides are all almost identical with those obtained in the preceding year.

The lunar monthly tide is 8 per cent. of the main tide again this year and is very nearly double of what it should be; of the four values now obtained, that of 1882-83 only approaches the theoretical proportion.

The lunar fortnightly tide is 0·065 of the main tide, the lowest value yet found; in the other three years the values were near the theoretical proportion, 0·086. The luni-solar fortnightly tide is 23 per cent. of the main tide, while by theory it is insignificant, but the proportion has always been found high at Kidderpore.

The solar annual tide bears very nearly the same proportion to the main tide as it did last year, and is about 10 per cent. less than the values of the other two years.

The solar semi-annual tide is this year only 18 per cent. of the main tide, while in the two preceding years it was over 19 per cent., and in the first year it was 26 per cent.; the theoretical value of this tide is only 4 per cent. of the main tide.

The epochs of the lunar monthly tide are very irregular, those of the lunar fortnightly show a difference of 18°, but those of the luni-solar fortnightly are more accordant, the greatest difference being about 12°.

The epoch of the solar annual is 12° greater than last year and about 4° greater than the values of 1881-82 and 1882-83. The time of maximum appears to be between the 17th and 29th August

The values of the epoch of the solar semi-annual are very discordant.

VALUES OF THE TIDAL CONSTANTS, ELEPHANT POINT, 1884.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884 observations at Elephant Point; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884 observations:—

Short Period Tides.

$A_0 = 16{\cdot}314$ feet.

S_1	H =	0·140	M_6	R	0·280	Q_1	R	0·035	T_2	R =	...
	κ = ζ =	91°·02		ζ	198°·23		ζ	205°·68		ζ =	...
S_2	H = R =	2·384		H	0·252		H	0·043		H =	...
	κ = ζ =	139°·57		κ	338°·65		κ	23°·11		κ =	...
S_4	H = R =	0·092	M_8	R	0·123	L_2	R	0·508	$(MS)_4$	R =	0·322
	κ = ζ =	181°·37		ζ	256°·52		ζ	101°·71		ζ =	194°·91
S_6	H = R =	0·013		H	0·107		H	0·440		H =	0·310
	κ = ζ =	294°·19		κ	323°·75		κ	116°·82		κ =	121°·72
S_8	H = R =	0·009	O_1	R	0·282	N_2	R	0·995	$(2SM)_2$	R =	0·168
	κ = ζ =	307°·49		ζ	274°·29		ζ	77°·30		ζ =	328°·97
				H	0·344		H	0·961		H =	0·163
				κ	5°·59		κ	90°·24		κ =	42°·16
M_1	R =	0·037	K_1	R	0·644	λ_2	R	0·195	$2N_2$	R =	0·291
	ζ =	99°·95		ζ	185°·90		ζ	255°·15		ζ =	348°·37
	H =	0·039		H	0·723		H	0·188		H =	0·281
	κ =	25°·54		κ	19°·52		κ	161°·97		κ =	87°·44
M_2	R =	6·086	K_2	R	0·745	ν_2	R	0·137	$(M_2N)_4$	R =	0·252
	ζ =	175°·07		ζ	273°·86		ζ	300°·72		ζ =	94°·01
	H =	5·876		H	0·980		H	0·132		H =	0·235
	κ =	101°·88		κ	120°·49		κ	67°·51		κ =	33°·75
M_3	R =	0·022	P_1	R	0·162	μ_2	R	0·371	$(M_2K_1)_3$	R =	0·067
	ζ =	124°·95		ζ	208°·15		ζ	59°·72		ζ =	305°·83
	H =	0·021		H	0·162		H	0·346		H =	0·073
	κ =	15°·16		κ	17°·86		κ	273°·33		κ =	66°·26
M_4	R =	0·289	J_1	R	0·024	R_2	R	...	$(2M_2K_1)_3$	R =	0·066
	ζ =	224°·97		ζ	327°·95		ζ	...		ζ =	330°·61
	H =	0·270		H	0·029		H	..		H =	0·069
	κ =	78°·58		κ	77°·32		κ	...		κ =	350°·60

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·135	75°·01	0·120	348°·88
„ Fortnightly „ . . .	0·123	85·66	0·190	9·87
Luni-Solar „ „ . . .	0·234	343·03	0·226	56·23
Solar-Annual „ . . .	0·812	196·92	0·812	117·21
„ Semi-Annual „ . . .	0·134	3·51	0·134	204·09

The mean level of the water (A_0) as determined from this (1884), the first year's observations, is 16·314 feet above the zero of the gauge.

During 1880-81 observations were taken at a site which had to be abandoned, the results obtained at the new site in 1884 will be compared with the old values at the old site in 1880-81.

The mean amplitude (H) of the main lunar tide (M_2) is 5·876 feet, which is almost identical with the value obtained at the old site; its epoch, too, agrees very closely.

The amplitude of the main solar tide (S_2) is 2·384 feet, or 0·05 foot greater than the value obtained at the old site; its epoch is 3½° less. The proportion of the main solar tide to the main lunar tide is 0·406, which is very nearly the same proportion as obtained at the old site, and about 6 per cent. less than what theory would give.

The luni-solar semi-diurnal tide (K_2) is this year 17 per cent. of the main tide, or about 4 per cent. greater than it should be, while in 1880-81 it was only 7 per cent. Its epoch is 29° later.

The large lunar elliptic tide (N_2) is 16 per cent. of the main tide, which is 10 per cent. less than the value at the old site, but is nearer the theoretical proportion, which is 19 per cent.

The smaller lunar elliptic tide (L_2) has a somewhat greater proportion to the main tide than was obtained at the old site, and is about 2½ times as large as it should be.

Of the two evectional tides (ν_2) and (λ_2) the proportions obtained for them are very much less than at the old site, *viz.*, 0·022 and 0·032 of the main tide, against 0·116 and 0·112; their theoretical proportions are 0·038 and 0·007.

The value of the lunar elliptic tide of the second order ($2N_2$) is about 5 per cent. of the main tide and nearly double the theoretical value, while at the old site it is about 9 per cent. of the main tide.

The variational tide (M_3) is 0·06 of the main tide, this proportion is almost identical with the 1880-81 values at the old site, and is a little more than double what it should be by theory.

The proportions of the three principal diurnal tides (K_1, O_1 and P_1) are 12, 6 and 3 per cent. of the main tide respectively; these values are very accordant with those found in 1880-81 at the old site and also with those of the same tides at Amherst, but they are all much smaller than their theoretical values, *viz.*, 58, 42 and 19 per cent. The values of the epochs of (K_1, O_1 and P_1) agree very well with the values obtained at the old site.

The other diurnal tides agree in their proportions to the main tide with the values obtained at the old site.

Regarding the overtides, they all agree fairly well in their proportions to the main tide, with the values at the old site, with the exception of the lunar (M_4) which is 0·046 of the main tide, the other value at the old site is just over 1 per cent., but the value now deduced agrees with the value of this tide at Amherst.

The values of the compound tides are all accordant with the values deduced for them at Amherst.

Regarding the long period tides, the lunar monthly tide is just 2 per cent. of the main tide, and agrees with the 1880-81 value at the old site. The lunar fortnightly is twice as large as it was in 1880-81 at the old site, but is less than half of what it should be theoretically, being 0·032 of the main tide instead of 0·086. The luni-solar fortnightly tide is nearly 4 per cent. of the main tide, in 1880-81 it was 1 per cent., which is as near as possible the theoretical proportion.

The solar annual tide is 14 per cent. of the main tide; in 1880-81, at the old site it was 16 per cent. Its epoch is about a month earlier than in 1880-81, making its time of maximum the 16th July instead of the 15th August.

The solar semi-annual tide is 2 per cent. of the main tide; in 1880-81, at the old site, it was 4 per cent., which is its theoretical proportion. Its epoch is about six days later than in 1880-81 at the old site.

VALUES OF THE TIDAL CONSTANTS, RANGOON, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Rangoon: and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations:—

Short Period Tides.

A_0=14·739 feet.

S_1	H = R =	0·105	M_6	R =	0·251	Q_1	R =	0·029	T_2	R =	...
	κ = ζ =	128°·52		ζ =	17°·32		ζ =	6°·56		ζ =	...
S_2	H = R =	2·021		H =	0·226		H =	0·036		H =	...
	κ = ζ =	171°·70		κ =	88°·72		κ =	38°·76		κ =	...
S_4	H = R =	0·088	M_8	R =	0·102	L_2	R =	0·520	$(MS)_4$	R =	0·400
	κ = ζ =	264°·56		ζ =	124°·01		ζ =	92°·83		ζ =	310°·43
S_6	H = R =	0·011		H =	0·089		H =	0·444		H =	0·386
	κ = ζ =	32°·12		κ =	99°·20		κ =	150°·31		κ =	214°·23
S_8	H = R =	0·007	O_1	R =	0·234	N_2	R =	1·088	$(2SM)_2$	R =	0·160
	κ = ζ =	96°·71		ζ =	21°·39		ζ =	189°·99		ζ =	313°·44
				H =	0·287		H =	1·050		H =	0·154
				κ =	31°·36		κ =	116°·01		κ =	49°·64
M_1	R =	0·028	K_1	R =	0·593	λ_2	R =	0·332	$2N_2$	R =	0·241
	ζ =	128°·34		ζ =	145°·67		ζ =	325°·85		ζ =	126°·11
	H =	0·031		H =	0·668		H =	0·320		H =	0·233
	κ =	51°·58		κ =	37°·90		κ =	168°·65		κ =	74°·36

Short Period Tides—contd.

A_0=14·739 feet.

M_2	R=	5·840	K_2	R=	0·437	ν_2	R=	0·526	$(M_2N)_4$	R=	0·103
	ζ=	228°·30		ζ=	208°·73		ζ=	324°·30		ζ=	201°·36
	H=	5·635		H=	0·578		H=	0·508		H=	0·096
	κ=	132°·10		κ=	172°·65		κ=	109°·09		κ=	31°·18
M_3	R=	0·032	P_1	R=	0·167	μ_2	R=	0·543	$(M_2K_1)_3$	R=	0·091
	ζ=	213°·99		ζ=	304°·13		ζ=	120°·39		ζ=	267°·40
	H=	0·031		H=	0·167		H=	0·506		H=	0·099
	κ=	69°·69		κ=	54°·70		κ=	287°·99		κ=	63°·43
M_4	R=	0·450	J_1	R=	0·032	R_2	R=	...	$(2M_2K_1)_3$	R=	0·110
	ζ=	3°·54		ζ=	218°·33		ζ=	...		ζ=	145°·19
	H=	0·419		H=	0·039		H=	...		H=	0·116
	κ=	171°·13		κ=	89°·93		κ=	...		κ=	60°·56

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·193	26°·85	0·171	4°·62
,, Fortnightly ,, . . .	0·173	325·06	0·270	28·91
Luni-Solar ,, ,, . . .	0·549	315·17	0·530	51·37
Solar-Annual ,, . . .	1·201	166·40	1·201	145·83
,, Semi-Annual ,, . . .	0·071	304·41	0·071	263·27

The mean level of the river (A_0) is 14·739 feet above the zero of the gauge, it is the lowest value obtained and is 0·244 feet less than the mean of the preceding four years' observations.

The mean amplitude (H) of the main lunar tide (M_2) is 5·635 feet and is 0·079 foot higher than the mean of the previous four years' results; its epoch is well established.

The mean amplitude of the main solar tide (S_2) compares well with the 1882-83 value and is about 0·02 foot more than the other three values found. Its epoch also is well established.

The luni-solar semi-diurnal tide (K_2) is again 10 per cent. of the main tide; this value has always been obtained, the theoretical proportion is 3 per cent. greater. Its epoch this year is 172°·6, which is practically the same as it was in 1881-82 and is about 5° more than in the remaining three years of observation.

The larger lunar elliptic tide (N_2) has this year almost the same proportion to the main tide as in 1880-81, and is very slightly less than it should be, in fact, in the whole five years of observation the proportion agrees very well. The smaller lunar elliptic tide (L_2) is this year 8 per cent. of the main tide, which agrees with the previous year's value; in 1882-83 it was 9 per cent. and in the other two years it was about 6 per cent., the theoretical value being about 3 per cent. The epochs of the larger tide (N_2) for the several years are all very similar, while those of the smaller (L_2) show a difference of about 17° between the greatest and least values.

The evectional tide (ν_2) is 9 per cent. of the main tide, which accords well with the first year's proportion, in the other three years it was from 3 to 7 per cent., which is nearer the theoretical value. The proportion of the other evectional tide (λ_2) is nearly 6 per cent. of the main tide, and agrees with the results of the first two years, but in the other two years it was about 3 per cent. The values of the epochs of these two tides are irregular.

The lunar elliptic tide of the second order ($2N_2$) is 0·041 of the main tide, the other value deduced was just about half of this amount, while by theory it should be 0·026 of the main tide.

The variational tide (μ_2) agrees in its proportion to the main tide with the values hitherto determined and is nearly four times as large as it should be.

The values of the three principal diurnal tides (K_1, O_1 and P_1) are very nearly the same for the whole five years of observation, and are respectively 12, 5 and 3 per cent. of the main tide, these are all much smaller than they should be by theory, but they correspond with the values obtained for these tides at Kidderpore, Elephant Point, Amherst and Moulmein. The epochs of these three diurnal tides have been fairly well determined.

The remaining diurnal tides are all as usual insignificant.

There is nothing special to say regarding the several overtides and compound tides, their proportions to the main tide remaining the same as those already found.

The lunar monthly tide is 0·003 of the main tide, or 1½ per cent. less than it should be; this value, however, agrees with that of 1882-83: in 1880-81 and 1883-84 it was about 5

per cent. of the main tide, while in 1881-82 very nearly the theoretical proportion was found.

The lunar fortnightly tide is about 5 per cent. of the main tide: although less than the theoretical proportion, it is the highest yet obtained; but the values in all the five years agree well with one another.

The proportion of the luni-solar fortnightly tide to the main tide agrees very well with former values, although it is about thirteen times greater than the theoretical value.

The solar annual tide is 21 per cent. of the main tide, which is the least value obtained for it at Rangoon, the other values were from 25 to 29 per cent. The epoch of this tide is fairly accordant with former values, its time of maximum being between the 12th and 25th August.

The solar semi-annual tide is a little over 1 per cent. of the main tide: in 1881-82 this tide was very small, and in the other three years of observation it was three per cent. of the main tide, or about 1 per cent. less than it should be theoretically.

The epoch of this tide is very variable.

VALUES OF THE TIDAL CONSTANTS, MOULMEIN, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Moulmein, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations:—

Short Period Tides.

A_0=8·146 feet.

S_1	H = R =	0·114	M_6	R =	0·086	Q_1	R =	0·046	T_2	R =	...
	κ = ζ =	143°·69		ζ =	334°·43		ζ =	52°·73		ζ =	...
S_2	H = R =	1·364		H =	0·077		H =	0·056		H =	...
	κ = ζ =	150°·10		κ =	208°·07		κ =	79°·36		κ =	...
S_4	H = R =	0·071	M_8	R =	0·050	L_2	R =	0·389	$(MS)_4$	R =	0·741
	κ = ζ =	222°·67		ζ =	47°·87		ζ =	236°·56		ζ =	17°·55
S_6	H = R =	0·007		H =	0·043		H =	0·330		H =	0·714
	κ = ζ =	246°·37		κ =	119°·40		κ =	123°·33		κ =	215°·44
S_8	H = R =	0·002	O_1	R =	0·222	N_2	R =	0·643	$(_2SM)_2$	R =	0·160
	κ = ζ =	120°·96		ζ =	157°·06		ζ =	126°·26		ζ =	247°·85
				H =	0·273		H =	0·620		H =	0·155
				κ =	55°·47		κ =	92°·37		κ =	49°·67
M_1	R =	0·017	K_1	R =	0·404	λ_2	R =	0·189	$2N_2$	R =	0·085
	ζ =	43°·28		ζ =	105°·87		ζ =	204°·57		ζ =	50°·44
	H =	0·019		H =	0·456		H =	0·183		H =	0·082
	κ =	121°·57		κ =	43°·96		κ =	153°·28		κ =	144°·78
M_2	R =	4·030	K_2	R =	0·207	ν_2	R =	0·451	$(M_2N)_4$	R =	0·218
	ζ =	275°·77		ζ =	102°·72		ζ =	220°·71		ζ =	231°·76
	H =	3·887		H =	0·275		H =	0·435		H =	0·203
	κ =	113°·66		κ =	158°·46		κ =	127°·76		κ =	35°·75
M_3	R =	0·020	P_1	R =	0·145	μ_2	R =	0·344	$(M_2K_1)_3$	R =	0·148
	ζ =	180°·29		ζ =	348°·34		ζ =	224°·40		ζ =	327°·43
	H =	0·019		H =	0·145		H =	0·320		H =	0·162
	κ =	117°·12		κ =	52°·59		κ =	260°·17		κ =	103°·41
M_4	R =	0·974	J_1	R =	0·013	R_2	R =	...	$(2M_2K_1)_3$	R =	0·094
	ζ =	137°·02		ζ =	251°·70		ζ =	...		ζ =	319°·73
	H =	0·906		H =	0·016		H =	...		H =	0·099
	κ =	172°·78		κ =	62°·95		κ =	...		κ =	57°·40

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide . . .	0·388	133°·31	0·344	5°·08
„ Fortnightly „ . . .	0·138	170·90	0·217	31·98
Luni-Solar „ „ . . .	1·089	240·37	1·050	42·49
Solar-Annual „ . . .	2·032	117·77	2·032	143·52
„ Semi-Annual „ . . .	0·501	216·19	0·501	267·69

The mean level of the river (A_0) at Moulmein as found this year is 8·146 feet above the zero of the gauge, or 0·591 foot lower than in the preceding year; it is also 0·513 foot lower than the values in 1881-82 and 1882-83, and 0·307 foot lower than the other value in 1880-81; it differs from the mean of all the preceding years by nearly half a foot.

The value of the amplitude of the main lunar tide (M_2) is almost exactly the same as in 1880-81, but is 0·162 foot higher than the mean value of the other three years. The epoch of this tide is well established.

The main solar tide (S_2) is 0·019 foot more in amplitude than it was during the preceding three years, and nearly double this amount less than the value found in 1880-81; the greatest difference in the epochs of this tide is about 5°, or 10 minutes in time.[1] The proportion of this tide to the main tide corresponds very closely to those previously obtai ed.

The luni-solar semi-diurnal tide (K_2) is 7 per cent. of the main tide, which is very near the value obtained in 1881-82; the other values are from 8 to 11 per cent., while accordingly to theory it should be 13 per cent. of the main tide.

The two lunar elliptic tides (N_2 and L_2) are respectively 16 and 9 per cent. of the main tide; these values compare very well with previous ones, excepting the value of (L_2) in 1881-82, which is exceptionally large: the theoretical values for (N_2 and L_2) are respectively 19 and 3 per cent. of the main tide.

The proportion of the larger evectional tide (ν_2) to the main tide is much larger than it has ever been hitherto, being 11 per cent.; during the other years it ranged from 5 to 8 per cent., while by theory it is less than 4 per cent. The smaller evectional tide (λ_2) is 5 per cent. of the main tide, the other values are from 3 to 6 per cent., and theoretically it is insign ficant.

The lunar elliptic tide of the second order ($_2N_2$) is as much under its theoretical value, 0·026, as it was over it last year.

The values of the variational tide (μ_2) are very accordant in all the five years, and are about $3\frac{1}{2}$ times greater than the theoretical value.

With regard to the diurnal tides, their values are very consistent throughout the five years' observations; the proportions of the three principal tides (K_1, O_1 and P_1) are 12, 7 and 4 per cent. of the main tide, and agree with those found at Rangoon and Amherst, while theoretically they should be 58, 42 and 19.

Of the overtides, the lunar (M_4) is the most important: it is 23 per cent. of the main tide; in former years the proportion was somewhat greater, but the several values of this tide are very consistent; at Rangoon this tide is only 8 per cent. of the main tide.

The values of the compound tides are very similar to those obtained last year, the greatest difference is in the quarter diurnal, $(M_2\,N)_1$, being about 2 per cent. greater.

Regarding the long period tides, the values deduced for all of them are smaller than last year's. The lunar monthly tide is 9 per cent. of the main tide, which is double the theoretical proportion.

The lunar fortnightly tide is 6 per cent. of the main tide; in former years it ranged from 7 to 10 per cent., but the mean of all the values gives a value nearly corresponding to the theoretical proportion, which is $8\frac{1}{2}$ per cent. of the main tide.

The luni-solar fortnightly tide is 27 per cent. of the main tide; in the other years it was even larger, namely, from 28 to 31 per cent., while by theory this tide is insignificant: only at one other port (Kidderpore) this tide bears such a large proportion to the main tide, where it is about 24 per cent. The values of its epoch are very accordant in the five years' observations which have been deduced.

The solar annual tide is 52 per cent. of the main tide, its other values are from 63 to 68 per cent. Its time of maximum is this year the 12th August, about eight days earlier than last year, but agrees with that of the first year.

The solar semi-annual tide is 13 per cent. of the main tide; the other values are 15 to 18 per cent.; by theory it should be only 4 per cent. of the main tide. The epoch of this tide varies between the 2nd and 19th August.

VALUES OF THE TIDAL CONSTANTS, PORT BLAIR, 1884-85.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1884-85 observations at Port Blair; and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1884-85 observations:—

Short Period Tides.

A_0=4·689 feet.

S_1	H=	R=	0·051	M_6	R=	0·002	Q_1	R=	0·018	T_2	R=	...
	κ=	ζ=	28°·34		ζ=	47°·12		ζ=	305°·50		ζ=	...
S_2	H=	R=	0·963		H=	0·002		H=	0·022		H=	...
	κ=	ζ=	320°·21		κ=	133°·46		κ=	254°·77		κ=	...
S_4	H=	R=	0·004	M_8	R=	0·002	L_2	R=	0·058	$(MS)_4$	R=	0·008
	κ=	ζ=	126°·03		ζ=	188°·75		ζ=	103°·38		ζ=	318°·37
S_6	H=	R=	0·001		H=	0·001		H=	0·049		H=	0·007
	κ=	ζ=	167°·01		κ=	63°·87		κ=	327°·41		κ=	107°·15
S_8	H=	R=	0·000	O_1	R=	0·126	N_2	R=	0·438	$(_2SM)_2$	R=	0·023
	κ=	ζ=	277°·60		ζ=	92°·84		ζ=	22°·97		ζ=	118°·83
					H=	0·155		H=	0·423		H=	0·022
					κ=	300°·18		κ=	273°·67		κ=	330°·05

Short Period Tides—contd.

A_0—4,689 feet.

M_1	R=	0·024	K_1	R=	0·369	λ_2	R=	0·090	$2N_2$	R=	0·097
	ζ=	233°·94		ζ=	30°·15		ζ=	253°·53		ζ=	289°·27
	H=	0·028		H=	0·417		H=	0·087		H=	0·094
	κ=	288°·03		κ=	330°·20		κ=	175°·94		κ=	281°·89
M_2	R=	2·103	K_2	R=	0·135	ν_2	R=	0·186	$(M_2N)_4$	R=	0·113
	ζ=	133°·24		ζ=	218°·93		ζ=	102°·40		ζ=	57°·48
	H=	2·029		H=	0·179		H=	0·179		H=	0·105
	κ=	282°·02		κ=	278°·59		κ=	297°·56		κ=	96°·96
M_3	R=	0·005	P_1	R=	0·176	μ_2	R=	0·130	$(M_2K_1)_3$	R=	0·024
	ζ=	164°·36		ζ=	256°·76		ζ=	342°·57		ζ=	327°·79
	H=	0·005		H=	0·176		H=	0·121		H=	0·026
	κ=	27°·53		κ=	319°·02		κ=	280°·13		κ=	56°·62
M_4	R=	0·018	J_1	R=	0·028	R_2	R=	...	$(2M_2K_1)_3$	R=	0·004
	ζ=	174°·75		ζ=	105°·80		ζ=	...		ζ=	168°·37
	H=	0·017		H=	0·033		H=	...		H=	0·004
	κ=	112°·31		κ=	305°·32		κ=	...		κ=	165°·88

Long Period Tides.

	R	ζ	H	κ
Lunar Monthly Tide	0·001	231°·26	0·001	129°·34
„ Fortnightly „	0·023	117·88	0·036	31·97
Luni-Solar „ „	0·019	166·48	0·018	17·70
Solar-Annual „	0·165	134·74	0·165	162·47
„ Semi-Annual „	0·157	120·78	0·157	176·25

The value of the mean level of the sea (A_0) is 4·689 feet above the zero of the gauge, or 0·03 foot lower than the mean of the three preceding years, and $\frac{1}{10}$th of a foot lower than that derived in 1880-81.

The amplitudes and epochs of the main lunar and solar tides (M_2 and S_2) agree well with the values obtained in former years, and the proportion of the main solar (S_2) to the main lunar (M_2) is just 1 per cent. greater than the theoretical proportion 0·465.

The luni-solar semi-diurnal tide (K_2) is 9 per cent. of the main tide, or 4 per cent. less than it should be; for the other four years of observations, values slightly larger than the theoretical were obtained. The values of the epoch of this tide for the first four years were very consistent, but this year's value differs from the mean of them by 33°, or 1 hour and 6 minutes in time.

The larger lunar elliptic tide (N_2) agrees in its proportion to the main tide, with all the former values, and is very close to the theoretical proportion, while the smaller elliptic tide (L_2) is 0·024 of the main tide, which is only half of the value derived for it last year and in 1881-82; the proportions in the other two years were about the same as they are now, and approach the theoretical value, 0·028.

The two evectional tides (ν_2 and λ_2) are 9 and 4 per cent. of the main tide respectively; the value of the larger tide (ν_2) in the first two years was 7 per cent., in 1882-83 it was nearly the theoretical proportion 0·038, and last year it was only 1 per cent. of the main tide: the values of the smaller tide (λ_2) are more accordant, as they are from 2 to 4 per cent., but by theory this tide is very small.

The lunar elliptic tide of the second order ($_2N_2$) is about twice as large as it should be, last year it was 2 per cent. of the main tide, which is nearly the theoretical proportion.

The variational tide (μ_2) is 6 per cent. of the main tide, the other values are about 4 per cent., and by theory this tide should be about 2½ per cent.

Regarding the diurnal tides, the values obtained for them this year agree with those obtained in the former years. The three important ones are (K_1, O_1 and P_1), and they are 21, 8 and 9 per cent. of the main tide, while their theoretical values are 58, 42 and 19 per cent.; their epochs are well determined.

The overtides as hitherto are all insignificant.

Of the compound tides, the quarter diurnal (M_2 N) calls for remark; it is 5 per cent. of the main tide, while last year it was under 2 per cent. and its theoretical proportion is 4 per cent. of the main tide.

Of the long period tides, the proportions of the lunar monthly, the lunar fortnightly and the luni-solar fortnightly to the main tide, as hitherto, are very small.

The solar annual tide is this year 8 per cent. of the main tide, the four previous values of this tide are 3, 11, 13 and 15 per cent. of the main tide. Its epoch this year is identical with that obtained in 1880-81, but the several values are not consistent, giving a difference of 47°; its time of maximum seems to vary between the 1st August and 16th September.

The solar semi-annual tide agrees exactly in its proportion to the main tide with last year's value, and fairly well with the others, but it is about double the theoretical value. Its epoch also corresponds with that found last year, and its times of maxima remain about the 18th June and 18th December.

Extract from Report by Major W. J. HEAVISIDE, R.E., *Deputy Superintendent, in charge Astronomical Parties Nos. 1 and 2,—dated 13th January 1886.*

The results of the observations given in the table below show northerly attraction of the plumb line at Rámuápur and Jarúra, southerly attraction at the last five stations and scarcely any attraction at Nimkár. The attraction at Rámuápur is very large but tends to bear out General Walker's remark in the Report for 1867-68, that the northerly attraction of the Himalayas is more fully compensated in the western than on the eastern plains. Thus we can refer to four stations nearly in the plains at which astronomical latitudes have been determined and all pretty nearly equally distant from the Himalayas:—

Sháhpur near the meridian of 75° showing no attraction.
Isanpur „ „ 76 „ 3·9″ of northerly attraction.
Kaliána „ „ 78 „ 5·2 „ „
Rámuápur between „ 80 and 81 „ 11·0 „ „

With the exception of an insignificant belt of rather high ground between Rámuápur and Jarúra, the country from Rámuápur to Pavia appears perfectly flat, broken only by an occasional deep and wide river bed, though the eye in search of visible causes for a deflection of the plumb line is occasionally led astray by a mound which generally turns out to be an old brick kiln, and under these circumstances the southerly attraction shewn at Etora, Dewarsán and Kánákhera is unaccounted for. Pavia is on a small isolated rocky hill, but the Latitude station was in the plain due west of the hill. There are, however, large masses of hill, ranging from 1,100 to 1,300 feet in height, about 30 miles to the south. Potenda is on a high wide ridge with considerable masses of hill, about 10 miles distant from the station, both to the north and south with an apparent preponderance of matter to the south. The results exhibited in the Table may, I venture to think, be considered good. The probable errors are small for a first season's work, and the (N—S) equation no larger than was anticipated. But when the results come to be sifted, some unpleasant features are revealed. The dislevelment of the instrument as shewn by the two levels, is subject to large discrepancies similar to those noticed by Major-General Campbell in his Report for 1871-72, which, he considered, were due to the effects of changes of temperature on the cradle carrying the levels. Colonel Herschel in his Report for 1870-71 refers to instability evidenced by the different indications of the level, and in the manuscript Volume for 1871-72 refers to abrupt changes in the instrumental adjustments, such as I have also met with, and he estimates these at $\frac{3}{10}$ths of a second. With a view to obtain some guide to the magnitude of these discrepancies as affecting the final results from my observations, I have had results deduced for each station, using only one level, and find that the effect on the resulting latitude is to make the final results at Rámuápur and Jarúra, respectively, 0·16″ and 0·24″ in defect of the results obtained by using the two levels. At the other stations the effect is small, not larger than is to be expected from the probable errors of the results, and I think that the large differences at Rámuápur and at Jarúra may be chiefly due to the use of level No. 3, which is certainly not satisfactory, showing a tendency in the bubble when tested to settle at certain points of its curve. Moreover, the temperatures at Rámuápur and at Jarúra were considerably lower than at any other stations, and though attempts were made to obtain scale-values of the levels at these low temperatures, the values obtained were not satisfactory, more especially with level No. 3, owing perhaps to the want of proper appliances for testing them. I think that scale-values for levels should certainly be obtained at the highest and lowest temperatures at which they are used in observing.

Results of the Latitude Observations taken by Major W. J. HEAVISIDE, R.E., *with Strange's Zenith Sector No. 2, Season 1884-85.*

Station.		North Stars. Number of Stars observed.	North Stars. Number of observations.	North Stars. Mean Zenith Distance.	North Stars. Extreme Zenith Distance.	South Stars. Number of Stars observed.	South Stars. Number of observation.	South Stars. Mean Zenith Distance.	South Stars. Extreme Zenith Distance.	Mean Resulting Latitude by North and South Stars combined. λ_o	(N—S).	$(\lambda_o - \lambda_c)$.	Approximate Longitudes.
				° ′	° ′			° ′	° ′	° ′ ″ ″	″	″	° ′
Rámuápur	T. S.	14	78	6 34	12 43	14	79	6 19	13 15	28 22 0·04±0·07	—0·79	—11·00	80 31
Jarúra	T. S.	13	59	6 44	12 53	13	62	6 58	12 39	27 59 50·06±0·07	—1·91	—5·88	80 31
Nimkár	T. S.	14	60	4 17	11 0	14	59	4 4	8 51	27 21 8·06±0·07	—0·52	—0·03	80 32
Etora	T. S.	14	50	4 27	10 4	15	49	4 23	9 57	26 54 22·60±0·07	—0·70	+4·75	80 42
Dewarsán	T. S.	17	55	4 42	12 16	16	57	4 42	9 19	26 15 58·32±0·06	—0·35	+5·43	80 21
Kánákhera	T. S.	16	68	5 43	14 3	16	65	5 26	14 42	25 51 25·82±0·06	—0·05	+4·87	80 28
Pavia	H. S.	18	71	6 4	14 27	17	63	6 17	14 18	25 27 21·01±0·06	—0·11	+3·62	80 47
Potenda	P. S.	15	55	5 50	12 23	16	60	5 39	12 2	24 37 24·56±0·06	—0·09	+1·52	81 0

NOTE.—The column headed (N—S) exhibits the mean difference of latitude between Stars north and south of the Zenith. The column headed $(\lambda_o - \lambda_c)$ exhibits the difference between the observed astronomical latitude λ_o and the geodetic latitude λ_c as computed from the origin of the Triangulation. The negative sign shown northerly, and the positive sign southerly, attraction of the plumb line.

xtract from the Narrative Report of MAJOR G. STRAHAN, R.E., *Deputy Superintendent, in charge No. 2 Astronomical Party, for season 1885-86.*

I reached Agra on my return from furlough on the 6th November 1885, and proceeded at once to take over charge of No. 2 Astronomical Party from Major Heaviside.

The transit instruments belonging to the two Astronomical Parties had been sent out from England a short time before my arrival in Agra, at which place they had been set up for the purpose of examining the repairs and improvements that had been made under my superintendence in England, and also for the purpose of instructing Lieutenant Burrard in the method of determining electro-telegraphic differences of longitude, as it had been decided that he should succeed Major Heaviside in charge of No. 1 Party when the latter officer proceeded on furlough.

The personal equation between Major Heaviside and myself was measured on the 11th, 12th and 13th November, and all necessary preparations having been made, Major Heaviside and Lieutenant Burrard left Agra on 18th November to proceed to Mooltan; the first arc on the programme of the season being Agra-Mooltan. This was begun on November 23rd, and, owing to the prevalence of favorable weather, was completed in six consecutive nights. The work of the 27th was carried on through the superb display of meteors which occurred on that night.

The next arc to be measured being Deesa-Mooltan, I proceeded at once to the former station, where I arrived on December 4th, but owing to some delays on the Rajputana Railway, my instruments were not ready for beginning the work till December 7th. The old pillars, which had been used by Major Heaviside in 1881, were found in good order and were utilized for the current season. Seven nights were required for this arc, and by December 17th, I had again reached Agra to commence the arc Agra-Amritsar. It had been directed that on one arc of the season there should be an interchange of observers after half the work was finished, their instruments being left standing. The arc Agra-Amritsar was the one selected for this experiment. Accordingly, after four nights had been completed, I proceeded to Amritsar, and Major Heaviside to Agra, in which position four more nights' work was added, he using my telescope, clock and chronograph, and I using his. This was the first arc on which Lieutenant Burrard took an active part in the work, the fourth and eighth nights were both done by him at Amritsar. I measured a personal equation with him at Amritsar on the 30th and 31st December. The arc Amritsar-Mooltan was next on the list. This was begun on January 5th and completed on January 19th, the delay being caused by cloudy weather at Amritsar; all three observers took part in the measurement of this arc: the nights of the 7th, 10th, 16th, and 24th were utilized in determining the personal equation between Major Heaviside and Lieutenant Burrard at Amritsar.

Mooltan-Kurrachee was the next arc undertaken. The latter station was the one at which my apparatus was erected, and of the six nights of observations four were worked by Major Heaviside and two by myself at Kurrachee, Lieutenant Burrard officiating at Mooltan throughout. On February 1st and 2nd, I again measured a personal equation with Major Heaviside, after which he proceeded on furlough and Lieutenant Burrard was left in sole charge of No. 1 Party.

The next arc Peshawar-Mooltan was commenced on February 9th and completed on February 18th with some difficulty, owing to the gradual approach of bad weather. On the succeeding arc Amritsar-Peshawar, the weather was the worst that has ever been experienced since the Longitude work was first begun, and owing to this, and partly also to an attack of dysentery, by which I was prevented from working for more than a week, no less than 26 days were occupied on this one arc.

On the 25th and 26th March, while my equipment was moving to Dehra Dun, I again measured a personal equation with Lieutenant Burrard at Amritsar. Between the 1st and 12th April the arc Dehra Dun-Amritsar was finished, and between 20th and 25th April the last arc of the season, Dehra Dun-Agra, was successfully measured. Lieutenant Burrard then brought his equipment to Dehra, and the observations were taken in the experimental arc; after which the party returned to recess quarters at Mussooree and opened office there on 17th May.

There were but few novelties in the procedure during the season. On the first three arcs, *viz.*, Agra-Mooltan, Deesa-Mooltan, Agra-Amritsar, the telescope at the eastern station had its pivots reversed in the middle of each night's work, *i.e.*, between the 2nd and 3rd groups of stars, and that at the western station at the close of each night's observations. Subsequently, it was decided that the uncertainty of the telescope taking up at once a permanently stable position immediately after reversal more than counterbalanced the advantages aimed at, *viz.*, the systematic variation as far as possible of the circumstances under which the observations were made. This method was therefore abandoned, and on the remaining arcs the telescope at the eastern station was reversed after the 1st, 3rd and 5th nights, and that at the western station after the 2nd, 4th and 6th.

The method known in this department as "observations of transits with local clocks combined by clock comparisons," which had been employed in previous years under the impression that it was a valuable and independent check on that called "observations of transit at both stations with the same clock," was abandoned this season, partly because the check afforded by it is more apparent than real, as instrumental errors are similarly involved in both, and partly because it was considered that the length of programme

necessary for carrying out both methods somewhat overtaxed the observer's endurance, and it is universally admitted among scientific men that bodily or mental fatigue is fatal to accuracy of observation.

There was no novelty in the remaining arcs, and the customary procedure was carried out in all of them. After their completion, the experimental arc alluded to above, was undertaken at Dehra Dun, on which all corrections for collimation and level were made in the usual manner, but the deviation correction was obtained by the use of a meridian mark fixed on the Mussooree hills for this purpose, instead of by circumpolar stars, as usually practised. The method of obtaining its true position and other details, which may be of some interest for future observers, are therefore given below.

The observations for personal equation appear to be somewhat discordant this season for some unknown reason, and it was at first sight a little difficult, where all three observers are concerned, so to adjust their relative equations that that subsisting between the 1st and 3rd should equal the difference of those between the 1st and 2nd and the 2nd and 3rd ; in fact, the observations were somewhat contradictory, and as this was the first season in which Lieutenant Burrard had made any observations of the kind, I was at first inclined to attribute the discordance to a fluctuating value of his personality. On further examination of the matter however, his transit observations seemed to be so good that I hesitated at this solution of the difficulty, and determined on making a graphic representation of the data from which the personal equations are determined, and on getting the values of the equation for each arc by interpolation from the curves so obtained. I believe this method to be a very sound one, and have appended the equation curves to this report. They need but little explanation. The divisions proceeding horizontally represent two days each, and vertically, hundredths of a second of time. The dates on which the observations for personal equation were made are duly entered, and the corresponding values of the equation between the observers plotted off from the straight line to which my name is attached. I have selected this line as a basis, as I am the only one of the three observers who worked throughout the whole season and took part in all the arcs. The thick black lines at the bottom and top of the page represent the dates during which the measurement of each arc was carried on, and the dotted lines through the equation curves are drawn at the middle of each arc, and give the interpolated value of the personal equation at once by actual measurement. North and south stars are kept separate both in this process and in the reduction of transits. In former years it was the custom for each observer to take each night some few stars that passed sufficiently close to the zenith of both stations under both aspects, *i. e.*, that the passage over the first ten wires was noted by the observer with his face towards the south, and the last ten with his face towards the north or *vice versâ*. This procedure was omitted on the last four arcs of the present season for two reasons: first, because I had come to the conclusion that the equation thus deduced, which has been hitherto called the absolute N—S equation, is merely a matter of curiosity; and secondly, because the hurry involved in getting round the instrument, to be in time for the last ten wires, seems to produce some uncertainty in the observations.

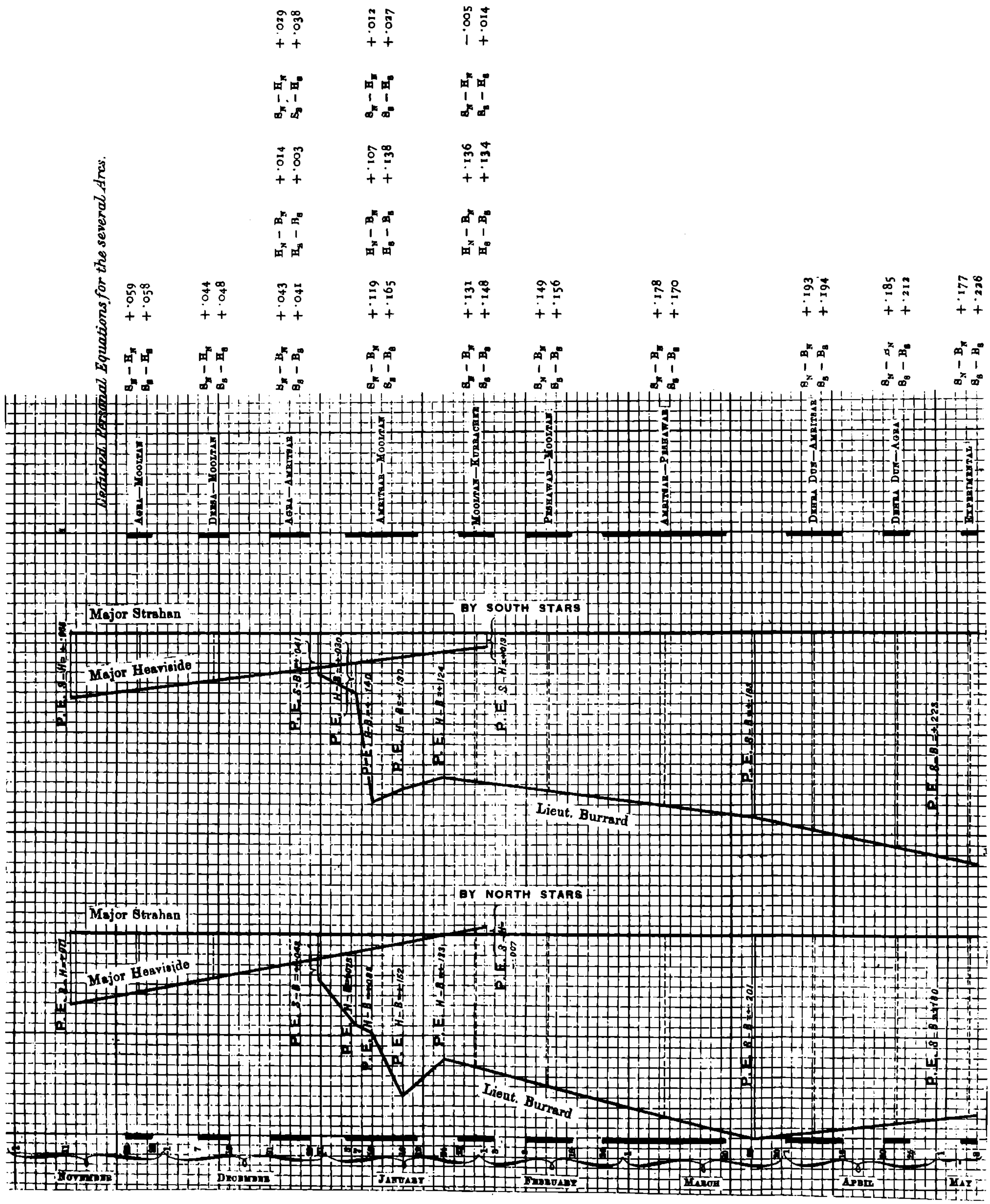
The position of Dehra Dun affords most unusual opportunities for the use of a permanent meridian mark, situated as it is, due south of a range of hills rising 5,000 feet above it, and at a distance at which the solar focus of the largest telescopes we employ can be safely used. The use of such a mark is a very great saving of time in observing and computing transits ; it avoids all chance of observing wrong circumpolar stars or of losing them by the intervention of clouds, and also the necessity of so selecting the time of observation of transits as to fit in with a previously-chosen circumpolar pair. The usual difficulty of obtaining a suitable site at a sufficient distance is fortunately absent in the present case.

A rough guess at its probable position on the hill having been made, an assistant was sent there with a heliotrope and directed to show a steady light on the Dehra Dun observatory. Two heliotropes, one on the east and one on the west side of the observatory, about 70 or 80 yards apart, were then adjusted on him ; after a preconcerted interval, the one on the side towards which it was wished he should proceed was flashed a certain number of times corresponding to the estimated number of yards he was to move. Having paced out or estimated the distance, he proceeded to show his heliotrope again, which was then well within the range of the micrometer of a previously adjusted transit telescope. A repetition of the process established the true position of the mark within a fraction of a yard. A lamp was shown at night from the spot thus fixed, and its distance from the true meridian obtained by a set of observations to the pole star which I will now describe.

The principle underlying the method is that with a knowledge of the true sidereal time we can compute the distance of Polaris from the meridian, and therefore if we note the reading of the micrometer at a certain time when Polaris is passing the centre (or any known) wire and then take a reading of the micrometer when the same wire intersects our approximate meridian mark, we obviously have data for determining its position. Several things however have to be attended to in actual practice, the most important perhaps being that, as a series of observations is necessary for accuracy, it would be unsafe to assume the stability of the line of collimation during the whole time they are being made. The programme I arranged was as follows :—

(1) Observations for collimation,
(2) ,, for level,
(3) Transits of two Nautical Almanac Stars, for time about 45 minutes before the culmination of Polaris, followed by—

PERSONAL EQUATION DIAGRAM



R. W. Foster, Photo.

C. G. Ollenbach, Zinco.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun, March 1887

(4) Micrometer reading of North Collimator.
" " Meridian lamp.
" " Polaris with corresponding chronometer time.
" " South Collimator.
" " South Collimator.
" " Polaris with chronometer time.
" " Meridian lamp.
" " North Collimator.

This was repeated again and again until Polaris was about as far past culmination as it had been before it when the series was begun.

The observations were then completed by transits of two more Nautical Almanac stars for time, and lastly, by determinations of level and collimation. The reductions, with an explanation of them, will be found among the other computations submitted this season, and need not be further dwelt upon here; suffice it to say that the result is that the true position for the mark was found to be 20·1 inches westward of the assumed one with a probable error of ± 1·3 inches. On the site thus obtained, a meridian mark in the shape of a wedge pointing upwards, about 6 feet broad at base and 10 feet high, has been built of stone for future use.

The recess work has been unusually heavy owing to the large number of arcs measured during the season, and in consequence of my having the Andaman Party on my hands as well as the astronomical work. Having also undertaken the preparation of the new Longitude Volume for the press, I have had but little time to give to the details of the computations, which therefore devolved chiefly upon Lieutenant Burrard.

There has been no novelty in this part of the work needing much explanation in detail.

An approximate method of reduction of transits to the centre wire, which had been previously employed with a view to saving labor, was abandoned, as not being sufficiently exact, and the star constants A, B, C, for correcting transits for azimuth, level and collimation, were computed for each star, instead of being taken from tables. The saving of labor by the latter method was practically *nil*, as in order to get a true value a good deal of interpolation was necessary, so that the computation of the constants for each star separately appeared to be little, if at all, more laborious. The mass of figures required for the reduction of the observations is very large, but I am glad to be able to report that with the assistance of two computers kindly lent by Mr. Cole, they have been fully completed and no arrears of any kind remain.

A question has been occasionally raised amongst the various officers hitherto employed on the Electro-telegraphic Longitude work as to the desirability of establishing some criterion for the rejection of abnormally discordant wires in the observation of transits. The subject was again brought to my notice by Lieutenant Burrard, R.E., in a conversation at Amritsar, and I determined to investigate the matter further, and endeavoured to form, on the basis of Professor Peirce's criterion, a somewhat similar test applicable to the Longitude work. For this purpose I undertook an analysis of personal errors of star transits on the arc Agra-Mooltan. This arc was chosen for discussion on account of its being a remarkably complete one, only three stars being wholly missed on the six nights' work, and nearly every star having been observed on the full complement of wires, *viz.*, 11. The words "personal error" are used above in contradistinction to those errors which depend on want of adjustment or defects in the instruments, such as errors of collimation, level, deviation, irregular clock rate, &c., which are not here considered, but merely those caused by the failure of the observer to note the passage of a star over every wire in an exactly similar way; or, as it may be expressed, by a variation in the observer's personality. Every wire observed has been used in the discussion whether apparently wide of the mean or not, as one of the principal objects of the investigation is to discover, with the assistance of Peirce's criterion, a limiting error beyond which observations must be rejected. It is obviously impossible to apply Peirce's criterion *in extenso* to every star observed during a season's work, owing to the vast amount of computation required, and the small value of the ends attainable, but a table may be advantageously formed on the results of one arc from which, by inspection, the limiting errors may be found with quite sufficient accuracy to determine the rejection of abnormal intersections for all arcs. This table is No. II and sufficiently explains itself.

The reduced time of passage of a star over each wire was first subtracted from that over the mean wire to form the residuals (v). Table No. I contains for each star on each night three quantities, *viz.*, $\Sigma(v^2)$ = the sum of the squares of the residuals, m = number of wires observed, and $\varepsilon = \sqrt{\frac{\Sigma(v^2)}{m-1}}$ = the mean error = 1·48 × probable error.

Chauvenet's notation is retained throughout.

A certain number of zenith stars were observed on 10 wires North aspect and 10 wires South aspect. These have been kept separate in the discussion. The whole series of stars is arranged in order of Declination for convenience of reference. It might have been supposed *a priori* that the errors would vary as the secant of the star's declination, but this has not been found to be the case in practice, and so no regular law has been deduced.

The observations themselves have been considered as furnishing the best values of ε, as magnitude and other causes may combine to mask any law depending on the secant of declination.

TABLE

FIRST PART.—*South Stars—i.e.,*

Star.	1678	1508	μ Eridani	α Ceti	o Tauri	1068	Daily means.	1087	1591	1485	δ Arietis	Daily means.
Declination	° ′ −0 58	° ′ +2 19	° ′ −3 28	° ′ +3 38	° ′ +8 38	° ′ +9 20	° ° 0 to 10	° ′ +12 33	° ′ +15 27	° ′ +15 42	° ′ +19 18	° ° 10 to 20
November, 23	$\Sigma(v^2) =$ ·0151	·0203	·0307	·0191	·0264	·0329	·1445	·0197	·0614	·0490	·0098	·1399
	m = 11	11	11	11	10	11	65	11	11	11	11	44
	ϵ = ·039	·045	·055	·044	·054	·057	·047	·044	·078	·070	·031	·056
November, 24	$\Sigma(v^2) =$ ·0175	·0131	·0119	·0339	·0168	·0841	·1773	·0265	·0182	·0319	·0368	·1134
	m = 11	11	11	11	11	11	66	11	11	11	11	44
	ϵ = ·042	·036	·035	·058	·041	·092	·052	·051	·043	·056	·061	·051
November, 25	$\Sigma(v^2) =$ ·0184	·0429	·0195	·0385	·0146	·0276	·1615	·0228	·0120	·0257	·0207	·0812
	m = 11	11	11	11	11	11	66	11	8	11	11	41
	ϵ = ·043	·066	·044	·062	·038	·053	·049	·048	·041	·051	·045	·044
November, 26	$\Sigma(v^2) =$ ·0221	·0349	·0176	·0156	·0137	·0254	·1293	·0176	·0200	·0211	·0243	·0830
	m = 11	11	11	11	11	10	65	11	11	11	11	44
	ϵ = ·047	·059	·042	·039	·037	·053	·045	·042	·045	·046	·049	·043
November, 27	$\Sigma v(^2) =$ ·0227	·0465	·0143	·0176	·0554	·0149	·1714	·0234	·0551	·0229	·0414	·1428
	m = 11	11	11	11	11	11	66	10	11	11	11	43
	ϵ = ·048	·072	·038	·042	·074	·039	·051	·051	·074	·048	·064	·058
November, 28	$\Sigma(v^2) =$ ·0212	·0209	·0133	·0190	·0547	·0395	·1686	·0108	·0297	·0177	·0122	·0704
	m = 11	11	11	11	11	11	66	11	11	11	11	44
	ϵ = ·046	·046	·036	·044	·074	·063	·051	·033	·054	·042	·035	·040
Mean of 6 days	$\Sigma(v^2) =$ ·1170	·1786	·1073	·1437	·1816	·2244	·9526	·1208	·1964	·1683	·1452	·6307
	m = 66	66	66	66	65	65	394	65	63	66	66	260
	ϵ = ·042	·052	·040	·047	·053	·059	·049	·043	·056	·051	·048	·049

No. 1.

Stars observed South of the Zenith.

1637	η Tauri	957	1497	1577	1444	974	1025	1658	Daily means.	Means for all South Stars.	
° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° c		
21 59	23 45	24 48	27 42	28 7	28 23	28 38	28 38	28 50	20 to 30		
·0249	·0323	·0353	·0358	·0247	·0231	·0446	·0272	·0345	·2824	·5668	Probable Error = ·6745 × ε
11	11	11	10	10	10	10	10	10	93	202	
·050	·057	·059	·063	·052	·050	·070	·055	·062	·055	·053	
·0346	·0462	·0242	·0560	·0199	·0343	·0490	·0146	·0227	·3015	·5922	
11	11	11	10	10	10	10	7	10	90	200	
·059	·068	·049	·079	·047	·062	·074	·046	·050	·058	·054	
·0109	·0307	·0589	·0568	·0438	·0379	·0451	·0106	·0337	·3284	·5711	
10	11	11	10	10	10	10	10	10	92	199	
·033	·055	·077	·111	·070	·065	·070	·034	·061	·060	·054	
·0350	·0154	·0405	·1106	·0491	·0275	·1025	·0646	·0255	·4707	·6830	
11	10	11	6	10	10	10	10	10	88	197	
·059	·041	·064	·036	·074	·055	·107	·085	·053	·073	·059	
·0818	·0507	·0314	·0078	...	·0369	·0472	·0608	·0285	·3454	·6596	
11	11	11	10	...	10	9	8	10	80	189	
·090	·071	·056	·050	...	·064	·072	·087	·056	·066	·059	
·0205	·0242	·0153	·0222	·0638	·0133	·0416	·0154	·1322	·3482	·5872	
11	11	11	10	10	10	10	10	10	93	203	
·045	·049	·039	·079	·084	·038	·068	·041	·121	·061	·054	
·2077	·1995	·2056	·2892	·2013	·1730	·3300	·1932	·2771	2·0766	3·6599	
65	65	66	56	50	60	59	55	60	536	1190	
·057	·055	·056	·072	·064	·054	·075	·059	·068	·062	·055	

TABLE

SECOND PART.—*Stars observed*

Star.	1497	1577	1444	974	1025	1658	Daily means.	1207	1614	1452	1175	ι Aurigæ.
Declination .	° ′ 27 42	° ′ 28 7	° ′ 28 23	° ′ 28 38	° ′ 28 38	° ′ 28 50	° ° 20 to 30	° ′ 31 33	° ′ 32 33	° ′ 32 39	° ′ 32 45	° ′ 32 59
November, 23 $\Sigma(v^2)$ =	·0393	·0486	·0254	·0449	·0354	·0152	·2088	·0657	·0910	·0417	·0276	·0313
m =	10	10	10	10	10	10	60	11	11	11	11	9
ϵ =	·066	·073	·053	·071	·063	·041	·067	·081	·095	·065	·052	·059
November, 24 $\Sigma(v^2)$ =	·0429	·0203	·0788	·0409	·0096	·0716	·2641	·0194	·0472	·1316	·0393	·0209
m =	10	10	10	10	8	10	58	11	11	11	11	11
ϵ =	·069	·047	·094	·067	·035	·089	·068	·044	·069	·114	·063	·046
November, 25 $\Sigma(v^2)$ =	·0991	·0618	·0222	·0243	·0703	·0695	·3472	·0806	·0294	·0515	·0410	·0640
m =	10	10	10	9	10	10	59	11	11	11	11	11
ϵ =	·105	·083	·050	·052	·088	·088	·078	·090	·054	·072	·064	·080
November, 26 $\Sigma(v^2)$ =	·0208	·0732	·0669	·0796	·0369	·0780	·3554	·0355	·0219	·0429	·0258	·0366
m =	10	10	10	10	10	9	59	11	8	11	11	11
ϵ =	·048	·090	·086	·094	·064	·098	·078	·060	·052	·065	·051	·075
November, 27 $\Sigma(v^2)$ =	·0139	...	·0505	·0182	·0400	·0193	·1419	·0377	·0257	·0552	·0767	·0232
m =	9	...	10	10	10	10	49	10	11	10	11	11
ϵ =	·040	...	·075	·045	·067	·046	·054	·065	·050	·078	·087	·048
November, 28 $\Sigma(v^2)$ =	·0447	·0065	·0580	·0473	·0141	·0228	·1934	·0411	·0483	·0559	·0968	·0430
m =	10	6	10	10	10	10	56	10	11	10	11	11
ϵ =	·070	·033	·080	·072	·040	·050	·059	·067	·069	·079	·098	·065
Mean of 6 days $\Sigma(v^2)$ =	·2607	·2104	·3018	·2552	·2063	·2764	1·5108	·2800	·2635	·3788	·3072	·2390
m =	59	46	60	59	58	59	341	64	63	64	66	64
ϵ =	·067	·068	·071	·066	·060	·068	·067	·066	·065	·077	·068	·061

No. 1—*continued.*

North of the Zenith.

1627	1017	1123	1530	1602	1219	Daily means.	963	993	Daily means.	Means for all North Stars.	General Mean.	
° ′	° ′	° ′	° ′	° ′	° ′	° °	° ′	° ′	° °			
33 15	33 48	37 13	37 43	38 21	39 41	30 to 40	40 31	42 5	40 to 43			
·1043	·0415	·0412	·0228	·1020	·0469	·6160	·1054	·0458	·1512	·9760	1·5428	Probable Error $= \cdot 6745 \times \varepsilon$
11	11	11	11	11	11	119	11	11	22	201	403	
·102	·064	·064	·048	·101	·068	·072	·103	·068	·085	·070	·062	
·0631	...	·1059	·0458	·0203	·0348	·5283	·0340	·0264	·0604	·8528	1·4450	
11	...	11	11	11	11	110	11	11	22	190	390	
·079	...	·103	·068	·045	·059	·070	·058	·051	·054	·067	·061	
·0323	·0908	·0317	·0247	·0663	·0986	·6109	·0860	·0582	·1442	1·1023	1·6734	
11	11	11	11	11	11	121	11	11	22	202	401	
·057	·095	·056	·050	·081	·099	·071	·093	·076	·085	·074	·065	
·1529	·0727	·0927	·0501	·1017	·0382	·6910	·0611	·0536	·1147	1·1611	1·8441	
11	11	11	11	11	11	118	11	11	22	199	396	
·123	·085	·096	·071	·100	·062	·077	·078	·073	·074	·076	·067	
·0251	·0408	·0445	·0459	·0648	·0684	·5080	·0719	·0715	·1434	·7933	1·4529	
11	11	11	11	11	11	119	10	11	21	189	378	
·050	·064	·066	·068	·080	·083	·066	·089	·084	·085	·065	·062	
·0411	·0786	·0366	·0539	·0825	·0433	·6211	·0496	·0163	·0659	·8804	1·4676	
11	11	11	11	11	11	119	11	11	22	197	400	
·064	·089	·060	·073	·091	·066	·073	·070	·040	·056	·067	·061	
·4188	·3244	·3526	·2432	·4376	·3302	3·5753	·4080	·2718	·6798	5·7659	9·4258	Probable Error of single wire $\pm$ ·0426
66	55	66	66	66	66	706	65	66	131	1178	2368	
·080	·077	·073	·061	·081	·071	·071	·079	·064	·072	·070	·063	

Table No. I is so arranged as to show at the foot of each column $\Sigma(v^2)$, m and ε for each star on the mean of the six nights. Means for the sum of the stars on each night are also given, and at the end of the table is the mean result for the whole, and r the probable error of one intersection for the whole arc. The stars have been divided into the following groups according to declination, 0° to 10°, 10° to 20°, 20° to 30°, 30° to 40°, and 40° to 43° for which ε is found to be ·049, ·049, ·065, ·071 and ·072. From these values, with the aid of Table X in Chauvenet's Astronomy, the following table is compiled.

TABLE II.—*Criterion for rejecting doubtful observations.*

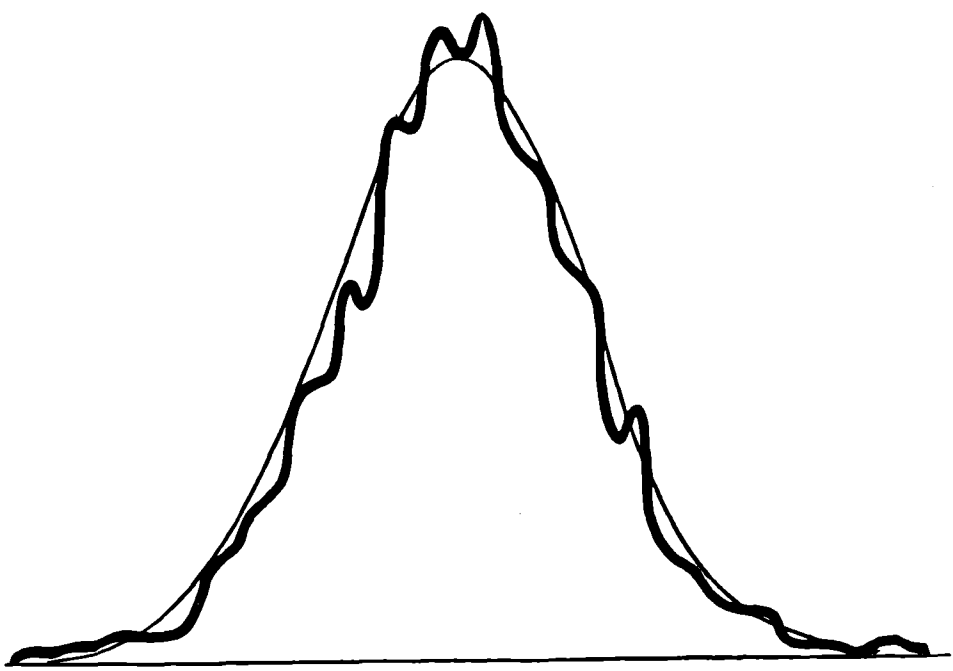
Number of wires observed.	0° to 10°	10° to 20°	20° to 30°	30° to 40°	40° to 43°
5	·11	·11	·15	·16	·16
6	·13	·13	·17	·18	·19
7	·14	·14	·19	·20	·21
8	·15	·15	·20	·22	·22
9	·16	·16	·22	·24	·24
10	·17	·17	·23	·25	·25
11	·18	·18	·24	·26	·27

The application of this table rejects only one observation on the present arc Agra-Mooltan.

The probable error of one intersection, r, by the rigorous formula $= ·6745\sqrt{\frac{\Sigma(v^2)}{m-1}} = ·0426$;

and by the approximate formula (Chauvenet Vol. II, p. 497) $r = ·8453\frac{\Sigma v}{\sqrt{m}\,(m-1)} = ·0420$.

Advantage was taken of the numbers collected together in Table I to draw out a curve of which the abscissa at any point represents the magnitude of any error and the ordinate represents its relative frequency, and to compare it with the probability curve, with which it should theoretically coincide.



The two curves are shown in the diagram, the thin line being the probability curve computed with the help of Chauvenet's Table IX A., and the thick line being plotted from the actual errors, 2368 in number.

The agreement between the two is striking. It must, however, be remarked that these errors are not deduced under precisely the same circumstances as contemplated by Chauvenet. The latter case provides strictly for the errors of measurement of one and the same quantity, the former for a number of groups of measurements of similar things under circumstances exactly similar (except so far as declination is concerned). It is much the same thing as if the measurements had all been made on the same quantity, and had then been sub-divided into groups of 10 or 11 in each before the residuals had been determined. The mean of each group being then taken, the residuals are determined by subtracting

each observation from the mean of the group in which it occurs. The numerical agreement of the probability curve with the curve of errors is shown in the following table :—

Between.	Errors by Theory.	Errors Actual.
s *s*		
0·00 and 0·01	302	314
0·01 „ 0·02	294	310
0·02 „ 0·03	280	278
0·03 „ 0·04	258	260
0·04 „ 0·05	234	225
0·05 „ 0·06	206	192
0·06 „ 0·07	178	172
0·07 „ 0·08	148	141
0·08 „ 0·09	120	120
0·09 „ 0·10	96	93
0·10 „ 0·11	74	67
0·11 „ 0·12	56	52
0·12 „ 0·13	42	40
0·13 „ 0·14	30	27
0·14 „ 0·15	20	17
0·15 „ 0·16	14	18
0·16 „ 0·17	8	13
0·17 „ 0·18	5	8
0·18 „ 0·19	2	7
0·19 „ 0·20	2	5
Over 0·20	1	7

DRAWING OFFICE, CALCUTTA.

SECTION I.—GEOGRAPHICAL DRAWING AND COMPILING.

Statement showing the work performed and the progress made from 1st October 1885 to 30th September 1886.

TITLE OF MAP.	Number of Sheets.	Scale.	REMARKS AND PROGRESS.
General.		In. Mls.	
India. Engraved Map . .	6	1 = 32	Additions to date, and hills.
Do. Ditto . .	4	1 = 64	Skeleton Maps: additions and changes in boundaries and railways, &c., to date.
Do. Ditto . .	2	1 = 80	
Do. Ditto . .	2	1 = 96	
Do. Railway Feeders . .	6	1 = 32	Re-drawn for photozincography.
Do. External Trade . .	1	1 = 80	
Do. Railway Map . .	6	1 = 32	Showing railways, steam routes, and light-houses.
Do. Canal Map . . .	6	1 = 32	New edition. Published.
Do. Geological . . .	1	1 = 128	For Geological Survey.
Do. Skeleton . . .	6	1 = 32	Showing only principal rivers, towns and mountain ranges.
Do. Ditto . . .	2	1 = 64	Showing districts.
Do. Crop Maps . . .	2	1 = 64	Hand-painted and prepared from data furnished by Revenue and Agricultural Department: 71 copies were prepared and supplied to Revenue and Agricultural Department.
Do. Land Settlement . .	2	1 = 64	
Do. Revenue Rates . .	2	1 = 64	
Do. Density of Population .	2	1 = 80	Hand-painted in shades of neutral tint for Revenue and Agricultural Department, and Colonial Exhibition (6 copies).
Do. Emigration Map . .	1	1 = 128	Hand-painted in colours to illustrate residence of emigrants (6 copies).
Do. Ditto . .	2	1 = 64	
Do. Showing Native States .	1	1 = 128	Hand-painted in colours.
Do. External Trade . .	2	1 = 64	Ditto to illustrate external trade and places of registration.
Do. Railway Map . .	1	1 = 128	Corrected to date.
Skeleton Map of Burma and Assam Frontier.	1	1 = 32	Prepared for the Political Department of India Office.
Skeleton Map of Eastern Afghanistan and Punjab.	1	1 = 32	
Skeleton Map of Baluchistan and Sind Frontier.	1	1 = 32	
Mysore State	1	1 = 16	New compilation from 1″=1 mile, Topographical Surveys. The first edition to be photozincographed, but ultimately to be engraved.
Baluchistan	1	1 = 16	A new compilation. In progress.
Province of Assam . . .	2	1 = 16	Additions in outline and hills.
Rajputana Agency . . .	2	1 = 16	Ditto up to date in outline and hills.
North-West Provinces and Oudh	2	1 = 16	Western sheet completed for engraving.
Central Provinces . . .	1	1 = 32	Drawn on 1″=16 miles for reduction by photozincography to 1″=32 miles.
NORTH-WEST TRANS-FRONTIER.			
Sheets Nos. 29 S. E., 29 S. W., 30 S. W., and 30 N. W.	4	1 = 4	From routes and latest surveys. Published.
Sheet No. 22	1	1 = 8	Despatched to Dehra after completing available information.
Sheets Nos. 22 S. E., 28 S. E., and 27 S. E.	3	1 = 4	Being drawn in uniformity with rest of sheets.
Sheets Nos. $29\frac{N.E.}{1}$, $29\frac{N.E.}{3}$, $29\frac{S.E.}{1}$, $29\frac{S.E.}{3}$, and $30\frac{N.W.}{1}$	5	1 = 2	From recent surveys; in full sheets.
North-East Trans-Frontier Sheet No. 22.	1	1 = 8	From latest surveys by Colonel Woodthorpe.
Kohat Sheet No. 7 . . .	1	1 = 1	Drawn for photozincography.
Simla Revision Survey Sheets Nos. 1, 2, 3, 4, 6, 7, 8, 12, and 13.	9	24 = 1	Showing level contours at 50 feet vertical intervals.
Gujarat Survey Sheet No. 184 .	4	2 = 1	Completed heading, reference and foot-notes.
Cutch Survey Sheets Nos 31, 32, 52, 53, and 70.	5	1 = 1	
Burma Reconnaissance Sheets Nos. 23 N. W., and 23 S. W., N. E. Trans-Frontier.	2	1 = 4	Prepared by Captain Hobday from surveys, routes, reconnaissance and local information. Printed and finished in Drawing Office.
Burma Reconnaissance Sheet No. 1 S. E., Trans-Frontier.	1	1 = 4	
Map of Kathiawar . . .	1	1 = 10	For Political Agent, Kathiawar, for reduction by photozincography to 1″=16 miles.
Map of Suakim . . .	1	1 = 1	Inserted borders, headings and foot-notes.
Chart of Triangulation, Suakim .	1	1 = 1	
Outline Map of Dalhousie Sanitarium.	4	10 = 1	Drawn from survey executed in 1870.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

TITLE OF MAP.	Number of Sheets.	Scale.	REMARKS AND PROGRESS.
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Map of the World, illustrating the Exports and Imports of India during 1883-84.	1	...	For Revenue and Agricultural Department.
Map of the World, illustrating the Exports and Imports of India during 1884-85.	1	...	For Revenue and Agricultural Department.
Triangulation Chart of the N. E. Trans-Frontier.	1	1 = 4	Completed border, heading, foot-notes, &c.
Routes from Nushki to the Helmand.	2	1 = 8	Tracings supplied to the Government.
Boundary between Sind and Jodhpore.	1	1 = 4	Ditto to Political Agent, Western Rajputana.
Bangalore City, Cantonment and Environs.	4	12 = 1	Inserted level contours on sheets.
Garo Hills, Lower Assam	1	1 = 2	Additions and corrections for photozincography.
Map of Delhi	6	1 = 1	Prepared for Camp of Exercise, for reduction by photozincography to half scale.
Do. Gurgaon	3	1 = 1	Prepared for Camp of Exercise, for reduction by photozincography to half scale.
Do. Karnal	5	1 = 1	Prepared for Camp of Exercise, for reduction by photozincography to half scale.
Skeleton Map of Bengal	12	1 = 8	For general use. (Not yet complete) for reduction by photozincography to 1″ = 16 and 1″ = 24 miles.
Sheets of the Atlas of India.			
No. 4 S.E.	1	1 = 3	Being drawn for heliogravure.
,, 6 N.E	1	1 = 3	Drawn for heliogravure.
,, 12 N-W.	1	1 = 4	Hills in brush for engraving.
,, 14 S.W.	1	1 = 3	Preparing for heliogravure. Hills in brush.
,, 15 N.E.	1	1 = 4	Artistically drawn for photozincography.
,, 15 S W.	1	1 = 4	Hills in brush for engraving.
,, 19 N.E.	1	1 = 4	Ditto ditto.
,, 23 N E.	1	1 = 4	Completing outline for engraving.
,, 35 S.W.	1	1 = 4	Hills in brush for engraving.
,, 36 N.W.	1	1 = 4	Completed outline and printing for engraving.
,, 37 S.W.	1	1 = 4	Outline and names for engraving.
,, 38 S.E., S.W.	2	1 = 4	Hills in brush for engraving.
,, 39 S.E.	1	1 = 4	Ditto ditto.
,, 40 N.E.	1	1 = 4	Ditto ditto.
,, 46 full plate	1	1 = 4	Corrected boundaries and inserted new roads.
,, 47 S. W.	1	1 = 4	Prepared border, heading, and foot-notes for photozincography.
,, 48 N. E.	1	1 = 4	Re-writing names on outline print (original lost).
,, 49 S. E.	1	1 = 4	Hills in brush for engraving.
,, 50 S.E, N.W.	2	1 = 4	Additions in outline and names for engraving.
,, 60 N.E., S.E.	2	1 = 4	Ditto ditto ditto
,, 60 N. W., S. E.	2	1 = 4	Hills in brush for engraving.
,, 67 S. W.	1	1 = 4	Additions in outline and names for engraving.
,, 77 N. E., N. W.	1	1 = 4	Hills in brush for engraving
,, 88 S.E.	1	1 = 4	Ditto ditto.
,, 114 S.E.	1	1 = 4	Additions in outline and names for engraving.
Divisions of Bengal.			
Presidency Division	4	1 = 4	Compiled from latest materials for reduction to 1″ = 8 miles by photozincography.
Bhagalpur	2	1 = 4	Being compiled for reduction to 1″ = 8 miles by photozincography.
Patna	8	1 = 4	Being compiled for reduction to 1″ = 8 miles by photozincography.
Burdwan	2	1 = 4	Being compiled for reduction to 1″ = 8 miles by photozincography.
District Maps.			
District Jessore	1	1 = 4	Prepared for lithography from transfers from copper-plates.
Do. Nuddea	1	1 = 4	Prepared for lithography from transfers from copper-plates.
Do. Jalpaiguri	1	1 = 4	Prepared for lithography from transfers from copper-plates.
Do. Sonthal Pergunnahs	1	1 = 4	Prepared for lithography from transfers from copper-plates.
Do. Cachar	1	1 = 4	Prepared for lithography from transfers from copper-plates.
Do. 24-Pergunnahs	1	1 = 4	Prepared for lithography from transfers from copper-plates.
Do. Nowgong	1	1 = 4	Prepared for lithography from transfers from copper-plates.
Do. Sibsagar	1	1 = 4	Prepared for lithography from transfers from copper-plates.
Do. Sylhet	1	1 = 4	Corrected to date.
Do. Ghazipur	1	1 = 4	Touched up for photozincography.
Do. Lohardugga and Chota Nagpore	4	1 = 4	Corrected to date.
Do. Kohat	1	1 = 4	Compiled from latest materials.
Do. Hooghly	1	1 = 4	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION I—*continued.*

TITLE OF MAP.	Number of Sheets.	Scale.	REMARKS AND PROGRESS.
		In. Mls.	
Administration Report Maps.			
North-West Provinces . .	1	1 = 80	Corrections and additions for Government North-West Provinces.
Punjab	1	1 = 32	Corrections and additions for Punjab Government and Superintendent of Forest Surveys.
Do.	1	1 = 80	
Central Provinces . . .	1	1 = 32	
Ditto	1	1 = 80	
Central India	1	1 = 80	
Bengal	1	1 = 80	
Assam	1	1 = 80	
PROVINCE OF BENGAL—			
Districts Nuddea, Khoolna, Midnapore, Dacca, Noakholly, 24-Pergunnahs, Beerbhoom, Korea, Monghyr, Gya, Tipperah, Chang-Bhakar, Singhbhum, Bonai, Sundarbans, Orissa, Tributary Mehals.	16	1 = 8	Reduced from Atlas sheets, &c.
CENTRAL PROVINCES—			
Districts Bhandara, Mandla, Seoni, Hoshangabad, Betul, Raipur, Balaghat, Bilaspur, Sironcha, Nimar, Narsinghpur, Damoh, Chanda, Nagpur, Sambalpur and Wardha.	16	1= 8	Ditto ditto.
NORTH-WEST PROVINCES AND OUDH—			
Districts Sultanpur, Gonda, Moradabad, Agra, Basti, Banda, Etawah, Etah, Lucknow, Mirzapur, Bahraich, Gorakhpur, Sháhjahánpur and Muzaffarnagar.	14	1= 8	Ditto ditto.
PROVINCE OF ASSAM—			
Districts Sibsagar, Kamrup, Sylhet, Nowgong, Goalpara and Naga Hills.	6	1= 8	Ditto ditto.
PROVINCE OF PUNJAB—			
District Muzaffargarh . .	1	1= 8	Ditto ditto.
Index Maps.			
Provincial Index, Sind . .	1	1=32	Drawn for reduction by photozincography.
Ditto Bombay .	1	1=32	
Ditto Madras I .	1	1=32	
Ditto Ditto II .	1	1=32	
Ditto Nizam's Dominions.	1	1=16	
North-West Trans-frontier .	1	1=64	Re-drawn for ditto ditto.
Cutch Topographical Survey .	1	1=18	Table of new and old Index numbers added.
Gujarat Survey . . .	1	1=24	Ditto ditto.
Miscellaneous Maps.			
Map of Sundarbans . .	2	1= 4	Additions for photozincography.
Charts of Arabian Sea, Indian Ocean, and Gulfs of Aden and Persia.	9	1=37	For the Meteorological Reporter for Western India for reduction by photozincography to 1″=145 miles.
Military Map of India . .	6	1=32	On Skeleton India, 1″=32 miles, Military Outposts and Cantonments, also Railways open and under construction added, for reproduction by photozincography.
Map showing boundaries claimed by Maharajah Holkar.	1	1= 4	Prepared for Secretary of State for India, by combining Atlas Sheets, Nos. 37 N.E., S.E. and 54.
Map of Rewah . . .	1	1=32	Prepared by transfer from copper plate for Political Agent, Rajputana.
Table showing Trade of India with the World.	1	...	For Revenue and Agricultural Department, for reproduction by photozincography.

DRAWING OFFICE, CALCUTTA.

SECTION II. REVENUE.

Statement showing the work performed and the progress made from 1st October 1885 to 30th September 1886.

TITLE OF MAPS.	Number and size of sheets.	Scale.	REMARKS.
PUNJAB.		In. Mls.	
District Hissar . . .	14 (30′ × 15′)	1 = 1	Nos. 242, 243, 257, 258, 259, and 260, completed up to margin and examined. Nos. 241, 256, and 261, in progress. No. 244, reduced by pentagraph and completed up to margin, from details obtained from the 1″ sheets of District Sirsa and Bickaneer State.
Do. do.	29 sections. (15′ × 7′ 30″	2 = 1	Nos. 242 S. E., 243 N. E. S. E., 257, 258, 259, 260, and 261, passed with final press order.
District Rawalpindi (Kahuta Forest).	13 sections. (7′ 30″ × 3′ 45″)	4 = 1	Nos. 160 $\left(\frac{\text{N.E.}}{2,3,4}\ \frac{\text{S.E.}}{2,4}\right)$, 161 $\left(\frac{\text{N.E.}}{2,3}\ \frac{\text{S.E.}}{2}\right)$, 183 $\left(\frac{\text{S.W.}}{3}\right)$, 186 $\left(\frac{\text{S.W.}}{1,2,3,4}\right)$, examined and sent to press. Proofs examined of Nos. 160 $\left(\frac{\text{S. E.}}{1,3}\right)$, 161 $\left(\frac{\text{S.E.}}{3 \text{ and } 4}, \frac{\text{N.E.}}{1}\right)$, 162 $\left(\frac{\text{N.E.}}{1,2,3,4}\right)$, 185 $\left(\frac{\text{S.W.}}{2,3,4}\right)$, and 186. $\left(\frac{\text{N.W.}}{1,2,3,4}\right)$ Publication deferred pending settlement of Forest Boundaries.
District Karnal (Government Cattle Farm).	4	16 = 1	Nos. 1, 2, 3, 4 examined and sent to press.
District Delhi	6	1 = 1	Nos. 298, 299, 319, 320, 321, and 322 corrected, and sent to press for second edition.
NORTH-WESTERN PROVINCES.			
Meerut Division.			
Districts Aligarh and Etah .	15 sections. (7′ 30″ × 15′)	2 = 1	No. 35 final press order given. Nos. 23, 36, 37, 52 and 53 examined and sent to press.
Ditto ditto .	6 (30′ × 15′)	1 = 1	No. 23 under examination. Nos. 36, 37, 52, and 53 examined and being completed up to margin.
District Gorakhpur . .	8 sections. (30′ × 15′)	1 = 1	Skeleton sheets, showing trijunctions of villages, Nos 207 N.E. S.E., 208 N.E. S.E., 216 N.W. S.W., and 217 N.W. and S.W., were received. No. 207 N.E. S.E., details reduced by pentagraph from the 16-inch cadastral plans, drawn and typed. No. 208 N.E. S E. in hand.
District Mirzapur . . .	12 in 31 sections. (30′ × 15′)	1 = 1	Nos. 168 S.E.; 169 N.E .S.E.; 170 N.W., N.E., S W., S.E.; 171 N.E., S.E.; 181 S.W., S.E.; 182 N.E., N.W., S.W., S.E.; 183 N E., N.W., S.E., S.W.; 184 N.W., N.E.; 197 N.W., S.W., 198 N.W., S.E., S W., 199 N.E., N.W., S.E., S.W. and 212 N.W. converted into blue prints: 29 sections drawn and typed; remainder in hand.
Benares Division.			
Districts Ghazipur, Ballia, &c. .	13 in 37 sections. (30′ × 15′)	1 = 1	Nos. 194, 195, 196, 197, 208, 209, 210, 211 217, 218, 219, 220, and 221 received. Nos. 208, 210, 211, 217, 218, 219, preliminarily examined and under correction. No. 209 examined and sent to press,
Benares City (including Sikrol and Pandipur Cantonments).	4 (2′ 45″ × 3′ 30″)	8 = 1	Projected. Plotting of points in hand.
Ganges and Gogra Rivers .	40 sections. (7′ 30″ × 3′ 45″)	4 = 1	Nos. 210 $\left(\frac{\text{E.}}{2,4}\right)$, 211 $\left(\frac{\text{N.E.}}{2}\right)$, 217 $\left(\frac{\text{S.W.}}{1,2,3,4}\ \frac{\text{S.E.}}{3}\right)$, 218 $\left(\frac{\text{N.W.}}{2}, \frac{\text{N.E.}}{1,2,3,4}, \frac{\text{S E}}{2}\right)$, 219 $\left(\frac{\text{N.W.}}{1,2,3,4}, \frac{\text{N.E.}}{1,2,3,4}\ \frac{\text{S.W.}}{1,2,3,4}\ \frac{\text{S.E.}}{1,2}\right)$, 220 $\left(\frac{\text{N.W.}}{3}, \frac{\text{S.W.}}{1,2,3,4}, \frac{\text{S.E.}}{3}\right)$, 221 $\left(\frac{\text{N.W.}}{1,2,3,4}\ \frac{\text{N.E.}}{1,2,3}\right)$, received. No. 219, 13 sections preliminarily examined.
Oudh	6 (30′ × 15′	1 = 1	Nos. 136, 150, 163, 164, 174, 176, and 177, press order given. Nos 104, 116, 122, 132, 137, sent to press for corrections and omissions to be supplied.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

TITLE OF MAPS.	Number and size of sheets.	Scale. In. Mls.	REMARKS.
CENTRAL PROVINCES.			
Saugor City	4 sections.	8 = 1	Final press order given.
BENGAL.			
District Cuttack . . .	3 (30′ × 15′)	1 = 1	Nos. 225, 226, 227 remain in hand.
District Midnapur . . .	1	1 = 4	Final press order given.
Hooghly River Survey . .	9 in 116 sec.	16 = 1	Proofs examined and final press order given.
Ditto ditto . .	1-4 in 8 sec.	6 = 1	Originals and proofs examined. Final press order given.
Ditto ditto . .	5-9	6 = 1	Examined for press.
Ditto ditto . .	1-10	3 = 1	Final press order given,
Ditto ditto . .	1 & 2	1 = 1	Originals and proofs examined. Final press order given.
Jalpaiguri	12 (30′ × 15′)	1 = 1	Nos. 270, 271, 272, 295, 296, 316, 317, 318, and 337. Final press order given. Nos. 293, 294, and 315 sent to press for correction.
BOMBAY.			
Konkan Survey . . .	4 (30′ × 15″)	1 = 1	Nos. 161, 135, 167, and 141 examined. Proofs Nos. 136 and 162 examined and final press order given. Nos. 161 and 135 sent to press for publication.
Do. do. . . .	53 (7′ 30″ × 3′ 45″)	4 = 1	Nos. 159 (1 section), 160 (10 sections), 133 (4 sections), 134 (8 sections) examined and sent to press. Proofs Nos. 162 (8 sections), 161 (16 sections), 136 (8 sections), examined. Press order given for preliminary edition.
Deccan Survey . . .	5 (30′ × 15′)	1 = 1	Proofs of Nos. 238 and 270 examined and sent to press for correction. Nos. 169, 170, 171, 203 and 239, examined. Nos 169, 170, 171, sent to press for reduction to half scale.
BURMA.			
Districts Hanthawaddy, Pegu and Shwegyin.	4-(14 sections.) (7′ 30″ × 15″)	2 = 1	Proofs Nos. 96, 112, 97, 127, 98, 114, and 128 passed with press order for preliminary edition. Nos. 123, 124, 125, and 126 examined and sent to press for preliminary edition.
Districts Bassein and Henzada .	11 (30′ × 15′)	1 = 1	Nos. 65, 79, 80, 96, 66, 81, 82, 67, 77, 78, and 97 examined with 16″ inch plans and under correction.
District Tharrawaddy . .	5-in 19sections. (15′ × 7′ 30″)	2 = 1	Proofs of Nos. 93, 94 and 95 passed with press order for preliminary edition.
District Prome . . .	6 (30′ × 15′)	1 = 1	Proof of No. 92 sent to press. No. 93 sent to press. Nos. 74, 75, 76, and 77 drawn and under examination.
Provincial Index Map of Bengal	1	1 = 52	Drawn on scale of 1″ = 32 miles for reduction to 1″ = 52 miles.
Annual Report Index Maps, Index to the Survey Operations in the Punjab, Bilaspur, Raipur, Jubbulpore, Sambulpur, (Central Provinces), Basti, Gorakpur (North-West Provinces), Kamrup, Darrang, (Assam), Mozufferpore (Bengal), Ajmere (Rajputana), Akyab (Burma), Deccan and Konkan, and South Maratha (Bombay).			Index Maps to the Survey Operations in Bilaspur, Raipur, Jubbulpore, Mozufferpore, and South Maratha were redrawn; others revised and brought up to date for Annual Report of 1885-86.
Examination of proofs.			
Photozincographed maps . .	537		
Lithographed maps . . .	42		

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

DESCRIPTION OF WORK.	REMARKS.
Computations examined.	
District Hissar, Seasons 1882—84.	
„ Dehra Dun, Seasons 1883—85.	
„ Shewgyin, Seasons 1883—85.	
Traverse data, &c., supplied.	
Traverses of 10 villages of District Bhagalpore .	For Collector of Bhagulpore.
„ of 24 „ „ Mozufferpore .	For Civil Superintendent of Survey.
„ of District Jaunpur along District Mirzapur.	For W. H. Patterson, Esq., Deputy Superintendent.
„ of Main Circuit No. 10, Mirzapur, along portion under Topographical Survey.	Ditto ditto.
„ of Pargana Chainpur, District Shahabad, along District Mirzapur.	Ditto ditto.
„ of 12 villages of District Nuddea . .	For Settlement Deputy Collector.
„ of 38 „ „ Moorshedabad .	For Collector of Moorshedabad.
„ of 1 Frontier Circuit, District Sylhet .	For Secretary, Chief Commissioner, Assam.
„ of Main Circuit Nos. 2, 3, 4, District Larkhana, along Kalat.	For Mr. McNair, Surveyor.
„ of Main Circuit No. 2 Kohishtan . .	Ditto ditto.
„ of 4 villages (old and new Surveys), District Moorshedabad.	For Collector of Moorshedabad.
„ of 12 villages of District Patna . .	For Collector of Patna.
„ of District Benares, along the unsurveyed portion of District Mirzapur	For Deputy Superintendent.
„ of Mirzapur villages, (12 pages) . .	For Major Sandeman.
„ of Cachar Tea Grants, (6 pages) . .	For Deputy Commissioner.
„ of District Bassein, along District Thonkwa(19 pages).	For Deputy Superintendent.
Field Area Statements of District Pegu (139 pages)	For Superintendent of Survey and Settlement.
Values and Description of Level Bench marks in District Agra (40 pages).	For Executive Engineer, Irrigation Department.
Triangulation data of Kohistan, Circuit No. 2. .	For Mr. McNair, Surveyor.
Miscellaneous.	
Preparation of a statement showing Area, Total Cost, and Rate per Square Mile of the Districts in the North-West Provinces.	For Revenue Board, North-West Provinces.
Computation of Lat. and Long. for the projection of Hutted Camps, District Hazara, as well as for the projection of District Burdwan ; also rectangular co-ordinates for the projection of certain sheets of the Hooghly River Survey and of the City and Cantonment of Benares.	
Preparation of Area Statements of Districts Jaunpur by Parganas, of District Raipur by Zemindaries, and of District Henzada by Townships.	
Computation of Lat. and Long. of Nimar Triangulated points.	
Preparation of a list of all the villages in District Chittagong, showing their state of demarcation.	For Revenue, Agriculture and Commerce Department.
Preparation of a statement showing Areas of Districts in the Punjab according to revised boundaries.	For Director of Settlements.
Plotting of Jungle Circuit No. 1, District 24-Parganas.	For Collector.
Calculation of Areas of Districts Jhelum, Simla, Umballa, Kohat, Rawalpindi and Akyab, also of Kulu State in District Kangra, and of the Districts in the Hyderabad State.	
Preparation of a General Statement for all India showing the population in every District or State according to religion for the preparation of a Religion Map of India.	

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

TITLE OF MAPS.	Scale.	REMARKS.
Tracings.		
Copies of 8 village plans of Pargana Nathpur, District Pubna (transferred to District Bhagalpur).	4=1	For Collector.
Tracings of 2 village plans of Pargana Nathpur, District Pubna (transferred to District Bhagalpur).	4=1	Ditto.
Copy of 1 village plan of Pargana Muhumud Shahee, District Pubna.	4=1	For Deputy Collector, Kooshtea.
Copies of 3 village plans of Pargana Sahaujal, District Nuddea.	4=1	Ditto ditto.
Copies of 3 village plans of Pargana Taragunia, District Nuddea.	4=1	For Collector of Pubna.
Tracings of 3 villages, Ganges Deara Survey.	4=1	Ditto ditto.
Copies of 2 village plans of Pargana Taragunia, and Sahaujal, District Nuddea.	4=1	For Deputy Collector, Nuddea.
Copy of 1 village plan of Pargana Medanmal, District 24-Parganas.	4=1	For Collector.
Copies of 2 village plans of Parganas Calcutta and Buran, District 24-Parganas.	4=1	Ditto.
Tracing of portion of boundary between District Sylhet and Hill Tipperah.	4=1	For Chief Commissioner, Assam.
Ditto ditto.	1=1	Ditto ditto.
Tracings of 6 village plans of Pargana Salempur Majhauli, District Gorakhpur.	4=1	For Major Sandeman, Deputy Superintendent.
Tracings of 12 village plans of Pargana Kalyanpur Kuwari, District Saran.	4=1	Ditto ditto.
Tracings of 3 village plans of Pargana Chaubara, District Saran.	4=1	Ditto ditto.
Copies of 2 village plans of Pargana Goa, District Saran.	4=1	For Collector, Saran.
Tracing of portion of boundary between Kalat and District Larkhana.	4=1	For Mr. McNair.
Ditto ditto.	2=1	For Ditto.
Ditto ditto.	1=1	For Ditto.
Copies of 3 village plans of Pargana Jamuni, District Bhagalpur.	4=1	For Deputy Collector, Maldah.
Tracing of Pargana Kankjaul, District Purnea, Season 1847.	4=1	Ditto ditto.
Tracings of 4 villages of the Ganges Deara Survey.	4=1	Ditto ditto.
Tracings of 3 village plans of Parganas Laskarpur and Goas, District Nuddea.	4=1	Ditto ditto, Nuddea.
Tracing of 1 village plan of Pargana Goas, District Moorshedabad	4=1	Ditto ditto.
Tracing of portions of Sheets Nos. 13, 14, 17, 18, and 20, Main Circuit No. 10, Ganges Deara Survey (in duplicate).	4=1	For Sub-Divisional Officer, Barh.
Tracing of portion of Sheet No. 10, Main Circuit No. 8 Ganges Deara Survey (in duplicate).	4=1	Ditto ditto.

DRAWING OFFICE, CALCUTTA.

SECTION II—*continued.*

TITLE OF MAPS.	Scale.	REMARKS.
Tracing of Jungle Circuit and adjoining villages, Pargana Medanmal District, 24-Parganas.	4=1	For Collector.
Copy of 1 village plan of Pargana Sahaujal, District Nuddea.	4=1	For Settlement Officer.
Tracings of Sheets Nos. 26, 33 and 35, Bijeraghogarh District, Jubbulpore.	4=1	For G. H. Cooke, Esq., Deputy Superintendent.
Tracings of 3 village plans of Pargana Baraich, District Baraich.	4=1	For Executive Engineer, Kapurthala State.
3 Tracings of Reserved Forest Tracts in Tahsil Bijeraghogarh, District Jubbulpore.	4=1	For G. H. Cooke, Esq., Deputy Superintendent.
2 Tracings of Reserved Forest Tracts in Parganas Sonpur and Singorgarh, District Jubbulpore.	4=1	Ditto ditto.
Copies of 2 village plans of Pargana Kentunagar, District Moorshedabad.	4=1	For Collector.
Copy of 1 village plan of Pargana Hajeepore, District Mozufferpore	2=1	For Sub-Divisional Officer, Barh.
Tracing of Sheet No. 5, Main Circuit No. 8, Ganges Deara Survey.	4=1	Ditto ditto.
Copy of 1 village plan of Pargana Futehsingh, District Moorshedabad.	4=1	For Collector.
Tracing of Grant No. 18 (old rules) District Lakhimpur.	4=1	For Settlement Officer.
Copies of 2 village plans of Pargana Kasimnagar, District Maldah.	4=1	For Collector.
Copy of 1 village plan of Pargana Esuphshahi, District Pubna.	4=1	Ditto
Copies of 7 village plans of Pargana Poladassi, District Bogra.	4=1	Ditto
Tracing of portion of boundary between Districts Mirzapur and Benares.	2=1	For W. H. Patterson, Esq., Deputy Superintendent.
Tracing of portion of Boundary between Districts Mirzapur and Shahabad.	1=1	Ditto ditto.
Copies of 290 village plans of Pargana Bisara Tappa Bhatsalla Districts Mozufferpore.	4=1	For Settlement Officer.
Tracing of portions of Sheets Nos. 13, 14, 17, 18, 20, Ganges Deara Survey.	4=1	For Deputy Collector, Nuddea.
Copies of 122 village plans of Pargana Gadeshar, District Mozufferpore.	4=1	For Settlement Officer.
Copies of 754 village plans of Pargana Bisara (Chakla, Girjaul), District Mozufferpore.	4=1	Ditto ditto.
Copies of 339 village plans of Pargana Ratti, District Mozufferpore.	4=1	Ditto ditto.
Copies of 225 village plans of Pargana Hajeepore, District Mozufferpore.	4=1	Ditto ditto.
Map colouring.	Number.	
Maps on various scales.	207	For Surveyor General's Office.
Ditto ditto . . .	207	For Deputy Surveyor General's Office.
Ditto ditto . . .	892	For India Office.
Ditto ditto . . .	512	For District officials.

DRAWING OFFICE, CALCUTTA.

EXAMINING SECTION.

Work done from the 1st October 1885 to 30th September 1886.

TITLE OF MAP.	Number of Sheets.	Scale. In. Mls.	REMARKS AND PROGRESS.
Original Standard Sheets	26	4= 1	Examined with plane-table sheets and carried out corrections for photozincography.
	12	2= 1	
	12	1= 1	
	7	1= 2	
	9	1= 4	
	1	1= 8	
Original Large Scale Plans	9	24= 1	Simla sheets. Examined revised contours for photozincography.
	21	12= 1	Examined with plane-table sheets for photozincography.
	4	10= 1	
	2	6= 1	
Original Triangulation Charts	1	2= 1	Examined for photozincography.
	1	1= 2	
	1	1= 4	
Original Atlas Sheets for reduction by Heliogravure.	2	1= 3	Examined and given to Draftsmen.
Original Atlas Sheets, or portions thereof, compiled in Drawing Office and received from field parties.	35	1= 4	Examined and sent to Engraving Office.
General and Provincial Maps	1	1= 10	Examined additions to railways, hills, &c., mostly for the Engraving Office.
	11	1= 16	
	19	1= 32	
	4	1= 64	
District Maps compiled in Drawing Office	9	1= 4	Examined for photozincography.
Index Maps prepared in ditto	1	1= 12	
	2	1= 16	
	3	1= 24	
	7	1= 32	
	2	1= 64	
	1	1=128	
Special Maps compiled in Drawing Office for various purposes	1	1= 2	
	4	1= 4	
	24	1= 8	
	10	1= 16	
	3	1= 32	
Engraved proofs of Atlas Sheets in various stages.	114	1= 4	Examined and sent to Engraving Office.
Engraved proofs of General and Provincial Maps	2	1= 8	Examined mostly additions and corrections made on copper-plates from time to time.
	9	1= 16	
	7	1= 32	
	16	1= 64	
	8	1= 80	
	3	1=128	
Lithographic proofs of Atlas Sheets and District Maps transferred from copper-plates.	8	1= 4	Examined corrections in territorial changes and public constructions, such as boundaries, canals, roads, &c.
Lithographic proofs of General and Provincial Maps, including Index Charts.	6	1= 16	Examined additions and corrections made on stones from time to time.
	14	1= 32	
	4	1=128	
	2	1=256	
Lithographic proofs of Special and Miscellaneous Maps.	1	1= 16	Examined and given to Draftsmen.
	13	1= 32	
	6	1= 80	
	1	1=128	

DRAWING OFFICE, CALCUTTA.

EXAMINING SECTION—*continued.*

TITLE OF MAP.	Number of Sheets.	Scale. In.	Scale. Mls.	REMARKS AND PROGRESS.
Photographic proofs of Standard Sheets, large scale Plans and various other Maps	27	24	1	Examined and given to Draftsmen.
	41	12	1	
	4	6	1	
	77	4	1	
	31	2	1	
	90	1	1	
	22	1	2	
	33	1	4	
	97	1	8	
	1	1	10	
	2	1	12	
	6	1	16	
	1	1	18	
	3	1	24	
	35	1	32	
	5	1	48	
	7	1	64	
	2	1	70	
	2	1	128	
	1	1	256	
	16	1	200 ft.	
Projection and Examination of graticules and plotting of points.	45			
TOTAL	1,007			

N. B.—In addition to the above, miscellaneous jobs, such as tracings of sketches, charts, supply of geographical data to various officials, calculation of areas, computation of graticules for the plates of the Indian Atlas and testing the same on copper, have been performed by the Examining Section, as well as various other minor works too numerous to be mentioned here.

DRAWING OFFICE, CALCUTTA.

State of Publication of Cadastral Maps on the 30th September 1886.

Districts.	Number of Sheets. Maps Prepared. Up to 30th September 1885.	Added during past 12 months.	Total up to 30th September 1886.	Published. Up to 30th September 1885.	By Surveyor-General's Office during past 12 months.	Total to 30th September 1886.	Remaining to be published.	Remarks.
North-West Provinces.								
Agra	2,924	...	2,924	2,924	...	2,924	...	
Azamgarh	930	...	930	930	...	930	...	
Ballia	1,384	10	1,394	1,384	10	1,394	...	
Banda	3,317	...	3,317	3,317	...	3,317	...	
Basti	1,402	1,608	3,010(b)	...	199	199	2,811	
Benares	1,444	371	1,815	1,014	796	1,810	5	
Bijnour	31	...	31	31	...	31	...	
Dehra Dun	701(a)	...	701(b)	188	463	651	50	(a) Figures of previous return have been changed to agree with final results.
Ghazipur	3,050	...	3,050	3,050	...	3,050	...	
Gorakhpur	1,795	1,448	3,243(b)	...	1,123	1,123	2,120	
Hamirpur	2,926	...	2,926	2,926	...	2,926	...	
Jaunpur	3,434	...	3,434	3,434	...	3,434	...	
Moradabad and Terai	4,023	...	4,023	4,023	...	4,023	...	
Muttra	1,658	...	1,658	1,658	...	1,658	...	
Mirzapur	3,658	...	3,658	3,638	...	3,638	20	(b) These figures are liable to alteration until publication has been completed.
Tarai	346	...	346	346	...	346	...	
Total	33,023	3,437	36,460	28,863	2,591	31,454	5,006	
Lower Burma.								
Akyab	946(c)	915	1,861(b)	107	540	647	1,214	(c) Includes 39 sheets of Akyab town surveyed on the scale of 64 inches to the mile.
Bassein	3,076(a)	...	3,076	2,813	263	3,076	...	
Hanthawaddy and Pegu	4,601	...	4,601	4,601	...	4,601	...	
Henzada	1,391(a)	...	1,391	543	848(d)	1,391	...	
Prome	847	...	847	797	50(e)	847	...	
Tharrawaddy	1,363	...	1,363	1,363	...	1,363	...	
Total	12,224	915	13,139	10,224	1,701	11,925	1,214	(d) Includes 3 sheets of Henzada City surveyed on the scale of 64 inches to the mile.
Bengal.								
Patna and Gya	3,054	...	3,054	3,054	...	3,054	...	(e) Includes 10 sheets of Prome Town on the scale of 64 inches to the mile.
Shahabad	4,924	...	4,924	4,924	...	4,924	...	
Pooree (Khorda State)	4,565(a)	...	4,565	4,490	75	4,565	...	
Total	12,543	...	12,543	12,468	75	12,543	...	
Assam.								
Kamrup	1,024(a)	653	1,677(b)	383	640	1,023	654	
Sylhet	61	...	61	16	...	16	45	
Total	1,085	653	1,738	399	640	1,039	699	
Central Provinces.								
Raipur	43	...	43	43	...	43	...	
Total	43	...	43	43	...	43	...	
Grand Total N.-W. Provinces, Burma, Bengal, Assam, and Central Provinces	58,918	5,005	63,923	51,997	5,007	57,004	6,929	

Abstract of work performed during past year.

Provinces.	Number of Sheets. Examined and rendered suitable for photo-zincography.	Traced and examined for zincography.	Proof copies examined previous to press order.	Coloured and subsequently examined.	Remarks.
North-West Provinces	1,542	1,038	2,751	2,591	Scale 16 inches = 1 mile.
Lower Burma	1,180	561	1,818	1,701	
Bengal	...	...	44	75	,, 32 ditto.
Assam	404	234	641	640	,, 16 ditto.
Total	3,126	1,833	5,254	5,007	

ENGRAVING OFFICE, CALCUTTA.

Report of progress from 1st October 1885 to 30th September 1886.

Title of Map.	Outline.	Writing.	Hills and Sand.	Remarks showing Progress.
	Sq. In.	Letters Cut.	Sq. In.	
General Maps, &c.				
India, in six sheets, scale 1 inch =32 miles. Sheet 1	28	820	32 H.	Additions; hills in progress.
„ 2	8	669	...	Small portion of outline and writing finished.
„ 3	12	425	...	Additions; hills in progress.
„ 4	...	...	...	Corrections and additions in progress.
„ 5	...	740	...	Ditto completed.
„ 6	...	...	...	Slight corrections, completed.
India, in four sheets, scale 1 inch =64 miles.	13	1,063	24 H.	Plates brought up to date, additional railways, &c.
Skeleton Map of India, in four sheets, scale 1 inch=64 miles.	...	567	...	Corrections, finished.
India, in two sheets, scale 1 inch =80 miles.	...	423	...	Ditto.
India, scale 1, inch=128 miles	...	146	23 H.	Ditto.
Bengal, in two sheets, scale 1 inch=16 miles.	...	...	100 H.	Hills well advanced on sheet 1.
Rajputana, in two sheets, scale 1 inch=16 miles.	21	1,672	28 H.	Hills in progress.
Central India Agency, in two sheets, scale 1 inch=16 miles	...	2,120	...	Additional writing.
Central Provinces, in two sheets, scale 1 inch=16 miles.	...	36	...	Slight additions, completed.
North-West Provinces and Oudh, in two sheets, scale 1 inch=16 miles.	...	816	...	Projected, border cut, outside, figures in progress.
Punjab, in four sheets, scale 1 inch=16 miles.	556	...	...	Outline well advanced; in progress.
Assam, scale 1 inch=16 miles	...	35	...	Slight additions.
Berar, scale 1 inch=8 miles .	...	522	23 H.	Plate completed and published.
Index Chart to the Great Trigonometrical Survey.	...	40	...	Additions and corrections, completed.
Patna Division, scale 1 inch =16 miles.	...	1,396	...	Ditto to outline, and writing.
Bay of Bengal Weather Chart .	36	4,342	...	Projected, border cut, outline writing and tint on land, engraved; completed.
Native Officers' Commission Form.	...	12,050	...	New plate engraved, one half in the Persian character, the other in ornamental lettering.
The Viceroy's Appointment plate, Lord Dufferin's Crest.	...	1,000	...	Completed.
Three Tints, Nos. 16, 17, 18, measuring 20 inch × 14 inch.	...	200	...	Ditto.
Three Tints, measuring 18 inch ×12 inch.	...	483	...	Engraved, for Photozinco. Office, Poona.
Two scales, 16 inch=1 mile . 1 chain=48·75 feet or ¼ side of a Bigah.	...	640	...	Completed.
Scale 80 Kadams=1 inch .	...	386	...	Completed.
Scale 2·995 inch=100 Lagis in Nagri character.	...	662	...	Completed.
Bigah Comb scale, 16 inches =1 mile.	...	379	...	Completed.
Scale 3⅛ chains=1 inch or 24 inch = 1 mile.	...	530	...	Completed.
Scale 16 inches=1 mile .	...	564	...	Completed.
Scale of chains 2 inches=1 mile.	...	190	...	Completed.
Indian Atlas border . .	...	763	...	Blank plate of border, scale, and outside figures only engraved.
Imprint plates . . .	...	200	...	Three plates corrected.
Vernier scales . . .	...	3,242	...	Forty-six scales figured for Mathematical Instrument Office.
Theodolite circles . .	...	3,014	...	Seven figured ditto.
Brass Sun Dial . . .	...	848	...	Figured ditto.
Zenith Sector in heliogravure	...	750	...	Title engraved.
Two plates of the Archæological Survey of Western India, in heliogravure.	...	782	...	Titles and lettering engraved.
Photo-electrotype plate .	...	278	...	Title engraved.
Heliogravure plates by Colonel J. Waterhouse.	...	6,184	...	Titles and lettering engraved on fifteen plates.
Total .	674	48,977	230 H.	

ENGRAVING OFFICE, CALCUTTA.

Title of Map.	Outline.	Writing.	Hills and Sand.	Remarks showing Progress.
	Sq. In.	Letters cut.	Sq. In.	
Indian Atlas Sheets (New) completed.				
12 S. W.	...	300	4 H. 14 jungle.	Completed.
38 S. E.	...	272	36 H.	
38 S. W.	3	771	97 H.	
39 S. W.	...	688	171 H.	
40 N. E.	5	1,636	200 H.	Completed up to margin.
49 N. E.	...	1,926	...	
49 S. E.	...	819	8 H. 20 jungle	
67 N. W.	...	1,949	...	
67 S. W.	...	17,625	...	
Total	8	25,986	516 H. 34 J.	
Indian Atlas Sheets (New) in progress.				
6 N. E.	...	711	...	Additional writing completed.
11 S. W.	80	...	...	Projected, border cut; outline in progress.
12 N. E.	53	3,257	...	Additional outline, writing, and outside figures engraved.
12 N. W.	172	3,283	...	Reprojected, new border, scale, and outside figures cut, outline completed, writing in progress.
14 N. E.	...	4,335	...	Writing finished as far as material supplied.
14 S. E.	...	7,175	...	Writing in progress.
15 N. W.	...	8,511	...	Scale and outside figures cut; writing in progress.
15 S. W.	...	13,375	16H.	Outline and writing finished; hills in progress.
16 N. W.	223	...	...	Outside figures cut, outline finished as far as material supplied.
16 S. W.	212	152	15S. H.	Outline finished as far as material supplied, sandy bed of river dotted; outside figures in progress.
18 S. E.	...	...	53S. H.	Sand hills well advanced; in progress.
19 S. E.	...	...	65S. H.	Ditto ditto.
20 S. E.	16	842	15H.	Outline and writing finished, waiting hill drawing.
21 S. E.	...	6,448	...	Outside figures cut, outline and writing finished as far as material supplied.
21 S. W.	20	1,828	...	Reprojected, new border cut, outline and writing finished as far as material supplied.
22 N. E.	89	5,883	...	Outline finished as far as material supplied, writing in progress.
23 N. E.	7	600	...	Outline and writing finished as far as material supplied.
23 S. E.	...	7,321	...	Ditto ditto.
35 S. W.	40	1,167	20H.	Hills in progress.
36 N. W.	18	4,341	...	Outline and writing finished as far as material supplied.
36 S. W.	14	640	...	
37 N. W.	114	1,224	...	Border, scale, and sand banks cut; writing in progress.
37 S. W.	39	446	...	Portion of additional outline engraved; writing in progress.
38 N. E.	...	8,334	..	Outline and writing nearly finished as far as material supplied.
38 N. W.	4	20	...	Additional railways and writing engraved.
39 N. E.	...	392	...	Outside figures in progress, writing about to be commenced.
39 N. W.	5	4,376	33 H.	Writing completed; hills in progress.
39 S. E.	...	13,607	8 H.	Writing completed; hills just commenced.
40 N. W.	80	2,490	...	Outline completed as far as material supplied; writing in progress.
Carried over	1,186	99,738	92 H. 133 S. H.	

N.B.—A full sheet of the Indian Atlas contains 927·2 square inches.

ENGRAVING OFFICE, CALCUTTA.

Title of Map.	Outline.	Writing.	Hills and sand.	Remarks showing progress.
Indian Atlas Sheets (New) in progress—continued.	Sq. In.	Letters cut.	Sq. In.	
Brought forward .	1,186	99,738	92 H. 133 S. H.	
40 S. E.	15	1,214	...	Outline and writing completed as far as material supplied.
42 S. E.	...	3,600	...	Writing in progress.
43 N. E.	...	2,914	...	
43 S. E.	13	1,543	...	Scale cut; outline and writing finished as far as material supplied.
48 N. E.	...	1,727	...	Writing in progress.
48 S. W.	...	5,975	...	Outline and writing finished as far as material supplied.
49 N. W.	85	6,120	...	Scale cut; outline and writing finished as far as material supplied.
49 S. W.	...	2,512	...	Outline and writing finished as as far as material supplied.
50 N. E.	207	10,972	...	Outline completed to margin; writing in progress.
50 N. W.	10	1,869	...	Outline and writing finished as far as material supplied.
60 N. E.	16	10,000	...	Writing in progress.
60 N. W.	3	18,314	...	
60 S. E.	...	9,722	...	
61 N. E.	19	...	...	Outline completed up to margin; writing in progress.
61 S. E.	...	702	...	Rivers waterlined; additional writing cut; waiting hill drawing.
68 N. W.	75	...	...	Outline completed as far as material supplied; writing about to be gone on with.
76 N. E.	...	200	...	Slight additons; finished; waiting hill drawing.
76 S. W.	...	370	...	Rivers waterlined; lakes shaded; additional writing cut; waiting hill drawing.
77 S. E.	...	606	...	District names engraved; waiting hill drawing.
78 N. E.	25	4,086	...	Rivers waterlined; additional writing cut.
79 N. W.	...	3,717	...	Additional writing cut.
79 S. W.	5	...	...	Rivers waterlined.
88 N. E.	135	2,107	...	Scale cut; outline completed as far as material supplied; writing in progress.
88 S. E.	3	...	...	Outline completed as far as material supplied.
88 S. W.	...	777	16 H.	Completed as far as material supplied.
103 N. W.	50	96	...	Outline completed as far as material supplied.
103 S. W.	41	96	...	
114 N. E.	...	8,813	...	Outline and writing completed as far as material supplied.
114 S. E.	...	1,299	...	
114 S. W.	131	14,604	...	Writing well advanced; in progress.
115 N. E.	...	100	...	Slight additions completed.
125 S. E.	4	3,449	...	Scale and outside figures cut; writing in progress.
Total . .	2,023	218,262	108 H. 133 S.H.	
Additions and Corrections to the Indian Atlas Sheets.				
2 S.E.	...	...	...	Slight corrections completed.
8 S.E.	...	...	...	
8 S.W.	8	885	8 Jungle	Additional railway, outline, and writing, completed.
13 S E.	...	50	...	Slight corrections completed.
19 N E.	...	10	...	
Carried over .	8	945	8 Jungle	

ENGRAVING OFFICE, CALCUTTA.

Title of Map.	Outline.	Writing.	Hills and Sand.	Remarks showing Progress.
	Sq. In.	Letters cut.	Sq. In.	
Additions and Corrections to the Indian Atlas Sheets—contd.				
Brought forward .	8	945	8 Jungle	
28 S.E.	...	2,600	...	Corrections made on the matrices, electrotyped from the old full plate 28.
28 S.W.	...	2,750	...	
31 N.W.	6	740	...	Heavy corrections and additions finished.
31 S.E.	...	1,907	...	Outline and writing of heavy corrections and additions finished; waiting hill drawing.
31 S.W.	...	169	...	Corrections and additions finished.
32 N.E.	...	4,776	5 S.H. 15 Jungle	District names, boundaries and corrections, finished.
32 N.W.	...	...	...	Slight corrections completed.
32 S.E.	...	12	...	
34 N.E.	...	...	...	
34 S.E.	...	...	...	
36 N.E.	...	241	...	Slight additions completed.
37 S.E.	...	...	...	Slight corrections to outline finished.
48 S.E.	...	204	...	Slight additions completed.
53 N.E.	...	73	...	
66 N.E.	...	68	...	
66 S.E.	...	390	...	
66 S.W.	...	414	...	Additional railway, boundaries and names cut.
67 N.E.	...	62	...	Additional canals and names completed.
67 S.E.	...	404	...	Additional Railways, canals and names completed.
69 S.E.	...	44	...	Slight additions completed.
77 N.E.	...	60	...	District names finished.
87 N.E.	...	230	...	Additions completed.
87 S.E.	8	1,597	...	Railways, corrections to outline and names, completed.
91 N.W.	...	23	...	Slight corrections to outline and writing, completed.
91 S.E.	...	47	...	
Total .	22	17,786	5 S.H. 23 Jungle	
Corrections and Additions to old plates of the Indian Atlas.				
25	...	...	34 H.	Hills being repaired.
28	...	...	106 H.	Heavy corrections and additions finished.
30	...	468	...	Corrections to outline and writing finished.
46	...	6,697	174 H.	Hills repaired; writing being recut.
47	...	...	202 H.	Hills being repaired.
65	...	...	44 H.	
94	...	...	...	Corrections to outline and writing in progress.
102	...	480	...	Slight additions completed.
Total .	...	7,645	560 H.	
New Plates Projected, Borders Cut, &c.				
11 N.E.	...	...	...	Projected.
11 N.W.	...	...	...	Ditto and border cut.
11 S.E.	...	..	...	Ditto ditto.
15 N.E.	...	1,833	...	Border, scale, and outside figures cut.
15 S.E.	...	1,535	...	Border and outside figures cut.
25 S.E.	...	...	...	Projected.
26 N.E.	...	...	...	Ditto and border cut.
Carried over .	...	3,368	...	

ENGRAVING OFFICE, CALCUTTA.

Title of Map.	Outline.	Writing.	Hills and sand.	Remarks showing progress.
	Sq. In.	Letters cut.	Sq. In.	
New Plates Projected, Borders Cut, &c.—contd.				
Brought forward .	...	3,368	...	
26 S.E.	...	...	...	Projected and border cut.
30 N.E.	...	...	...	Ditto.
30 N.W.	...	...	...	Ditto.
30 S.E.	...	1,236	...	Ditto border and outside figures cut.
30 S.W.	...	...	...	Ditto.
47 N.E.	...	...	...	Ditto.
47 N.W.	...	...	...	Ditto.
47 S.E.	...	...	...	Ditto.
47 S.W.	...	1,329	...	Ditto, border, scale and outside figures cut.
Total .	...	5,933	...	

Abstract of work completed and in progress.

Engraving.

	Plates.
Atlas sheets completed	9
Ditto in progress in various stages	61
General maps, plans, &c. . . .	129
Repairs, corrections, and additions .	38
Projections engraved, borders cut, &c. .	16
Total .	253

Copper-plate printing.

Impressions taken	18,401
Proofs pulled	612
Transfers pulled	292
Total .	19,305

Steel-facing.

	Plates.
Double elephant plates steel-faced .	17
Ditto ditto steel removed	9
Quarter plates steel-faced . .	57
Ditto steel removed . . .	81
Miscellaneous plates steel-faced .	34
Ditto steel removed .	18
Total .	216

Square inches of hill etching . .	1,552
Ditto of jungle etched . .	57
Ditto of outline . . .	2,727
Number of letters engraved . .	324,589

Extract from the Report of Lieutenant-Colonel J. Waterhouse, S.C., *Assistant Surveyor General, in charge Photographic Office,—Season 1885-86.*

Out-turn.—Although there is a slight falling off in some items from the very large out-turn of last year, the work of the office generally, especially in the Zinc-printing Section for the ordinary departmental and extra departmental work, shows a large increase. The number of subjects received from other departments shows a falling off, though the number of printed copies is greater. The Cadastral work is well up to the average, the number of sheets reproduced being larger than last year, but the number of printed copies is less.

Original Subjects.—The number of subjects received for reproduction in the various sections of the Normal Establishment amounted to 1,518, of which 892 were departmental and 626 extra-departmental, as against 853 departmental and 849 extra-departmental of last year. The number of Cadastral sheets reproduced was 5,203, of which 3,387 were original drawings reproduced by photo-zincography and 1,818 transfer tracings for zincography.

Negative Section.—The number of negatives of departmental and extra-departmental work taken in the Normal Establishment, including 70 reversed negatives and transparencies required in the Photo-Collotype and Heliogravure Sections, was 2,671, or 98 more than last year. Mr. Turner took a series of negatives on dry plates of the interior of the Mint and also several photographs of objects of Indian art, the Bengal screens, Bamboo and Forest trophies and other exhibits going to the Indo-Colonial Exhibition, for the Revenue and Agricultural Department and the Government of Bengal. The number of negatives taken of Cadastral sheets was 3,387, or 103 less than last year.

The processes in this section have not been changed. The new method of intensification with sulphate of copper and bromide of potassium, followed by treatment with nitrate of silver, noticed in the Report for last year, has been in use all the year and proved satisfactory, as regards density, clearness of detail and keeping properties of the negatives,

and has been definitely adopted for all the ordinary work. The expense for chemicals is considerably greater than with the old system of intensifying with bichloride of mercury, followed by treatment with hyposulphite of soda and ammonia, but the results are better in many ways, and Mr. J. Mackenzie reports that the new system has the very great advantage, that the glasses are not stained, as they are with the bichloride of mercury, and can be used over and over again without fear of traces of old work appearing.

PHOTO-TRANSFER SECTION.—The total number of photo-transfer prints produced was 5,812, of which 2,320 were departmental and extra-departmental maps, &c., and 3,492 were Cadastral sheets. Last year the total number of prints was 5,900. No change has been made in the processes in this section.

ZINC-PRINTING SECTION.—The number of plates printed off by the Normal Establishment was 823, the number of pulls being 151,801 and of copies 267,989. The printing work is much in excess of last year, the number of pulls then being 121,909 and of copies 159,370. The increase is chiefly in departmental work. The presses in the Normal Establishment have all been fully worked every day throughout the year.

The number of sheets printed off by the Cadastral Establishment was 5,282 and the number of copies 144,760. Though 122 sheets more were printed off than last year, the number of copies printed is much less. This is owing to the increase in the number of North-West Provinces sheets, of which only 12 copies each are printed, while the Bengal and Burma sheets, of which 40 and 34 copies each are printed, have decreased.

SILVER-PRINTING SECTION.—The number of prints produced in this section during the year was 5,399 and exceeds by 1,493, the unusually large out-turn of last year. The principal item is an extensive series of large prints from the sketches in neutral tint made by Major E. L. Durand with the Afghan Boundary Commission. A great deal of work was also done for the Governments of India and Bengal in connection with the photographs taken by Mr. Turner of the exhibits for the Indo-Colonial Exhibition and of the former series of photographs made in the Calcutta Exhibition. Prints were also taken from a large number of dry plate negatives taken by Mr. C. L. Griesbach, of the Geological Survey, attached to the Afghan Boundary Commission.

PHOTO-COLLOTYPE SECTION.—The out-turn of this section has been 4,880 copies from 43 plates. This is not quite so much as last year, but the results have been much better; there is more certainty in working during the hot and rainy seasons, and the process is becoming one of the recognized means of reproducing ordinary photographs required for the illustration of the Archæological Survey and other Reports and for book illustrations.

Mr. Haward has paid a good deal of attention during the year to various methods of obtaining collotype or grained transfers from half-tone negatives suitable for printing from stone or zinc. Such prints, though not so delicate and perfect in gradation as collotype prints, are more easily and quickly produced and are consequently cheaper. The most successful results were obtained from transfers from collotype plates especially prepared with chloride of calcium in order to give a clear open grain. The process is, however, so delicate and requires such care in giving the collotype plates just the proper amount of softness to give the required grain that it seems unlikely to answer practically in this country.

Trials have also been made, but not as yet very successfully, with the somewhat similar process invented by Sergeant-Major Husband, R.E., of the School of Military Engineering at Chatham, in which, instead of a collotype-plate and reversed negative being necessary, common salt is added to the gelatine used for coating ordinary photo-lithographic transfer paper as well as to the sensitising solution of bichromate of potash, and the transfer is printed in the usual way from any ordinary negative. After exposure the print is wetted and is then found to be covered with a fine vermicular grain very similar to that produced on collotype plates. It is then inked in while damp, with a glue-roller, and the result is a transfer print with a very delicate graduated grain. The best results are produced by transferring to a polished stone. I saw the process working at Chatham when on furlough and have been trying it again since my return. If this or some similar process could be worked successfully all through the year, it would be exceedingly valuable as a cheap and speedy means of printing half-tone subjects and has many advantages over collotype for that purpose, though the results would never be quite so good.

HELIOGRAVURE SECTION.—Owing partly to my absence during the greater part of the year and to the fact that the work of reproducing the negatives of art objects from the Calcutta Exhibition was discontinued under the orders of Government, there has not been so much work done as would otherwise have been the case. The principal feature of the work done during the year in this section has been the extension of electrotyping for the duplication of the engraved copper plates of the Indian Atlas and other standard maps. Three quarter-sheets of the Atlas and one double-elephant sheet of the 32-mile map were duplicated, and matrices taken of three other quarter-sheets of the Atlas and one sheet of the 32-mile map. The process seems likely to be of great service to the Engraving Office in enabling incomplete sheets, or sheets for which accurate surveys do not exist, being filled in temporarily for immediate issue without engraving on the original plates. In the same way the 32-mile Map of India may be temporarily completed on the duplicated plates pending completion from survey results. The whole of the work has been done with the

simple Vienna batteries described in earlier Annual Reports, and they have been found to answer perfectly well for the large double-elephant sized plates, the deposit being very regular and good in quality. Cow-hide of local manufacture is used for the porous cells.

Experiments have also been made by Mr. Turner with the object of obtaining transfers of half-tone subjects to zinc or stone from photo-engraved plates prepared so as to give a much stronger grain than is necessary for printing in the copper-plate press. Two plates were successfully transferred to stone for the illustration of the Archæological Survey Reports, and the method is perhaps more likely to be successful and give better results than the paper or collotype-grained transfers tried in the Photo-collotype Section, though it is more complicated and expensive.

A photo-electrotype plate is prepared in the way described in the Annual Report of the Survey of India for 1881-82 (Appendix, page 99), but using well-washed graining sand stearined with 8 grains of stearine to the ounce of sand. This gives a coarser grain than the stearined-washed flour emery powder. A thin negative is best so that a thin gelatine relief may be obtained through which the sand may thoroughly penetrate and give a good open grain. The deposit of copper need not be so thick as for copper-plate printing, and eight or ten days in the battery are sufficient. After coming out of the battery the plates require a careful cleaning up to bring out the grain well.

At the beginning of the year a few photo-engraved plates were done for the Revenue and Agricultural Department and sent home to Mr. W. Griggs for illustration of the *Indian Art Journal*. Two very successful plates of archæological drawings in pen and ink were also done for Dr. Burgess. The drawings were exceedingly fine to begin with, but they stood a very considerable reduction without any blocking up of the lines, which would have been impossible by photo-zincography.

The photo-etching process has also made some progress during the year, and Mr. Turner has tried several ways of getting a stronger grain so as to overcome the difficulty there is in printing the very delicate half-tones. He found that by using powdered resin, instead of asphaltum, the grain was stronger and stood the biting with perchloride of iron better.

A few type blocks have also been produced by the gillotype method of etching on zinc with nitric acid.

INDO-COLONIAL EXHIBITION.—Besides the special work done for the Revenue and Agricultural Department and Government of Bengal on account of the Indo-Colonial Exhibition, a series of exhibits illustrating the different processes worked in the office was prepared and included specimens of photo-zincography as applied to extra-departmental work, photo-engraving by the etching and electrotype processes, photo-collotype and silver-printing.

FURLOUGH.—I was compelled by ill-health to take furlough at the commencement of the hot weather in March and did not return until the middle of December. Lieutenant-Colonel W. F. Badgley had charge of the office during the greater part of my absence. During the first few months of the period under report, until I went on furlough, I was fully occupied, both in the Lithographic and Photographic Offices, with work of various kinds in connection with and preparation for the Indo-Colonial Exhibition, as well as preparing for the introduction of the new system of payment for work done for other departments. I was thus able to give little or no personal attention to the development of new processes.

During my stay in Europe I took the opportunity of re-visiting the Military Geographical Institute at Vienna and of visiting the new Topographical Depôt and the School of Roads and Bridges at Paris. I spent two or three days at the Ordnance Survey Office, Southampton, studying the new system of photo-zincographic work there and also the arrangements for electrotyping by means of the dynamo-electric machine.

I visited the School of Military Engineering at Chatham to see the working of Sergeant-Major Husband's process of Papyrotint. I made other enquiries about small motors for electro-typing, the air-brush, copying colored drawings with ortho-chromatic dry plates and other subjects connected with the working of the office, and was able to acquire some useful information, though the time I had at my command was very short, as most of my furlough had to be spent at health resorts on the Continent. A detailed report of my enquiries was submitted to the Secretary of State for India before I left England.

OFFICE ACCOMMODATION.—The pressing question of office accommodation again occupied a good deal of my attention during the early months of the year before I went on furlough. In consultation with the Government Architect the plans and estimates for the Photographic and Lithographic Offices were finally completed. On the occasion of the visit of the Hon'ble Sir S. C. Bayley, K. C. S. I., in January 1886, I drew up the following memorandum showing the inconveniences and deficiencies of the existing accommodation of these offices.

Memorandum on the existing Accommodation of the Photographic and Lithographic Offices, Calcutta, dated 28th January 1886.

These offices are located in three houses, *viz.*—

PHOTOGRAPHIC OFFICE.—Nos. 1 and 2, Wood Street.

PHOTOGRAPHIC OFFICE, CALCUTTA.

No. 1, Wood Street.—Office of Assistant Surveyor General in charge Lithographic and Photographic Offices; Negative and Transfer-printing Sections (Normal and Cadastral); Zinc-printing (Normal) 6 Presses; Silver-printing and Collotype-printing.

Private House.—Monthly rent ₹350+ ₹23-6-3 taxes (since raised to ₹31-7-8).

No. 2, Wood Street.—Zinc-printing (Cadastral) 11 Presses, Heliogravure (1 copper plate press) and Electro-typing Stores.

Private House.—Monthly rent ₹265 + ₹13-6 taxes (since raised to ₹23-13-6).

LITHOGRAPHIC OFFICE.—*No. 1, Camac Street* (lower floor). Lithographic, Drawing and Printing Sections (17 Litho. Presses and 1 Lithographic Machine), Type-printing (5 Presses and 1 machine in Mathematical Instrument Office).

Private House.—Monthly rent ₹300 + ₹20-1 taxes (since raised to ₹23-4).

Total annual rent for the three houses ₹11,661-15 (with extra taxation it now amounts to ₹11,923)

2. The objections to the present location of the Lithographic and Photographic Offices are as follow:—

(I) The division of these offices, which are both under my charge, in three separate buildings, one of them at some distance from the others, is excessively inconvenient, necessitating references and visits to and fro, and rendering efficient supervision difficult. The zincographic and lithographic presses, all doing similar work, are scattered between the three houses, in small rooms; those in No. 2, Wood Street, very dark and crowded; effective and constant supervision by the assistants in charge is impossible. Were they brought together, as proposed in the new buildings, there would be less loss of power and better work could be done by the use of stone or zinc, as might be best suited to the particular class of work required. The staff being concentrated could work together to better advantage, and the whole would be more effectively superintended. This is a reform I have long wanted to introduce.

(II) The present accommodation in private dwelling houses is quite unsuitable for such special technical work and processes. It is difficult to make proper provision in hired houses for the water-supply and the heating and drying arrangements necessary for our photographic work. Most of these houses are very badly built—No. 2, Wood Street particularly so, and it was much shaken by the earthquake which occurred in July 1885. The upper floors will carry no weight, and even the lower floors in some of the houses are not strong enough for heavy presses. It is true we have carried on for many years, but these defects have added greatly to our difficulties and stopped improvements. To have to go on working year after year in a makeshift manner without suitable arrangements, must inevitably tend to make the skilled assistants lose heart in their work.

(III) The photographic glass-house was built in 1869 to last for three years, in the hope that new buildings would be ready then. It is now very much cracked and has had to be shored up. The rooms are small and unsuitable for Europeans working in the hot weather, especially with the large plates we now use. The touching up and finishing of the negatives has to be done in an open shed exposed to the weather and dust. There is no proper place for keeping negatives.

(IV) For want of proper store-rooms, the photographic chemicals and stores are scattered between Nos. 1 and 2, Wood Street. There is no suitable place for storing apparatus out of use, and it is difficult to keep things in proper order and avoid loss and waste by spoiling.

(V) The silver-printing rooms are in an old cook-house, very damp and close to a drain which is often very offensive. The accommodation is quite unsuitable for the work.

(VI) In the Lithographic Office the space for the type composing and printing is very cramped and unsuitable. The type-printing machine has to be worked by the Mathematical Instrument Office. Both it and the lithographic printing machine could easily be worked by a small engine, but it is impossible to set up such machinery in a dwelling-house. In this office also the space for stores and records is very insufficient and unsuitable.

3. The actual want of space is not so much to be complained of at present, especially in the Photographic Office, as the general unsuitability of the accommodation for the purposes of work-rooms.

4. Nothing can be done to relieve the Photographic Sections of the offices until the new Mathematical Instrument Office is completed, and that building must therefore be taken in hand first. But if money were available a commencement might also be made of the new block for the Lithographic Office and zinc-printing rooms, which could be built immediately to the south of the dividing wall between No. 9, Park Street, and No 13, Wood Street, without interfering with the work of other offices. If this were done, the two houses, No. 1, Camac Street, and No. 2, Wood Street, could be given up. The Photographic Office would remain in No. 1, Wood Street until the remaining block of new buildings could be built on the site of the present Mathematical Instrument Office. This latter building is very old and shaky and also quite unfitted for a machine factory.

5. While fully appreciating the financial difficulties which beset the Government at the present moment, I really think that this important question which has been under consideration for the past 15 years, should be dealt with without further delay if it is possible by any means to do so. The plans, as now designed, have been brought within the sanctioned estimates, though they barely do more than cover present requirements.

PHOTOGRAPHIC OFFICE, CALCUTTA.

Statement showing Expenditure (Dr.) and Value of work done (Cr.) during the Survey year, from 1st October 1885 to 30th September 1886.

Dr.	R. a. p.		Cr.	R. a. p.	
Normal Establishment.					
Superintendent's salary	5,444 1 6		Departmental maps and plans	52,502 12 11	
Assistant Superintendent's salary	2,000 0 0	7,444 1 6	Miscellaneous maps and plans, Extra-departmental	27,749 7 0	80,252 3 11
Establishment	32,150 5 0		Cadastral maps, North-West Provinces	35,470 2 0	
Rent of offices and taxes	4,502 15 6		Ditto British Burma	25,949 0 0	
Contingencies	2,586 9 11	39,239 14 5	Ditto Assam	11,475 0 0	
			Ditto Bengal	721 12 0	73,615 14 0
Cadastral Establishment.					
Superintendent's salary	5,444 1 6		Old tin and packing cases sent to the Mathematical Instrument Office	257 9 0	
Assistant Superintendent's salary	2,000 0 0	7,444 1 6	Articles and stores supplied to other offices	50 1 0	307 10 0
Establishment	33,056 15 0		Sale of unserviceable articles	147 10 9	
Office-rent and taxes	3,351 7 5		Pure silver recovered from silver residues	2,187 12 10	2,335 7 7
Contingencies	7,400 2 3	43,808 8 8			
Chemicals and stores received from England	14,669 2 3		Printing paper supplied to Litho. Office	1,638 11 0	1,638 11 0
Paper received from England	47,271 9 6	61,940 11 9			1,58,149 14 6
Stores and materials received from the Stationery Office	518 13 4		Balance against the Department	...	7,972 11 3
Printing paper and cloth received from Stationery Office	2,446 0 0	2,964 13 4			
Stores received from the Medical Store Department	81 13 0				
Work done by Her Majesty's Mint	46 0 0				
Work done by the Foundry and Shell Factory	56 9 7	184 6 7			
Stores received from the Mathematical Instrument Office	418 5 0				
Cost of repair of articles at Mathematical Instrument Office	91 11 0	510 0 0			
Cost of type transfers supplied from Litho. Office	2,586 12 0	2,586 0 0			
Total	...	1,66,122 9 9	Total	...	1,66 122 9

PHOTOGRAPHIC

Statement of Departmental Work done between

Specification of Plate or Print.	Progress made.	Scale of Map.		Number of Sheets or Subjects.	Negatives.		Photozincographic Printing.				
		Original.	Reproduced.		Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.
General Maps.		M. I.	M. I.								
Afghanistan and adjoining Country	Order completed	...	...	...	...	...	...	...	2	150	150
Burma and Regions adjacent	Do.	32=1	32=1	1	4	...	6	1	6	575	575
India shewing Railways open to Traffic, under Construction, and Survey	Negative and transfer taken last year. Order completed.	...	...	...	...	...	...	...	1	50	50
India, shewing Feeders to Railways	Order completed	32=1	32=1	6	14	...	14	6	6	600	600
Railway Map of India	...	...	...	...	...	...	...	...	34	3,800	3,600
Skeleton Map of India	Order completed	32=1	½ & ¼	6	12	...	12	3	1	250	250
Do. do. with Military Posts and Railways	...	32=1	32=1	2	20	...	20	5	5	110	110
Skeleton Map of Eastern Afghanistan and Punjab	Negatives and transfers taken. Printing in progress.	...	...	3	3	...	3	2	...	...	...
Skeleton Map of Burma and Assam											
Do. of Baluchistan and Sind											
Territories of H. H. the Khan of Khelat	...	...	...	...	...	...	...	...	4	160	160
Total	...	...	...	18	53	...	55	17	59	5,695	5,495
Provincial Maps.											
Central Provinces	Order completed	32=1	32=1	1	2	...	2	2	1	270	270
Do.	...	16=1	32=1	2	2	...	2	...	...	...	...
Total	...	...	...	3	4	...	4	2	1	270	270
Divisional Maps.											
British Burma, Pegu Division	Order completed	...	...	...	...	...	...	...	4	200	200
District Maps.											
Bannu, Dehra-Ismail-Khan, Delhi, Gurdaspur and Umballa	Order completed	...	...	...	...	...	...	...	3	1,400	5,400
Garo Hills, Lower Assam	Ditto	2=1	4=1	1	4	...	4	1	1	150	150
Bahraich, Chota-Nagpur, Dehra-Ghazi-Khan, Ferozepur, Gujranwala, Hooghly, Jhang, Jowanpur, Kamrup, Kohat, Lohardugga, Lucknow, Midnapur, Nowgong, Seoni and Sunderbuns	Ditto	4=1	4=1	13	39	...	39	12	12	2,170	7,170
Amritsar, Bannu, Gujrat, Hoshiarpur, Lahore, Ludhiana, Peshawar, and Shahabad.	Negatives and transfers taken. Printing in progress.	4=1	4=1	8	30	...	30	9	...	...	...
Betul, Bhandara, Darrang, Dehra-Dun, Goalpara, Mandla, Naga Hills, Nagpur, Nimar, Raipur, Sibsaugor, Shahpur, and Sultanpur	Ditto	4=1	8=1	13	13	...	13	3	...	...	...
Balaghat, Bilaspur, Cooch-Behar, Damoh, Gonda, Hoshungabad, Khoolna, Maldah, Midnapur, Mirzapur, Narsinghpur, Nuddea, Patna, Pilibhit, Rae-Bareilly, Shahabad, Singbhoom and Sonthal Parganas.	Ditto	4=1 6=1 8=1	8=1	19	17	...	16	4	...	...	...
Bankoora, Chittagong, and Rungpore	Order completed	8=1	8=1	2	2	...	2	1	1	1,000	3,000
Kathiawar	Ditto	10=1	10=1 16=1	2	5	...	1	2	1	540	1,080
Alighur, Allahabad, Amritsar, Backergunge, Bareilly, Cawnpore, Chittagong Hill Tracts, Chumparun, Gujrat, Gurgaon, Hissar, Hoshiarpur, Jhansi, Jullundur, Kangra, Karnal, Kumaon, Lalitpur, Lahore, Mainpuri, Multan, Partabgurh, Peshawar, Pilibhit, Purnea, Rohtak, Sialkot, and Simla.	Negatives and transfers taken last year. Order completed.	...	...	...	...	...	...	...	11	7,350	26,350
Total	...	...	...	58	110	...	105	32	29	12,610	43,150
Plans of Cities and Cantonments.											
City of Mysore and Environs	Order completed	1=12	1=12	6	24	...	24	6	6	600	600
Hutted Camps Khyra Gully, Chungla Gully, Bara Gully, Kalabagh, Jhobba, Ghoradhaka and Kunja Gully.	Ditto	1=12	1=12	6	24	...	24	6	6	120	120

Silver and other Printing.			Heliogravure and Electrotyping.					Photocollotype.		Value.	Remarks.
Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo. Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.		
										R a. p.	
...	...	...	...	...	...	...	...	...	...	19 7 3	Reprint.
...	...	...	...	...	...	...	...	...	...	190 1 0	
...	...	...	...	...	...	...	...	...	...	10 9 0	
...	...	...	...	...	...	...	...	...	...	379 5 8	
...	...	...	...	...	...	...	...	...	...	975 5 6	Ditto.
...	...	...	...	...	...	...	...	...	...	223 14 6	
...	...	...	...	...	...	...	...	...	...	297 3 2	
...	...	...	...	...	...	...	...	...	...	49 3 2	
...	...	...	...	...	...	...	...	...	...	59 2 0	Ditto.
...	...	...	...	...	...	...	...	...	...	2,204 3 3	
...	...	...	...	...	...	...	...	...	...	62 11 9	
...	...	...	...	...	...	...	...	...	...	23 4 7	
...	...	...	...	...	...	...	...	...	...	86 0 4	
...	...	...	...	...	...	...	...	...	...	45 7 9	Ditto.
...	...	...	...	...	...	...	...	...	...	188 10 4	Ditto.
...	...	...	...	...	...	...	...	...	...	76 10 8	
...	...	...	...	...	...	...	...	...	...	947 2 7	
...	...	...	...	...	...	...	...	...	...	384 4 0	
...	...	...	...	...	...	...	...	...	...	155 3 7	
...	...	...	...	...	...	...	...	...	...	211 7 11	
...	...	...	...	...	...	...	...	...	...	142 15 8	
...	...	...	...	...	...	...	...	...	...	109 2 7	
...	...	...	...	...	...	...	...	...	...	709 9 2	
...	...	...	...	...	...	...	...	...	..	2,924 9 6	
...	...	...	...	...	...	...	...	...	...	448 7 0	
...	..	...	...	...	...	...	...	...	...	322 2 2	

PHOTOGRAPHIC

Statement of Departmental Work done between

Specification of Plate or Print.	Progress made.	Scale of Map.		Number of Sheets or Subjects.	Negatives.		Photozincographic Printing.				
		Original.	Reproduced.		Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo.-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.
		M. I.	M. I.								
Plans of Cities and Cantonments— *contd.*											
Ajmere City and Environs, sheets 1 to 5	Order completed	1=12	1=12	1	1	...	5	1	5	250	250
Simla, Revised Map, sheets 1 to 4, 6 to 8, 12 and 13.	Negative and transfer taken. Printing in progress.	1=24	1=24	9	36	...	36	9	...	...	...
Saugor City and Cantonment	Order completed	1=8	1=6	4	8	...	8	2	2	300	300
Benares City, 3rd portion (in duplicate)	Negative and transfer taken only.	1=16	1=16	2	4	...	4	2	...	...	...
Bhuj City and Cantonment	Order completed	1=12	1=12	7	14	...	14	7	7	1,050	1,050
Dalhousie Sanitarium	Negative and transfer taken. Printing in progress.	1=10	1=6	4	4	...	4	1	...	...	...
Dungarpur and Environs, and Cantonment of Kherwara.	Ditto.	...	Scale	2	8	...	8	3	...	...	...
City of Baroda, sheets 1 to 16	Ditto.	...	Scale	16	31	...	29	16	...	...	...
Total		...	...	57	154	...	156	53	26	2,320	2,320
Indian Atlas.											
Sheet 47, N.W. and S.W.		...	...	...	...	...	...	1	1	...	...
Full sheet 47		4=1	4=1	1	6	...	10	1	...	...	...
Quarter-sheet 4 N.W.		4=1	4=1	1	2	...	2	1	1	3	3
Ditto. 4 S.E.	Only three tracing Prints taken.	...	...	...	...	...	...	...	1	100	100
Total		...	...	2	8	...	12	3	3	103	103
Standard Maps.											
Andaman Survey—											
Sheets 8 (12, 20), 13, 14, 15		1=4	1=4	9	24	...	24	6	6	850	850
Assam Survey—											
Sheet 30		,,	1=2	...	...	...	...	...	1	50	50
Baluchistan Survey—											
Sheets 29 N.E./3, N.W./4, S.E./3, S.W./3, 30 N.W./1·3, S.W./1		2=1	2=1	7	28	...	28	6	2	300	300
Bengal Survey—											
Tirhoot District, Chukla Girjaul, Pargana Bisara		...	...	...	...	...	...	1	1	200	200
Pargana Gudehsur		1=1	1=1	1	1	...	1	1	1	200	200
Tirhoot, Mozufferpore and Durbhunga, Pargana Maps of		1=1	1=1	5	13	...	13	...	...	...	...
Tirhoot District, Parganas Hajeepore and Ruttee		1=1	1=1	2	6	...	6	2	2	400	400
Mozufferpore, sheets 112 and 113		...	...	...	...	...	...	...	2	560	560
Durbhunga, sheets 143, 144, 170 to 173, 199, 200		...	...	...	...	...	...	...	8	2,240	2,240
Mozufferpore and Durbhunga, 114 and 145		...	...	...	...	...	...	...	2	560	560
Tirhoot District, Pargana Gurh Chawand and Burail, Jahangirabad and Kasma, Saraisa, District Mozufferpore and Durbhunga		...	...	...	...	...	...	4	...	...	...
Burma Survey—											
Bassein District—											
Sheets 104 S.E., S.W.; 112 N.E., N.W., S.E., and S.W.	Negatives and transfers taken last year. Order completed.	...	..	...	...	...	...	15	15	2,250	2,250
Sheets 113 N.E., N.W., S.E., S.W.											
,, 121 N.E., N.W., S.E.											
,, 122 N.W. and S.W.											

OFFICE, CALCUTTA.

1st October 1885 and 30th September 1886.

Silver and other Printing.			Heliogravure & Electrotyping.					Photocollotype.		Value.	Remarks.
Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo. Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.	₹ a. p.	
...	...	...	...	...	...	...	...	...	...	138 14 1	
...	...	...	...	...	...	...	...	...	...	475 3 2	
...	...	...	...	...	...	...	...	...	...	193 14 5	
...	...	...	...	...	...	...	...	...	...	54 0 0	Plate cancelled.
...	...	...	...	...	...	...	...	...	...	385 10 2	
...	...	...	...	...	...	...	...	...	...	53 1 7	
...	...	...	...	...	...	...	...	...	...	117 9 7	
...	...	...	...	...	...	...	...	...	...	464 1 7	
...	...	...	...	...	...	...	...	...	...	2,652 15 9	
...	...	...	...	...	...	...	...	..	...	8 12 0	Plate cancelled.
...	...	...	...	...	...	...	...	...	...	97 3 0	Including four Transfers for Litho: office.
...	...	...	...	...	...	...	...	...	...	36 7 0	
...	...	...	...	...	...	...	...	...	...	18 1 4	
...	...	...	...	...	...	...	...	...	...	160 7 4	
16	...	...	...	...	...	...	...	...	...	587 10 1	
...	...	...	...	...	...	...	...	...	...	14 3 1	
...	...	...	...	...	...	...	...	...	...	432 3 11	
...	...	...	...	...	...	...	...	...	...	49 6 1	
...	...	...	...	...	...	...	...	...	...	36 9 5	
...	...	...	...	...	...	...	...	...	...	168 0 0	
...	...	...	...	...	...	...	...	...	...	153 11 2	
...	...	...	...	...	...	...	...	...	...	139 6 7	
...	...	...	...	...	...	...	...	...	...	632 13 0	
...	...	...	...	...	...	...	...	...	...	163 6 9	
...	...	...	...	...	...	...	...	...	...	25 0 0	
...	...	...	...	...	...	...	...	...	...	601 8 4	Including the cost of 18 Tracing Prints.

PHOTOGRAPHIC

Statement of Departmental Work done between

Specification of Plate or Print.	Progress made.	Scale of Map.		Number of Sheets or Subjects.	Negatives.		Photozincographic Printing.				
		Original.	Reproduced.		Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.
		M. I.	M. I.								
Standard Maps—*contd.*											
***Burma Survey*—contd.**											
Districts Pegu and Hanthawaddy— Sheets 127 N.E., N.W., and S.W. ,, 115 N.E., N.W., S.E., and S.W. Sheets 128 N.E., N.W., S.E., and S.W. Sheets 96 N.E. and S.E.; 97 N.E. ,, 98 S.E.; 112 N.W. and S.W. Sheets 114 N.E., N.W., S.E. and S.W.		1=2	1=2	7	28	...	25	7	17	459	459
District Tharrawaddy— Sheets 76 N.E., N.W., S.E., and S.W. Sheets 76 $\frac{S.E.}{4}$; 77 $\frac{S.W.}{3}$; 93 S.W. ,, 95 N.E., N.W., S.E. and S.W.		1=2 1=4	1=2 1=4	11	44	...	44	10	4	108	108
District Prome— Sheets 61 and 93 ,, 77 $\frac{N.E.}{4}$; 93 $\frac{N.E.}{1\cdot3}$; 94 $\frac{S.E.}{2}$		1=2	1=1	8	8	...	8	2	...	...	...
$\frac{N.E.}{4}$ 110 $\frac{S.W.}{1}$, $\frac{N.W.}{1\cdot3}$		1=4	1=4	8	32	...	28	17	...	...	...
Sheets 123 and 111 N.W.		1=2	1=2	2	8	...	8	3	...	...	...
,, 125		1=2	1=2	4	16	...	8	...	...	...	...
,, 93 $\frac{N.E.}{2\cdot4}$, $\frac{S.E.}{1\cdot2\cdot3\cdot4}$ 94 $\frac{N.E.}{2}$	Sheets 94 $\frac{S.E.}{4}$ and										
,, 92 $\frac{S.E.}{3\cdot4}$; 94 $\frac{S.E.}{4}$ and 110 $\frac{S.W.}{3}$	110 $\frac{S.W.}{3}$ are printed off. Rest in progress.	1=4	1=4	9	36	...	40	...	2	300	300
***Burma Topographical Survey*—**											
Sheet 95 $\frac{N.E.}{4}$		1=4	1=4	1	4	...	4	1	...	...	...
***Central India and Rajputana Survey*—**											
Sheets 148 and 149		1=1	1=1	2	8	...	8	2	2	300	300
,, 95 and 118		1=1	1=1	2	8	...	8	2	2	100	100
***Cutch Survey*—**											
Sheets, 26, 27, 28, and 29		1=2	1=1	16	20	...	20	4	4	600	600
,, 3, 4, 10, and 11		1=2	1=2	1	4	...	4	1	1	150	150
,, 33, 34, 35, and 69		1=2	1=1	16	16	...	16	4	...	...	...
,, 17, 18, 24 and 25		...	...	...	...	...	...	...	1	150	150
***Deccan Survey*—**											
Sheets 64, 65, and 203		1=2	1=1	12	12	...	12	3	...	...	...
***Ghasipur District*—**											
Sheet 209 N. E., N. W., S. E. and S. W.		1=2	1=1	4	4	...	4	1	...	...	...
***Gujarat Survey*—**											
Sheets 41, 41 $\frac{N.E.}{2\cdot4}$, $\frac{N.W.}{1\cdot2}$, $\frac{S.E.}{1\cdot3}$											
,, 42 $\frac{N.W.}{1\cdot2\cdot4}$, $\frac{S.E.}{3}$, $\frac{S.W.}{1\cdot2\cdot3\cdot4}$		1=4	1=4	25	100	...	92	25	25	3,750	3,750
,, 43 $\frac{N.W.}{1\cdot2\cdot3\cdot4}$, $\frac{S.W.}{1\cdot2\cdot3\cdot4}$											
,, 50, Sections 5, 7, and 9											
,, 15 ,, 1, 2, and 3		1=2	1=2	6	24	...	24	7	7	1,050	1,050
,, 35 ,, 1, 2, 3, and 4											
,, 36 ,, 1, and 2		1=2	1=2	2	8	...	8	2	2	300	300
,, 15 and 184		1=2	1=1	1	5	...	5	1	2	300	300
,, 44		1=2	1=1	4	4	...	4	1	...	...	...
,, 36 $\frac{N.E.}{2\cdot4}$ and $\frac{S.E.}{3}$		1=4	1=4	5	20	...	20	4	1	150	150
,, 50, Sections 6 and 8											

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Silver and other Printing.			Heliogravure and Electrotying.					Photocollotype.		Value.	Remarks.
Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Photo-electrotyped Plates.	Heliogravure Photo-etched Plates.	Heliogravure Prints.	Photo. Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.		
										R a. p.	
...	...	...	...	...	...	...	...	...	...	713 1 11	
...	...	...	...	...	...	...	...	...	...	621 9 10	
...	...	...	...	...	...	...	...	...	...	113 1 7	
...	...	...	...	...	...	...	...	...	...	455 6 5	
...	...	...	...	...	...	...	...	...	...	114 9 7	
...	...	...	...	...	...	...	...	...	...	145 3 2	
...	...	...	...	...	...	...	...	...	..	516 7 1	
...	...	...	...	...	...	...	...	...	...	54 0 0	
...	...	...	...	...	...	...	...	...	...	191 8 0	
...	...	...	...	...	...	...	...	...	...	147 6 0	
...	...	...	...	...	...	...	...	...	...	434 1 0	
...	...	...	...	...	...	...	...	...	...	104 14 9	
...	...	...	...	...	...	...	...	...	...	211 3 1	
...	...	...	...	...	...	...	...	...	...	47 2 0	
...	...	...	...	...	...	...	...	...	...	175 0 0	
...	...	...	...	...	...	...	...	...	...	54 0 0	
...	...	...	...	...	...	...	...	...	...	2,363 8 0	
...	...	...	...	...	...	...	...	...	...	642 11 10	
...	...	...	...	...	...	...	...	...	...	209 13 5	
...	...	...	...	...	...	...	...	...	...	160 9 2	
...	5	...	...	...	...	...	...	...	...	52 12 9	
...	...	...	...	...	...	...	...	...	...	307 4 0	
	...	...	...	...	...	...	...	...	...		

Statement of Departmental Work done between

Specification of Plate or Print.	Progress made.	Scale of Map.		Number of Sheets or Subjects.	Negatives.		Photozincographic Printing.				
		Original.	Reproduced.		Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.
		M. I.	M. I.								
Standard Maps—*contd.*											
***Gujarát Survey*—contd.**											
Sheets 18 and 37, Section 1		1=2	1=2	2	8	...	8	2	...	...	...
,, 18 and 13 ,, 2											
,, 18		1=2	1=1	4	4	...	4	1	...	...	...
,, 50 Supplement to Sections 1, 3, and 10		...	...	...	...	...	...	...	3	450	450
***Hissar District*—**											
Sheets 242 S. E., 243 N. E., S. E.											
,, 257 N.E.,N. W.,S. E. and S. W.											
,, 258 N.E.,N.W.,S. E. and S. W.											
,, 259 N.E.,N.W.,S. E. and S. W.		1=2	1=2	23	92	...	92	23	23	3,450	3,450
,, 260 N.E.,N W.,S. E. and S. W.											
,, 261 N.E.,N.W.,S. E. and S. W.											
***Hooghly River Survey*—**											
Sheet 1 Q R.											
,, 2,Sections C. D.											
,, 6 ,, A. D. E. F. G. H. I. K.											
,, 7 ,, C. D. E. F. G. H. I.		1=16	1=16	32	64	...	60	18	15	3,000	6,000
,, 7 ,, J. K. L. M. N.											
,, 8 ,, C. F. G. H. I. J. K. L.											
,, 6, 7, and 8		1=6	1=6	3	12	...	12	3	3	18	18
,, 4, 6, 7, 9 and 10		1=3	1=3	5	20	...	20	5	5	10	10
,, 1, 2, 3, and 4		1=8	1=6	8	16	...	16	4	4	600	600
,, 1, Sections L. M. N. O. P.											
,, 2 ,, A. B. E. F. G. H. I. J. K.											
,, 3 ,, E. and H.		1=16	1=16	32	33	...	32	33	...	...	...
,, 4 ,, H. I. J. K. L. M. N. O. P.											
,, 5 ,, E. J. K. L. O. P. and Q.											
,, 6 ,, B. C.											
,, 7 ,, A. B.											
,, 8 ,, A. B. D. E.											
,, 5 ,, A. B. C. D. F. G. H. I. M. N.		1=16	1=16	38	76	...	86	21	17	4,200	8,400
,, 9 ,, A. B. C. D. E. F. G. H. I.											
,, 3 ,, A. B. C. D. F. G. I. J. K.											
,, 4 ,, A. B. C. D. E. F. G.											
,, 1 and 2		1=6	1=6	2	8	...	8	2	2	300	300
,, 1, Sections A. and E., B. and P., D. and H., I. and K.		...	...	...	...	...	...	...	6	1,200	1,200
***Hyderabad Survey*—**											
Daverconda Circar—											
Isolated portion of		1=1	1=1	2	6	...	6	2	2	150	150
Koilkondah Circar—											
Sheets (100, 101, 124, 125)											
,, (102, 103, 126, 127)		2=1	2=1	3	11	...	11	3	3	225	225
,, (104, 105, 128, 129)											
Moodgul Circar—											
Sheets 54, 55, 56, 57, 30, 31, 32											
,, (33 and 58), (82 and 108)		1=1	1=1	14	43	...	43	14	13	975	975
,, (53, 80A and 106), 80, 81, 83, 84											
Mulkaid Circar—											
Sheets (106, 130), (101, 102, 103, 125, 126, 127)		2=1	2=1	3	9	...	9	3	3	225	225
,, (104, 105, 128, 129)											
Yedgary Circar—											
Sheets (104 and 105)		1=1	1=1	1	3	...	3	1	1	75	75
***Jullundur, Ludhiana and Kupurthala States*—**											
Sheets 251 N.E., N.W., S.E. and S.W.		1=2	1=1	4	4	...	4	1	1	150	150
***Kathiawar Survey*—**											
Sheets 21 and 35											
,, 26, 28, 29, and 45											
,, 6, 7, 9, 12, 15, 16, 17, 22, 24		1=2	1=1	81	93	...	93	20	21	3,150	3,150
,, 27, 32, 33, 43, 52, and 53											

OFFICE, CALCUTTA.

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Silver and other Printing.			Heliogravure and Electrotyping.					Photocollotype.		Value.	Remarks.
Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo-Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.		
										R a. p.	
...	...	...	...	...	...	...	...	...	...	106 12 9	
...	...	...	...	...	...	...	...	...	...	52 12 9	
...	...	...	...	...	...	...	...	...	...	141 13 3	
...	...	...	...	...	...	...	...	...	...	2,262 12 9	
...	...	...	...	...	...	...	...	...	...	1,608 6 9	
...	...	...	...	...	...	...	...	...	...	161 1 3	
...	...	...	...	...	...	...	...	...	...	287 9 5	
...	...	...	...	...	...	...	...	...	...	358 11 9	
...	...	...	...	...	...	...	...	...	...	774 0 0	
...	...	...	...	...	...	...	...	...	...	2,093 3 7	
...	...	...	...	...	...	...	...	...	...	181 2 8	
...	...	...	...	...	...	...	...	...	...	227 10 0	
...	...	...	...	...	...	...	...	...	...	140 10 0	
...	...	...	...	...	...	...	...	...	...	239 7 3	
...	...	...	...	...	...	...	...	...	...	927 10 6	
...	...	...	...	...	...	...	...	...	...	210 10 0	
...	...	...	...	...	...	...	...	...	...	68 12 5	
...	...	...	...	...	...	...	...	...	...	95 12 0	
...	...	...	...	...	...	...	...	...	...	2,124 12 5	

PHOTOGRAPHIC

Statement of Departmental Work done between

Specification of Plate or Print.	Progress made.	Scale of Map.		Number of Sheets or Subjects	Negatives.		Photozincographic Printing.				
		Original.	Reproduced.		Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.
		M. I.	M. I.								
Standard Maps—*contd.*											
Kohat Survey—											
Sheet 7		1=1	1=1	1	4	...	4	1	1	150	150
Konkan Survey—											
Sheet 79 N.E./1, 2, 3, 4; N.W./1, 2, 3, 4; 80 N.E./1, 2, 3, 4; N.W./1, 2, 3, 4; S.E./1, 2, 3, 4; S.W./1, 2, 3, 4; 81 N.E./1, 2, 3, 4; N.W./2,4; S.E./1, 2, 3, 4; S.W./2, 4; 82 N.E./1, 2, 3, 4; S.E./1, 2, 3, 4; 4A S.W./3; 4B S.E./1, 2, 3, 4; 7 N.E./3; N.W./1,3; S.E./1, 3, 4; S.W./1, 2, 3, 4; 7A N.E./1, 2, 3, 4; N.W./1,3; S.E./1, 2, 3, 4; S.W./1, 2, 3, 4; 79, 82, 135, 161.		1=2 / 1=4	1=1 / 1=2 / 1=4	53	134	...	134	53	42	6,541	6,541
Meerut Division—											
Aligbar and Etah District—											
Sheet 52 N.E., N.W., S.E. and S.W.											
,, 53 N.E., N.W., S.E. and S.W.											
,, 37 N.W.											
Aligbar District—		1=2	1=2	11	44	...	44	11	4	600	600
Sheet 23 N.W., S.E.											
,, 35 N.E., N.W., S.E., S.W.											
Mirzapur District—											
Sheet 186 N.E., N.W., S.E. and S.W.											
,, 187 N.E., 201 S.E., 202 N.E., N.W.	Order completed.	1=2	1=2 / Half scale	6	24	...	26	8	9	1,350	1,350
,, 186, 187 and 200.											
Montgomery District—											
Sheets 147, 148 149, 150, 170, 171, 172 173, 175, 194, 195, 196, 197, 198, 211 and 212		...	..	...	...	...	...	...	16	4,480	4,480
Mysore Survey—											
Sheets 3, 22, 24, 25, 26, 42, 49, 51, 52, 53, 54, 58, 59, 60, 61, 62, 63, 64, 67, 68 and 69		1=1	1=1	12	48	...	48	14	14	1,950	1,950
North-East Trans-frontier—											
Sheets 14 N.W./3·4; 14 N.W.; 7, 10, 11		...	...	...	...	...	...	3	6	900	900
,, 22 N.W.; N.W./1·3		2=1 / 4=1	2=1 / 4=1	3	12	...	12	3	3	450	450
,, 22		8=1	8=1	1	2	...	2	1	1	50	50
North-West Trans-frontier—											
Sheet 29 S.E./1·3; S.W.; 30 N.W./·3; S.W./1		...	...	...	...	...	...	3	7	950	850
,, 28 N.W., (a portion only)		4=1	4=1	1	1	...	1	1	1	150	150
,, 20 S.E.; S.W.; 21 N.E.; N.W.; S.E.											
,, 22 N.E./2·4; N.E.; 30 N.W./1·3		...	...	...	...	...	...	...	19	1,000	850
,, 29 S.E./1; 28 N.E.; N.W.; 27 S.E.											
,, 30 N.W.; S.W. (Baluchistan)		4=1	4=1	1	8	...	8	2	2	300	300
,, 29 S.E.; S.E./3		2=1 / 4=1	Scale	2	8	...	8	2	2	300	300
Rawal Pindi Survey—											
Sheets 162 N.E./1, 2, 3, 4		1=4	1=4	4	8	...	8	4	...	...	...
,, 185 S.W./2, 3, 4; 186 N.W./1, 2, 3, 4;		1=4	1=4	6	17	...	15	6	...	...	...
,, 160 N.E./2, 3, 4; S.E./3,4; 161 N.E./2,3; S.E./2											
,, 183 S.W./3; 186 S.W./1, 2, 3, 4		1=4	1=4	10	36	...	36	10	...	...	...
Total		...	...	538	1,329	...	1,315	410	359	52,676	59,626

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Silver and other Printing.			Heliogravure and Electrotyping.					Photocollotype.		Value.	Remarks.
Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo-Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.		
										R a. p.	
...	...	...	...	...	...	...	...	...	...	83 2 0	
...	...	...	...	...	...	...	...	...	...	3,564 1 7	Including the cost of five Tracing Prints.
...	...	...	...	...	...	...	...	...	...	769 3 5	
...	...	...	...	...	...	...	...	...	...	739 9 9	
...	...	...	...	...	...	...	...	...	...	1,233 3 2	
...	...	...	...	...	...	...	...	...	...	1,230 5 3	
...	...	...	...	...	...	...	...	...	...	246 15 3	
...	...	...	...	...	...	...	...	...	...	308 2 9	
...	...	...	...	...	...	...	...	...	...	49 1 4	
...	...	...	...	...	...	...	...	...	...	208 15 0	
...	...	...	...	...	...	...	...	...	...	55 2 2	
...	...	...	...	...	...	...	...	...	...	195 14 1	Reprint.
...	...	...	...	...	...	...	...	...	...	195 1 7	
...	...	...	...	...	...	...	...	...	...	191 7 11	
...	...	...	...	...	...	...	...	...	...	147 8 0	
...	...	...	...	...	...	...	...	...	...	264 1 0	
...	...	...	...	...	...	...	...	...	...	486 4 9	
16	5	...	...	...	...	...	...	...	...	32,871 2 6	

PHOTOGRAPHIC

Statement of Departmental Work done between

Specification of Plate or Print.	Progress made.	Scale of Map.		Number of Sheets or Subjects.	Negatives.		Photozincographic Printing.				
		Original.	Reproduced.		Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.
Index Maps.		M. I.	M. I.								
Rajputana		...	...	...	...	...	...	1	1	100	100
Dehra-Dun, Gorakhpur, Kamrup, and Sambulpur		...	...	...	...	...	...	...	3	1,550	2,200
North-East Trans-Frontier		...	...	...	...	...	...	...	1	100	100
Shwegyin District, Season's operations		4=1	Scale	1	1	...	1	...	2	34	34
South Maratha Survey		16=1	16=1	1	1	...	2	1	1	25	25
Ditto ditto		12=1	16=1	1	1	...	1	1	1	60	60
Trans-frontier of India		128=1	256=1	1	1	...	1	1	2	550	550*
Mozufferpore District		8=1	12=1	1	1	...	1	1	1	25	25
Punjab		...	...	...	...	...	2	1	1	1,050	550
North-West Trans-frontier		64=1	156=1	1	1	...	1	...	1	100	100
Ditto (Revised)		...	Reduced	1	1	...	1	1	...	...	...
H. H. the Nizam's Dominions		16=1	Reduced	2	2	...	2	1	1	50	50
Ditto ditto		16=1	32=1	2	2	...	2	1	1	50	50
Ditto Madras Sheet 1		32=1	64=1	1	1	...	1	1	...	...	...
Ditto Madras and Sindh Sheets 1 and 2		...	Scale	3	4	...	4	1	1	12	36
Ditto Madras and Sindh, Sheets 1 and 2		...	Reduced	3	3	...	3	1	1	50	150
North Trans-frontier and South-East Trans-frontier		...	...	...	...	...	2	2	...	...	...
Akyab, Andaman, Bassein, Cutch, Henzada, Hanthawaddy, Punjab, &c.		16=1 16=1 18=1	Scale 24=1 36=1	5	5	...	5	1	3	1,550	3,300
Ajmere, Basti, Burma, Garo, Khasi and Naga Hills and Merwara.		24=1 4=1 12=1	32=1 6=1 24=1	5	5	...	5	1	2	1,300	2,750
Akyab, Ajmere, Andaman, Bassein, Basti, Burma, Baluchistan, Cutch, Dehra-Dun, Deccan, Gorakhpur, Khasi and Garo Hills, Gujarat, Hanthawaddy, Henzada, Kamrup, Merwara, Mirzapur, Punjab, Rajputana, and Sambalpur.		...	...	...	...	...	...	...	9	650	1,050
Gujarat		24=1	32=1	1	1	...	1	1	2	775	550
Assam, Bengal, Burma and Punjab Provinces		24=1	50=1 48=1 52=1	4	4	...	4	1	4	1,060	1,240
Bengal and Punjab Provinces		...	...	...	...	...	1	1	1	50	100
Hooghly River Survey		25=1	4=1	1	1	...	1	1	1	50	50
Ajmere, Akyab, Bijaspur, Darrang and Kamrup		... 16=1	Reduced 16=1	3	3	...	3	1	...	...	...
Nepal Boundary		...	...	1	1	...	1	1	...	...	...
Deccan, Konkan, Mirzapur and Rajputana		16=1 24=1 16=1	Scale . 32=1	3	3	...	3	3	3	1,550	2,200
Mozufferpore and Sambalpur		4=1	8=1	1	1	...	2	1	...	...	...
Andamans and South Maratha		16=1	24=1	1	1	...	3	1	...	...	...
Trans-frontier of India and North-West Trans-frontier		...	Reduced	2	2	...	2	1	...	...	..
Ajmere		4=1	6=1	1	1	...	1	1	...	...	...
Rajputana		24=1	24=1	1	1	...	1	...	1	150	150
Akyab, Basti, Deccan, Gorakhpur and Konkan		... ...	Scale . Reduced	5	5	...	5	1	...	...	...
Gujarat		...	Reduced	1	1	...	...	...	...	...	...
Cutch		16=1	32=1	1	1	...	...	...	...	...	...
Damoh and Jubbulpore District		8=1	12=1	1	1	...	...	...	...	...	...
Total		...	...	55	56	...	62	30	44	10,891	15,420
Technical Charts.											
Triangulation Charts of Bhopal and Malwa Survey and of North-East Frontier Survey, Degree Sheets XIV and XXV		4=1	4=1	2	4	...	4	2	2	50	50
Triangulation Chart of North-East Frontier Survey, Degree Sheet X.		...	...	...	...	...	...	...	1	25	25
Total		...	...	2	4	..	4	2	3	75	75
Miscellaneous Maps and Plans.											
Province of Assam, illustrating percentage under Rice, Tea, Mustard to Total Cultivation		...	...	...	...	...	...	5	6	1,053	1,053

OFFICE, CALCUTTA.

1st October 1885 and 30th September 1886—continued.

Silver and other Printing.			Heliogravure and Electrotyping.					Photocollotype.		Value.	Remarks.
Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo-Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.		
										R a. p.	
...	...	...	...	...	...	...	...	...	...	13 12 10	
...	...	...	...	...	...	...	...	...	...	173 4 11	
...	...	...	...	...	...	...	...	...	...	11 9 5	
...	...	...	...	...	...	...	...	...	...	28 0 4	Including the cost of four tracing prints.
...	...	...	...	...	...	...	...	...	...	26 9 1	
...	...	...	...	...	...	...	...	...	...	17 0 0	
...	...	...	...	...	...	...	...	...	...	51 15 3	*Out of 550 copies 500 reprinted.
...	...	...	...	...	...	...	...	...	...	15 12 2	
...	...	...	...	...	...	...	...	...	...	94 0 2	
...	...	...	...	...	...	...	...	...	...	13 4 8	
...	...	...	...	...	...	...	...	...	...	13 2 0	Plate cancelled.
...	...	...	...	...	...	...	...	...	...	27 14 9	
...	...	...	...	...	...	...	...	...	...	37 2 3	
...	...	...	...	...	...	...	...	...	...	9 14 6	
...	...	...	...	...	...	...	...	...	...	60 0 9	
...	...	...	...	...	...	...	...	...	...	48 13 0	
...	...	...	...	...	...	...	...	...	...	14 1 7	Ditto.
...	...	...	...	...	...	...	...	...	...	220 5 10	
...	...	...	...	...	...	...	...	...	...	191 12 9	
...	...	...	...	...	...	...	...	...	...	59 5 0	Reprint.
...	...	...	...	...	...	...	...	...	...	71 3 9	
...	...	...	...	...	...	...	...	...	...	107 7 2	
...	...	...	...	...	...	...	...	...	...	8 10 0	
...	...	...	...	...	...	...	...	...	...	17 4 2	
...	...	...	...	...	...	...	...	...	...	38 0 0	
...	...	...	...	...	...	...	...	...	...	21 14 0	
...	...	...	...	...	...	...	...	...	...	212 8 9	
...	...	...	...	...	...	...	...	...	...	16 12 9	
...	...	...	...	...	...	...	...	...	...	28 3 2	
...	...	...	...	...	...	...	...	...	...	30 15 0	
...	...	...	...	...	...	...	...	...	...	13 12 9	
...	...	...	...	...	...	...	...	...	...	18 15 4	
...	...	...	...	...	...	...	...	...	...	58 6 9	
...	...	...	...	...	...	...	...	...	...	5 6 4	
...	...	...	...	...	...	...	...	...	...	5 1 7	
...	...	...	...	...	...	...	...	...	...	6 4 9	
...	...	...	...	...	...	...	...	...	...	1,788 11 6	
...	...	...	...	...	...	...	...	...	...	87 9 5	
...	...	...	...	...	...	...	...	...	...	13 6 1	
...	...	...	...	...	...	...	...	...	...	100 15 6	
...	...	...	...	...	...	...	...	...	...	205 14 8	

PHOTOGRAPHIC

Statement of Departmental Work done between

Specification of Plate or Print.	Progress made.	Scale of Map.		Number of Sheets or Subjects.	Negatives.		Photozincographic Printing.				
		Original.	Reproduced.		Number of Negatives (Direct).	Number of Negatives reversed and transparencies.	Number of Photo-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.
		M. I.	M. I.								
Miscellaneous Maps and Plans— *contd.*											
Bankoora and Manbhoom Districts— Main Circuit Maps, Nos. 7, 5 and 9, transferred to Burdwan District		1=1	1=1	3	11	...	11	3	3	450	450
Burdwan District—Main Circuit Maps, Nos. 1 to 10		1=1	1=1	12	32	...	32	12	12	1,800	1,800
North-West Frontier, country on either side of		32=1	32=1	1	6	...	6	3	3	74	74
Ditto		...	...	...	...	...	...	...	4	350	350
Baluchistan, portion of Sheet 29 N.W. and S.W.		4=1	3=1	1	1	...	1	1	1	1	1
Gujarat— Sheet 15, Sections 1, 2, 3		1=2	4=1	6	6	...	...	...	...	...	...
,, 35 ,, 1, 2, 3											
Baila, route to and from		...	...	...	...	...	...	1	1	20	20
Graticule scales		...	Scale	1	1	...	1	1	1	80	80
Scale for reducing relative height		...	½ scale	1	1	...	1	1	1	20	20
Irrawaddy River		...	Scale	1	4	...	8	3	3	300	300
Explanation of signs and abbreviations		...	Do.	1	1	...	1	1	1	50	50
North-East Trans-frontier, Sheets 7, 10, and 11		...	½ scale	3	3	...	...	...	...	...	...
Specimen of Engraved Hill Shading		4=1	2=1	3	3	...	...	...	...	...	...
Sketch of Hill drawing for Model Map		...	Scale	1	1	...	1	1	1	50	100
Kohat Survey, Sheet 7		1=1	4=1	1	1	...	...	...	...	...	...
Mysore, Sheets 3, 51, 52, 53, 55, 58, 59, 60, 61, 62, 64, 67, 68, and 69		1=1	4=1	14	14	...	...	...	...	...	...
Mysore, part of Sheet No. 6		...	...	...	...	...	...	...	...	...	...
Contour Map of India		32=1	64=1	6	6	...	5	2	...	...	...
Photographic, Lithographic and Mathematical Instrument Offices Plans and General Block Plan		20=1	20—1 Reduced	4	18	...	18	4	4	80	80
Ramsden's Zenith Sector		...		1	2	...	...	...	...	...	...
Arabian Sea, Indian Ocean and Gulfs of Aden and Persia		...	½ scale	9	5	...	5	1	1	225	225
Map of India		128=1	96=1	1	1	...	1	...	...	...	...
Benares City, Skeleton Map of		32=1	8=1	1	1	...	...	...	...	...	...
Kwin Maps, 16", Titles for		...	Scale	32	4	...	4	1	1	90	957
Mandalay, Map of various Military reconnoisances in the neighbourhood of		2=1	2=1	1	4	...	4	1	1	250	250
Specimens showing borders, scale 2=1, 1=1		1=1	Scale	3	8	...	8	1	1	400	400
Star Finder (Diagram)		...	½ scale	1	1	...	1	1	1	12	12
Kumaon and British Gurhwal, Sheet 1, (a portion)		1=1	1=1	1	1	...	...	...	...	...	...
Rajputana, sheets 148 and 149		1=1	4=1	2	2	...	...	...	...	...	...
Gwalior and Central India, sheets 85 and 99		1=1	4=1	2	2	...	...	...	...	...	...
Chart of the Suakim Survey and Reconnoissance Map of Country near Suakim		1=2 / 1=4	Scale	2	8	...	8	2	2	75	75
Triangulation Chart Suakim Survey		...	...	...	...	...	...	...	1	5	5
Burma— Sheets 92 S.E./3,4, 93 N.E./1, 2, 3, 4, S.E./1, 2, 3, 4, 94 N.E./2,4, S.E./2, 110 N.W./1,3, S.W./1,3		1=4	1=2	17	17	...	...	...	...	...	...
Cadastral maps, heading for		...	Scale	2	2	...	...	...	...	...	...
Map of Berar		8=1	12=1	1	2	...	...	...	...	...	...
Register of Expenditure and Receipts of Printing and Miscellaneous Stores		...	...	...	...	...	...	1	1	100	100
A. B. C. Maps, 6		...	...	...	...	...	...	...	2	12	18
Carte de l' Indo-Chine Orientale		...	...	...	...	...	...	1	1	150	150
Telegraph Map of India		...	...	...	...	...	...	...	6	300	300
Bhootia Teapot		...	...	...	...	...	...	1	1	50	50
Form showing Zamindars' and Patwaris' receipts		...	½ scale	1	1	...	1	1	1	1,750	14,000
Scale of contours		...	Scale	1	1	...	1	1	...	...	...
Cadastral work, Register of		...	...	...	...	...	...	1	1	200	200
Burma Survey—											
Sheet 93, Specimen Map of		...	...	...	...	...	...	...	1	100	100
,, 93 S. W. do.		...	...	...	...	...	...	1	1	100	100
Various grains		...	...	...	...	...	...	...	...	...	...

OFFICE, CALCUTTA.

1st October 1885 and 30th September 1886—continued.

Silver and other Printing.			Heliogravure & Electrotyping.					Photo-collotype.		Value.	Remarks.
Number of Silver Prints.	Number of Blue prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo-Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.		
										R a. p.	
...	...	...	...	...	...	...	...	...	...	241 2 3	
...	...	...	...	...	...	...	...	...	...	865 13 1	
...	...	...	...	...	...	...	...	...	...	151 15 10	
...	...	...	...	...	...	...	...	...	...	71 12 7	Reprint.
...	...	...	...	...	...	...	...	...	...	19 11 0	
...	12	...	...	...	...	...	...	...	...	43 2 0	
...	...	...	...	...	...	...	...	...	...	14 3 6	
...	...	...	...	...	...	...	...	...	...	17 3 3	
...	...	...	...	...	...	...	...	...	...	22 2 0	
...	...	...	...	...	...	...	...	...	...	127 2 0	
...	...	...	...	...	...	...	...	...	...	25 0 0	
...	...	...	...	...	...	...	...	...	...	18 12 0	
3	...	...	...	...	...	...	...	...	...	31 4 0	
... 4	...	...	...	...	...	...	...	...	...	41 6 6	
	...	...	...	...	...	...	...	...	...	9 6 0	
16	32	...	...	...	...	...	...	...	...	111 11 0	
2	...	...	...	...	...	...	...	...	...	1 14 0	
...	...	...	...	...	...	...	...	...	...	91 4 0	
...	...	...	...	...	...	...	...	...	...	286 9 5	
1	...	...	...	...	...	...	...	...	...	15 10 0	
...	...	...	...	...	...	...	...	...	...	80 8 3	
...	...	...	...	...	...	...	...	...	...	12 3 0	
1	...	...	...	...	...	...	...	...	...	6 11 6	
...	...	...	...	...	...	...	...	...	...	103 14 0	
...	...	...	...	...	...	...	...	...	...	111 4 1	
...	...	...	...	...	...	...	...	...	...	186 2 0	
...	...	...	...	...	...	...	...	...	...	16 8 0	
...	...	...	...	...	...	...	...	...	...	6 9 0	
8	...	...	...	...	...	...	...	...	...	16 3 0	
8	...	...	...	...	...	...	...	...	...	16 3 0	
...	...	...	...	...	...	...	...	...	...	103 7 5	
...	...	...	...	...	...	...	...	...	...	2 1 1	Reprint.
51	...	...	...	...	..	...	...	...	...	285 10 0	
...	...	...	...	...	...	2	...	...	...	40 10 0	
2	...	...	...	...	...	...	...	...	...	19 13 0	
...	...	...	...	...	...	...	...	...	...	14 7 3	
...	...	...	...	...	...	...	...	...	...	7 10 11	Reprint.
...	...	...	..	...	...	...	...	...	...	40 12 6	
...	...	..	...	...	...	...	...	...	...	72 2 8	
...	...	...	...	...	...	...	...	1	50	24 14 4	Reprint. Two good Collotype Transfers taken for experiment.
...	...	...	...	...	...	...	..	...	...	350 8 6	
...	...	...	...	...	...	...	...	...	...	10 12 9	
...	...	...	...	...	...	...	...	...	..	28 5 0	
...	...	...	...	...	...	...	...	...	...	119 11 3	
...	...	...	...	...	...	...	...	...	...	20 11 3	
...	...	...	...	...	...	...	..	12	...	15 0 0	Experimental Plates.

Statement of Departmental Work done between

Specification of Plate or Print.	Progress made.	Scale of Map.		Number of Sheets or Subjects.	Negatives.			Photozincographic Printing.				
		Original.	Reproduced.		Number of Negatives (Direct).	Number of Negatives reversed.	Transparencies.	Number of Photo-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.
Miscellaneous Maps and Plans—*contd.*		M. I.	M. I.									
Carved sandal-wood Book-stand ends, Aftaba and Chilumchee		...	...	2	...	2	2	...	...	...	...	...
Ordnance Survey of Ireland—Sheets 105, 151 and 191		...	...	...	...	...	3	...	...	...	...	...
Stone-carving, Plate of		...	...	...	...	1	...	...	...	...	...	...
Specimen Map (Cadastral)		...	Scale	1	1	...	...	1	...	...	309	1,850
Special Map		...	...	...	...	...	...	...	...	1	...	...
Postal Map of Bengal		...	...	...	...	...	...	...	...	12	60	60
Northern Burma and Regions adjacent		...	...	...	...	...	...	...	...	1	50	50
Sketch Map of the Country round Mandalay		...	...	...	...	...	...	...	...	1	50	50
India: Physical Configuration of India, shewing Cultivated and Irrigated area; Table to illustrate the Trade of India with the world.		...	...	...	...	...	...	...	...	3	15	30
Pishin Valley, plane-table of, by Captain Gore, R.E.		...	...	...	...	...	...	6	...	2	200	200
Metric Tables		...	...	...	...	...	...	4	1	...	...	...
Reconnoissance Map of Burma—Sheets 23 N. W. and S.W.		4=1	4=1	2	6	...	...	6	...	...	...	...
Kathiawar—Sheets 32, 43, 45, 52 and 53		...	...	...	...	...	...	...	...	...	...	...
Mirzapur—Sheets 186 N.E., N.W., S.E. and S.W.; 187 N.E.; 201 S.E.; 202 N.E. and N.W.		...	...	...	...	...	...	...	...	...	...	...
Colonel Tanner's Sketches		...	...	...	...	...	...	...	...	...	...	...
Jewellery and Textile Fabrics		...	...	...	...	...	...	...	...	...	...	...
Map of Agra and surrounding Country		...	...	...	...	...	...	...	...	...	...	...
Photographs of Native Musical Instruments		...	...	...	...	...	...	...	...	...	...	...
Photographs of Ancient Cuttack Sculptures		...	...	...	...	...	...	...	...	...	...	...
Views of the Archæological Survey		...	...	...	...	...	...	...	...	...	...	...
Travancore Jewellery		...	...	...	...	...	..	...	...	...	...	...
Burmese Do.		...	...	...	...	...	...	...	...	...	...	...
Mooltan Pottery		...	...	...	...	...	1	...	...	...	...	...
Darjeeling, Map of		...	...	...	...	...	1	...	...	...	...	...
Indian Atlas—Quarter Sheet 77 S. E. (Original and Duplicate)		...	...	2	...	...	...	...	...	...	...	...
Ditto 28 S. W. (Original and Duplicate)		...	...	2	...	...	...	...	...	...	...	...
Ditto 28 S. E. (Ditto)		...	...	2	...	...	...	...	...	...	...	...
Ditto 39 N. W. (¼ portion.)		...	...	1	1	...	1	...	...	...	...	...
Ditto 6 S. E. (portion)		...	...	1	1	..	...	...	...	...	...	...
Ditto 61 S. E.		...	...	1	...	...	...	...	...	...	...	...
Ditto 76 S. W.		...	...	1	...	...	...	...	...	...	...	...
Ditto 39 N. W.		...	...	1	...	...	...	...	...	...	...	...
Ditto 15 N. E.		...	...	1	1	...	...	...	...	...	...	...
Ditto 6 S. E.	1	...	...	1	1	...	...	...	...	...	...	...
Ditto 38 S. W.		...	...	1	1	...	...	...	...	...	...	...
Map of India, Sheet No. 1 (Original and Duplicate)		32—1	32—1	2	...	...	...	...	...	...	...	...
Ditto Sheet No 2		32—1	...	1	...	...	...	...	...	...	...	...
View of Snows		...	...	...	...	...	...	...	...	...	...	...
Viceroy's Crest		...	...	...	...	...	...	...	...	...	...	...
Making Tracing Prints		...	...	...	...	...	...	...	...	...	...	...
Total		...	...	159	183	3	8	135	53	84	8,831	23,560
ABSTRACT OF DEPARTMENTAL WORK.												
General Maps		...	...	...	18	53	...	55	17	59	5,695	5,495
Provincial Maps		...	...	...	3	4	...	4	2	1	270	270
Divisional Maps		...	...	...	...	...	...	...	...	4	200	200
District Maps		...	...	...	58	110	...	105	32	29	12,610	43,150
Plans of Cities and Cantonments		...	...	...	57	154	...	156	53	26	2,320	2,320
Atlas Sheets		...	...	...	2	8	...	12	3	3	103	103
Standard Sheets		...	...	...	538	1,329	...	1,315	410	359	52,676	59,626
Index Maps		...	...	...	55	56	...	62	30	44	10,891	15,420
Technical Charts		...	...	...	2	4	...	4	2	3	75	75
Miscellaneous Maps and Plans		...	...	...	159	183	11	135	53	84	8,831	23,560
Transfers and Proofs		...	...	...	...	...	...	...	...	...	2,690	...
Total		...	...	...	892	1,901	11	1,848	602	612	96,361	150,219

OFFICE, CALCUTTA.

1st October 1885 and 30th September 1886—continued.

Silver and other Printing.			Heliogravure and Electrotyping.					Photocollotype.		Value.	Remarks.
Number of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Plates Photo-electrotyped.	Heliogravure Plates Photo-etched.	Heliogravure Prints.	Photo. Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.		
										₹ a. p.	
...	...	...	...	...	...	...	...	...	...	11 8 2	
...	...	...	...	...	...	...	...	7	795	334 3 7	
...	...	...	...	...	...	...	...	1	...	...	
...	...	...	...	...	...	...	...	...	...	84 14 5	
...	...	...	...	...	...	...	...	...	...	9 9 7	
...	...	...	...	...	...	...	...	...	...	35 4 0	Reprint.
...	...	...	...	...	...	...	...	...	...	11 4 10	
...	...	...	...	...	...	...	...	...	...	15 12 10	Ditto.
...	...	...	...	...	...	...	...	...	...	6 1 10	Ditto.
...	...	...	...	...	...	...	...	...	...	83 15 7	From old negative.
...	...	...	...	...	...	...	...	...	...	27 9 0	Ditto.
...	...	...	...	...	...	...	...	...	...	84 0 0	
...	75	...	...	...	...	...	...	...	...	9 1 10	
...	28	...	...	...	...	...	...	...	...	3 2 5	
12	...	...	...	...	...	...	...	...	...	17 6 5	
10	...	...	...	...	...	...	...	...	...	13 3 2	
2	...	...	...	...	...	...	...	...	...	1 12 9	
2	...	...	...	...	...	...	...	...	...	4 8 0	
7	...	...	...	...	...	...	...	...	...	21 9 7	
25	...	...	...	...	...	...	...	...	...	19 3 2	
...	...	2	...	1	...	...	...	...	...	100 0 0	
...	...	2	...	1	...	...	...	...	...	100 0 0	
...	...	6	...	1	...	...	...	...	...	100 0 0	
...	...	1	...	1	...	...	...	...	...	100 0 0	
...	...	...	...	...	...	...	2	...	...	303 12 0	
...	...	...	...	...	...	...	2	...	...	303 12 0	
...	...	...	...	...	...	...	2	...	...	303 12 0	
...	...	...	...	1	...	...	...	...	...	107 8 0	
...	...	2	...	1	...	...	...	...	...	50 0 0	
...	...	...	...	...	...	...	1	...	...	151 14 0	
...	...	...	...	...	...	...	1	...	...	151 14 0	
...	...	...	...	...	...	...	1	...	...	151 14 0	
...	...	3	1	...	...	...	...	...	...	550 0 0	
...	...	17	1	...	...	...	...	...	...	550 0 0	
...	...	3	...	1	...	...	...	...	...	467 0 0	
...	...	...	...	...	...	...	2	...	...	675 0 0	
...	...	...	...	...	...	...	1	...	...	337 8 0	
...	...	3	1	...	...	...	...	...	...	100 0 0	
...	...	...	...	...	...	...	1	...	...	56 14 0	
...	...	...	...	...	...	...	...	...	...	78 9 6	
154	147	39	3	7	...	2	13	21	845	9,668 3 6	
		Pigment Prints.									
...	...	...	...	...	...	...	...	...	...	2,204 3 3	
...	...	...	...	...	...	...	...	...	...	86 0 4	
...	...	...	...	...	...	...	...	...	...	45 7 9	
...	...	...	...	...	...	...	...	...	...	2,924 9 6	
...	...	...	...	...	...	...	...	...	...	2,652 15 9	
...	...	...	...	...	...	...	...	...	...	160 7 4	
16	5	...	...	...	...	...	...	...	...	32,871 2 6	
...	...	...	...	...	...	...	...	...	...	1,788 11 6	
...	...	...	...	...	...	...	...	...	...	100 15 6	
154	147	39	3	7	...	2	13	21	845	9,668 3 6	
...	...	...	...	...	...	...	...	...	...	.....	
170	152	39	3	7	...	2	13	21	845	52,502 12 11	

PHOTOGRAPHIC

Statement of Work done between 1st

Specification of Plate or Print	Progress made.	Scale of Map.		Number of Sheets or Subjects.	Negatives.		Ppotozincographic Printing.				
		Original.	Reproduced.		Number of Negatives (Direct.)	Number of Negatives reversed and transparencies.	Number of Photo-transfer Prints.	Number of Zinc Plates transferred.	Number of Zinc Plates printed.	Number of Pulls.	Number of Copies.
Cadastral Maps.											
North-Western Provinces—											
Photozincographs		...	1,692	1,692	...	...	1,685	1,750	1,771	29,826	29,826
Zincographs		...	987	...	...	...	...	987	1,003	16,238	16,238
Total		..	2,679	1,692	...	...	1,685	2,737	2,774	46,064	46,064
Burma—											
Photozincographs		...	1,288	1,288	...	...	1,398	1,237	1,237	42,432	42,432
Zincographs		...	558	...	...	...	...	558	558	19,132	19,132
Total		...	1,846	1,288	...	...	1,398	1,795	1,795	61,564	61,564
Bengal—											
Photozincographs		...	...	...	...	...	...	34	34	1,496	1,496
Zincographs		...	...	39	...	...	...	39	39	1,716	1,716
Total		...	...	39	...	...	...	73	73	3,212	3,212
Assam—											
Photozincographs		...	...	407	407	...	409	408	408	21,624	21,624
Zincographs		...	...	232	...	...	...	232	232	12,296	12,296
Total		...	...	639	407	...	409	640	640	33,920	33,920
Transfers and Proofs		...	...	...	...	...	...	...	...	10,138	...
GRAND TOTAL		...	...	5,203	3,387	...	3,492	5,245	5,282	154,898	144,760
General Abstract of Work.											
Departmental Maps and Plans		...	...	892	1,901	11	1,848	602	612	96,361	150,219
Cadastral Maps		...	...	5,203	3,387	...	3,492	5,245	5,282	154,898	144,760
Extra Departmental Maps and Plans		...	...	626	700	59	472	208	211	55,440	117,770
Grand Total		...	...	6,721	5,988	70	5,812	6,055	6,105	306,699	412,749

OFFICE, CALCUTTA.

October 1885 and 30th September 1886—concluded.

Silver and other Printing.			Heliogravure and Electrotyping.					Photocollotype.		Value.	Remarks.
Nummber of Silver Prints.	Number of Blue Prints.	Number of Miscellaneous Prints.	Heliogravure Photo-electrotyped. Plates	Heliogravure Photo-etched. Plates	Heliogravure Prints.	Photo. Blocks.	Electrotypes.	Photocollotype Plates.	Photocollotype Prints.		
										R a. p.	
...	...	...	...	...	...	...	...	...	...	25,254 13 0	
...	...	...	...	...	...	...	...	...	...	10,215 5 0	
...	...	...	...	...	...	...	...	...	...	35,470 2 0	
...	...	...	...	...	...	...	...	...	...	20,158 0 0	
...	...	...	...	...	...	...	...	...	...	5,791 0 0	
...	...	...	...	...	...	...	...	...	...	25,949 0 0	
...	...	...	...	...	...	...	...	...	...	263 8 0	
...	...	...	...	...	...	...	...	...	...	458 4 0	
...	...	...	...	...	...	...	...	...	...	721 12 0	
...	...	...	...	...	...	...	...	...	...	8,272 0 0	
...	...	...	...	...	...	...	...	...	...	3,203 0 0	
...	...	...	...	...	...	...	...	...	...	11,475 0 0	
...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	73,615 14 0	
170	152	39	3	7	...	2	13	21	845	52,502 12 11	
...	...	...	...	...	...	...	...	...	...	73,615 14 0	
5,229	20	48	9	11	...	1	...	22	4,035	27,749 7 0	
5,399	172	87	12	18	...	3	13	43	4,880	153,868 1 11	

PHOTOGRAPHIC OFFICE, CALCUTTA.

Statement showing the Amount and Value of work done for other Departments between 1st October 1885 and 30th September 1886.

Name of Department.	Number of Sheets, Sections, or Subjects.	Negatives. Number of Negatives (Direct).	Negatives. Ditto Reversed.	Negatives. Ditto Transparencies.	Photo-zincographic Printing. Number of Photo-transfer Prints.	Photo-zincographic Printing. Number of Zinc Plates transferred.	Photo-zincographic Printing. Number of Zinc Plates printed.	Photo-zincographic Printing. Number of Pulls.	Photo-zincographic Printing. Number of Copies.	Silver and other Prints. Number of Silver Prints.	Silver and other Prints. Number of Blue Prints.	Silver and other Prints. Number of Miscellaneous Prints.	Heliogravure and Electrotyping. Heliogravure Plates Photo-electrotyped.	Heliogravure and Electrotyping. Heliogravure Plates Photo-etched.	Heliogravure and Electrotyping. Heliogravure Prints.	Heliogravure and Electrotyping. Photo. Blocks.	Heliogravure and Electrotyping. Electrotypes.	Photo-collotype. Photo-collotype Plates.	Photo-collotype. Photo-collotype Prints.	Value.	Remarks.
																				₹ a. p.	
Archæological Survey of India	12	...	12	12	...	1	...	...	...	1	...	17	4	...	...	...	...	2	...	483 4 0	
Adjutant General in India	...	...	...	...	...	...	2	120	180	...	...	...	...	...	...	...	...	...	...	21 6 0	
Asiatic Society of Bengal	5	2	7	7	2	2	2	1,055	3,540	6	...	...	1	...	...	1	...	17	3,743	728 5 0	
Chief Superintendent of Telegraph Stores	12	5	...	...	5	15	26	10,834	40,034	...	...	...	...	...	...	...	...	...	...	1,719 9 0	
Chief Engineer, Bengal, Public Works Department	15	81		...	81	29	27	2,450	2,450	...	...	...	...	...	...	...	...	...	...	1,576 5 0	
Director General of Telegraphs in India	1	2	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	25 0 0	
Do. of Railways	2	5	...	...	5	2	2	1,450	1,450	...	...	...	...	...	...	...	...	...	...	201 8 0	
Director of Garrison Instruction in India	3	3	...	...	3	1	1	125	375	...	...	...	...	...	...	...	...	...	...	74 5 0	
Do. of Geological Survey of India	104	...	...	...	...	...	...	...	...	313	...	...	...	...	...	...	...	...	...	187 13 0	
Government of India, R. and A. Department	70	72	2	15	5	5	2	1,000	2,000	797	...	27	4	10	...	...	...	2	...	3,132 6 0	
Do. do. Military Department	7	10	...	...	10	8	10	2,645	6,825	...	...	...	...	...	...	...	...	...	...	483 1 0	
Do. do. Foreign Department	81	100	...	...	32	7	7	518	652	2,844	...	...	...	...	...	...	...	...	...	4,845 15 0	
Do. do. Public Works Department	46	95	...	...	94	39	34	3,490	6,415	100	...	...	...	...	...	...	...	...	...	2,359 4 0	
Do. of North-West Provinces and Oudh	1	10	...	...	10	5	5	750	750	...	...	...	...	...	...	...	...	...	...	257 14 0	
Do. do. do. Public Works Department	18	18	...	...	18	2	2	450	1,265	...	...	...	...	...	...	...	...	...	...	689 5 0	
Do. of Punjab, Public Works Department	15	33	...	...	33	15	4	200	200	...	...	...	...	...	...	...	...	...	...	550 14 0	
Gorakhpur Municipality	5	20	...	...	...	...	...	...	...	...	20	...	...	...	...	...	...	...	...	166 3 0	
Inspector-General of Military Works	37	52	...	...	47	16	18	11,100	28,350	...	...	...	...	...	...	...	...	...	...	2,782 9 0	
Locomotive Superintendent, Indus Valley State Railway	1	1	...	...	1	3	3	60	300	...	...	...	...	...	...	...	...	...	...	61 4 0	
Master of the Mint, Calcutta	16	14	...	...	...	...	...	...	...	269	...	...	...	...	...	...	...	...	...	236 11 0	
Manager, Eastern Bengal State Railway	2	2	...	...	2	2	2	1,030	2,030	...	...	...	...	...	...	...	...	...	...	115 7 0	
Do. Rajputana-Malwa Railway	...	...	...	...	...	1	1	50	100	...	...	...	...	...	...	...	...	...	...	50 0 0	
Do. Bombay, Baroda, and Central India Railway	...	...	...	...	...	1	1	100	100	...	...	...	...	...	...	...	...	...	...	17 13 0	
Meteorological Reporter, Government of India	13	16	...	...	16	7	8	3,135	6,135	...	...	...	...	...	...	...	...	...	...	976 12 0	
Postmaster General, Bengal	8	17	...	...	17	8	8	2,472	1,648	...	...	...	...	...	...	...	...	...	...	1,062 2 0	
Port Commissioners, Calcutta	2	2	..	...	2	2	1	110	110	...	...	...	...	...	...	...	...	...	...	52 15 0	
Port Officer, Calcutta	2	6	...	...	6	2	3	230	230	...	...	...	...	...	...	...	...	...	...	131 8 0	
Quarter Master General in India	17	52	...	...	50	20	24	9,955	9,630	...	...	...	...	...	...	...	...	...	...	2,537 5 0	
Sanitary Commissioner, Government of India	6	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13 13 0	
Do. do. Government of Assam	...	...	...	...	...	...	1	250	250	...	...	...	...	...	...	...	...	...	...	41 6 0	
Secretary to the Board of Revenue, North-West Provinces	4	8	...	...	8	4	4	800	800	...	...	...	...	...	...	...	...	...	...	360 3 0	
Do. to the Chief Commissioner, Central Provinces	1	1	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	12 0 0	
Do. do. Assam	...	...	...	...	...	...	1	250	250	...	...	...	...	...	...	...	...	...	...	50 11 0	
Do. to the Bengal Executive Committee, Indo-Colonial Exhibition	54	54	...	...	1	1	1	30	60	731	...	...	...	...	...	...	...	...	...	961 14 0	
Superintendent, Government Printing, India	12	15	...	...	15	8	10	756	1,591	...	...	...	...	...	...	...	...	...	...	307 2 0	
Do. Carriage and Wagon Dept., East Indian Railway	1	1	...	...	1	1	1	25	50	...	...	...	...	...	...	...	...	...	...	23 12 0	
Lieutenant A. C. Yate	...	...	...	...	...	...	...	...	...	68	...	...	...	...	...	...	...	...	...	172 9 0	
Major H. Cooper, A.-D.-C.	48	...	...	...	...	...	...	...	...	100	...	...	...	...	...	...	...	...	...	59 2 0	
Messrs. Newman & Co.	1	1	...	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	23 12 0	
,, Ralli Brothers	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12 0 0	
"The Indian Daily News"	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24	12 0 0	
Dr. G. King (Botanical Gardens)	2	...	2	1	...	...	...	...	...	...	...	4	...	1	...	...	...	...	...	150 0 0	
Dr. V. Richards	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	268	22 8 0	
	626	700	24	35	472	208	211	55,440	1,17,770	5,229	20	48	9	11	...	1	...	22	4,035	27,749 7 0	

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Extract from the Report of LIEUTENANT-COLONEL J. WATERHOUSE, S.C., *Assistant Surveyor General, in charge Lithographic Office,—Season 1885-86.*

The number of lithographed maps, plans, drawings, &c., taken in hand or printed during the year amounts to 677, of which 190 were for the Survey Department and 487 for other Departments. The total number of impressions or pulls in the Lithographic-printing Section was 424,872, yielding 356,877 complete copies, of which 201,912 were departmental and 154,965 extra-departmental. Although the number of subjects received and of complete copies printed off are somewhat less than last year, the actual printing work done, as measured by the number of press pulls, was much larger and shows an increase of 92,654 over last year. This increase is due to increased demands for forms.

In the Type-printing Section the work has again increased—5,566 pages or items were set up, and the total number of pulls amounts to 928,114; the out-turn last year being 760,670 pulls from 5,687 items.

The hand-power lithographic machine and steam type-printing machine have been steadily employed during the year and have been found to be of the greatest use in enabling the Office to meet the expanding demands for departmental forms and for expediting the supply of urgent work.

I have been anxious to introduce the working of zinc plates with the lithographic machine, and, while in England on privilege leave in 1885, I purchased some of the lithographic plates for trial, as reported in the Photographic Office Report for last year. A trial was made of these plates during my absence this year with promising results, but the difficulty is to make corrections on the plates without having the proper solution for preparing them. I lately saw the manufacturers, Messrs. Layton and Company in London, and obtained from them the latest instructions for working the plates. I also ascertained that they would be prepared to grant a license to enable us to prepare the plates ourselves on reasonable terms, though definite rates have as yet not been fixed. These plates are so thin and light and so easily stowed away that they should offer many advantages. In any case, thin zinc plates might be used in the machine and printed in the ordinary way. I hope to make further trials in this direction immediately.

The expenditure of the Office during the year under report has been ₹65,824-6-2 and the value of the work performed ₹63,236-7-2, showing a balance of ₹2,587-15-0 against the Office. In making out the return of expenditure, the system obtaining in the Photographic Office has been followed, *i.e.*, the expenditure includes the cost of all materials and plant received during the year, and not, as in last year's return, merely the cost of materials actually expended. A system of book-debit account with other departments, similar to that obtaining in the Mathematical Instrument Department and other Government Factories, came into force on the 1st April, and revised cost-rates for work done were introduced at the same time, so that six months of the year, from October to March, were under the old system of accounts, and the other six under the new. The difference between the rates under the two systems is not very great, as both were based upon the principle of approximating as nearly as possible receipts and expenditure. Under the new system a percentage of 20 per cent. in addition is charged to cover cost of wear and tear, increases to stock and plant, and other working expenditure not specially accounted for. Even with this addition the receipts and expenditure should nearly balance, and if they do not, the rates will require readjustment from time to time. Had the 20 per cent. allowance been credited for the work done all through the year, instead of only for the last six months, the balance against the Office would have been much less.

Munshi Mahomed Azim, Examiner, retired on superannuation pension on the 1st May 1886. He had served in the Department for upwards of 34 years, with great credit. He was an excellent draughtsman and compiler and a very useful man in the office.

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement of Departmental Work done between 1st October 1885 and 30th September 1886.

Specification of Stone or Print.	Lithographic Printing.							Type Printing.					Remarks.
	Progress made.	Scale of map.	Size of each sheet.	Number of sheets or subjects.	Number of stones.	Number of colored copies.	Number of uncolored copies.	Number of pages or items.	Number of pulls to each item.	Total number of pulls.	Number of copies.	Value.	
		In. Mls.										R a. p.	
General Maps.													
Preliminary Canal Map of India, in 6 sheets, with hills.	Re-transfer made with corrections and color stone prepared.	1 = 32	Dl. elephant.	6	11	...	...	...	...	...	...	159 9 0	Not yet printed.
External Trade Routes of India.	Additions and corrections made.	1 = 80	Special .	1	1	...	112	...	...	112	112	197 15 0	
India, showing Density of Population.	Additions and corrections made and color stones prepared.	1 = 80	Ditto .	1	3	...	...	...	...	...	...	224 6 0	Not yet printed.
Drawn previously but printed during the present year.													
Contour Map of India, in 6 sheets, Nos. 1 to 6.	Corrections made.	1 = 32	Dl. elephant.	6	6	...	200	...	...	1,200	200	967 12 0	
India, showing principal Religions.	Ditto	1 = 80	Special .	1	7	112	...	...	...	784	112	351 2 0	
Reprints.													
Eastern Bengal, Assam, Burma and parts of China and Siam, in 4 sheets.	Corrections and Additions made.	1 = 32	Imperial .	1	8	...	200	...	...	1,600	200	216 3 0	
Lecture Map of India, in 6 sheets, Nos. 1 to 6.	Ditto .	1 = 32	Dl. elephant.	6	6	...	400	...	...	2,400	400	496 5 0	
India, showing Provincial and District boundaries, in 2 sheets.	Corrections made.	1 = 64	Ditto .	2	2	...	250	...	...	500	250	175 2 0	
India, showing the progress of Imperial Survey to 1st October 1885, to accompany Annual Report.	Corrections made and color stones prepared.	1 = 128	Imperial .	1	4	500	25	...	...	2,025	525	206 6 0	
Southern Afghanistan and part of Baluchistan, in 4 sheets, with hills.	...	1 = 4	Dl. Imperial.	4	8	..	75	...	...	600	75	99 11 0	
Provincial Maps.													
Transferred previously from engraved sheets but printed during the present year.													
Skeleton Map of Punjab and Surrounding Countries.	...	1 = 32	Dl. elephant.	1	1	...	75	...	...	75	75	25 10 0	
Drawn previously but printed during the present year.													
Nizam's Dominions, including the Assigned Districts of Berar, in 2 sheets.	Corrections made.	1 = 16	Dl. elephant.	2	2	...	100	...	...	100	100	121 9 0	
Reprints.													
Central Provinces . .	Corrections made.	1 = 80	½ Sheet foolscap.	1	1	...	500	...	...	500	500	17 13 0	
Provinces of Bengal, Behar, Orissa and Chota Nagpore.	Ditto .	1 = 32	Dl. elephant.	1	1	...	200	...	...	200	200	101 8 0	
Ditto ditto, in 4 sheets.	...	1 = 16	Imperial .	4	8	...	100	...	...	800	100	86 13 0	
Punjab	Corrections made.	1 = 80	½ Sheet foolscap.	1	1	...	300	...	...	300	300	16 1 0	
District Maps.													
Transferred from Copperplate.													
Nuddeah	Additions and corrections made.	1 = 4	Atlas . .	1	1	...	...	...	...	...	...	109 3 0	Not yet printed.
24-Pergunnahs . . .	Ditto. .	1 = 4	Ditto .	1	1	...	...	...	...	...	...	159 9 0	
Julpaigurl . . .	Ditto .	1 = 4	Ditto .	1	1	...	...	...	...	...	...	126 0 0	
Jessore	Ditto .	1 = 4	Ditto .	1	1	...	...	...	...	...	...	84 0 0	
Khoolna	Ditto .	1 = 4	Ditto .	1	1	...	...	...	...	...	...	63 0 0	
Transferred previously from engraved sheets but printed during the present year.													
Shahabad	Further corrections made.	1 = 4	Antiquarian	1	1	...	100	...	...	100	100	94 12 0	
Dacca	Ditto .	1 = 4	Atlas . .	1	1	...	100	...	...	100	100	79 12 4	
Carried over .	...	...	...	46	77	612	2,737	...	...	11,396	3,349	4,180 1 4	

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement of Departmental Work, &c.—continued.

Specification of Stone or Print.	Lithographic Printing.							Type Printing.				Value.	Remarks.
	Progress made.	Scale of map.	Size of each sheet.	Number of sheets or subjects.	Number of stones.	Number of colored copies.	Number of uncolored copies.	Number of pages or items.	Number of pulls to each item.	Total number of pulls.	Number of copies.		
		In. Mls.										R a. p.	
Brought forward .	...	...	...	46	77	612	2,737	...	...	11,396	3,349	4,180 1 4	
Reprints.													
Rungpore . . .	Corrections made.	1 = 4	Atlas . .	1	1	...	150	...	...	150	150	71 14 0	
Sylhet . . .	Ditto .	1 = 4	Dl. elephant,	1	1	...	100	...	...	100	100	33 7 0	
Plans of Cantonmea and Cities.													
Reprints.													
Calcutta, in 2 sheets .	...	6 = 1	Dl. elephant,	2	4	100	...	...	...	400	100	59 0 0	
Calcutta	...	3 = 1	Super-royal ,	1	1	...	100	...	...	100	100	10 5 0	
Atlas Sheets.													
Drawn during the year.													
Indian Atlas, Quarter sheet No. 4 N. E.	Drawn on stone.	1 = 4	¼ Sheet Atlas	1	1	...	...	...	...	...	...	249 9 0	Not yet printed.
Transferred from Copper-plate.													
Quarter Sheets, Nos. 47 S.-W., and 49 S.-W.	Corrections made.	1 = 4	¼ Sheet Atlas	2	2	...	200	...	...	200	200	160 4 2	
Standard Sheets.													
Drawn during the year.													
Oudh Revenue Survey, Sheets No. 103 and No. 151.	Re-drawn on transfer paper.	1 = 1	Double royal	2	2	...	...	...	...	...	...	795 8 0	Not yet printed.
Oudh Revenue Survey, Sheet No. 145.	Drawn on transfer paper.	1 = 1	Ditto .	1	1	...	...	...	...	...	...	397 12 0	
District Mymensingh Sheets Nos. 345 and 346.	Ditto .	1 = 1	Ditto .	2	2	...	...	...	...	...	...	795 8 0	
Drawn previously, but printed during the present year.													
Oudh Revenue Survey, Sheets Nos. 136, 150, 163, 164, 176 and 177.	Corrections, &c., made.	1 = 1	Double royal	6	6	...	1,610	...	...	1,610	1,610	2,463 9 10	
District Julpaiguri, Sheets, Nos. 270, 271, 272, 296, 317, 318 and 337.	Ditto .	1 = 1	Ditto .	7	7	...	1,400	...	...	1,400	1,400	694 1 0	
District Montgomery, Sheet No. 174.	Ditto .	1 = 1	Ditto .	1	1	...	200	...	...	200	200	124 6 0	
Index Maps.													
Reprints.													
Index Maps, Nos. 2 and 8, Topographical Parties, on the scale of 1 inch=1 mile to accompany Annual Report.	Corrections made and color stones prepared.	...	Foolscap .	2	5	940	200	...	...	2,530	1,140	109 9 4	
Index to the Indian Atlas, showing the state of the engraving and materials for engraving to 1st October 1885, to accompany Annual Report.	Ditto .	1 = 256	Ditto .	1	2	670	100	...	...	1,440	770	76 6 8	
Index to the Indian Atlas, showing the Sheets that have been published to 1st October 1885, to accompany Annual Report.	Ditto .	1 = 256	Ditto .	1	2	890	200	...	...	1,560	1,090	75 5 8	
Index to the Sheets of the Atlas of India, 1885.	Ditto .	1 = 128	Imperial .	1	2	...	...	...	...	...	...	54 9 0	Not yet printed.
Miscellaneous Maps .	...	...	...	37	45	100	12,698	...	...	14,583	12,798	651 5 4	
Departmental Forms .	...	...	...	75	75	...	178,905	...	...	230,814	178,905	10,846 13 2	
Total .	...	...	...	190	237	3,312	198,600	...	...	266,503	201,912	21,859 6 6	
Circular Orders . .	...	...	...	...	...	...	...	62	6,900	...	5,550	268 7 0	
Memoranda, &c. . .	...	...	...	...	...	...	...	449	215,175	...	189,600	1,908 12 0	
Forms, &c., for Survey Department.	...	...	...	...	...	...	...	746	671,944	...	259,551	7,463 4 0	
Transfers for headings, foot-notes, references of published maps for Photo. and Litho. Offices.	...	...	...	...	...	...	...	4,309	34,095	...	34,095	3,880 2 0	
14 Rubber Stamps made for Survey Department.	...	...	...	...	...	...	...	...	...	...	...	52 7 0	
Total .	...	...	...	...	...	...	...	5,566	928,114	...	488,795	13,573 0 0	
Total Value .	...	...	...	...	...	...	...	...	...	...	...	35,432 6 6	

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement showing the Amount and Value of work done for other Departments between 1st October 1885 and 30th September 1886.

Name of Department.	Lithographic Printing.				Total number of pulls.	Number of copies.	Value.	Remarks.
	Number of sheets or subjects.	Number of stones.	Number of colored copies.	Number of uncolored copies.			R a. p.	
Archæological Survey of India	38	12	...	25,560	8,070	25,560	1,094 15 7	
	18	8	...	...	...	...	636 0 0	Not yet printed.
Asiatic Society of Bengal	1	1	...	735	735	735	96 0 0	
Adjutant General, India	14	5	60	1,200	720	1,260	350 15 0	
Calcutta Municipality	1	5	305	...	1,525	305	104 3 0	
Central Provinces, Public Works Department	2	2	...	305	610	305	416 11 0	
Consulting Engineer, India	3	3	...	252	252	252	25 13 9	
Commissary General-in-Chief	6	5	...	1,017	917	1,017	98 0 2	
Chief Commissioner, Central Provinces	2	2	...	1,062	1,062	1,062	160 10 0	
Chief Commissioner, British Burma	1	2	355	...	710	355	92 0 0	
Director of Garrison Instruction in India	5	4	1,435	...	2,170	1,435	266 15 0	
Director of Agriculture, Central Provinces	3	3	...	1,660	1,660	1,660	215 10 0	
Director of Agriculture, Bengal	2	1	...	14,000	7,000	14,000	122 13 0	
Geological Survey of India	8	14	1,352	3,885	11,655	5,237	1,023 8 9	
	1	4	...	...	...	...	58 12 0	Not yet printed.
Government of India, Home Department	1	1	...	415	415	415	39 10 0	
Government of India, Revenue and Agricultural Department	48	58	9,752	5,041	31,033	14,793	2,939 2 6	
Government of India, Military Department	21	2	...	605	105	605	157 14 3	
Government of India, Foreign Department	47	45	30	2,831	2,698	2,861	1,171 12 9	
	8	2	...	...	...	...	49 8 0	Not yet printed.
Government of India, Financial Department	24	6	...	3,000	750	3,000	93 8 0	
	1	1	...	...	...	...	9 6 0	Not yet printed.
Government of Bengal	15	10	...	5,066	3,030	5,066	303 13 9	
Government of Bengal, P. W. D.	6	4	...	420	320	420	176 11 0	
Government of the N.-W. Provinces and Oudh, P. W D.	1	2	...	...	...	...	151 15 0	Not yet printed.
Government of Punjab	13	9	230	4,995	4,235	5,225	480 12 0	
	2	4	...	...	...	...	54 9 0	Not yet printed.
Government of Punjab, Public Works Department	1	1	...	2,000	2,000	2,000	212 6 0	
	4	4	...	...	...	...	591 3 0	Not yet printed.
General Superintendent, Horse and Mule Breeding Operations in India	1	3	105	...	315	105	107 13 4	
	1	3	...	...	...	...	221 1 0	Not yet printed.
Meteorological Reporter, India	21	30	4,160	6,047	14,882	10,207	1,653 4 0	
Meteorological Reporter, Bengal	2	2	...	26,400	26,400	26,400	342 10 0	
Medical College	1	1	...	650	650	650	45 4 0	
Miscellaneous Maps, Plans, &c.	7	5	...	680	780	680	98 12 0	
Ordnance Department, India	2	1	...	300	150	300	34 12 0	
Postal Department, India	1	1	...	210	210	210	187 9 0	
Postal Department, North-Western Provinces and Rajputana	4	4	...	268	468	268	334 3 0	
Port Officer and Registrar of Wrecks	2	4	155	155	620	310	176 8 0	
Political Agent, Baghelkhand	1	1	...	200	200	200	67 7 0	
Police Department	10	5	...	550	300	550	181 4 0	
Quarter Master General in India	46	45	125	3,637	4,157	3,762	3,670 5 0	
	16	26	...	...	...	...	4,935 6 0	Not yet printed.
Rajputana-Malwa Railway	1	1	...	...	...	...	14 6 0	Not yet printed.
Sanitary Commissioner, India	21	14	2,110	5,300	8,520	7,410	958 6 2	
Sanitary Commissioner, Bengal	1	6	421	...	2,526	421	359 6 0	
Sanitary Commissioner, Assam	1	2	250	...	500	250	60 9 0	
Secretary for Berar to the Resident at Hyderabad	8	8	...	1,805	1,805	1,805	455 14 0	
Settlement Department, Punjab	1	1	...	4,340	4,340	4,340	993 7 0	
Settlement Department, Julpaiguri	1	1	...	200	200	200	58 14 0	
Superintendent, Government Printing, India	5	5	...	1,665	1,665	1,665	97 7 0	
Superintendent of Forest Surveys	1	1	...	415	415	415	168 14 0	
Surgeon General, Her Majesty's Forces	5	2	...	75	30	75	25 8 0	
	1	1	...	...	...	...	6 0 0	Not yet printed.
Stationery Office	6	6	...	2,120	2,120	2,120	195 4 0	
Telegraph Department, India	11	9	...	4,549	4,039	4,549	437 7 5	
	11	11	...	...	...	...	61 12 0	Not yet printed.
Tirhoot State Railway	1	1	...	505	505	505	82 0 0	
Total	487	420	20,845	134,120	158,309	154,965	27,226 7 5	

LITHOGRAPHIC AND PRINTING OFFICE, CALCUTTA.

Statement showing Expenditure (Dr.) and Value of work done (Cr.) during the Survey year, from 1st October 1885 to 30th September 1886.

Dr. *Cr.*

	₹ a. p.	₹ a. p.		₹ a. p.	₹ a. p.
Superintendent's salary	5,444 1 6		Standard and other Maps and Plans issued to the Survey of India Department	10,351 4 0	
Assistant Superintendent's salary	2,000 0 0				
Establishment	33,574 14 11		Miscellaneous Maps issued to the Survey of India Department	661 5 4	
Office rent and taxes	3,859 14 0				
Contingencies	1,322 8 7		Departmental Forms	16,846 13 2	
		46,201 7 0			21,859 6 6
Lithographic, drawing and printing materials received from England	764 5 2		Miscellaneous Maps and Plans, extra-departmental	27,226 7 5	27,226 7 5
Litho. stones received from England	889 4 9				
Type printing materials received from England	62 5 2		Work done in Type Department	13,573 0 0	13,573 0 0
Miscellaneous type received from England	400 14 8		Paper supplied to Photo. and other Offices of the Survey of India Department	374 2 0	
Paper received from England	4,092 12 9				
		6,209 10 6	Old tin and packing cases sent to Mathematical Instrument Office	72 15 0	
Paper received from Stationery Office	12,519 1 11				
Miscellaneous articles received from Stationery Office	78 11 10		Sale of waste paper, &c.	130 8 3	
		12,597 13 9			577 9 3
Broken and miscellaneous type received from Mathematical Instrument Office	8 0 0				
Map typing machine received from Mathematical Instrument Office	72 7 0				
Cost of repair of articles at Mathematical Instrument Office	141 13 0				
		222 4 0			
Type received from Superintendent, Government Printing, India	70 8 7				
		70 8 7			
Type received from Surveyor General's Office	415 11 8				
Paper received from Survey of India Offices	50 4 8				
		466 0 4	Balance against the Department		2,587 15 0
Landing and shipping charges incurred by the Marine Department	56 10 0	56 10 0			
TOTAL		65,824 6 2	TOTAL		65,824 6 2

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE A.

Detail of Issues to, and Receipts from, Provinces and Departments during Financial Year 1885-86.

Provinces and Departments.	M. I. O. Receipts.	M. I. O. Issues.	Debits.	Credits.
	Value, ₹	Value, ₹	Value, ₹	Value, ₹
Archæological Survey	...	361	361	...
Assam	3,010	4,854	1,844	...
Bengal, Civil	24,524	18,348	...	6,176
Bengal, Military	4,546	8,468	3,922	...
Berars	125	73	...	52
Bombay, Civil	1,033	453	...	580
Bombay, Military	3,266	578	...	2,688
Bombay, Military (Egyptian Expedition)	...	23	23	...
Burma	9,181	8,839	...	342
Central India[1]	1,451	330	...	1,121
Central Provinces	3,564	3,627	63	...
Colonial Government, Straits Settlements	...	4,740	4,740	...
Forests	...	2,059	2,059	...
Gazetteers and Statistical	...	36	36	...
General Administration, Foreign States	...	14	14	...
Geological Survey and Museums	...	170	170	...
Inland Customs	...	19	19	...
Land Revenue, Ajmir Land Settlement	...	97	97	...
Law and Justice, Port Blair	...	76	76	...
Madras, Civil	7,475	11	...	7,464
Madras, Military	190	4,104	3,914	...
Marine	49	1,030	981	...
Meteorological Department	342	1,973	1,631	...
Mint	64	...	...	64
North-Western Provinces and Oudh	145	1,292	1,147	...
Political, Afghan Boundary Commission	270	2,075	1,805	...
Punjab	5,690	18,050	12,360	...
Public Works Department, Military Works	4,378	18,321	13,943	...
Ditto ditto, Rajputana-Malwa State Railway	...	92	92	...
Ditto ditto, Rajputana	458	311	...	147
Ditto ditto, Sind-Pishin State Railway	384	17,301	16,917	...
Ditto ditto, Bhopal State Railway	152	...	...	152
Ditto ditto, Coorg	...	31	31	...
Ditto ditto, N. W. Railway	...	1,838	1,838	...
Ditto ditto, E. I. Railway	...	502	502	...
Ditto ditto, Hyderabad	455	533	78	...
Survey Department	22,868	60,362	37,494	...
Telegraphs	...	184	184	...
TOTAL	93,620	1,81,175	1,06,341	18,786
NETT DEBITS	...	...	87,555	
Cash Sales	...	3,767	3,767	
GRAND TOTAL	93,620	1,84,942	91,322	

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE B.

List of Instruments, &c., purchased during 1885-86.

Names of Instruments, &c.	No.	Value.	
		₹	a.
Barometers, aneroid, large	2	72	0
„ „ small	2	50	0
Chains, measuring, iron, 66 feet	150	1,162	8
Clinometers	2	40	0
Compasses, bow, plain, electrum, spring	7	10	12
„ „ ink, brass, jointed	37	39	0
„ „ „ „ double-jointed, plain	12	18	0
„ „ „ electrum, single-jointed	111	231	0
„ „ „ „ double „	45	144	0
„ „ „ „ spring	30	45	4
„ „ pencils, brass, double-jointed, plain	12	18	0
„ „ „ „ jointed	43	46	0
„ „ „ electrum, single-jointed	119	249	0
„ „ „ „ double „	38	122	0
„ „ „ „ spring	7	10	8
„ „ common, brass, 5″	98	118	0
„ „ „ „ 6″	135	211	8
„ „ with pen and pencil points, brass, 6″	23	230	0
„ „ for pen and pencil points, brass, single and double-jointed	53	272	8
„ „ with pen and pencil points, electrum, 6″	16	192	0
„ „ for pen and pencil points, single-jointed, electrum	32	192	0
„ „ for pen and pencil points, double-jointed, electrum	3	22	8
„ Magnetic, for plane-tables, 2″ and 2½″ needles	45	270	0
„ „ pocket, in brass cases	3	10	8
„ „ „ in electrum cases	2	4	0
„ „ „ in wooden cases	11	11	0
„ prismatic, Hunter's pattern	1	30	0
Curves, French, horn set	39	39	0
„ „ single, wooden and ebonite	222	181	3
„ Railway or Circular, large and small sets	2	70	0
Declinometers	3	10	8
Hydrometers, with brass floats	1	47	8
Hygrometers, Mason's	1	11	0
Lamps, bull's eye	6	28	0
Lenses, reading, 1″	55	53	8
„ „ 3½″	1	2	10
Levels, spirit, in metal cases, 1′ 2″	1	7	8
„ reflecting, Abney's	1	20	0
Machines, map-printing, Ordnance pattern	12	510	0
Opisometers	18	87	0
Pedometers	1	5	0
Pens, double or road	1	3	0
Pins for maps, brass	1,660	51	14
„ „ electrum	800	50	0
Prickers	11	11	0
Protractors, plain, circular, brass, 6″, 8″ and 9″	1	12	0
„ rectangular, ivory, 6″	33	99	8
„ „ wooden, 6″	9	4	8
„ Sandhurst, boxwood	19	76	0
Pins for chains, common pattern	8,500	664	1
Rules, carpenter's, boxwood, 2′ 2-fold, 2′ 4-fold, and 3′ 4-fold	62	62	0
Rules, engineering, steel, 1 foot	6	9	0
„ parallel, bar, ivory	1	0	8
Carried over	12,505	5,938	4

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE B—*contd.*

List of Instruments, &c., purchased during 1885-86—continued.

Names of Instruments.	No.	Value. R	Value. a.
Brought forward	12,505	5,938	4
Rules, parallel, bar, wooden, 12″	3	4	8
,, ,, on rollers, brass, 9″	1	9	0
,, ,, ,, ,, 12″	1	12	0
,, ,, ,, ,, 2′ and 2½′	2	64	0
,, ,, ,, electrum, 12″	1	15	0
,, sight for plane-tables	100	300	0
,, straight edge, steel, 6′	1	10	0
Scales, architects, boxwood, sets	1	10	0
,, ,, ,, single	45	111	0
,, ,, ebonite ,,	4	8	0
,, diagonal, wooden	3	4	8
,, engine divided, card-board, single	24	20	0
,, Marquois, sets, wooden	8	40	0
,, off-sets, ebonite, single	120	60	0
,, off-sets, single, wooden	268	100	8
,, plotting, sets, wooden	11	71	8
,, ,, ,, ebonite	2	20	0
,, ,, ebonite, single	156	199	0
,, ,, single, wooden	266	266	0
,, ,, triangular section, single, boxwood	8	24	0
Sectors, ivory	33	82	8
,, wooden	35	35	0
Squares, optical German pattern	301	1,955	0
,, set, ebonite, single	135	100	8
,, ,, wooden, set	2	15	0
Staves, levelling, telescopic, Sopmith's and Strange's	5	75	0
Stands for plane-tables	325	2,275	0
T Squares, wooden, of sizes	16	40	0
Tapes, measuring, steel, pocket and others	1	18	0
Telemeters	3	135	0
Thermometers, chemical	14	80	0
,, maximum, common, self-registering	7	22	12
,, minimum, common	6	12	12
,, maximum and minimum on same board	3	75	0
,, spare for Syke's hydrometers	12	18	0
,, grass	1	13	0
Trammel heads for beam compasses	3	22	8
TOTAL	1,4432	12,262	4
Books.			
Pickering's Physical Manipulations	1	8	7
Blow-Pipe Analysis, Landaner	1	2	12
Hints to Travellers	19	76	0
Manual of Surveying	6	72	0
Practical Surveying, Kelly's	1	7	0
"Light," Mayer and Barnard	1	1	8
Nautical Almanacs	50	83	10
Tables, Hydrometer (Casella's)	1	3	0
Tables, Logarithmic, Chamber's	26	68	10
TOTAL	106	322	15

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE B—*contd.*

List of Instruments, &c., purchased during 1885-86—continued.

Names of Instruments, &c.	No.	Value.
Sundries.		₹ a.
Bars, lengthening, brass	18	4 8
,, ,, electrum	11	4 2
Boxes, of sorts	5	5 0
Typing ink, tins	6	21 0
Wooden casks	1	3 7½
Glasses for pluviometers	27	114 0
Ink legs for compasses, brass	37	13 14
,, ,, ,, electrum	24	12 0
Spare glass and key for a watch	2	2 8
Hand press, with stand	1	25 0
Numbers for chains, iron, sets	1,250	351 9
Pencil legs for compasses, brass	12	4 8
,, ,, ,, electrum	12	6 0
Telescopes for 3″ pocket sextants and range-finders	12	87 8
Cases, leather	12	42 0
Umbrellas	4	64 0
Knives, pocket	24	21 0
Glass ink-bottles	32	7 14
Stencil plates	123	92 4
TOTAL	1,613	882 2½
Add total of Instruments	14,432	12,262 4
,, ,, of Books	106	322 15
SUM TOTAL	16,151	13,467 5½

TABLE C.

List of Instruments, &c., manufactured in Workshop during 1885-86.

Names of Instruments, &c.	No.	Value.
		₹ a.
Bars, standard, steel	8	222 0
Boards, drawing, deal, large	31	397 1
,, ,, ,, small	15	109 12
,, ,, teak, large	6	52 8
Chains, measuring, 30 and 33 feet	7	31 8
,, ,, 66 feet	395	3,357 8
,, ,, 100 ,,	50	500 0
,, other sizes and sorts	301	1,810 8
Clinometers	6	240 0
,, with hill shading scale and plummets	12	18 0
,, survey pattern	25	620 0
Combs, bigha scale	208	52 0
,, acre-calculating card-board	2,040	510 0
Compasses, magnetic, for plane-tables, 5″ needles	45	564 0
Hold alls	24	321 10
Plane-tables, deal	281	2,573 0
,, ,, ,, military pattern	39	302 8
Pluviometers, country pattern	38	684 0
,, Simon's pattern	36	522 0
Pins for chains, common pattern	2,000	250 0
Quadrants, Gunners'	3	90 0
Rule, sight, for plane-tables	50	200 0
,, ,, brass for military plane tables	28	573 1
Rule, sight, for plane-tables with telescopic attachment and metal	24	408 0
Carried over	5,672	14,409 0

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE C—*contd.*

List of Instruments, &c., manufactured in Workshop during 1885-86—continued.

Names of Instruments, &c.	No.	Value.	
		₹	a.
Brought forward .	5,672	14,409	0
Scales, Bengali, metal	104	104	0
,, diagonal, card-board	4,564	664	14
,, ,, metal	1	12	3
,, engine-divided, card-board, single . .	1,000	125	0
,, off-set, single, ivory and slips . . .	415	181	6
,, plotting, single, ivory	6	8	4
Squares, optical, German pattern	12	160	8
Staves, cross or off-sets	2	10	8
,, for omnimeters	3	70	0
,, levelling, Gravatt's pattern	10	160	0
,, telescopic, Sopmith's and Strange's . .	40	600	0
Stands for heliotropes, 6″, 8″, 9″ and 12″ . .	4	56	0
,, for plane-tables	30	540	0
,, for theodolites	7	221	8
,, for thermometers	12	96	0
Thermometers, minimum, black bulb	2	36	8
,, maximum and minimum on same board .	6	75	0
Vane, sight for referring lamp	2	40	0
TOTAL .	11,892	17,570	11
Sundries.			
Boxes, of sorts	26	61	
Cases, packing	680	2,844	2
Stand for camera lucida apparatus	1	35	0
Camera lucida apparatus	1	40	0
Doolies	16	28	0
Girder-tester	1	51	6
Gauges, writing	41	93	0
Globes, metal, wire	1	5	0
Handles, brass for chains	16	12	0
Levels, spirit, for staves	6	33	0
Numbers for chains, brass, single	83	11	10
Plates, copper for scales	1	30	0
Rods for pickets, wooden	6	21	0
Screw-drivers and levers for theodolites . .	9	6	12
Stool and benches, teak wood	2	145	2
Type-holders for Gastrell's pattern press . .	1	28	11
Tubes, tin and zinc, in wooded cases, &c. . .	77	54	8
Ink-rollers, small	11	33	0
Plummets	12	13	8
Brass strap keepers for instrument boxes and leather strap	26	2	8
Screws for plane-tables	2	5	4
Washers, brass	506	10	6
Diaphragms for camera	5	2	0
Set of figures for stamping, with handle complete . .	11	25	0
Stands for thermometers, padded	1	4	8
Bottles, metal	5	51	8
Almirahs, mahogany	1	232	0
Spider lines, box	1	2	0
India-rubber rings	12	1	0
TOTAL . .	1,561	3,883	2
Add total of Instruments . . .	11,892	17,570	11
SUM TOTAL . .	13,453	21,453	13
Brass castings, &c., for material stock . .		1,260	0
GRAND TOTAL . .	...	22,713	13

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE D.

List of principal Instruments repaired in Workshop during 1885-86.

Names of Instruments.	Number.
Actinometers	2
Alt-azimuth	1
Anemometers	10
Anemographs	3
Arithmometers	2
Barometers of sorts	66
Boards, drawing, of sorts	13
Camera of sorts	2
Cases, leather, writing	5
Chains of sorts	73
Chronographs	3
Chronometer	1
Clinometers	7
Compass, azimuth	1
Compass, beam	1
Compass, boat	1
Compass, card	1
Compasses, drawing, of sorts	137
,, magnetic, for plane-tables	27
,, ,, pocket	14
,, prismatic of sorts	69
,, proportional	9
,, rectangular for theodolite	4
,, Ship	2
,, Surveying, of sort	33
Curves, of sort	1
Glasses, binocular	12
Heliographs	20
Heliotropes	6
Hydrometers	20
Instruments, drawing, of sorts	60
Lamps, bull's eye	6
,, referring	6
Lenses of sorts	3
Levels of sorts	117
Log, patent	1
Machines, hand-printing	8
,, map-printing	2
,, paper-cutting	1
Microscopes, of sorts	4
Padded, boards	2
Pens, drawing, of sorts	112
Pentagraphs of sorts	2
Perambulators	3
Plane-tables	8
Planimeters	16
Pluviometers	4
Polariscope	1
Press, for litho. of sorts	1
Pricker	1
Protractors	5
Quadrants, Gunner's	1
Quintants	2
Range-finders of sorts	41
Refrigerator	1
Rules of sorts	28
,, sight, for plane-tables	8
,, straight edges	3
Carried over	993

MATHEMATICAL INSTRUMENT OFFICE, CALCUTTA.

TABLE D—*contd.*

List of principal Instruments repaired in Workshop during 1885-86—continued.

Names of Instruments.	Number.
Brought forward .	993
Scales of sorts	13
Seismometer cylinder	4
Sextants of sorts	8
Spectroscope	1
Squares, optical	63
Stand for barometer	1
Stand for camera	1
Stands for compasses	64
,, ,, heliographs	14
,, ,, heliotropes	2
,, ,, levels	54
,, ,, plane-tables	7
,, ,, theodolites	50
,, ,, thermometer	1
Staves of sorts	75
T squares of sorts	6
Tapes of sorts	72
Telescopes of sorts	27
Theodolites of sorts	95
Thermometers of sorts	20
Tide-gauge clocks	2
Watches	2
Wind vanes	17
Van Rysselberghe's meteorograph	1
Total of principal Instruments repaired .	1,593
Total of all Instruments repaired .	2,267

Profit and Loss Account of Workshop for 1885-86.

Debits.	R	a.	Credits.	R	a.
Workshop Establishment (less proportion debitable to the Store Branch for cleaning and adjusting serviceable Instruments) .	33,829	7	By repairs for Public Officers .	14,457	9
One-third of Office Establishment . .	2,255	1	Ditto to Stock . . .	21,377	12
Workshop contingencies as distinguished from materials purchased . . .	1,260	10	By manufactures for Stock :—		
Value of materials :—			"Instruments" . .	18,582	15
For special work	11,577	7	"Packing Cases" .	2,870	14
For general workshop use . .	456	12	By manufacture for materials .	1,260	0
For manufacture of packing cases .	1,722	9	Ditto for store . .	890	7
Paid for repairs	177	0	Work on prepayment . .	1,472	4
Wear and tear of plant	1,116	0			
Half of rent at R325 per mensem . .	1,950	0			
Printing and Stationery	207	3			
4 per cent. on value of Tools and Plant, amounting to R61,811	2,472	7			
Workshop profit	3,887	5			
TOTAL .	60,911	13	TOTAL .	60,911	13

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Extracts from the Narrative Report of MR. W. H. COLE, *M.A., Deputy Superintendent, 3rd grade, in charge of the Computing and Type-printing Sections of the Trigonometrical Branch Office, Dehra Dún,—Season 1885-86.*

The following tabular statements exhibit the money value of the work performed by the Computing Section :—

Statement of Expenditure (Dr.) and Amounts credited (Cr.) on account of the Computing Section during the Survey year 1st October 1885 to 30th September 1886.

DR. CR.

	₹	₹		₹	₹
Deputy Superintendent's salary	11,400		Work done for the Survey of India Department as shown in the following table	51,825	51,825
Assistant Superintendent's salary	7,000				
Establishment	33,500				
Contingencies	963	52,863			
Stationery	100	100	Extra Departmental work done	2,150	2,150
Library, books and periodicals	*1,012	1,012			
TOTAL	...	53,975	TOTAL	...	53,975

* Including charges for books, &c., obtained during the two preceding seasons.

Statement of Departmental Work done by the Computing Section between 1st October 1885 to 30th September 1886.

	Class.	Value.
		₹
1	Records, Library, inclusive of cost of purchase of books, &c.	2,235
2	Computations	11,510
3	Accounts, Returns, Correspondence	7,968
4	Supply of Data, &c.	1,730
5	Preparation of Press Copy	9,281
6	Examination of Press Proofs	5,209
7	Ditto Charts, &c.	665
8	Protection of Stations	1,230
9	Miscellaneous	9,286
10	Meteorology and General Science	2,711
	TOTAL	51,825

Statement showing the value of work done for other Departments by the Computing Section between 1st October 1885 and 30th September 1886.

Name of other Department.	Value.
	₹
Quartermaster General's Department in India	1,484
Meteorological Department	516
The Officer on special duty, Kashmir Railway Project Survey	150
TOTAL	2,150

The preceding statements afford a fair idea of the cost of the work performed under the various classes; but some explanation of these is necessary, and will now be given.

CLASS 1, RECORDS, LIBRARY.—The records of all the survey operations appertaining to the Trigonometrical Branch, from the time of Colonel Lambton to the present date, find a resting place in this office, where they are carefully stored and periodically inspected. Further, as each fresh instalment is received it is closely examined, indexed, registered, and a detail receipt furnished to the executive officer from whom it comes. During the past season a mass of records of the Káthiáwár Topographical Survey Party was received for deposit, and the examination has occupied a large share of the time of one computer for several weeks.

The custody of the Library, which now contains about four thousand books and pamphlets, chiefly of a scientific character, also comes under this head, as well as the cost of

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

books and periodicals purchased during the year, both for the Library itself and also for several survey parties of the Trigonometrical Branch. In the present instance, owing to the bills for the two preceding years not having been presented till recently, the cost includes three years' purchases.

CLASS 2, COMPUTATIONS.—The duty of this office is stated elsewhere to be the final reduction and publication of the operations of the Trigonometrical Branch. These operations consist of the execution of series of triangulation, in the taking of astronomical observations, in the carrying of lines of spirit levels over the country, &c. Primary reductions are made in the offices of the parties which execute the several works in order to present them complete each in itself; but a great deal then remains to be done before those works can be presented to the public, and it is necessary to fuse into a harmonious whole all the various geodetic operations: to effect this, very intricate calculations are required, and they form the main work of this office. Under this head may be specially mentioned the following:—

(1). The final reduction of the principal triangulation of the *South-West Quadrilateral.* This was commenced last year, and the main reduction was completed during the year under report, leaving for final adjustment only those portions of the principal triangulation which did not enter the circuit equations. That which appertains to two out of five series has been disposed of and greater progress would have been made, but that it was necessary to divert the computers engaged on it to other work of a more urgent character. When this quadrilateral is finished, the whole of the principal triangulation of India west of the meridian 92° will have been finally reduced.

(2). In the *Southern Trigon,* the work done has been chiefly in connection with the reduction of the secondary triangulation, of final terms, including a considerable portion of Colonel Lambton's operations. The principal triangulation, except so far as the heights of the stations are concerned, which await the completion of levelling operations in Southern India, is all reduced and the data nearly ready for the press.

(3). Only two Synoptical Volumes remain to complete the publication of the whole of the details of the *North-East Quadrilateral, viz.*, those of the North-East Longitudinal Series and the Assam Longitudinal Series which also includes the Assam Valley Series. The former cannot be taken in hand yet because the triangulation for fixing snow peaks is not complete. With the latter considerable progress has been made, and there only remains to obtain the values of the distances and azimuths of snow peaks in final terms to complete the data for the volume; this is in hand.

(4). *Observed Latitudes.*—Observations of 1884-85, having been received from Astronomical Party No. 1, were finally reduced in the same manner as all the previous observations, and now those from Colonel Lambton's time to the end of the above-mentioned season are completely reduced, and the preparation of the details for the press is in hand and considerable progress has been made with the copy.

(5). *Electro-Telegraphic Longitudes.*—Assistance was afforded to Astronomical Parties Nos. 1 and 2 in bringing up their calculations for 1885-86. These calculations were performed under the direct superintendence of Lieutenant S. G. Burrard, R.E., and the assistance rendered was equivalent to the services of a pair of computers for a little short of three months.

(6). *Khandesh Topographical Survey.*—In compliance with the directions of the Officiating Surveyor General a pair of computers was placed under the orders of Mr. W. H. Patterson, Officiating Deputy Superintendent, 4th grade, for a little over two months, to aid in bringing up the arrears of this survey.

(7). The new edition of the *Auxiliary Tables to facilitate the calculations of the Survey of India* has been steadily in hand and good progress has been made with it. The necessary calculations have been completed up to the end of Table LIII.

CLASS 3, ACCOUNTS, RETURNS, CORRESPONDENCE.—Under this heading are included Indents, Estimates, Monthly detailed and abstract progress reports, stock returns of ordnance stores, the compilation of the Annual Report and various other items. Assistance has also been rendered in the current work of the Deputy Surveyor General's Office.

CLASS 4, SUPPLY.—Requisitions from 18 officers for data of various kinds have been complied with, some of which involved a good deal of discussion and calculation. In this class is also included the cost of labour in the despatch of maps, charts, books, and forms.

CLASS 5, PREPARATION OF PRESS COPY.—This consists in the writing of the letter-press for the several publications; and also in abstracting and compiling the results of the several calculations in a suitable form for publication. All tabular data when so compiled are carefully compared twice before handing to the printer. The details of the work under this head are as follows:—

Southern Trigon.—The manuscript for the Introductory Chapters of the Volume, which will contain the details of this section of the principal triangulation, has been commenced, and nearly the whole of the numerical and descriptive data have been compiled for the press of which a great portion has been finally compared.

North-West Quadrilateral.—The remaining portion of Professional Volume IVA. (Jodhpore and Eastern Sind Meridional Series) was completed. The volume has now been bound and is in course of issue. The compilation of the corresponding Synoptical Volume is nearly complete.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

Observed Latitudes.—The calculations having been completed, the preparation of the details for the press has been taken in hand and a good deal of copy is ready.

Auxiliary Tables to facilitate the Calculations of the Survey of India.—Several tables have been compiled and the explanatory introduction has been re-written for the first 52 tables, with considerable additions.

Spirit-levelled Heights.—Pamphlets Nos. 2 and 3 of Levels in the Bombay Presidency and the Nizam's Dominions, and No. 1, Madras Presidency, were revised and corrected for the press. That for the Bombay Presidency is complete and is being got ready for issue, while the pamphlet for Madras only requires a chart (which will shortly be ready) to complete it also. Other subjects were of lesser importance and need not be detailed here.

CLASS 6, PRESS PROOFS.—The work done under this heading properly relates entirely to the Printing Section, for it consists of the examination and comparison of proofs; and as most of the matter printed is numerical or depends on numerical data, this examination can only be performed by men thoroughly acquainted with all the details of the subject in hand. Ordinary press-readers therefore could not be expected to render the critical examination which such matter requires. The charge for this class, though necessarily included in the cost of the Computing Section, has also to be reckoned in calculating the value of the work turned out by the Printing Section, and it is accordingly distributed over the various works of that section. Should the cost of the two sections be combined this charge (₹5,209) should manifestly be deducted from the total.

CLASS 7, CHARTS.—The careful examination of all charts of triangulation and of spirit-levelled heights before publication, is a matter of very great importance, and this work is also performed by the Computing Section, where the familiarity with the original records renders the detection of mistakes much easier and more certain than if the examination was made by the draftsmen themselves. All the charts, diagrams, &c., prepared during the year by the Drawing Section for the publications of the office were so examined; among them may be especially noted the Reduction Chart of the Eastern Sind Series of the Principal Triangulation for Professional Volume IV A., and the final chart of the Jodhpore Series for the Synoptical Volume, while several of the Degree Sheets of the Assam Longitudinal Series for the Synoptical Volume of that series have received their first comparison.

CLASS 9, MISCELLANEOUS.—In this class is included several duties of the Computing Section which cannot fairly be assigned to any of the other classes.

Early in 1886 Colonel Haig directed that a short base-line should be measured with the Colby compensation bars and microscopes for the purpose of instructing the officers and assistants of the department who were then present at Dehra in the use of the base-line apparatus, as it appeared to him that those who had had experience in such operations were gradually leaving the department without handing on their experience to their successors. He selected a site in the southern portion of the field adjoining the Survey office in which the observatory for the large photo-helio. stands. The ends of the base-line were marked by masonry pillars, surmounted by circular stone caps containing dots on silver plugs let into brass, the dots being flush with the ground level.

The length of the base-line was first chained and so chosen as to be nearly equal to 11 sets of bars and microscopes, when arranged in line for measurement, or 231 yards. The preliminary operations began on the 11th February and continued till the 12th April, partly in order that the work of the office might not be interrupted, and partly in accordance with Colonel Haig's desire that as much opportunity as possible might be afforded to officers visiting Dehra of seeing the process.

The officers who took part in the preliminary operations and the measurement itself were as follows:—

Colonel C. T. Haig, R.E.
Mr. W. H. Cole, M.A.
" J. Eccles, M.A.
" C. Wood.
" A. J. Wilson.
" G. W. E. Atkinson.
" J. A. May.*
Mr. H. W. Peychers.
" W. W. McNair.
" C. H. McA'Fee.
" J. Bond.
" W. J. Cornelius.
" F. E. Warde.

Before the conclusion of the measurement Major G. Strahan, R.E., arrived from the field and took the opportunity of inspecting the operations.

None of these, except Mr. Bond, had ever been present at a base-line measurement, and *he* had only taken a minor part. I myself had had a good deal to do with portions of the apparatus, especially when I assisted in the re-determination of the factors of expansion of standard Bar A. I had also assisted General Walker in the preparation of Volume I of the Operations of the Great Trigonometrical Survey of India, the subject of which is the measurement of the base-lines in India, and further the Mergui Base-line had been reduced under my direct superintendence. I therefore possessed a considerable theoretical knowledge of the subject, and with the aid of the article on geodesy by Captain Yolland,

* Died, 26th June 1886.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

R.E., in the course of Mathematics prepared for the use of the Royal Military Academy, I had no difficulty in carrying out Colonel Haig's orders. The Base-line apparatus required a good deal of cleaning and preparation before it was ready for use. This work was principally performed by Mr. Eccles and myself, aided by Mr. Bond. As the standard Bar A is in store at Calcutta, Bar $\frac{I}{B}$ was used for comparison with the compensation bars; this is one of the two 10-foot standards which were constructed for this survey by Messrs. Troughton and Simms in 1864, and its relation to Bar A being known, its use has only entailed a slight extra calculation to reduce the base-line to the same terms as all others.

The work commenced with the comparison of the thermometers against standard No. 4246 at intervals of temperature of about 2°, ranging from 56° to 88° F.

After this the Base-line microscopes were set up on the comparing pillars in the Bar-room and their runs determined against two $\frac{1}{20}$th inch spaces on the standard steel Foot IF by Troughton and Simms. This operation was repeated after the measurement of the Base-line in accordance with the usual custom.

The next operation was the adjustment and testing of the compensation microscopes for "collimation," "verticality" and "parallelism," and then their comparison with their scales. Seven microscopes were employed. The comparison of the microscopes with their scales was also made again after the measurement. The index errors of the levels on the compensation bars were ascertained by means of a dumpy level placed equally distant from the tongues of the bars. This was done once for all.

Bar comparisons with the standard were made before and after the measurement of the Base-line.

The Base-line itself was measured at the rate of one set of six bars with the microscopes per diem: the exact length as determined by the bars was 693·104 feet of standard Bar A.

I may mention that Mr. Eccles has been thoroughly instructed in every process, mathematical and practical. The time of the other officers could not be spared more than to enable them to take an educational share in the different practical operations as they proceeded. I am indebted to Mr. Bond for the assistance he afforded in several practical details, such as the laying out and clearing the line, fixing the terminal points, adjusting the trestles, &c.

The remaining miscellaneous work was principally as follows:—

Two candidates were examined for the Junior Division of the Department. Sixty-six sets of observations for time were taken and reduced, and the rating of chronometers and of the Dehra office turret-clock attended to. A sub-surveyor was instructed in taking and reducing observations for time, latitude, and azimuth. Observations of 22 stars for latitude, made at the Dehra Observatory, were reduced. Several observations for longitude by zenith distances and for azimuth, taken by officers of the department for practice, were reduced for them.

The index errors of certain Meteorological Instruments were determined and many other minor duties were performed.

CLASS 10.—METEOROLOGY AND GENERAL SCIENCE.

Explorations.—The diary of an explorer has been translated into English and revised.

Actinometry.—The comparisons for determining the relations of certain Thermometer tubes to the standard were resumed and completed.

Meteorological Observations.—No change has been made on the procedure of former years. The results of the observations taken at Dehra Dún twice daily throughout the year have been supplied to the Meteorological Reporter to the Government of the North-West Provinces and Oudh; daily weather telegrams were sent from Mussooree to Simla during the five months the office was open at Mussooree, and anemograms for Mussooree for five months and for Dehra for twelve months have been furnished to the Meteorological Reporter to the Government of India. The usual tables of monthly results and of the mean velocity of wind at Dehra are appended. Another twelve months' observations of earth thermometers have been added to the results exhibited in the table at page cxlvi of the Administration Report for 1884-85. The office having now been established in the same locality in Mussooree for twenty-one years, and registers of the rainfall having been kept regularly throughout each season, it has been thought that a table showing the average fall to date, from the 1st June, for the rainy season, would be both of value and interest. This table has accordingly been added to those usually furnished. It should be remarked that the rainfall in Mussooree varies very much with the locality. Much larger falls are registered at lower elevations than at this office, and especially where there are gorges.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

Mean Monthly Readings of Earth Thermometers.

Depth in feet of thermometer bulbs below surface of ground.	Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
		°	°	°	°	°	°	°	°	°	°	°	°
25·6	1881	...	...	...	...	...	73·55	73·90	75·02	76·07	76·69	76·98	*76·71
	1882	75·91	75·13	74·52	74·11	73·97	74·05	74·31	74·95	75·69	76·14	76·39	76·37
	1883	75·85	75·02	74·28	73·89	73·97	73·96	74·32	74·90	75·66	76·16	76·28	76·12
	1884	75·20	74·39	73·90	73·64	73·65	73·95	74·34	76·00	76·87	77·33	†77·27	76·72
	1885	75·83	74·95	74·34	74·00	73·92	74·02	74·25	‡	‡	‡	‡	
	1886	‡	‡	‡	‡	‡	‡	‡	‡	‡	...	...	...
12·8	1881	...	...	...	...	...	74·87	76·47	77·88	78·98	79·26	77·71	74·89
	1882	72·33	70·79	70·47	71·70	73·37	75·23	76·87	78·20	78·98	79·02	77·64	74·89
	1883	72·46	70·36	69·83	70·94	73·00	75·17	76·82	78·20	78·97	78·93	76·93	73·50
	1884	70·95	69·75	70·04	71·47	73·39	75·75	77·42	79·24	79·82	79·34	§77·08	74·52
	1885	72·18	70·37	70·03	71·14	72·66	73·93	76·09	78·98	79·42	79·25	77·93	75·36
	1886	72·49	70·56	70·26	70·95	72·46	74·12	76·18	78·63	79·54	...	...	...
6·4	1881	...	...	...	...	...	80·66	81·01	80·75	81·24	80·33	75·80	70·58
	1882	67·17	66·06	67·75	72·20	76·47	80·01	80·78	81·30	81·32	80·16	75·75	71·03
	1883	67·64	65·10	66·48	71·00	76·72	79·29	80·70	81·42	81·12	79·50	74·50	68·71
	1884	66·03	65·61	67·95	72·36	76·99	80·76	81·46	81·64	81·10	78·85	73·81	69·57
	1885	66·64	64·83	66·73	71·10	74·29	77·59	80·32	80·77	80·85	79·90	76·19	70·97
	1886	66·53	64·72	66·61	69·99	74·87	77·87	80·34	81·54	81·70	...	...	...
3·2	1881	...	...	...	...	..	85·93	83·29	82·03	82·40	79·67	72·20	65·59
	1882	62·57	62·31	67·61	75·49	80·86	84·77	82·71	83·04	82·20	79·21	71·73	66·14
	1883	62·27	60·70	64·83	74·13	81·57	83·44	83·00	83·43	81·74	78·23	69·72	62·50
	1884	61·23	61·90	67·69	75·75	82·32	85·11	84·20	81·94	81·38	76·50	69·32	64·18
	1885	61·38	60·28	65·97	73·52	76·30	82·30	82·68	80·94	81·35	78·73	72·55	65·37
	1886	60·79	60·22	65·33	72·39	78·89	82·14	82·55	82·48	82·37	...	...	...
1·1	1881	...	...	...	...	...	89·16	84·14	82·55	83·19	77·81	67·81	60·72
	1882	58·91	59·41	69·50	78·88	84·99	88·24	83·48	84·08	82·89	77·85	67·96	62·17
	1883	57·98	58·45	65·87	79·53	86·65	87·94	84·55	84·89	82·19	76·70	65·41	57·83
	1884	58·28	59·89	69·56	80·14	88·27	88·57	85·59	82·03	81·64	74·14	65·38	60·10
	1885	57·35	57·75	68·28	77·20	78·63	87·22	84·35	81·16	82·09	77·45	69·03	60·91
	1886	57·13	57·76	66·25	77·19	83·02	86·44	83·78	82·99	83·16	...	...	...
Thermometer in shade.	1881	...	...	...	...	..	87·68	82·54	81·00	82·86	82·72	75·22	71·19
	1882	66·77	66·51	81·36	88·72	91·04	89·11	81·61	82·40	84·62	83·47	75·04	72·36
	1883	64·80	68·72	75·89	91·83	95·54	90·60	83·54	83·85	82·86	82·00	70·95	66·12
	1884	67·36	68·52	81·32	89·51	97·33	89·69	83·86	79·73	80·30	77·30	71·77	67·37
	1885	62·50	65·44	79·35	85·63	84·47	91·97	82·74	79·08	82·41	81·98	75·09	66·31
	1886	63·04	67·49	73·74	88·55	87·82	90·60	82·35	81·75	85·05	...	...	...

* The hole which had gradually filled up about 2½ feet was dug down to the original depth between the 20th and 24th December 1881.

† The hole which had gradually filled up 2 feet since December 1881, was dug down to the original depth between the 9th and 18th November 1884.

‡ Earth fell in from the sides of the hole on the 2nd and 3rd August 1885, and covered the thermometer to the depth of 11 feet. It has been found impossible, as yet, to sink another thermometer to this depth.

§ The hole which had gradually filled up 11 inches since June 1881, was dug down to the original depth on the 17th and 18th November 1884.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

Mean Velocity in Miles of the Winds which blew at Dehra Dún during the Twelve Months of 1885-86 for each Hour of the Day.

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1	0·97	0·83	0·42	0·32	0·51	1·13	0·70	0·55	0·33	0·10	0·32	0·92
1 „ 2	1·00	0·80	0·23	0·55	0·37	0·84	0·47	0·39	0·40	0·23	0·30	0·73
2 „ 3	0·77	0·53	0·29	0·42	0·25	0·90	0·40	0·55	0·30	0·45	0·13	0·50
3 „ 4	0·58	0·33	0·29	0·45	0·25	0·55	0·47	0·65	0·43	0·32	0·30	0·63
4 „ 5	0·42	0·10	0·13	0·52	0·21	0·45	0·23	0·35	0·40	0·19	0·23	0·37
5 „ 6	0·48	0·10	0·19	0·61	0·29	0·32	0·33	0·42	0·27	0·06	0·08	0·44
6 „ 7	0·29	0·07	0·26	0·48	0·61	0·35	0·27	0·26	0·17	0·29	0·07	0·27
7 „ 8	0·13	0·10	0·03	0·29	0·25	0·32	0·30	0·39	0·23	0·06	0·08	0·65
8 „ 9	0·10	0·03	0·06	0·42	0·43	0·23	0·47	0·65	0·50	0·26	0·30	0·42
9 „ 10	0·42	0·13	0·10	0·68	0·75	0·42	0·90	1·13	0·77	0·32	0·62	0·90
10 „ 11	0·94	0·30	0·29	0·81	1·29	0·74	1·57	1·45	1·23	0·48	0·80	1·31
11 „ 12	1·06	0·67	0·77	1·61	1·29	1·55	2·10	1·39	1·37	0·81	0·85	1·08
12 „ 13	1·48	0·93	0·87	1·58	1·46	1·74	1·90	1·55	1·63	0·74	0·65	1·06
13 „ 14	1·58	0·97	0·90	1·06	2·25	2·77	2·50	2·29	2·03	0·77	0·85	1·13
14 „ 15	1·58	1·07	0·81	1·74	2·32	2·71	2·70	2·52	1·63	0·97	0·81	1·15
15 „ 16	1·03	0·73	0·74	1·26	1·82	2·16	2·30	2·35	2·00	1·00	0·81	1·17
16 „ 17	0·58	0·27	0·48	0·94	1·43	2·29	2·07	1·84	2·07	0·58	0·60	0·87
17 „ 18	0·32	0·13	0·13	0·48	0·89	1·74	1·47	1·58	1·33	0·29	0·48	0·33
18 „ 19	0·94	0·47	0·10	0·29	0·50	0·58	0·30	1·19	0·63	0·32	0·50	0·38
19 „ 20	1·32	1·00	0·13	0·16	0·43	0·68	0·23	0·90	0·60	0·26	0·40	0·79
20 „ 21	1·29	1·13	0·29	0·29	0·36	0·61	0·33	0·55	0·53	0·13	0·13	0·62
21 „ 22	1·94	1·03	0·39	0·55	0·50	0·65	0·67	0·81	0·67	0·29	0·30	0·77
22 „ 23	1·97	1·13	0·65	0·58	0·54	0·90	0·77	0·58	0·50	0·55	0·10	0·94
23 „ 24	1·45	1·07	0·32	0·32	0·50	0·81	0·97	0·55	0·73	0·52	0·17	1·27
Sums	22·64	13·92	8·87	16·41	19·73	25·44	24·42	24·89	20·75	9·99	9·88	18·70
Average	0·94	0·58	0·37	0·68	0·82	1·06	1·02	1·04	0·86	0·42	0·41	0·78

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN.

Monthly Meteorological Results

Year and Month.	Barometer reduced to 32° Fahrenheit.						Hygrometer.			
	At 9-30 A.M.			At 3-30 P.M.			At 9-30 A.M.		At 3-30 P.M.	
	Highest.	Lowest.	Monthly mean.	Highest.	Lowest.	Monthly mean.	Monthly mean temperature of dew point.	Monthly mean humidity.	Monthly mean temperature of dew point.	Monthly mean humidity.
1885.										
October	27·797	27·655	27·718	27·667	27·567	27·621	57·7	·621	57·9	·479
November	·937	·711	·827	·827	·629	·736	49·2	·619	50·5	·464
December	·897	·673	·814	·827	·608	·729	46·5	·760	47·2	·556
1886.										
January	28·065	·621	·795	·954	·525	·724	45·6	·786	47·1	·596
February	27·906	·626	·763	·809	·544	·686	44·6	·713	45·1	·467
March	·906	·567	·696	·839	·476	·618	52·8	·659	52·9	·511
April	·701	·484	·603	·604	·389	·518	50·5	·395	48·8	·274
May	·681	·459	·560	·591	·353	·469	60·5	·497	59·1	·411
June	·542	·301	·428	·453	·227	·344	67·5	·579	66·5	·500
July	·505	·311	·400	·431	·249	331	75·2	·856	76·7	·818
August	·512	·340	·442	·432	·236	·356	74·2	·888	75·4	·813
September	·705	·388	·550	·607	·364	·463	71·6	·812	72·8	·699

The following table gives the average rainfall in inches to date, for the months of June the records kept at the Trigonometrical Branch Office,

Day of the month.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
June	·04	·11	·24	·33	·36	·44	·63	1·21	1·36	1·52	1·68	1·83	1·98	2·18	2·31
July	9·83	10·80	11·55	12·20	13·14	13·71	14·87	15·61	16·14	16·79	17·62	18·25	19·10	20·04	20·95
August	39·09	40·78	41·45	42·27	43·02	44·10	45·51	46·67	47·49	48·45	49·16	49·71	50·38	51·07	52·00
September	64·67	65·45	65·79	66·13	66·73	67·23	67·63	68·04	68·57	69·14	69·75	70·07	70·23	70·38	70·58

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

taken from the Register.

THERMOMETER.								RAIN.		WIND.	CLOUD.	
DRY BULB.					WET BULB.							
Maximum in sun's rays.	Minimum on grass.	Maximum in air.	Minimum in air.	Monthly mean in air.	Maximum in wet.	Minimum in wet.	Monthly mean wet.	Number of days it fell.	Fall in inches.	Most frequent direction.	At 9-30 A.M.	At 3-30 P.M.
105·4	46·8	86·6	54·1	71·5	71·5	49·1	61·1	0	·0	N.	0	0
97·4	38·5	77·6	46·3	63·8	68·4	42·1	54·6	0	·0	Calm.	0	1
86·4	33·4	70·3	40·2	56·3	57·9	37·4	50·0	4	3·78	Calm.	2	4
83·0	33·9	68·5	39·6	54·9	57·8	38·1	49·6	7	3·29	Calm.	5	6
93·1	29·8	77·8	35·4	56·8	62·9	34·3	49·2	5	1·69	Calm.	4	4
101·4	41·8	82·9	46·8	65·1	69·4	44·2	56·7	10	2·76	Calm.	4	6
116·5	41·6	97·7	48·6	75·6	71·5	42·6	59·1	1	·03	Calm.	1	2
115·8	53·7	98·2	58·7	79·4	77·9	55·3	66·4	7	3·56	Calm.	2	5
117·2	57·0	102·0	62·9	82·9	79·5	53·7	71·0	10	7·72	Calm.	3	4
110·8	68·9	89·2	71·1	80·2	82·1	69·4	75·6	24	35·47	Calm.	8	8
108·9	65·9	88·0	70·1	78·2	79·5	66·2	74·1	26	28·27	S.	7	7
106·9	61·2	86·8	66·4	77·8	79·7	61·4	71·6	11	8·03	N. W.	3	5

to September, commencing from the 1st June, for the 21 years 1866-86, as obtained from Evelyn Hall, Mussooree. Height above mean sea level 6,880 feet.

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Average for the month.
2·38	2·63	2·79	3·00	3·29	3·89	4·09	4·71	4·90	5·76	6·10	6·64	7·20	7·87	8·73	...	8·73
21·79	22·63	24·44	25·46	26·31	27·25	28·53	29·55	30·60	31·71	33·11	34·10	35·15	36·19	37·44	38·21	29·48
52·88	53·83	54·79	55·49	56·17	56·75	57·37	57·91	58·61	59·46	59·94	60·51	61·34	62·07	63·16	64·17	25·96
71·08	71·39	71·91	72·02	72·24	72·36	72·51	72·68	72·85	73·04	73·17	73·34	73·35	73·43	73·58	...	9·41

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

TYPE-PRINTING SECTION.—The usual table showing the work annually performed by this Section during the past five years is given below, the unit (a page of foolscap) being the same throughout. It will be observed that the out-turn of the past year is largely in excess of any previous one.

	1881-82.	1882-83.	1883-84.	1884-85.	1885-86.
Pages composed	1,283	1,381	1,489	1,505	1,340
,, printed	471,616	475,586	362,386	470,970	638,593

An analysis of the pages composed is as follows:—

		Pages.
For Professional Volumes	Longitude Operations	249
	Latitude ,,	14
	Jodhpore and East Sind Meridional Series	109
	Great Arc Series, Section 8° to 18°	90
	South-East Coast and Ceylon Series	24½
	Madras Meridional and Coast ,,	38
	Mangalore Meridional ,,	15
	South Konkan Coast ,,	4
	Volume V—Corrigendum	1
	TOTAL	544½

		Pages.
For Synoptical Volumes	Jodhpore and East Sind Meridional Series	18
	Great Arc Meridional Series, Section 8° to 18°	6
	Madras Meridional and Coast Series	24
	South-East Coast and Ceylon ,,	16½
	Mangalore Meridional ,,	15
	South Párasnáth and South Malúncha Series	2½
	Jogitila Series	1
	South Afghanistan Triangulation	½
	TOTAL	83½

Miscellaneous	Spirit-levelled Heights, Nos. 2 and 3, Bombay Presidency	53
	Ditto ditto, No. 1, Madras Presidency	205
	Letter-press for Chart-headings and foot-notes	51
	Auxiliary Tables	203
	Orders, Memoranda, Forms, &c.	167½
	For Forest Department	28½
	,, Quartermaster General's Department	4½
	TOTAL	712

Statement of expenditure (Dr.) and amounts credited (Cr.) on account of the Type-printing Section during the Survey year, 1st October 1885 to 30th September 1886.

DR. CR.

	R	R		R	R
Superintendence	920		Letter-press, forms, diagrams, &c., for the Survey of India Department	13,974	
Establishment	7,121				13,974
Aid rendered by Computing Section	5,209				
Wear and tear of plant	578				
Contingencies	99				
		13,927			
Stores received from England	*85		Miscellaneous letter-press, &c., extra-departmental	202	
		85			202
Stores purchased in India	...				
Stationery from Stationery Office	*164				
		164			
TOTAL	...	14,176	TOTAL	...	14,176

* Financial year 1885-86.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

Statement of Departmental Work done by the Type-printing Section between 1st October 1885 and 30th September 1886.

Specification of print.	No. of pages.	Total No. of pulls.	No. of copies*.	Value.
				₹
Professional Volumes	318	61,279	510	5,338
Synoptical ,,	64	7,714	360	544
Pamphlets of Spirit-levelled Heights	262	21,534	510	3,577
Letter-press for Charts, map-headings and foot-notes	121	3,404	28	439
Auxiliary Tables	141	45,581	1,012	2,751
Forms	56	8,830	176	582
Miscellaneous work done for the Trigonometrical Branch	205	21,041	112	743
TOTAL	†1,167	169,383	...	13,974

* Approximate number.
† Equal 1,308 pages of standard (foolscap) size.

Statement showing the Amount and Value of work done for other Departments by the Type-printing Section between 1st October 1885 and 30th September 1886.

Name of other Departments.	No. of pages.	Total No. of pulls.	No. of copies.	Value.
				₹
Forest Department	32	2,477	112	194
Quarter Master General's Department	6	46	7	8
	*38	2,523	...	202

* Equal 32 pages of standard (foolscap) size.

Statement of Expenditure (Dr.) and Amounts Credited (Cr.) on account of the Drawing Section, during the Survey year, 1st October 1885 to 30th September 1886.

DR.			CR.		
	₹ a.	₹ a.		₹ a.	₹ a.
Superintendence	4,800 0		Maps, Charts, &c., for the Survey of India Department	30,126 11	30,126 11
Establishment	29,464 0				
Contingencies	223 0				
		34,487 0			
Stationery from Stationery Office	143 10	143 10	Maps, &c., Extra-departmental	4,503 15	4,503 15
TOTAL	...	34,630 10	TOTAL	...	34,630 10

Statement showing the Value of Work done for other Departments by the Drawing Section, from the 1st October 1885 to the 30th September 1886.

Name of other Departments.	Value.	REMARKS.
	₹ a.	
For the North-Western Provinces Government	72 0	
,, Foreign Office	68 11	
,, Quarter Master General	4,342 0	
,, Forest Department	21 4	
TOTAL	4,503 15	

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

Departmental Work done in Drawing Section, from 1st October 1885 to 30th September 1886.

Title of Map.	Scale=1 inch.	Remarks and Progress.
Final Charts of Triangulation.		
Assam Longitudinal Series Degree Sheets Nos. 1 to 28	4 miles	In course of preparation.
Jodhpore Meridional Series	4 ,,	For reduction to half scale. Ready for the Press.
Reduction Chart of Eastern Sind Meridional Series, for Vol. IVA.	6 ,,	For reduction to half scale. Published.
Compilations.		
Mussooree and Landour Guide Map	1/8 ,,	In course of preparation.
Spirit Levelling Operations, Nos. 2 and 3, Bombay Presidency (revised edition)	6 ,,	For reduction to half scale. Published.
Spirit Levelling Operations, No. 1, Madras Presidency (revised edition)	6 ,,	For reduction to half scale. Ready for the Press.
Map of Burma, comprised in South-East Trans-frontier Sheets Nos. 4, 5, 12, 13	16 ,,	In course of preparation.
Rajputana Survey Sheet No. 260 (new numbering) second edition	1 ,,	Ditto ditto.
Miscellaneous.		
Graticule sheets. South-Western Asia λ 24° to 42° (9 sheets)	8 ,,	Published.
North-West Trans-frontier, λ 24° to 28° and λ 32° to 36° (4 sheets)	8 ,,	Ditto.
North-East Trans-frontier, λ24° to 32° (4 sheets)	8 ,,	Ditto.
Northern Trans-frontier, λ 26° to 32° (3 sheets)	8 ,,	Ditto.
South-Western Asia, λ 28° to 32° (1 sheet)	16 ,,	Ditto.
North-West Trans-frontier, λ 24° to 36° (3 sheets)	16 ,,	Ditto.
North-East Trans-frontier, λ 24° to 32° (2 sheets)	16 ,,	Ditto.
Northern Trans-frontier, λ 28° to 36° (2 sheets)	16 ,,	Ditto.
Prepared a Tracing of Afghan Boundary Commission map of country between Mashad and Hari Rud and part of the route from Herat to Kabul, in 3 parts	8 ,,	For Office use.
Prepared 29 tracings of Afghan Boundary Commission Survey Original Sheets and scrutinized the same	4&8 ,,	Ditto.
Examined 10 photo-zincographed copies of Afghan Boundary Commission Survey maps, received from Survey of India Office, against original sheets corrected by Afghan Boundary Commission Survey, and entered corrections on photo-zincographed copies	4&8 ,,	Ditto.
Prepared an Index to Afghan Boundary Commission Survey and Survey of India Office maps	32 ,,	Ditto.
Prepared a Tracing of the Index to the Sheets of North-East Trans-frontier, and North Trans-frontier, Darjeeling and Nepal Boundary Survey	16 ,,	Ditto.
Prepared Tracings of Trigonometrical points falling in Sheets 12 and 13 of North-West Trans-frontier	8 ,,	For use of a Sub-Surveyor proceeding to join the Afghan Boundary Commission.
Prepared Tracings of Baluchistan Survey Charts	4 ,,	For Office use.
Examined and touched up names on silver prints of map of Turquie d'Asie	About 24 ,,	Ditto.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

Departmental Work done in Drawing Section, from 1st October 1885 to 30th September 1886—contd.

Title of Map.	Scale=1 inch.	Remarks and Progress.
Miscellaneous—contd.		
Prepared a List of Materials available for sheets of South-West Asia and drew their limits on Index Maps	128 miles	For office use.
Prepared a List of data for Map of Burma and China	...	Ditto.
Determined Magnetic Curves applicable to Trans-frontier Maps	...	Ditto.
Correcting Photo-zincographed copies of the Index to the North-East Trans-frontier Sheets to show Pemberton's route in Bhutan and Lama's route in Tibet	64 miles	In course of preparation.
Transliterated Russian names on Sheet 2 of North-West Trans-frontier	8 ,,	For office use.
Collating Geological Notes for Trans-frontier and South-West Asia Maps	...	Ditto.
Prepared Specimens of Printing for Trans-frontier Sheets	...	Ditto.
Prepared Tracings of Routes from Chitral to Gakuch *vid* Mastuj, Yasin, &c., by Colonel Woodthorpe	4 miles	Ditto.
Prepared a rough plot of Explorer M. H.'s route in Nepal and Tibet from Dagmára Thana to Tribeni Ghât on 2 inches=1 mile; and adjusted the same between obligatory points	4 ,,	For report. In course of preparation.
Examined dispersion of error in Lama U. G.'s traverses in North-Eastern Trans-frontier Sheets Nos. 6 and 7	...	
Computed and corrected Nain Sing's Traverse of 1865-66	...	
Assisted the office of the Himalaya Party in drawing Colonel Tanner's Sketch Map of Sikhim, Darjeeling, &c., and Charts	4 miles.	
Compared Colonel Gerard's Route Map of Kurdistan with his itinerary	16 ,,	For office use.
Corrected Original Sections of Gujarat Survey Sheet No. 41	½ mile	For publication.
Examined and corrected Rajputana Survey Sheets Nos. 73, 74, and 75	1 ,,	Published.
Examined and corrected Sheets Nos. 1 to 8 of Jeypore City and Environs	⅛ ,,	Ditto.
Examined Original Sheets Nos. 6 and 7, of Ajmere City, and prepared the heading and index for this set of maps	1/12 ,,	In course of preparation.
Examined Mirzapur Survey Sheet No. 201 N. E.	½ mile.	
Examined Mirzapur Survey Sheet No. 200	1 ,,	
Examined Nepal Boundary Survey Sheets Nos. 44 and 45, 2nd edition	1 ,,	Published.
Map of Kishenganga Valley	About 4 miles	For correction of Atlas Sheet No. 28.
Projected the few points fixed in 1882-83 on Secondary Triangulation Charts of the Burma Party, Season 1876-77	4 miles	For office record.
Prepared 7 plates of figures of the Great Arc Series from λ 8° to 18° for reduction to half scale	Various	For publication in Professional Volumes.
Prepared 2 plates of figures of the Jodhpore Meridional Series	6 miles	Ditto ditto.
Prepared 2 plates of figures of the Eastern Sind Meridional Series	6 ,,	Ditto ditto.
Drew boundaries of districts in Bombay Longitudinal and Mangalore Meridional Series Preliminary Charts	4 ,,	For use of Computing Section.
Engaged on Charts showing Snowy Peaks on the Himalayas from Assam to the Kunar River	16 ,,	For Australian Geographical Society.
Prepared Monthly Diagrams of conspicuous Sun-spots from October 1885 to August 1886	...	Published in Survey Notes.
Constructed Scales of Latitudes and Longitudes and Miles between the parallels of latitude 0° to 40°	4 and 8, 16 and 32 miles combined	Published.
Drew plan and elevation of New Observatory Building	3 feet	For office use.
Maps, colored. No. of copies — 3,557	...	The coloring this year has been specially heavy.
Supervising Sub-surveyors re-surveying parts of Mussooree and Landour for the new edition of the Guide Map	⅛ mile	In course of preparation.
Prepared one copy of General Report, South-West Baluchistan, Season 1884-85	. . .	For Baluchistan Party.
Prepared Introduction to General Report, South-West Baluchistan, and compared the same	. . .	For Baluchistan Party.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

Statement of extra departmental work done by the Drawing Section.

Title of Map.	Scale=1 Inch.	Remarks and Progress.
Compilation, Mapping, &c.		
Completed Map of Dehra Dún and Siwáliks, Sheet No. 2, by insertion thereon of south-western portion of Tiri Garhwál	1 mile	For Executive Engineer, Dehra Dún, completed.
Corrected Colonel Tanner's Sketch Map of Sikkim, Darjeeling, &c.	4 miles	For Foreign Office.
Adjusted and mapped a confidential exploration route falling into six Trans-frontier Sheets	8 „	For the Quartermaster General of India.
Prepared Skeleton Map to illustrate the diary of a confidential route exploration	32 „	Ditto ditto.
Prepared vertical sections of a confidential route	Horizl. 9 miles. vertl. 3,000 ft.	For the Quartermaster General of India.
Prepared a Diagram (Appendix B), illustrating the system of working on a confidential route	6 miles	Ditto ditto.
Prepared Map of country between Umballa and Delhi	About 4 miles	Ditto ditto.
Prepared Tracing of the work done by the Gilgit Mission	4 „	Ditto ditto.
Plotted and reduced route survey by Abdul Jalil, explorer, from Shah Kadar *vid* Jelalabad, Asmar, &c., to Malta	1 „	Ditto ditto.
Completed with respect to headings and foot-notes, Forest Maps, before sending to Press	Various	For Forest Department.
Coloring Maps.		
North-East Trans-frontier Sheet No. 6, in four sections, 24 sets	4 miles	For Foreign Office.
Colonel Tanner's Sketch Map of Sikkim, Darjeeling, &c., 26 copies	4 „	Ditto.
Sketch Map of a Journey in the Pamir and Upper Oxus, 40 Copies	12 „	Ditto.
Map of the Country between Gilgit Fort and Khomar Nala, 12 copies	6 „	Ditto.
Work done with Gilgit Mission by Colonel Woodthorpe, 6 copies	4 „	Ditto.
Map to illustrate Report on Sind-Kalat Boundary, 30 copies	1 „	For Commissioner of Sind (F. O.)

Statement of expenditure (Dr.) and amounts credited (Cr.) on account of the Photo-zincographic Section, during the Survey year 1st October 1885 to 30th September 1886.

DR. CR

	R a.	R a.		R a.	R a.
Superintendence	2,400 0		Maps, Forms, Diagrams, &c., for the Survey of India Department	11,078 1	
Establishment	8,806 0				
Contingencies	151 11				
		11,357 11			11,078 1
Chemicals and Stores from England	2,111 9				
Paper received from England	3,759 3				
		5,870 12	Miscellaneous Maps, Plans, &c., extra departmental	5,583 7	5,583 7
Chemicals and Stores purchased in India	52 3				
Stationery (paper) from Stationery Office	618 3				
		670 6	Balance to debit of Department	...	1,261 2
Shipping and Landing charges	23 13	23 13			
TOTAL	...	17,922 10	TOTAL	...	17,922 10

Note.—In addition to the credits above shown, the section has realized (by sale *on payment* of maps, &c.) and paid into the Treasury the sum of R663-7.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*contd.*

Statement shewing the Amount and Value of work done for other Departments by the Photozincographic Section between 1st October 1885 and 30th September 1886.

Names of other Departments.	Photozincographic Printing.						Type Printing.		No. of Pulls.	No. of Copies.	Value.	Remarks.
	No. of Sheets or Sections or subjects.	No. of Negatives.	No. of Photo. transfer Prints.	No. of Zinc Plates.	No. of Silver Prints.	No. of Blue Prints.	No. of Pages or Items.	No. of Copies.				
Foreign Department .	10	41	41	11	...	4	...	...	...	...	639 15	
Forest Department .	67	208	269	48	37	554	...	...	5,582	6,782	4,219 6	
Quarter Master General . .	2	9	42	6	...	...	...	...	2,275	2,300	678 11	
Secretary to Government, N.-W. P. and Oudh, Irrigation Branch . .	1	3	3	1	...	...	...	...	50	50	45 7	
Total .		261	355	66	37	558	...	...	7,907	9,132	5,583 7	

Statement of Departmental work done by the Photo-zincographic Section between 1st October 1885 and 30th September 1886.

Specification of Plate or Print.	Photozincographic Printing.									Type Printing.		Total No. of pulls.	No. of copies.	Value.	Remarks.
	Progress made	Scale of maps.	Size of each sheet.	No. of sheets, sections or subjects.	No. of negatives.	No. of photo. transfer prints.	No. of zinc plates.	No. of silver prints.	No. of blue prints.	No. of pages or items.	No. of copies.				
		1 inch=												₹ a. p.	
Nepal Boundary Survey, Sheet No. 28	F.	¼ mile.	D.E.	1	...	...	...	...	...	...	...	53	53	6 15 0	
Do. do. Sheets Nos. 29 to 43	,,	¼ ,,	,,	15	90	90	15	...	...	...	...	805	805	1,806 14 0	Final issue.
Do. do. ,, Nos. 44 and 45	,,	1 ,,	,,	2	16	16	2	...	...	...	...	155	155	306 3 0	
Do. do. Mechi Sheets Nos. 1 to 4	,,	¼ ,,	,,	4	24	24	4	..	30	...	...	30	30	463 12 0	For use of Field Party.
Darjeeling Survey, Daling Hills Sheets Nos. 1 to 7, skeleton	,,	½ ,,	,,	7	46	46	7	...	32	...	...	32	32	168 6 0	
Gujarát Survey, Sheets Nos. 40 and 49	,,	4 ,,	...	2	8	...	...	32	...	...	...	...	8	95 0 0	Atlas reductions for Engravers.
Do. ,, No. 50, Sec. 11	,,	½ ,,	¼ D.E.	1	2	2	1	6	4	...	...	8	11	54 10 0	For use of Field Party.
Do. ,, No. 50, Sec. 11	,,	¼ ,,	D.E.	1	8	9	1	...	...	...	...	86	86	171 14 0	
City of Jeypore with Amer, Sheets Nos. 1 to 8	,,	½ ,,	,,	16	84	84	16	...	...	...	...	1,184	592	1,772 15 0	In *two* colours.
Rajputana Survey, Sheets Nos. 73, 74, 75	,,	1 ,,	,,	3	18	18	3	..	...	...	.	469	469	444 11 0	
Do. do. Nos. 73, 74, 75	,,	4 ,,	...	3	3	...	...	12	...	...	...	...	12	23 5 0	Atlas reductions for Engravers.
Do. do. No. 56 E	,,	2 ,,	...	1	1	...	...	3	...	...	...	...	3	12 7 0	
Gwalior and Central India Survey, Sheets Nos. 227, 228, 230; 208, 224, 207, 223; 227 in 2 parts	,,	2 ,,	...	5	5	...	...	20	...	...	...	...	20	73 8 0	For use of Field Party.
Graticule Sheets, *with trigonometrical points*, North-West Trans-frontier, Nos. 14, 21, 22	,,	8 ,,	D.E.	3	18	18	3	...	27	...	...	42	42	320 5 0	
Graticule Sheets, *blank*, North-West Trans-frontier; 24° to 26°, 26° to 28°, 28° to 30°, 34° to 36°	,,	8 ,,	,,	4	6	6	4	...	...	...	...	78	78	133 4 0	
Do. ,, North Trans-frontier; 26° to 28°, 28° to 30°, 30° to 32°	,,	8 ,,	,,	3	...	...	3	...	...	...	...	49	49	11 8 0	
Do. ,, North-East Trans-frontier; 24° to 26°, 26° to 28,° 28° to 30°, 30° to 32°	,,	8 ,,	,,	4	...	...	4	...	...	...	...	103	103	23 11 0	
Do. ,, South-West Asia, 24° to 26°, 26° to 28°, 28° to 30°, 30° to 32°, 32° to 34°, 34° to 36°, 36° to 38°, 38° to 40°, 40° to 42°	,,	8 ,,	,,	9	20	20	9	...	...	...	...	382	382	505 3 0	
Do. ,, North-West Trans-frontier; 24° to 28°, 28° to 32°, 32° to 36°	,,	16 ,,	,,	3	18	18	3	...	12	...	...	40	40	290 2 0	
Do. ,, North Trans-frontier, 28° to 32°, 32° to 36°	,,	16 ,,	,,	2	...	...	2	...	...	...	..	27	27	7 . 3 0	
Do. ,, North-East Trans-frontier, 24° to 28°, 28° to 32°	,,	16 ,,	,,	2	...	...	2	...	...	...	...	27	27	7 3 0	
Do. ,, South-West Asia, 28° to 32°	,,	16 ,,	,,	1	...	...	1	...	...	...	...	26	26	7 12 0	
North-East Trans-frontier Sheet No. 5	* ,,	8 ,,	,,	1	6	6	1	...	...	...	..	60	60	99 5 0	Preliminary prints.
Do. do. No. 6	* ,,	...	...	1	...	...	1	...	12	...	...	12	12	3 12 0	
Northern Trans-frontier Sheets Nos. 20 and 21	,,	8 miles	D.E.	2	12	12	2	...	...	...	...	120	120	198 10 0	Do. do.
Kishenganga Valley, Kashmir	,,	4 ,,	½ ,,	1	2	2	1	12	...	...	...	2	14	77 13 0	Including Atlas reductions for Engravers.
Turkestan Confidential Edition, Sheets 1, 2, 4	* ,,	32 ,,	D.E.	3	...	...	3	...	...	...	...	90	90	20 10 0	
Eastern Afghanistan and Kafiristan	* ,,	16 ,,	½ ,,	1	...	...	1	...	...	...	...	12	12	1 14 0	
Eastern Turkestan, 1873-74	* ,,	40 ,,	D.E.	1	...	8	1	...	...	...	...	306	306	122 1 0	
Kandahar District Triangulation, season 1880-81, Finl Chart	,,	8 ,,	½ ,,	1	4	4	1	...	...	...	...	136	136	90 7 0	For Synoptical Volume IA.
Diagram of North-West Quadrilateral	,,	64 ,,	⅛ ,,	1	1	2	1	...	...	...	...	78	156	38 1 0	Do. do.
Diagram of figures (polygonal) of the Jodhpore and Eastern Sind, Meridional Series	,,	12 ,,	⅛ ,,	4	4	8	4	...	...	...	...	7,060	2,120	215 0 0	For Professional Volume IVA.
Reduction of Chart of principal Triangulation of the Eastern Sind Meridional Series	,,	12 ,,	⅛ ,,	1	2	2	1	...	...	...	...	530	530	55 7 0	Do. do.
Diagram shewing Triangulation connecting Fyzabad Longitude Station	In Press.	1 ,,	½ ,,	1	2	4	1	...	...	...	...	100	200	56 2 0	For Professional Volume of Electro-telegraph longitudes.
Diagram of figures (polygonal of the Great Arc Meridional Series.	F.	6 and 12 miles.	¼ and ⅛ D.E.	5	5	14	5	...	...	...	...	875	2,500	270 7 0	For Professional Volume of Southern Trigon.

Principal chains of triangles west of the meridian of 92°		200 miles	1/8	1	1	2	1	...	...	...	...	250	500	35 5 0	For Professional Vol. IVA.
South-West Asia Index (corrected)	*	128 "	D.E.	1	...	...	1	...	...	...	...	35	35	7 8 0	
Do. do.		320 "	1/2 F.P.	1	1	2	1	...	...	...	...	264	528	47 14 0	
Chart of Spirit-levelling Operations, seasons 1877-80		24 "	1/2 D.E.	1	2	2	1	...	...	...	..	530	530	71 9 0	For pamphlet of Spirit-levelled Heights Nos. 2 and 3, Bombay Presidency and Nizam's Dominions (Revised edition.)
Diagram shewing lines of levels in South India		200 "	1/16 "	1	1	8	1	...	...	...	...	125	1,000	66 13 0	For pamphlet of Spirit-levelled Heights.
Dera-Ismail-Khan Frontier	*	2 "	D.E.	1	...	...	1	...	...	..	...	32	32	7 2 0	
Map of North-East Persia		1/12 "	...	1	2	...	...	8	...	...	...	...	4	25 2 0	
Hyderabad Survey Sheets Nos. 220 and 224		1 "	D.E.	2	12	12	2	...	...	...	...	150	150	202 6 0	
Bangalore Cantonment Chart		1/2 "	"	1	7	7	1	...	...	...	...	25	25	99 0 0	
Cantonment and City of Bangalore		1/12 "	"	2	12	12	2	...	...	...	...	400	400	251 10 0	
Abstract Account of conspicuous Sun-spots, November 1885 to August 1886		...	1/2 F P.	10	10	20	10	...	...	...	...	1,029	2,058	303 4 0	For Survey of India notes.
Russian map of Trans-Caspian region, 1877		20 versts	D.E.	1	8	8	1	...	...	...	...	4	4	153 5 0	} For office use.
Map of the Pamir and co-terminous countries		20 miles	...	1	6	...	...	18	...	...	...	...	3	74 11 0	
Asiatique deL'Empire Ottoman		24 "	...	1	20	...	...	60	...	...	...	...	3	249 0 0	
Katmandu Valley, with key		2 "	D.E.	3	6	6	1	...	6	...	...	9	9	86 3 0	For confidential use.
Afghan Boundary Maps, Nos. 19, 20, 28, 30, 31, 34, 35		4 "	D.E. and 1/2 D.E.	7	32	32	7	...	...	...	...	35	35	431 13 0	For office use.
Miscellaneous Forms, &c., &c., for departmental use		..	...	22	11	27	22	...	...	...	...	6,638	3,756	762 14 0	
Copies of Maps of "Other Departments" taken for Departmental use.															
Index Map to the Melghat Taluk Forest Survey		8 miles	1/2 D.E.	1	1	2	1	...	...	...	...	10	20	2 12 0	Copies retained, *for office record*, of maps, &c., requisitioned for by other departments; the cost of press pulls and stationery being all that is here charged to the Survey Department.
Do. to Forest Survey of Bashahr		4 "	"	1	5	5	1	...	.	...	...	24	24	3 1 0	
Forest map, Berar Forests, part of Sheet No. 14		1/4 "	D.E.	1	8	8	1	...	.	...	...	40	40	6 4 0	
Do. of Melghat Taluk, District Ellichpur, Berar, Sheet No. 14 (parts)		1/4 "	"	1	6	6	1	..	...	...	...	44	44	8 10 0	
Do. Berar Forests, Sheets I, II & III		1/4 "	"	3	18	18	3	...	...	...	...	120	120	28 8 0	
Do. Do. Melghat Taluk, Sheets Nos. 19 and 20		1/4 "	"	1	4	4	1	..	...	...	...	44	44	8 10 0	
Do. Do. Sheet No. 15		1/4 "	"	1	4	4	1	...	...	...	...	40	40	9 8 0	
Do. of Ellichpore Taluk, Berar		1 "	"	1	6	6	1	...	...	...	...	40	40	9 8 0	
Do. Chota Nagpore, Sheet No. 157 S. E.		1/4 "	"	1	7	7	1	...	.	...	...	20	20	4 12 0	
Do. do. do.		1 "	1/4 "	1	1	1	1	...	...	...	...	10	10	2 9 0	
Kumaun and Garhwál Forest Map No. II		1/2 "	"	1	2	2	1	...	...	...	...	20	20	2 14 0	
Do. do. do. No. III A. III B., IV & V.		1/4 "	D.E.	4	24	24	4	...	...	...	...	160	160	38 0 0	
Forest Map of Kumaun and Garhwal, Sheets Nos. 69, 70, 71 and 74		1/4 "	"	4	24	25	4	...	2	...	...	176	176	34 8 0	
Kumaun and Garhwál Triangulation Chart No. V		1 "	"	1	6	6	1	...	...	...	...	22	22	4 5 0	
Do. do. do. No. V		2 "	1/4 "	1	2	2	1	..	...	...	...	24	24	2 4 0	
Do. do. do. No. VII		1 "	D.E.	1	6	6	1	...	...	...	...	27	27	4 15 0	
Do. do. do. No. VII		2 "	1/4 "	1	2	2	1	...	...	...	...	20	20	1 4 0	
Tiri Garhwál Forest Survey Sheet No. 1, Bhagirathi		1/4 "	D.E.	1	6	7	1	...	2	...	...	44	44	8 10 0	
Do. do. No. 2, 3 do.		1/2 "	"	2	12	12	2	...	...	...	...	80	80	17 10 0	
Ganges Working Circle Forest Map		1 "	"	1	6	6	1	...	...	...	...	20	20	3 2 0	
Kheri and Pilibhit Reserved Forests		4 "	1/2 "	1	2	4	1	...	...	...	...	10	20	2 12 0	
Forest Map of Bahraich		4 "	1/2 "	1	2	4	1	...	...	...	...	10	20	2 12 0	
Do. Tarhoch		1/4 "	D.E.	1	4	4	1	...	...	...	...	25	25	2 10 0	
Dehra Dún and Saháránpur Forest Division		4 "	1/2 "	1	3	3	1	...	...	...	...	20	20	2 0 0	
Jaunsar Division Forest Map		4 "	1/2 "	1	4	4	1	...	...	...	...	20	20	2 0 0	
Deota Sledge road		16 feet	1/4 "	1	1	2	1	...	...	...	...	15	30	2 0 0	
Do. do. longitudinal Section		300 "	D.E.	1	4	4	1	...	...	...	...	22	22	4 1 0	
Forest Map of Deota		1/2 mile.	1/2 "	1	1	2	1	..	...	...	...	15	30	1 11 0	
References for Forest Survey Maps		1/4 "	1/16 "	1	1	2	1	...	..	...	...	3	6	1 5 0	
Country between Umballa and Delhi		4 "	D.E.	1	8	40	5	...	...	...	...	86	86	12 6 0	
Appendix B, illustrating the system of working on a confidential route		6 "	1/2 F.P.	1	1	2	1	...	...	...	...	5	10	1 4 0	
Trace of work done with the Gilgit Mission		4 "	1/2 D.E.	1	4	4	1	...	...	..	...	8	8	2 12 0	
Sind-Kalát Boundary Survey		1 "	D.E.	1	8	8	1	...	...	...	...	25	25	3 4 0	
Nadrai Aqueduct Foundation Plan		40 feet	1/2 "	1	3	3	1	...	...	...	...	23	23	2 15 0	
TOTAL	...	...	...	25	722	790	202	171	127	...	...	16,774	19,718	11,077 1 0	

* Additional points of previous publications. D.E. represents Double Elephant; F.P. represents Foolscap. F‖ Finished.

TRIGONOMETRICAL BRANCH OFFICE, DEHRA DUN—*concld.*

Statement of Expenditure (Dr.) and Amounts credited (Cr.) on account of the Solar Photography Section, during the Survey year 1st October 1885 to 30th September 1886.

Dr.	₹ a.	₹ a.	Cr.	₹ a.
Superintendence	600 0		Value of Negatives and Silver prints taken for the Solar Physics Committee, under authority from the Secretary of State for India (debitable to the Industry, Science and Art Department)	9,820 13
Solar Photographer	6,000 0			
Establishment	269 0			
Contingencies	1,371 0			
		8,240 0		
Chemicals and Stores received from England	1,520 0			
		1,520 0		
Chemical and Stores purchased in India	50 13			
		50 13		
Shipping and Landing Charges	10 0			
		10 0		
Total	...	9,820 13	Total	9,820 13

Table of Working Facts for the year 1885-86.

1885-86.	Number of Days.				Number of Negatives.								Number of working days when Solar Phenomena were	
		Failures.			Solar Phenomena.									
	When Negatives were taken.	From bad weather.	From various causes.	Total.	Spots and Faculæ.		Spots only.		Faculæ only.		Total.		Visible.	Absent.
					8″	12″	8″	12″	8″	12″	8″	12″		
October	31	...	...	31	55	20	...	...	2	1	57	21	31	
November	30	...	...	30	47	22	...	...	7	2	54	24	30	
December	26	5	..	31	39	18	...	...	10	1	49	19	26	
January	18	13	...	31	23	6	...	...	12	4	35	10	18	
February	24	4	...	28	44	10	...	..	1	..	45	10	24	
March	22	9	...	31	38	12	...	...	...	...	38	12	22	
April	27	3	...	30	51	16	1	...	1	...	53	16	27	
May	22	9	...	31	34	...	...	...	7	...	41	...	22	
June	25	5	...	30	43	...	...	...	2	..	45	...	25	
July	15	16	...	31	26	...	...	...	1	...	27	...	15	
August	20	11	...	31	28	...	...	...	2	...	30	...	20	
September	30	...	...	30	40	3	...	...	11	...	51	3	30	
Total	290	75	...	365	468	107	1	...	56	8	525	115	290	

One thousand and four silver prints of the 8-inch and 127 of the 12-inch pictures were prepared; and weekly despatches of both silver prints and negatives made as usual to the India Office.

Table of Percentages of daily Visibility of the Sun and the presence of features.

Year.	In 100 days the Sun was invisible on	In 100 days features were present on
1877-78	9 days (obtained from 273 days).	30 days (obtained from 248 working days).
1878-79	11 ,, ,, 89 ,,	28 ,, ,, 79 ,,
1879-80	14 ,, ,, 289 ,,	82 ,, ,, 232 ,,
1880-81	15 ,, ,, 365 ,,	96 ,, ,, 307 ,,
1881-82	10 ,, ,, 365 ,,	100 ,, ,, 328 ,,
1882-83	13 ,, ,, 365 ,,	100 ,, ,, 318 ,,
1883-84	21 ,, ,, 366 ,,	100 ,, ,, 285 ,,
1884-85	22 ,, ,, 365 ,,	100 ,, ,, 284 ,,
1885-86	21 ,, ,, 365 ,,	100 ,, ,, 290 ,,

Contrasting the percentages of days of invisibility above given with those for Greenwich, as furnished by Astronomer Royal's Reports, we have :—

Year.	At Dehra, year ending 30th September.	At Greenwich.
1880-81	15	60 } Year ending 20th May.
1881-82	10	45 }
1882-83	13	45 }
1883-84	21	41 } Year ending 31st December.
1884-85	22	58 }
1885-86	21	

Government of India Central Printing Office.—No. 13 S. G.—20-4-87.—425.

File No. 56.
Serial No. 8.

1887.

GOVERNMENT OF INDIA.

REVENUE AND AGRICULTURAL DEPARTMENT.

SURVEYS.

RESOLUTION.

Circular No $\frac{39. S.}{56—8.}$

Dated Simla, the 19th July 1887.

SUBJECT.

REMARKS on the Report of the Survey of India Department for 1885-86.

Government of India Central Printing Office.—No. 147 R. & A.—26-7-87.—985.

Circular No. $\frac{39.\ S.}{56-8.}$

Extract from the Proceedings of the Government of India, in the Revenue and Agricultural Department (Surveys), under date Simla, the 19th July 1887.

READ—

The General Report on the Operations of the Survey of India Department for the year 1885-86.

RESOLUTION.

DURING the greater portion of the year, the administration of the Department was in the hands of Lieutenant-Colonel H. R. Thuillier, R.E., Colonel G. C. DePrée, S.C., the Surveyor General, having been obliged in February 1886 to proceed on furlough to England owing to ill-health. Intimation of the death of Colonel DePrée has recently been received with regret. After a service of 37 years in India, in nearly 33 years of which Colonel DePrée was connected with the Survey of India Department, he was about to retire on pension.

Colonel J. Sconce, S.C., resumed charge of the superintendence of Revenue surveys on his return from furlough in March 1886. Several changes took place in the personnel of the Head-Quarters Offices, owing to the departure on leave of Lieutenant-Colonel Waterhouse, and Majors C. Strahan and M. W. Rogers. Colonel C. T. Haig, R.E., continued to superintend the Trigonometrical Branch at Dehra.

2. The first part of the Report contains a summary of the operations of the year, while detailed accounts of the work of the several parties are given in Part II. The different operations were carried on by 25 parties, *viz.*, one Coast Triangulation, 10 Topographical, 6 Cadastral, 5 Traverse, 1 Geographical, and 2 Astronomical parties. Before remarking on the work accomplished, it may be observed that the old system of naming each party according to the province, district, or other locality in which it is employed, has been given up, and all the parties have now been serially numbered. The number now given to each party will be borne by it as long as it exists and in whatever locality it may be employed.

Secondary Coast Triangulation.

3. Secondary triangulation was carried along the east coast from Coconada to Masulipatam. The total distance triangulated was 145 miles; and the positions of 9 beacons, besides 7 other permanent marks, fixed for the use of the Marine Survey Department.

4. Three out of the 10 Topographical parties completed the surveys on which they had for some years been respectively engaged in the Andaman Islands, Cutch, and Mysore.

Andaman Islands.

5. The survey of the Andamans has been executed generally on the scale of $\frac{1}{3}$ inch = 1 mile, with special portions round the Port Blair Settlement on the 4-inch scale. The surveys cover all the islands excepting a large part of Little Andamans, where a survey was impracticable. The Governor General in Council is pleased to observe the commendation again bestowed on Captain Hobday and his assistants, both by the Officiating Surveyor General, and also by the Superintendent of Port Blair and the Nicobars. His Excellency also desires to express his thanks to the local authorities for the valuable assistance rendered to the survey party, to which the success of the operation is said to be largely due.

Cutch.

6. In addition to Cutch, the adjacent Rán, the peninsula of Nagar Párkar, and small portions of North Gujarát have been topographically surveyed.

Mysore.

7. The Mysore Survey was commenced in November 1875, and has therefore lasted for 11 years. The operations were, however, greatly impeded during the first three years by famine, and the outturn of work during that period by two full parties was only 4,701 square miles. Since November 1877 only one party has been at work and has completed the remaining large area of 26,238 square miles.

8. Three parties worked in the Bombay Presidency in the Deccan and Gujarát Districts and the Southern Mahratta Country.

Deccan.

The Deccan party surveyed a total area of 1,675 square miles, lying partly in the Kolába, Ratnagiri, and Satara Districts, and partly in the Kolába, Kolhápur, and South Mahratta Agencies. Some traversing, and the forest boundary survey in the Kolába and Ratnagiri Districts, was also executed. After the close of the year's work, the party was transferred to the Central Provinces for the prosecution of Revenue surveys. An area of 11,953 square miles has been left unfinished in the Deccan, which must lie over until the Revenue surveys required in connection with Settlement operations in the Central Provinces and elsewhere have been completed.

Gujarát.

9. The Gujarát party surveyed a total area of 2,524 square miles, besides triangulating 749 square miles and traversing with the theodolite 422 linear miles. A small party was also attached to the Special Commission appointed to settle the boundary dispute between Baroda and the Dangs States, when some boundary surveying was accomplished.

South Mahratta.

10. The South Mahratta party surveyed an aggregate area of 1,672 square miles, lying chiefly in Belgaum, but partly in the Dhárwár District and some neighbouring Native States. The skeleton traverse survey of the forests of six villages in Khánápur taluka was completed, and the work partially done for six other villages. A large area was also triangulated and traversed in advance for the next season's topography.

Mirzapur.

11. The party employed on the Mirzapur Survey has carried out the following operations :—

(*a*) the Detail survey of 487 square miles on the scale of 2 inches=1 mile, and 194 square miles of triangulation;

(*b*) the Revenue survey of village boundaries in the Dudhi Pargana;

(*c*) the setting up of the theodolite at 6,419 stations, embracing 1,172·6 miles of traverse. This work has proved that, with the aid of traverses, village maps can be utilised for the compilation of standard topographical sheets;

(*d*) the completion of records and General Reports of the Bhopal-Malwa and the Khandesh and Bombay Native States surveys.

Rajputana.

12. In Rajputana 3,540 square miles were surveyed on the $\frac{1}{2}$-inch scale in portions of Jodhpore and of the Maláni Districts near Bármer and the Luni river. On the scale of 1 inch=1 mile an area of 256 square miles was surveyed in a tract lying on the junction of the boundaries of the Jodhpore, Sirohi, and Pálanpur States. Triangulation in advance covered an area of 5,850 square miles. The village boundary sheets of the Ajmere-Merwara Survey were revised, and the district maps compiled.

Baluchistan.

13. In Baluchistan, one party was employed principally in work of a special nature for the requirements of the Military Department. The country surrounding Quetta was surveyed on the 2-inch scale, and also a portion of the Khwaja-Amran mountains, extending from the Ghwája Pass on the south to the Bogra Pass on the north. The routes between the Registan and Baluchistan were also explored, and very fair progress was made in the operations for the regular topographical survey of the country.

14. One Topographical party continued the Forest surveys in Burma. The Detail survey, partly on the 4-inch scale and partly on the scale of 2 inches =1 mile, covered a total area of 330 square miles of forests, extending over the greater portion of the tracts drained by the Taungnyo river in the Tharrawaddy District and the Shwele river in the Prome District. The survey was also carried over the Shwedaung hills to the south of Prome. The triangulation of the year covered an area of 263 square miles, and the traverse survey 345 square miles. The outturn was smaller than in the preceding year, but this is accounted for by the fact that work was greatly impeded during the year under review by the unsettled state of the province, and by the withdrawal of some of the Surveyors for survey operations required in Upper Burma. Burma Forest Survey.

15. The six Cadastral parties were employed in the districts shown in the following tabular statement, in which the total outturn of work of each party and particulars of cost of operations are also shown :— Cadastral Surveys.

Province.	District.	Area surveyed.	Average cost per square mile in 1885-86.				Average cost per square mile in 1884-85.			
			Traversing.	Detail surveying.	Record-of-rights, Khanapur.	Completion of records.	Traversing.	Detail surveying.	Record-of-rights, Khanapur.	Completion of records.
		Sq. M.	*R*	*R*	*R*	*R*	*R*	*R*	*R*	*R*
Burma	Akyab	661	60·2	183·9	...	...	78·5	205·6	...	...
North-Western Provinces . .	Gorakhpur . . .	820	20·5	70·5	30·5	38·5	16·8	66·3	34·3	43·9
Ditto Ditto . .	Basti	783	22·6	83·4	40·5	47·0	21·4	87·9	61·7	53·5
Central Provinces . . .	Bilaspur . . .	763	16·1	70·1	82·0	...	...	...	...	...
Assam	Kamrup . . .	468	33·4	94·2	68·6	...	31·8	92·8	42·8	48·3
Bengal	Mozufferpore . .	414	28·8	97·1	59·5	69·5	...	...	...	...

16. The tracts surveyed in the Akyab District are very much scattered, but mainly lay on the borders of the Kaladan and Padu rivers, east and north of the town of Akyab; while other tracts were situated in the valleys to the north-west of the district. Akyab.

17. In Gorakhpur District the Hata and Paranna tahsils were cadastrally surveyed, and, in addition, 41·07 square miles in the Sarun District in Bengal were surveyed topographically. Some changes were made in the system of cadastral surveys adopted in Gorakhpur, and will, it is believed, have the effect of accelerating the work and of saving some of the expenditure hitherto incurred by the Settlement Department. Gorakhpur.

18. The Cadastral operations of the Basti party were confined to the Basti and Khalilabad tahsils. A survey on the 4-inch scale of the villages on the right bank of the Gogra river was also effected. Basti.

19. The surveys in Bilaspur were carried out on the Gorakhpur system. The Surveyors were new to the work, and there were other reasons which tended to make the average cost higher than in Gorakhpur, but it is confidently expected that lower rates will be exhibited as the result of the next season's working. Bilaspur.

20. The operations of the year brought to a close the Cadastral survey of the Kamrup District; some preliminary traversing was also done for the survey of the Darrang District. Kamrup.

21. In the Mozufferpore District the Cadastral survey and record-of-rights were completed in Tappa Chakla Nosi (except 3 or 4 square miles within the Mozufferpore Municipality), and in Tappa Bhatsala (except an area of 90 square Mozufferpore.

miles). The cost rate of the operations, as shown above, is high as compared with that of similar work in other districts; but it includes several items of extraordinary expenditure, such as travelling allowances, carriage of equipment, cost of new tents, &c., amounting to R14,129. The detailed nature of the work, rendered necessary by local peculiarities, also tended to make the survey more expensive than in the North-Western Provinces traverse surveys.

Traverse Surveys, Ajmere.

22. Three-and-a-half full parties have been employed during the year under report. A detachment from one of these completed the survey of 51 jagir and of six minor istimrar villages in Ajmere, covering an area of 243 square miles.

Punjab.

23. The Punjab party resumed work in the Ludhiana and Umballa Districts, and extended them to the Jullundur, Hoshiárpur, and Gurdáspur Districts and to the Kapurthala State. The total outturn of work was :—

Traversing	3,770 sq. miles.
Mapping by reduction	1,922 „
Area tested	2,920 „
Area finally mapped	2,624 „

Central Provinces.

24. The remaining traverse parties were employed in the Central Provinces and surveyed a total area of 5,269 square miles in the Raipur, Sambalpur, Jubbulpore, and Damoh Districts. The operations in these districts consisted of a simple skeleton traverse survey, which will form the basis of complete skeleton maps, on which the patwaris will plot their measurements of the fields. The "field block" system of survey, which had been tried for two previous seasons in the Raipur and Sambalpur Districts, proved a failure, and has been finally abandoned.

Geographical and Miscellaneous. Himalaya party. Nipal boundary demarcation.

25. The Himalaya party was employed in continuation of the preceding years' operations on the Topographical survey of the Hill States about Simla and of the Kangra District, and on the demarcation of the Nipal-Bengal boundary on the Mechi river. Twenty-four miles of the boundary was demarcated, the erection and numbering of pillars being left over to be taken up on completion of the entire line of boundary. The party also undertook to bring up the arrears of mapping connected with the Nipal Boundary Survey, the Sikkim Triangulation, and the Darjeeling Revisionary and Dahing Lands surveys. Very little progress was, however, made, and the arrears of mapping and computations were transferred to the Trigonometrical Branch for completion.

Kangra and Simla Hill States.

26. The following is the outturn of work in Kangra and the Hill States :—

	sq. miles.			
Kangra	300	on the 16 inches=1	mile	scale.
Suket, Mandi, Kumhársain and Bashahr States	308	„ 2	„	
Ditto ditto . .	238	„ 4	„	

Geographical Surveys and Reconnaissances.

27. A large quantity of work was done during the year under review under the head of Geographical Surveys and Reconnaissances. Great credit is due to the officers of the Afghan Boundary Commission for the very large area of

Afghanistan.

120,000 square miles surveyed in Afghanistan. The whole of the province of Herat, including the hitherto unknown Taimani and Firozkuhi country, was mapped; almost the entire province of Afghan Turkistan, with a large portion of the Hazara country in the neighbourhood of Bamian, was reconnoitred or surveyed; and, on the return march of the Commission, all the important passes of the Hindu Kush were surveyed.

Gilgit.

28. The surveys executed by Colonel Woodthorpe, R.E., while attached to the Gilgit Mission, afford a mass of valuable information of the districts of Yasin, Chitral, Hunza and Wakkan. Colonel Woodthorpe's services merit the special commendation of the Government of India.

29. The route surveys executed by explorers M.—H. and R.—N. have added largely to the Geographical knowledge of Nepal and Thibet and of Western and Eastern Bhutan, besides affording valuable information regarding the trade routes to Thibet. Explorer R.—N. also made an unsuccessful attempt to obtain accurate information on a long-disputed question as to whether the Brahmaputra or the Irrawaddy is the recipient of the waters of the Sanpo. Trade routes.

30. In Upper Burma Captain Hobday, with a small detachment of Surveyors, made a reconnaissance survey round Mandalay and compiled the reconnaissance sketches executed by officers with the Burma field force. Captain Hobday and a Surveyor joined two Military expeditions, one to the Kachin Hills and the second to the south-east of Mandalay. They succeeded in extending triangulation southwards as far as latitude 21° and in surveying an area of 150 miles on the $\frac{1}{2}$ inch scale. Upper Burma.

31. Tidal observations were taken at 16 ports. Four new observatories were opened during the year at Bhavnagar, Cochin, Coconada, and Chittagong; and three observatories were closed at Diamond-Harbour, Amherst, and Moulmein, where the usual period of five years' registration had been completed. Tidal observations.

32. The spirit-levelling operations consisted of three main lines, (1) along the railway line from Madras, *viâ* Tanjore to Negapatam, (2) from Tanjore, *viâ* Ramnad to Pámban, and (3) from Ramnad to Tuticorin. Three pairs of test bench marks were also embedded in the vicinity of Negapatam, Pámban, and Tuticorin. Spirit-Levelling.

33. The two Astronomical parties resumed the electro-telegraphic observations for the determination of differential longitudes. Nine arcs were measured between stations of the Great Trigonometrical Survey, and observations taken on an experimental arc at Dehra Dun. Astronomical observations.

34. Very satisfactory progress has again been made in the operations of the Drawing, Engraving, Photographic, Lithographic and Mathematical Instrument Offices, full accounts of which are given in Part III of the Report. Head-Quarters Offices.

35. The maps issued numbered 210,288, valued at R1,66,749. The income derived from the sale of maps amounted to R8,732-14-0. In the Map Drawing Office a great deal of work was executed for the Colonial and Indian Exhibition, among which were a map of the World, exhibiting the Export and Import Trade of India, and maps of India to illustrate Density of Population, Emigration, External Trade, Land Settlements and Revenue, Geology and Religions. Three small skeleton maps were drawn, showing— Maps issued. Special maps.

(*a*) the Burma and Assam Frontier, (*b*) the Punjab and Afghanistan Frontier, and (*c*) the Sind and Baluchistan Frontier.

The district maps required for Administration Reports have all been completed, except two for Assam and two for the Central Provinces, and the Provincial maps have been taken in hand. District and Provincial maps.

36. The total number of Mathematical instruments issued to other Departments was 41,643 and their value R1,77,864. The serviceable stock increased during the year by 52,128 instruments, valued at R1,70,179. Of these, 13,453 were manufactured during the year at a cost of R21,454, and 3,103 instruments were repaired in the Mathematical Instrument Depôt, at a cost of R21,378, their value after repairs being estimated at R76,039. The account of the Mathematical Instrument Office at page cxviii of the Appendix shows a net profit of R3,887-5-0. Mathematical Instrument Office.

37. The principal work of the Dehra Office consists of the final reduction and publication of the various operations of the Great Trigonometrical Survey. Mr. Cole, the Superintendent, has been ably assisted in the work by Mr. Eccles. During the year under notice, the simultaneous reduction of the circuit triangles (South-West Quadrilateral), and the final reduction of Latitude observations taken up to the year 1884-85, were brought to completion. Considerable progress was also made in the secondary triangulation of the southern Dehra Office.

Trigon. The work of Solar photography was continued; 115 large and 525 small-sized pictures of the sun were taken.

38. The Survey Department has, during the year under review, made a considerable advance in the direction of improving its financial value to the State by undertaking work of a positively remunerative character. The most notable operation of this kind is the great Traverse survey of the Central Provinces which, by providing a frame-work for the detailed field plotting of villages by district establishments, will probably enable the Revenue authorities to complete the assessment of about 40,000 square miles, without the loss of a single year's revenue. The performance of this work has thrown a heavy burthen on the Department, which it has borne in an admirable manner, at a time when, for financial reasons, it has been required to contract its establishments, and when the demands for a survey staff on the Boundary Commission, in Upper Burma and in the North-West Frontier, had added to its difficulties. A traverse survey of the same kind was effected in Ajmir, while a large amount of cadastral work was done in the North-Western Provinces, Central Provinces, Bengal, Burma, and Assam, and at the same time some valuable forest surveys were executed in Burma and Bombay. The Government of India is glad to acknowledge that in no previous year has the Department done more to prove its financial value to the State, and accords its thanks to Colonel Thuillier, and the officers who assisted him for the energetic manner in which they have given effect to the policy advocated by the Government of carrying out survey operations in co-operation with the Revenue authorities on the system which has been found most conducive to the financial interests of the State. The labours of Colonel Barron, Major Sandeman, Colonel Steel, and Mr. Scott in the field of revenue survey, and the cordial assistance which they have, under Colonel Sconce, rendered in placing Cadastral surveys on an economical basis, are especially deserving of acknowledgment.

39. The Department has at the same time sustained its reputation in the field of geographical survey, and the Government of India cordially confirms the remarks of the Surveyor General on the exceptionally valuable services performed by Major Holdich, Captains Gore and Talbot on the Boundary Commission, and by Colonel Woodthorpe.

40. The Government of India regrets that the strain which has been thrown on the Department, partly by financial pressure and partly, as pointed out by the Surveyor General in paragraph 35 of the Report, by the demands made for officers to accompany political and military expeditions, has been so exceptionally severe. It is trusted, however, that by the gradual contraction of the Topographical programme, such as has been effected by the postponement of the Deccan surveys, some relief may be afforded, although it must be acknowledged that the present expansion of the Cadastral and Military programmes justifies serious consideration of the danger suggested by the Surveyor General that the Department may not be able to meet all the demands made upon it. In the meantime, His Excellency in Council desires that his high appreciation of the loyal manner in which the Department has answered to every call for its services may be placed on record.

ORDER.—Ordered, that the above Resolution be forwarded to the Local Governments and Administrations named in the margin, and to the Surveyor General of India, and to the Foreign and Military Departments for information. Ordered also, that it be published in the *Gazette of India*.

Madras.	Central Provinces.
Bombay.	Burma.
Bengal.	Assam.
N.-W. P. & Oudh.	Coorg.
Punjab.	

(True Extract.)

E. C. BUCK,

Secy. to the Government of India.