GENERAL REPORT

ON THE

Operations of the Survey of India Department,

ADMINISTERED UNDER THE GOVERNMENT OF INDIA

DURING

1883-84.

PREPARED UNDER THE DIRECTION

OF

COLONEL G. C. DEPRÉE, S.C.,

Surveyor-General of India.

Calcutta:

BENGAL SECRETARIAT PRESS.

1885.


YARKAND
76°
Bora
Ujadbai
Sanjoo
Kooloonatsee
Yarkand R.
K² 28278
OR
Shayok
TIBET
or Nubru R.
Karakooram Pass 18317
Temosgam
LEH
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L A D A K
Zangla
Kishtawur
Lachilunglango
Kilar
R U K S H U
Tso Morari L.
Chumba 3033
Kailung
Dhurmsalla
Kangra
Dankar
Hanle

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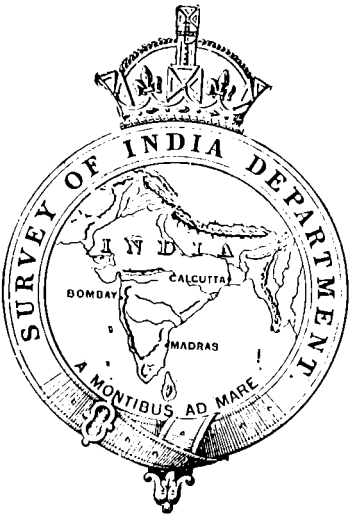

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GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1883-84.

PART I.

INTRODUCTORY.

THE general direction of the Survey of India Department during the year 1883-84 continued to be carried on by Colonel G. C. DePrée, B.S.C., who, upon the retirement of Lieutenant-General J. T. Walker, C.B., R.E., LL.D., F.R.S., &c., on the 12th January 1884, received the permanent appointment of Surveyor-General of India. The superintendence of the Topographical Branch, consisting of eight field parties, was also held by Colonel DePrée throughout the year.

2. On the same date, Mr. J. B. N. Hennessey, M.A., F.R.S., &c., then officiating as Deputy Surveyor-General in charge of the Trigonometrical Branch, was confirmed in that office. On the 5th March 1884, Colonel J. Sconce, B.S.C., proceeded on furlough, and, creating a vacancy amongst the three administrative officers, Lieutenant-Colonel H. R. Thuillier, R.E., Deputy Superintendent, 1st grade, was appointed to officiate as Deputy Surveyor-General in charge of the Revenue Branch, until the retirement of Mr. Hennessey on 1st October 1884, when he succeeded to the permanent office. To fill the vacancy caused thereby, Colonel C. T. Haig, R.E., Deputy Superintendent, 1st grade, was appointed to officiate as Deputy Surveyor-General in charge of the Trigonometrical Branch.

3. The Surveyor-General accompanied the Government of India during its location in Calcutta and Simla, except when he was engaged on inspection tours. The Deputy Surveyor-General in charge of the Revenue Branch continued in Calcutta, except when summoned to attend a conference at Simla, and subsequently at Naini Tal, when on inspection duty. The Deputy Surveyor-General in charge of the Trigonometrical Branch spent seven months at the hill station of Mussooree, and five months at his head-quarters at Dehra, an arrangement carrying with it a certain inconvenience, as the important offices at the latter station require the constant presence of a directing officer.

4. The large Technical, Correspondence, and Accounts offices situated in Calcutta were administered under the direction of the Surveyor-General by Major C. Strahan, R.E., Assistant Surveyor-General in charge of the Drawing and Engraving offices; by Major J. Waterhouse, B.S.C., in charge of the Photo-zincographic and Lithographic with Type-printing offices; and by Major M. W. Rogers, R.E., in charge of the Surveyor-General's Correspondence and Accounts offices, and of the Mathematical Instrument office. Captain St. G. C. Gore, R.E., performed the duties of Personal Assistant to the Surveyor-General until he joined the Afghan Boundary Commission; and Lieutenant-Colonel W. H. Wilkins assisted in the office of the Revenue Survey, and superintended the Map Record and Issue office, and the preparation of an official catalogue of published maps.

5. During the past year the connection of five officers with the department has closed. On the 12th January 1884, Lieutenant-General J. T. Walker, C.B., R.E., LL.D., F.R.S., &c., retired from the army after a service of 41 years, during 31 of which he had directed his energies towards the advancement of the knowledge of geography inside and beyond India, and to the continuation and

completion of that great work, the Great Trigonometrical Survey of India, the last field operations of which closed in 1881. On the retirement of General Sir A. Waugh, R.E., in 1861, General Walker succeeded to the administrative post of Superintendent of the Great Trigonometrical Survey. In 1878 he assumed the additional functions of Surveyor-General of India on the retirement of General Sir H. E. L. Thuillier, C.S.I., as well as administered the Topographical Branch until shortly before proceeding on furlough at the beginning of 1883. The Government of India have recorded the sense they entertain of the long and distinguished services of General Walker, especially in connection with the Great Trigonometrical Survey, by a Government of India notification.* The Secretary of State has also expressed† his appreciation of the able way in which, as Surveyor-General, he directed the department.

* No. 1693, dated 9th May 1884.
† Despatch No. 127, dated 2nd October 1884.

Mr. J. B. N. Hennessey, M.A., F.R.S., entered the Survey Department in 1844, and was promoted to the senior branch in 1854, since which time he has been connected with the offices at Dehra, and especially with the Computing office, which he superintended for many years, until eventually in 1883 he succeeded to the administration of the Trigonometrical Branch as Deputy Surveyor-General. On the 1st October 1884 he retired from the service, and has been awarded a special superannuation pension in recognition of his high scientific acquirements and long and faithful services.

Major R. V. Riddell, R.E., Assistant Surveyor-General, who had been for several years attached to the head-quarter's offices at Calcutta, left the department this year on being appointed Master of the Calcutta Mint.

Mr. J. O. N. James, for many years an Assistant Surveyor-General in charge of the Drawing and Map Issue offices at the Presidency, retired on being superannuated on 7th August 1884, thus ending a career of much usefulness.

In the junior branch five surveyors and assistant surveyors ceased to belong to the department, either by death, retirement, or other cause.

6. It will be an object in this report to place together particulars of a like nature, so that the results obtained by field parties, though belonging to the three branches and administered by the three Deputy Surveyors-General separately, may be comparable with one another, thus emphasizing the policy of a complete amalgamation of the three branches of Trigonometrical, Topographical, and Revenue Surveys. A tabular statement of outturn of work appertaining to all field parties, and one of cost rates will therefore be found in their appropriate places. This report also will be more conveniently indexed than heretofore; otherwise it will follow the arrangement adopted in the General Report of the Operations of the Survey of India for 1882-83 and preceding seasons.

7. The operations carried on during the year, or from 1st October 1883 to 30th September 1884, by the several field parties, numbering 26 of full size and 3 detachments, are shown in the following tabular statement:—

Statement of Survey Operations and Parties.

Name and *locale* of operation.	Pages in this Report.	Name of executive officer.	Designation of survey party.	Scale of Survey.
Triangulation,				
Coast, Orissa and Ganjam.	11	Mr. A. D'Souza ...	Secondary Triangulation.	
Topography.				
Aligarh and Etah districts.	12	Mr. J. O. N. James and Major E. H. Steel, S.C.	No. 3 Rev. Branch...	2″=1 mile for reproduction and reduction to 1-inch scale.
Andaman	13	Captain J. R. Hobday, S.C.	No. 4 Topo. Branch	8″=1 mile for reproduction and reduction to 1-inch scale and 4″=1 mile for reproduction.
Assam and North-East Frontier.	14	Lieut.-Colonel R. G. Woodthorpe, R.E.	No. 6 Topo. Branch	1″=4 miles and 1″=2 miles for reproduction.
Baluchistan	15	Lieutenant the Hon'ble M. G. Talbot, R.E.	No. 3 Topo. Branch	1″=8 miles, 1″=4 miles, and 1″=2 miles for reproduction.

Nature and *locale* of operations.	Pages in this Report.	Name of executive officer.	Designation of survey party.	Scale of survey.
Cutch	16	Lieut.-Colonel A. Pullan, S.C.	Cutch Survey ...	2″=1 mile for reduction to 1-inch scale and 4″ =1 mile for reproduction.
Guzerat	17	Colonel C. T. Haig, R.E., and Lieut.-Colonel W. F. Badgley, S.C.	Guzerat Survey ...	4″=1 mile and 2′=1 mile for reproduction and reduction to 1′ scale.
Malwa	18	Major T. T. Carter, R.E. ...	No. 2 Topo. Branch	1″=1 mile for reproduction.
Mirzapur district ...	19	„ J. R. Wilmer, S.C. ...	No. 5 Topo. Branch	2″=1 mile for reproduction and reduction to 1-inch scale.
Mysore	20	Lieut.-Colonel H. R. Thuillier, R.E., and Major J. R. McCullagh, R.E.	No. 8 Topo. Branch	1″=1 mile for reproduction.
Rajputana	21	Major R. Beavan, S.C. ...	No. 1 Topo. Branch	1″=1 mile, 2″ and 12″= 1 mile for reproduction.
South Deccan ...	22	Major D. C. Andrew, S.C. ...	No. 11 Rev. Branch	2″=1 mile for reduction to 1-inch scale.
Mouzawar, Bassein and Forest Surveys.				
Burma Forests ...	23	Mr. H. Hörst	No. 7 Topo. Branch	4″=1 mile and 2′ for reproduction.
Hissar district ...	25	Lieut.-Colonel D. McDonald, S.C., and Lieut.-Colonel F. Coddington, S.C.	No. 1 Rev. Branch	12′ and 6′=1 mile for reproduction, and 2″= 1 mile for reproduction and reduction to 1-inch scale.
Thana district ...	27	Major J. Hill, R.E., and Mr. A. M. Lawson.	No. 10 Rev. Branch	4″=1 mile for reproduction and reduction to 1-inch scale, and 2′=1 mile for reduction to 1-inch scale.
Cadastral Surveys.				
Ajmere-Merwara district...	28	Mr. A. J. Gibson ...	Ajmere detachment—(No. 1 Rev. Branch).	16″=1 mile skeleton traverse survey.
Bassein and Honzada districts.	30	Major H. S. Hutchinson, S.C.	No. 8 Rev. Branch	16″=1 mile for reproduction and 2″=1 mile for reproduction and reduction to 1-inch scale.
Benares and Basti districts	32	„ S. H. Cowan, S.C. ...	No. 4 Rev. Branch...	16″=1 mile for reproduction and 2″=1 mile for reduction to 4-inch scale.
Chhattisgarh Division ...	34	Mr. P. A. G. Cowley ...	Chhattisgarh detachment—(No. 3 Rev. Branch.)	16″=1 mile, test survey, and 16″=1 mile blocks for settlement survey.
Dehra Dún district ...	37	„ W. A. Wilson ...	Dehra Dún detachment—(No. 3 Rev. Branch.)	16″=1 mile for reproduction.
Gorakhpur district ..	39	Major J. E. Sandeman, S.C.	No. 5 Rev. Branch...	16″=1 mile for reproduction and 2″=1 mile for reduction to 1-inch scale.
Kamrup district ...	43	Mr. E. C. Barrett ...	No. 6 Rev. Branch...	16″=1 mile for reproduction and reduction to 2″=1 mile 1-inch scale.
Pegu and Shwegyin districts	45	Major J. R. McCullagh, R.E., and Mr. E. J. Jackson.	No. 2 Rev. Branch...	16″=1 mile for reproduction and 2″=1 mile for reproduction and reduction to 1-inch scale.
Prome and Akyab districts	47	Mr. H. B. Talbot ...	No. 7 Rev. Branch	16″=1 mile for reproduction to scale and 2″=1 mile for reproduction and reduction to 1-inch scale.
Geographical and Miscellaneous.				
Aka and Daphla	7	Lieut.-Colonel R. G. Woodthorpe, R.A.	... ...	
Dardistan, Chilas, and Kashmir.	8	Native Surveyor ...	Detachment ...	
Kafiristan,* Dir Chitral...	46	Mr. W. W. McNair ..	Exploration ...	Confidential.
Sikkim, Darjeeling and Nepal boundary.	50	Lieut.-Colonel H. C. B. Tanner, S.C.	Darjeeling Survey ...	8′=1 mile, 1″=1 mile and 1′=2 miles for reproduction.
South-West Baluchistan...	8	Lieutenant the Hon'ble M. G. Talbot, R.E.	Detachment ...	
Takht-i-Suliman ...	15	Major T. H. Holdich, R.E.	Detachment ...	
Tibet	7	Lama, U.G. ...	Exploration ...	
Tidal and Levelling Operations.				
Tidal operations ... Spirit levelling ...	52	Majors A. W. Baird, R.E., and J. Hill, R.E., and Mr. H. E. T. Keelan.	Tidal and Levelling Party.	
Geodetic.				
Electro-Telegraphic determinations of longitude.	54	Majors G. Straban, R.E., and W. J. Heaviside, R.E.	Nos. 1 and 2 Astronomical Parties.	

* An explorer in service of Educational Department

TRIANGULATION.

8. The preceding General Report of the Survey of India pointed out the several operations under contemplation at the end of 1882-83. They consisted of a secondary series along the coast of Orissa dependent on the great triangulation, with the object of fixing the position of the False Point Light-house and a system of fixed beacons for the use of the Marine Survey, and in aid of ocean navigation. This work has been successfully carried on during the season, and will be continued for some seasons longer until outlying foreshores on the eastern coast of India have been accurately marked. A second but very important secondary series for connecting India with the settlements of the Straits of Malacca has remained in abeyance, and it cannot at present be undertaken owing to the numerous calls elsewhere upon the officers and men of the Survey of India for other more urgent work. The project has, however, by no means been lost sight of.

SPECIAL OPERATIONS.

9. The two Astronomical Parties continued to work in concert in determining the differences of longitude between stations a few hundred miles apart. The series of arcs dealt with were those on the east of Calcutta; and the longitude of Moulmein has now been accurately determined with reference to Greenwich.

10. During the year the latest and probably final value of the longitude of the Madras Observatory, from which the time for all the trunk railways is regulated, was circulated to officials and to the world. A suitable note giving this value, viz. 80° 14′ 51″, and stating what correction is necessary to the meridians as shown on the published maps, will in future be attached to every atlas sheet or chart. The Tidal and Levelling Party has continued its operations. Automatic records are in constant progress at 19 observatories on the coasts of the Indian seas between Aden and Burma. Two new observatories have been erected in Ceylon, and are now maintained at the expense of the Government of India. The predictions of tides at many of the principal ports are now printed in convenient form, and are issued to the public for each year a few months in advance.

TOPOGRAPHY.

11. The regular topographical operations have been continued so as to further fill in the blank areas of unsurveyed country on the face of India. The country delineated consisted of portions of the Andaman Islands, Assam, Baluchistan, the forests of British Burma, Central India, Cutch, Guzerat, Malwa, Mirzapur, Mysore, Nepal Frontier, North-West Provinces, South Deccan, and the Punjab. The Mirzapur Party, in addition to detail delineation of natural features, carried on a system of traverses so as to regulate surveys made by the Settlement Agency. The Kohat Party ceased to exist, and became merged in the Baluchistan Survey. The members of the combined party were then formed into separate detachments, one of which executed a special survey under a large military escort from the summit of, and round about, the Takht-i-Suliman range; a second, accompanying the friendly mission of Sir R. Sandeman into the south-western tracts of Baluchistan, carried on a double series of triangulation from previously fixed points in Peshin to Panjgur, the capital town of that desert region, the position of which had been approximately determined by travellers starting from the sea coast. At the same time the two officers engaged made a detailed survey of the country embraced in that triangulation. Next, a native surveyor pushed across the frontier from the side of India, and continued the survey of that line, extending in a belt as far as the summits of the main mountain range running parallel to the border. In the meanwhile the other members of the party continued to add to the general topography of Baluchistan within the limits of British control.

12. The Assam Party had actually taken the field, and was marching with the object of surveying that unknown tract on the extreme east of Assam extending from Sadiya to the Burmese frontier, within the space of which,

it is believed, will be found the now forgotten road whereby the armies of the last-named power entered and retreated from Assam during their occupation of the country in the early part of this century. But it was suddenly diverted by the necessity which arose of sending a military force to chastise the hill tribe of the Akkas, and the party therefore advancing with the field force, and aiding it with their organized transport of carriers, mapped the entirely unknown country falling under their vision and limited by the distance traversed by the field force. This expedition being over, the surveyors employed themselves in adding to our knowledge of the mountain region bordering on Assam inhabited by the Daphlas and tribes on the east and west of the Akka country. Thus the North-Eastern or Assam frontier is becoming gradually less of a *terra incognita*.

13. The Andaman Party has connected the adjacent islands by a triangulation, and has mapped a good portion of ground on a large scale about the settlement, and the uncleared portions have been delineated on the usual scale so as to form a geographical map, to be supplemented eventually by a marine survey. Barren island and Narcondum, volcanic peaks rising from the sea near the Andaman group, have been delineated.

14. The Darjeeling Party has completed the survey of the Daling hills on the east of the Northern Bengal State Railway, as well as the survey of the boundary of Nepal between the Kossee and Gandak rivers.

MOUZAWAR, RIVERAIN, AND FOREST SURVEYS.

15. In the Punjab the survey of district Hissar has been completed on the system described at page 4 of the General Report of last year. This system provided an elaborate basis of permanent marks at half-mile intervals for a subsequent Cadastral Survey of fields to be carried out by the Settlement Department. On financial and other grounds, the Punjab Government has demanded the restriction of the scientific work to the lowest necessary limit in future, and it has been decided on the joint proposals of the Commissioner of Settlements, Punjab, and the Surveyor-General, to reduce the frame-work of traverses and to compile new Standard Sheets of the Punjab, by taking the topography from the settlement maps surveyed by the village *patwaris*, a novel experiment, the results of which will be watched with interest, and one which can only be practicable in an open and featureless country, such as the Punjab is. In the alluvial basins of the great rivers, however, a more complete survey has been determined on, in which the boundaries of the village lands are to be surveyed by professional surveyors, and a series of marks are to be fixed on the permanent lines of the boundaries on both banks beyond the influence of floods.

16. The Riverain Survey on the 4-inch scale, along the Ganges river, conterminous with the topographical operations in districts Aligarh and Etah, has been continued, embracing the village lands lying opposite thereto in district Budaun. A similar Riverain Survey on the Gogra river, which was commenced during the previous season in connection with the Cadastral Survey of district Ballia, has been carried on by the party working in the Gorakhpur district in the lowlying lands of the Ballia and Azamgarh district, as far as the cadastral operations have extended.

17. The survey of the Thana district has been continued for forest purposes by the Konkan Party on the scale of 4 inches to the mile. This undertaking will be completed during the current year, when the party will be transferred to the Southern Mahratta country.

18. The most intricate and difficult survey of the forests on the west of the Yoma range in British Burma has been advanced under the conditions explained in the previous report of this department.

19. The areas of all these operations are—

	Square miles.
Mouzawar	1,782
Riverain	310
Forest	875

CADASTRAL SURVEYS.

20. In the North-West Provinces the Cadastral Survey of the Benares district, including the domains of the Maharaja of Benares, has been completed, and the party engaged thereon has commenced operations in district Basti. The party that was employed in Mirzapur during the previous season has commenced the Cadastral Survey of district Gorakhpur.

21. In the Benares and Basti surveys, the system followed is that known as the Benares system, which was described in the last Annual Report, pages 26 and 27, under which the Survey and Settlement establishments work together, each preparing its own copy of the *khasra* and *jamabandi*. The results in Benares confirm the anticipations of the advantages derivable by the joint inter-working of the Survey and Settlement staffs. The same system was ordered to be adopted for the Gorakhpur survey, but many important changes in the procedure have been introduced there by Mr. La Touche, the Settlement Officer, and Major Sandeman, Deputy Superintendent of Survey, which remove the chief defects of the Benares system. The basis of the Gorakhpur system is that the Survey Department is responsible for all undisputed entries in the Record-of-Rights, and furnishes a complete list of all disputes. The classification of soils and the statistics for assessment purposes are also entrusted to it. Thus the Survey Department, in addition to the map, provides complete records ready for attestation and assessment. The report on the result of the operation during the first season in Gorakhpur testifies to the success of the new system and to the expectation of securing economy, both in time and expenditure. The cost rate of all the operations undertaken by the Survey Department is $4\frac{1}{2}$ annas per acre, or only $\frac{1}{2}$ anna more than the average rate of field survey alone used to be. The total cost of the two departments cannot be given until the work of the Settlement Department is finished, but the large amount of Settlement work from which that department has been relieved must very materially reduce the cost rates which prevailed in other districts worked under the old system.

22. The hand-book of instructions that was drawn up by Major Barron for the guidance of survey parties engaged in the combined operations of survey and settlement proved to be a valuable guide; but as it was written for the procedure current in Benares, many alterations are necessary to make it accord with the procedure in Gorakhpur. Major Sandeman is now engaged in revising this manual, and with the experience gained by the working of two years, a complete and accurate guide may be expected.

23. A detachment from the Benares Party has been employed in making a Cadastral Survey, with records under the Benares system, of the cultivated areas in the Dehra Dún district. It was found that the work required to be done there had been much under-estimated, and it could not be completed in consequence during the year under report.

24. Another detachment from the Aligarh and Etah Party has been engaged in the Central Provinces on various experimental operations in the Raipur district, consisting of a Cadastral Survey of a certain number of villages as a test on the accuracy of the Settlement maps; a skeleton boundary survey embracing blocks of fields of about 80 acres, and the instruction of *patwaris* in surveying with the object of utilizing this indigenous agency under the Settlement Department to fill in the interior detail of cultivation and general topography on the skeleton maps furnished by the Survey Department. The value of the working power of this class of men remains to be proved.

25. The skeleton traverse survey of district Ajmere-Merwara has been initiated at the request of the local authorities by a small party formed by detachments from Hissar and Aligarh Parties, with the object of furnishing a basis similar to that provided in Hissar for a survey of the cultivation by *patwaris*.

26. In Assam, a new Cadastral Survey, with records under the Benares system, has been commenced in the Kamrup district by No. 6 Revenue Party, which was transferred there on the completion of the Hooghly River Survey.

27. In British Burma three cadastral parties have continued their operations in the following districts:—Pegu, Bassein, Henzada, Prome, and Akyab. All the cadastral work required in the districts of Pegu and Prome has been completed. The Local Government on financial grounds has dispensed with the Pegu party from November 1884, and has reduced the Henzada party to

half strength, which it is estimated will complete the survey of that district by October 1885. The half party that has been dispensed with has been absorbed into other parties working in India. The full party has been retained in Burma for topographical operations which will be carried on in extension of the cadastral work in the Shwegyin district. This change of plans has necessitated the breaking up of the cadastral establishment belonging to this party; the diminution of trained cadastral machinery is a matter for much regret, seeing that large demands are likely to be made on the department for cadastral surveys in Bengal.

The areas surveyed cadastrally are—

	Square miles.		Square miles.
North-Western Provinces ...	1,747	Central Provinces ...	31
British Burma	1,749	Assam	228

TRAINING OF OFFICERS OF THE CIVIL SERVICE AND OF MILITARY STUDENTS.

28. A new system for training young officers of the Civil Service in the duties of cadastral field measurements has been commenced by attaching them to the regular field parties. Thus in the North-West Provinces seven Civilians have gone through a course of instruction in field surveying by the officers of the survey. The same idea of utilizing the field parties as training schools has been developed in another direction, by attaching native soldier students of the Roorkee College to the regular field parties of the Topographical Branch, to learn the method of delineating ground by plane-table survey. Four soldiers have received such thorough training, and have been returned to the military service, their places being taken by four others, who will receive a similar training. The cost of this work is met by the general survey grant, and the additional responsibilities thus imposed on the officers of the survey should be here acknowledged.

GEOGRAPHICAL EXPLORATION AND RECONNAISSANCE.

29. The publication in a complete form of the extraordinary adventures of the explorer A—K referred to in the last General Report has served to confirm the previous estimate of the scientific accuracy of his observations, the personal endurance and fortitude displayed by him under circumstances of the greatest difficulty and danger, and generally the great value of the geographical matter, and of the addition to our knowledge of the countries of Tibet and Great Mongolia brought in by this explorer. The Government of India, on the recommendation of the Surveyor-General, have been pleased to confer on this explorer the title of *Rai Bahadur* as a personal distinction, and further have presented him with a *jagheer* of rent-free land, and have rewarded his faithful companion with a sum of money.

30. The explorer and frontier native surveyor, known as "The Bozdar," has been similarly rewarded, the title of *Khan Bahadur* having been conferred upon him together with a grant of land. It may be here mentioned incidentally that much assistance was rendered during the Aka operation by Mr. W. Penny, a planter, whose local knowledge, willingly placed at the disposal of the Survey officers, proved of great value: that assistance has been recognized by the presentation of a piece of plate.

31. The guide, companion, and friend of Mr. W. W. McNair, named "The Meah," has been rewarded also by a money grant. The publication of the report and map, the product of the remarkable expedition carried out by Mr. McNair in 1883, has now been brought out. This enterprizing surveyor, after crossing the frontier of India, accompanied by "The Syud," traversed the mountain region of Dir and Chitral, visiting in his progress the country of the Kafirs, and ascending the mountains of the Hindu Kush, and thence, carrying his life in his hand, passed through into Gilghit and Kashmir. A brief account of these exploits was afforded in paragraph 203 of the General Report of the Survey of India for 1882-83. Since then public attention has been attracted to the great interest attaching to this expedition through the account delivered by the surveyor himself before the Royal Geographical Society of London, so that it is not necessary to recapitulate here the main facts of that

expedition. It may, however, be mentioned that the learned Society just named has awarded the "Murchison grant" to Mr. McNair. The Government of India have now, on presentation of the report, expressed their high estimation of his adventurous spirit and courage, and of the value of the information presented to them by this hardy and skilful surveyor, who, accoutred with his portable sketching table and instruments for mountain reconnaissance, and aided by his native assistant who measured a continuous route along the valley, has produced a map far surpassing in accuracy any other production of the same nature.

32. The report and map of Dardistan has now been compiled and published. The inaccessibility of this tract, and its situation, as intermediate between other tracts under our influence, admitting of a survey of the valley of the Indus from distant and surrounding peaks being executed, has already been described in the report of last year at pages 6 and 40.

33. It having been decided to despatch an expedition to demarcate the Afghan frontier, on the north-west, a detachment of the Survey of India was organized to accompany it. Eventually Major T. H. Holdich, R.E., Captain St. G. C. Gore, R.E., and Lieutenant the Hon'ble M. G. Talbot, R.E., were selected, and three competent native surveyors were appointed to accompany them, named Ata Mahomed, Hira Sing, and Imam Sharif, with a complete equipment of men and instruments. Owing to the fact that this detachment now operates under the orders of the Foreign Department, and to the incessant labour the surveyors endure on their lengthy marches, and to constant occupation on their arduous duties, regular reports have not been received by the Surveyor-General, but this is the less to be regretted in that the public journals contain full accounts of their progress. The map of the early part of the journey only has been received up to this date.

34. At the same time a military expedition into the Zhob valley was taken advantage of, and preparations were made to send a second detachment of surveyors to the front, so as to map the country covered by the troops. Lieutenant R. A. Wahab, R.E., an officer young in the service, but who had already gained experience in similar work in Baluchistan, with the veteran trans-frontier surveyor Mr. G. B. Scott, and an accomplished native surveyor, Munshi E. Sharif, comprised the working power under the orders of the military commander of the expedition. The report and maps obtained have been duly received, and a tract of about 6,000 square miles of hitherto unknown country in the south-east of Afghanistan has been added to our geographical information. Full reports and details of this expedition will be given in the report for 1884-85, to which it properly belongs.

35. The general result of the topographical operations is an outturn of—

4,034·0	Square miles surveyed on the		¼	inch scale.	
3,224·83	,,	,,	½	,,	
7,436·7	,,	,,	1	,,	
12,073·7	,,	,,	2	,,	
691·83	,,	,,	4	,,	
110·25	,,	,,	6	,,	and larger scales.

INSPECTIONS BY THE SURVEYOR-GENERAL AND DEPUTY SURVEYORS-GENERAL.

36. The Surveyor-General took advantage of a conference, held in October 1883, with the Commissioner of Ajmere to examine the field offices of two topographical parties employed in Rajputana. Again on the departure of Government from Calcutta in March 1884, he proceeded on a tour of inspection to Mysore, so as to see that topographical party when in the field: he took advantage of the opportunity, and visited the Madras Observatory in charge of Mr. N. R. Pogson, the Government Astronomer, as well as the head-quarters offices of the Madras Revenue Survey under Colonel H. T. Rogers, R.E., Superintendent of Revenue Surveys. It may be noticed here that Lieutenant-Colonel Sargeaunt, Deputy Superintendent of Revenue Surveys, in charge central office, had during the previous months paid a series of visits to the offices of the Survey of India in Calcutta. During the recess Colonel DePrée proceeded again to Mussooree, and examined the offices of the several field parties, and the Trigonometrical offices at Mussooree, and

afterwards the head-quarters offices of the Trigonometrical Branch and the Forest Survey offices at Dehra.

37. The Deputy Surveyor-General in charge of the Revenue Branch inspected the offices of the field parties recessing at Naini Tal, and joined a conference held at Simla during the recess season, and the parties stationed at Poona were formally inspected during the year by the Deputy Surveyor-General in charge of the Trigonometrical Branch.

38. The Assistant Surveyor-General in charge of the Photo-zincographic and Lithographic offices visited and submitted a report upon the offices of the field parties at Naini Tal and Mussooree, as well as the offices of the Trigonometrical Branch at Dehra, with a view to the more effective preparation of fair copy sheets for reproduction by those processes, and their publication for general use. This officer also took part in a committee convened to consider the unsatisfactory working condition of the large photo-heliograph received from England and lately set up in its new observatory at Dehra.

THE TECHNICAL OFFICES.

39. The great publishing and map-printing offices at Calcutta, and the minor offices of the same class at Dehra, have undertaken a large amount of work for the Foreign and other departments, being ever ready to meet the requirements of the service. Thus, besides the large issues of maps of every class, the ornamental award certificates of the late Calcutta Exhibition have been turned out to the number of three thousand by the Calcutta establishment, with the aid of the heliogravure and collotype processes; and a *fac simile* of an ancient manuscript in the Gurmukhi character of the Punjab has been reproduced by photo-zincography at the Dehra office, after the method adopted with the "Domesday Book" in England: besides many others.

40. The Mathematical Instrument office, which is the repairing shop of delicate instruments, the repository and issuing office of surveying implements for, speaking generally, the whole of India, having obtained a special grant of money has taken in hand on a much extended scale the repairs of the accumulated stock of slightly injured instruments with a view to their re-issue. The saving of expenditure on new instruments indented for from England will, it is expected, prove of importance.

41. The copper-plate Engraving office has continued the engraving of the great series of sheets of the Atlas of India. The probable date of the completion of this work cannot be calculated. Native artists have been trained, and are now regularly engaged on the process.

EXHIBITS AT THE CALCUTTA INTERNATIONAL EXHIBITION OF 1883-84.

42. The resources of the three Branches of the Survey of India were drawn upon with a view to presenting to the public specimens of the maps of the Trigonometrical, Topographical, and Revenue Surveys as reproduced by the photo-zincographic process now in such extensive and increasing use. These were supplemented by other specimens, the products of the Engraving and the Lithographic offices, and included the delicate impressions obtained by the Heliogravure and Collotype processes.

The maps comprised specimens of the cadastral or field-by-field surveys, of the city plans, forest surveys, and topographical delineations of countries within and beyond the boundary of India, of varying scales of the regular survey, down to that of the reconnaissance or route survey of the explorer.

A series of thirteen large maps were specially prepared so as to exhibit the material progress and state of India as regards geology, river basins, irrigation crops, rainfall, languages, religions, density of population, internal trade, missionary stations, telegraphs, railways, and roads. An *alto-relievo* model map of India showing the contour lines at regular intervals was also constructed.

43. A series of pictures of the sun's disc obtained by the agency of the photo-heliograph of 8″ diameter; and a set of diagrams, the resultant of the Tidal Operations which are in progress at the ports of the Indian seas, extending from Aden to British Burma, were laid out: and at the same time the intermediate

processes required for producing a complete map in chromo-lithography, photo-zincography, collotype, and heliogravure, were exhibited; as well as specimens of *fac simile* reproductions of ancient records, vernacular handwritings, and many miscellaneous objects.

44. Instruments in use in the various operations during the last half century were laid out for inspection, including one of the original 36-inch theodolites by Messrs. Troughton and Simms with which have been measured the angles of the principal triangulation of the Great Trigonometrical Survey; the fine zenith sector, one of the latest and most refined efforts of Messrs. Troughton and Simms; closing the series of angle-measurers with the small 3-inch theodolite intended for the use of the native explorers of the trans-frontier.

45. The volumes of the Account of the Operations of the Great Trigonometrical Survey were also exhibited.

46. The Executive Committee of the Exhibition have been pleased to award three gold medals to the department, including the Photographic and Lithographic Offices, as well as a silver medal for solar photographs to the Trigonometrical Branch, and it may be here remarked that the three thousand ornamental award certificates of that Exhibition were the work of the former office.

GENERAL REMARKS.

47. Thus the Survey of India in all its numerous ramifications has been entirely and effectively occupied. The duties falling under its hands have been multifarious, and have reached the full limit of its powers, so that no spare officers whatever have remained to form a reserve against a sudden emergency: the continued reductions of establishment, only lately came to an end after years of absorptions of steps, and the consequent cessation of appointments, have reduced the department to a dangerous ebb of depletion, so that it has been felt sometimes that the work was in excess of the capacity of the workmen. The question of filling the posts of superintending officers of the Photographic and technical offices, and of previous training of such officers, is one that should receive attention.

48. Some innovations have been introduced into the operations of the department during the year.

In all the technical offices thirteen European and Eurasian youths have been entertained as apprentices,—thus following out the principle inaugurated in the Ordnance Department of raising an indigenous staff of skilled workmen, a class hitherto obtained only from England.

A new system of accounts has been introduced into the Mathematical Instrument office, by which great saving of time and labour is effected, combined with simplicity of application.

An adaptation of the Heliogravure process, whereby copper plates are bitten into by chemicals kept under control by photography, and are engraved or etched so as to give a delicate and accurate impression of a map or other object, such as the works of art displayed in the late Calcutta Exhibition, has made great progress, and is being extensively utilized.

A printing machine, worked by hand, for the rapid production of maps, has been introduced into use in the Lithographic office with good results.

In the trans-frontier field detachments a mule equipment has been employed for the carriage of instruments, so as to spare the men, who otherwise would prove on an occasion incapacitated by fatigue, and unfit for their signalling duties.

For the general information of the department, the officers of which are scattered over and beyond the limits of the Empire of India, and are necessarily in a measure precluded from obtaining news of the doings of their brother officers and of the Department in all its branches, a monthly *brochure* entitled "the Survey of India Department Notes" has been established, and issued to all departmental officers on duty in India, to retired officers, and those absent in England, besides to societies and all who desire to receive it. This publication, referring to the year 1884, furnishes a concise history of the department, and a record of all orders for promotions and other subjects for the period named.

PART II.

THE OPERATIONS OF THE SEVERAL SURVEY PARTIES APPERTAINING TO THE THREE BRANCHES OF THE SURVEY OF INDIA.

TRIANGULATION.

COAST, ORISSA AND GANJAM.

(THE SECONDARY TRIANGULATION PARTY.)

MR. A. D'SOUZA, Surveyor, 1st grade, since promoted into the Senior Department, assumed charge of this party from Mr. J. McGill, Deputy Superintendent, 4th grade, on the 16th October 1883, on the latter taking furlough.

Personnel.

Mr. A. D'Souza, Surveyor, 1st grade.
„ C. D. Potter, Assistant Surveyor, 1st grade.

2. The work laid down for the party was the looking up of the old stations of the East Coast Series, extending from Pooree to Balasore, executed in 1858-59 by Major Saxton and Captain DePrée, and building beacons on such of the stations as may be found on the coast, so as to give points of reference at intervals of 5 to 15 miles on the coast for the use of the Marine Survey.

Doubts having been entertained as to the existence of the old stations on the coast, the ground was first reconnoitred, and it was found that, although nearly all these seaward stations had been destroyed by the encroachments of the sea, most of the inland flank stations were recovered. Those found on the coast were utilized, and beacons of the usual dimensions were built over them; but where stations had been destroyed, a new series of triangles was executed, based on the sides of the old triangulation, and the positions of the beacons which were constructed were thereby determined.

3. The beacons and buoys of False Point harbour and the Dhamra river were accurately fixed by triangulation, as well as all the prominent objects on the coast that could be used as landmarks for navigation along the coast.

4. The stations of the old triangulation which were found, besides those which were used for beacons, were repaired, and ordinary rectangular covering pillars were built over them, these latter being also covered with mounds of earth as a further protection. The beacons were generally built of masonry, obelisk shape, 15 feet high; but a few of them were constructed of wooden spars from 12 to 15 feet in height, embedded in masonry pillars, and topped with crosses or diamonds painted of various colours.

5. The country through which the work was carried on is unhealthy and intricate, and presents serious obstacles to rapid progress. The greater portion of it is jungly swamp, intersected by numerous rivers and tidal creeks. Boats had to be used for the transport of the party, almost throughout the season; provisions had to be brought from great distances; and building materials were only procurable from the principal towns, such as Cuttack, Pooree and Balasore, and had to be carried over distances, often exceeding a hundred miles.

6. The field season extended from 25th October 1883 to the middle of April 1884.

During the ensuing season the triangulation will be extended southwards along the Madras coast, in continuation of completed work.*

*Mr D'Souza reports favourably of the work performed by Mr. Potter.

TOPOGRAPHY.

ALIGARH AND ETAH DISTRICTS, NORTH-WEST PROVINCES.

(No. 3 PARTY, REVENUE BRANCH.)

7. This party, during the field season, has been under the charge of Mr. J. O. N. James and Major E. H. Steel. On Major Steel's return from furlough, he relieved Mr. James on 27th October 1883, and held charge till 26th January 1884, during Mr. James' absence on leave. Mr. James re-assumed charge on the latter date, and the party continued under his superintendence until 6th August 1884, the date of his retirement from the service, on attaining the age of 55 years. Major Steel, who in the meantime had been superintending the operations of three small detached parties, again received charge of this party in addition to his other duties.

Personnel.

Mr. J. O. N. James, Officiating Deputy Superintendent, 2nd grade, in charge from 1st to 26th October 1883 and from 27th January to 6th August 1884.
Major E. H. Steel, Deputy Superintendent, 4th grade, in charge from 27th October 1883 to 26th January 1884, and from 7th August 1884.
Mr. C. W. Wilson, Assistant Surveyor, 1st grade.
„ C. W. F. Seyers, ditto, 1st do.
„ F. W. Moore, ditto, 3rd do. from 13th December 1883.
„ T. W. Babonau, Jr., Assistant Surveyor, 3rd grade, from 15th January 1884.
37 Sub-surveyors, computers, &c.

8. The field operations commenced on 10th October 1883, and were continued until 15th April, when the party returned to its recess quarters in Mussoorie.

9. The same system of survey was continued as in previous seasons, the principal work being a 2-inch topographical survey in districts Aligarh and Etah. The riparian tract on both sides of the Ganges, conterminous with the above operation, has been surveyed on the 4-inch scale. In the 2-inch area the village boundaries have been obtained by transfer from maps of the Settlement Department, a connection therewith having been provided by fixing the trijunctions of the boundaries by means of traverses which were run between trigonometrical stations. In the riverain area the village boundaries have been re-surveyed.

10. The survey has extended down to the parallel of latitude 27° 30′, and the separate areas on the different scales in the districts that were under survey are shown in the following table:—

Districts.	On 2-inch scale.	On 4-inch scale.	Total.
	Sq. miles.	Sq. miles.	Sq. miles.
Aligarh	715·64	.....	715·64
Etah	785·00	49·92	834·92
Mainpuri	2·46	.....	.....
Budaon	.....	48·17	48·17
Total area ...	1,503·10	98·09	1,598·73

The civil station and city of Etah, covering an area of 3·6 miles, has also been surveyed on the 6-inch scale; and the survey of the town of Kasganj, now fast growing in importance, was undertaken for and at the expense of the municipality on the scale of 20-inches to a mile. In addition to the above, preparatory skeleton traversing has been extended over an area of 307 miles in advance of the detail survey.

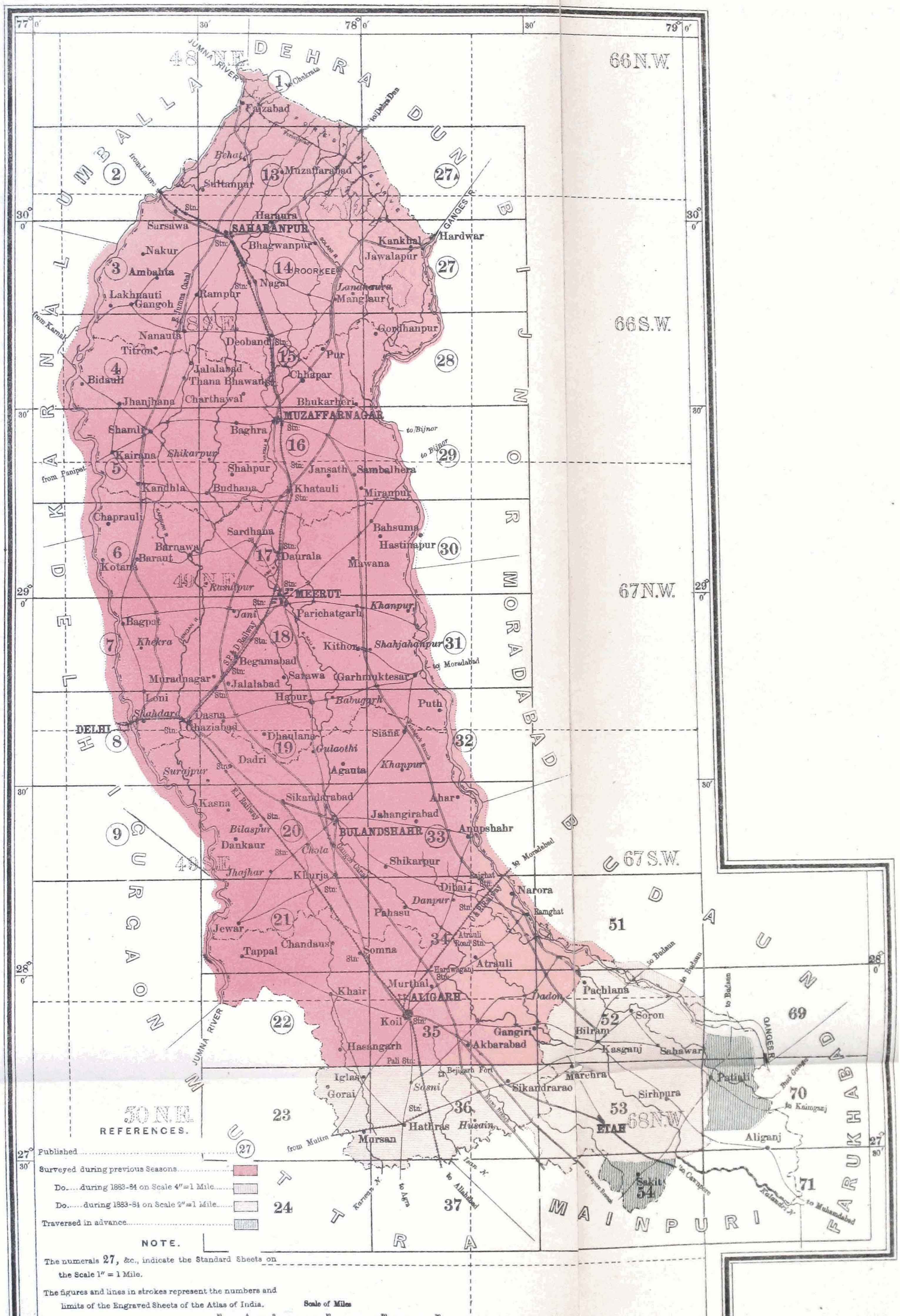
11. The topography, which was surveyed as minutely as the scale would admit, has been tested by 377 linear miles of check survey. The main traverses have been run between trigonometrical stations, and the chain measurements made to accord with the triangulated distances. 39 azimuths were observed for the verification of the angular work: the correction required in both classes was small, and the results satisfactory.

12. The permanent demarcation has been carried out by means of pottery cylinders embedded at all theodolite stations. An improved description of cylinder was used in district Etah, which was slightly smaller, but thicker and better baked and made at a greatly reduced cost.

INDEX TO THE

N. W. PROVINCES SURVEY.

No. 3 REV. PARTY.



Photozincographed at the Survey of India Offices, Calcutta

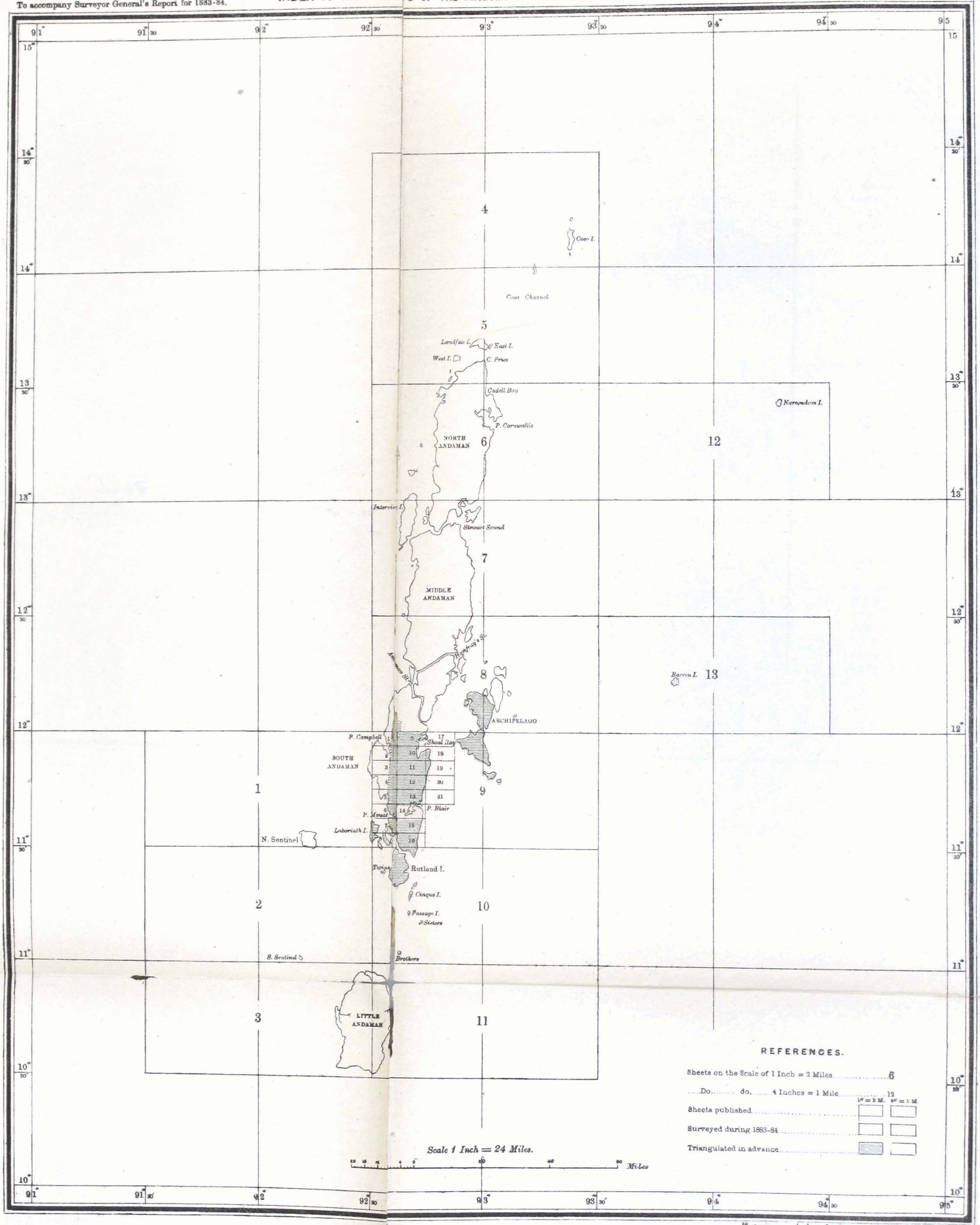
Published under the direction of Colonel G. C. De Prée, S.C., Surveyor General of India.

Survey of India Offices, Calcutta, March.

1885

To accompany Surveyor General's Report for 1883-84.

INDEX TO THE SHEETS OF THE ANDAMAN TOPOGRAPHICAL SURVEY.



REFERENCES.

	1/M = 2 M.	4/M = 1 M.
Sheets on the Scale of 1 Inch = 2 Miles 6		
....Do..... do. .....4 Inches = 1 Mile 19		
Sheets published		
Surveyed during 1883-84		
Triangulated in advance		

Scale 1 Inch = 24 Miles.

20 16 12 8 4 0 20 40 60 Miles

Published under the direction of Colonel G. C. De Prée, S. C., Surveyor General of India.

Survey of India Offices, Calcutta, February.

1885.

Photozincographed at the Survey of India Offices, Calcutta.

13. Two sets of fair maps of the season's outturn on the 2-inch scale have been drawn, comprising 30 sheets. Of these sheets, one set has been prepared for reproduction on the same scale, and the second set for reduction to the 1-inch scale. Traces of the Gangetic riparian tract have been made and furnished to the Collectors of the districts operated in. A reduction of the season's area to the scale of the atlas of India has also been prepared.

14. The office of this party was inspected in September by the Surveyor-General, who commends the able management of the Deputy Superintendent, Major Steel.

15. Under the orders of the Government of India, the continuance of the topographical survey of the remaining districts in the North-West Provinces has been suspended under the consideration that the existing revenue maps, in spite of their imperfections, will answer the requirements of the civil administration for revenue purposes, and that surveys in other provinces are more urgently required. This party has therefore been withdrawn from the Etah district, and will be employed in the ensuing season on the boundary traverse survey of the Ajmere-Merwara district.*

ANDAMAN SURVEY.

(No. 4 Topographical Party.)

16. On the representation of the Officiating Superintendent of Port Blair and the Nicobars to the Secretary to the Government of India, it was urged that the want of a suitable map of South Andaman Island was much felt by the Settlement Officers, in dealing with matters connected with land revenue, forest department, and other local works, whereupon the Government of India was pleased to sanction the survey of that island by their No. 349—117-6S, dated 9th August 1883.

Personnel.

Captain J. R. Hobday, Officiating Deputy Superintendent, 4th grade, in charge.
Mr. J. Keating, Assistant Surveyor, 2nd grade.
„ D. Campbell, ditto, 2nd do.

Sub-Surveyors.

Faida Ali, | Niaz Hosein, and one other.

17. Captain J. R. Hobday, who was in temporary charge of No. 11, South Deccan Topographical Party at Poona, was ordered to head-quarters, Calcutta, to organize a survey party to undertake the survey of the Andaman Islands, and embarked for the field of operations on the 24th November 1883.

Messrs. Keating, Campbell and sub-surveyor Faida Ali were transferred from No. 6, North-East Frontier Topographical Party, and sub-surveyor Niaz Hosein from the Burma Topographical Party. No additions or changes were made in the strength of the party during the season under review.

18. The only available datum on which to base the survey was the position of a point on Chatham Island in the harbour of Port Blair, the latitude and longitude of which had been determined astronomically in 1863 by the Great Trigonometrical Survey, so that in order to undertake a systematic triangulation it was necessary to measure a base line and determine an initial azimuth. The site of the base line was chosen and carefully levelled and drained, and finally measured with the standard iron bar on a raised causeway which served as a rifle range, situated on a piece of reclaimed land in Navy Bay, within the harbour of Port Blair. The result of the measurements was as follows:—

From A to B	...	...	...	...	2,881′ 4″·81
From B to A	...	...	...	...	2,881′ 4″·64
			Difference	...	0″·17

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* Major Steel reports that Mr. C. W. Wilson is an excellent surveyor, and that he always carries out his duties in an efficient manner; that Mr. C. W. Seyers has worked satisfactorily, both in the field and during the recess. Messrs. F. W. Moore and T. W. Babonau, Jr., who have lately joined the department, are both favourably reported on, and promise to become good surveyors.

The native surveyors, &c., have given satisfaction, and the following are specially commended:—Baboo Bhagobati Charana Chakravarti, writer and accountant; Kudar Nath, computer; Surfraz Khan and Didar Bux, draftsmen; and sub-surveyor Nejabut Hosain.

19. Starting from the newly-measured base line, Captain Hobday commenced the triangulation, aided by Messrs. Keating and Campbell, allotting to the former the extension into the southern district, whilst the latter extended it to the northward, the harbour of Port Blair dividing the two districts. The triangulation in the immediate vicinity of Port Blair was computed and the points plotted by distances and an approximate azimuth, thus enabling the detail survey to be commenced by sub-surveyor Faida Ali by the end of January, and about the middle of the same month sub-surveyor Niaz Hossein was ordered to run traverses along the tracks cut through the forest in the southern district. On Messrs. Keating and Campbell completing the triangulation allotted to them about the middle of April, they were deputed to plane-table in order to finish the detail survey of sheet No. 14, of which the sub-surveyors had already completed the greater portion. The result of the season's outturn is the map of Barren Island and the Island of Narcondam on the scale of 8 inches=1 mile, and sheet No. 14 on the scale of 4 inches=1 mile, for publication.

20. In consultation with the Chief Commissioner of the Andamans and Nicobars it has been decided that the $\frac{1}{2}$-inch scale is to be adopted for the general survey of the Andamans, and that certain portions of the South Andamans between the parallels of 11° 30″ and 11° 48′ 45″ shall be surveyed on the scale of 4 inches=1 mile. This, it is thought, will give a sufficient area for the development of the settlement for some time to come, whilst it is considered that the smaller scale will suffice for a reliable geographical map, showing an accurate delineation of the coast line and the principal hill ranges and creeks of these islands. To carry out this scheme, a steamer has been placed at the disposal of the Survey party during the coming field season. Officers from the Geological Survey and Forest Department will also accompany the Survey party to ascertain the resources of these islands.

21. The system adopted to show the hill features on the 4-inch maps is a modified method of contouring, the contours being obtained with the water-level along the ridges and spurs and the intermediate spaces sketched in by eye, each contour showing a vertical interval of 25 feet apart. The system of water-levels is a simple and speedy one, and causes very little delay to the surveyor engaged on the detail survey.

22. During the coming field season the detail survey of sheets 12, 13, 15, 16 and 20 on the scale of 4 inches=1 mile, and the triangulation and detail survey on the $\frac{1}{2}$-inch scale of the whole group, with the exception of the Little Andaman (our relations with the inhabitants of this island not being sufficiently amicable) will, if possible, be taken up.*

ASSAM AND NORTH-EAST FRONTIER SURVEY.

(No. 6 Topographical Party.)

23. This party, as stated in last year's report, was to have been employed in surveying the Noa Dihing valley, the hitherto unexplored portions of the Patkai range on the extreme north-eastern frontier of Assam, but owing to the Aka raid on Balipara, this work was postponed, and the survey party, in accordance with the wishes of the Chief Commissioner of Assam, was ordered to accompany the military force which was sent into the hills to recover certain captive British subjects.

Personnel.

Lieutenant-Colonel R. G. Woodthorpe, R.E., Officiating Deputy Superintendent, 4th grade, in charge.
Mr. M. J. Ogle, Surveyor, 3rd grade.
„ A. Ewing, Assistant Surveyor, 3rd grade

Sub-Surveyors.

Shah Nasiruddin. | Mahomed Hussain

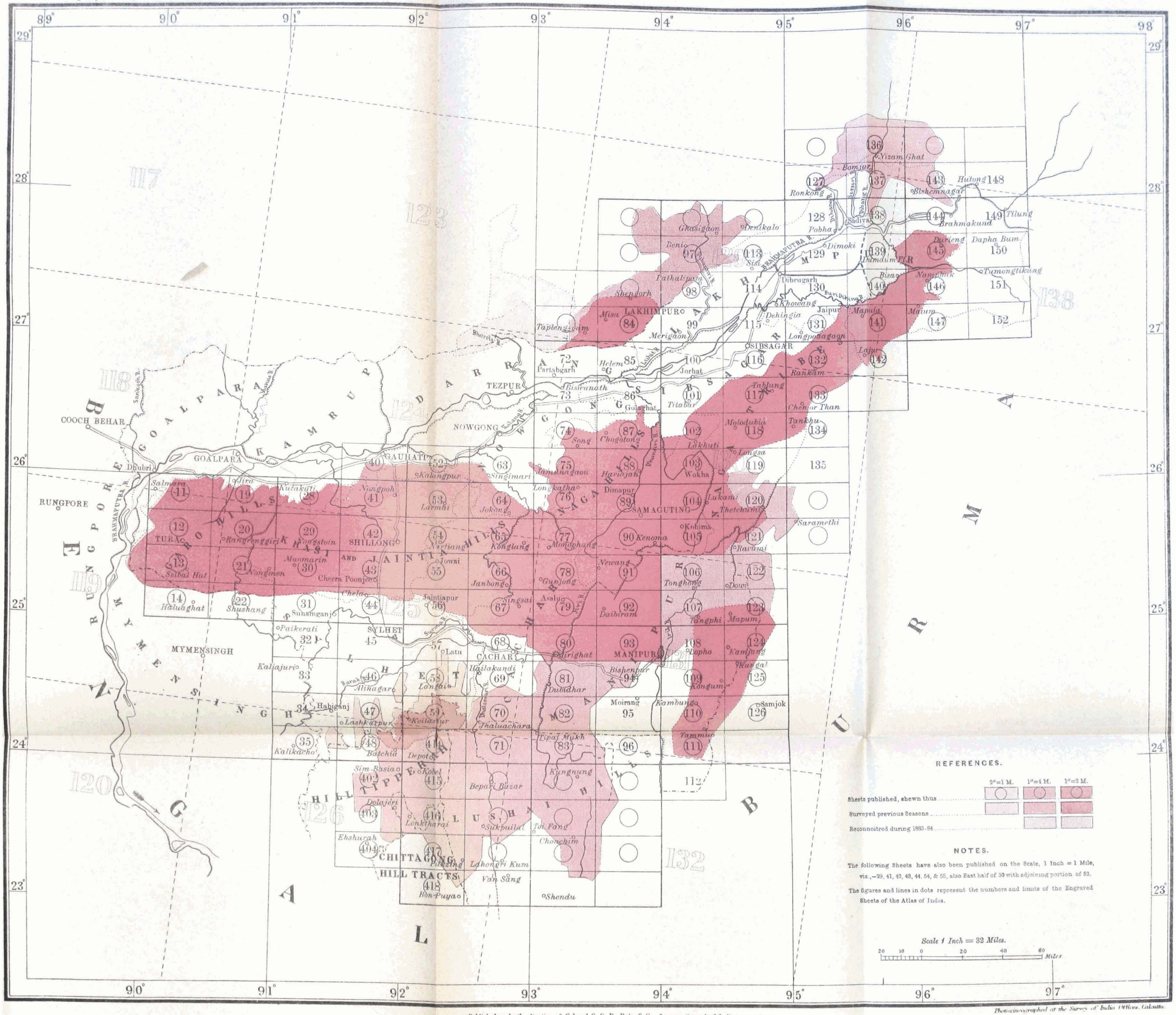
24. Lieutenant-Colonel Woodthorpe having placed 150 of his coolies at the disposal of the military authorities, an advance force under the command of Major Beresford left Dirju Mukh on the 17th December.

25. Whilst the expedition was being organized at Dirju Mukh, preliminary survey operations were carried on at three stations of the great triangulation—Singri, Sildubi and Kamakia—and two new peaks, Guinuja and Sonai, were cleared and observed from, giving a base for starting the detail sketching, which was continued along the whole line of march of the expedition, embracing

* Captain Hobday reports as follows regarding the services of his assistants and sub-surveyors: —
"The assistants and sub-surveyors worked zealously and well under peculiarly novel and trying circumstances in the field, and their duties in recess have been carried out with commendable assiduity."

To accompany Surveyor General's Report for 1883-84.

On the Scales of 1 Inch = 1 Mile, ½ Inch = 1 Mile, and ¼ Inch = 1 Mile.



NOTES.

The following Sheets have also been published on the Scale, 1 Inch = 1 Mile, viz.,—29, 41, 42, 43, 44, 54, & 55, also East half of 30 with adjoining portion of 52.

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

Photozincographed at the Survey of India Offices, Calcutta

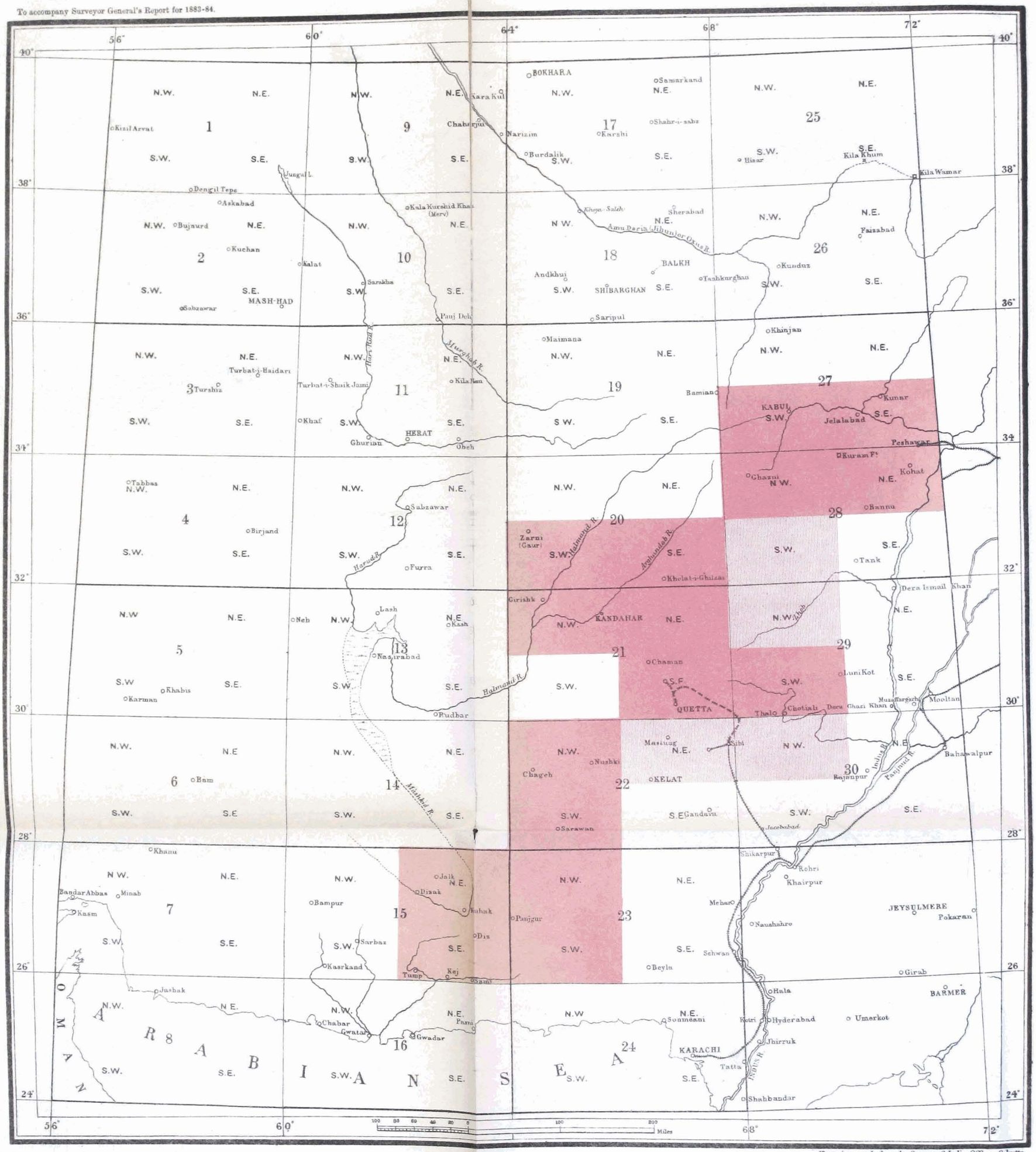
Published under the direction of Colonel G. C. De Prée, S. C., Surveyor General of India.
Survey of India Offices, Calcutta, April
1885

Survey of India Department.

INDEX TO THE SHEET MAPS OF THE NORTH WESTERN TRANS-FRONTIER

On the Scales of 1 Inch = 16 Miles, 8 Miles, 4 Miles, and 2 Miles.

To accompany Surveyor General's Report for 1883-84.



NOTE.

Sheets on the Scale of 1 Inch = 8 Miles are numbered No. 1, No. 2, &c.

A Sheet on the Scale of 1 Inch = 16 Miles will consist of 4 of the Sheets shown on the Index; they are indicated by slightly thicker lines. They will be entitled thus:—Sheet No. (1, 2, 9 and 10).

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. $\frac{2\ N.W.}{3}$, $5\ \frac{S.E.}{2}$ &c. *(Vide Diagram).*

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

Published under the direction of Colonel G. C. De Prée. S.C., *Surveyor General of India.*

Survey of India Offices, Calcutta, April 1885

Photozincographed at the Survey of India Offices, Calcutta.

REFERENCES.

New numbers on Index.	Old numbers on Sheets.
No 27 S.W.	Nos 1 Afghanistan.
,, 27 S.E	,, 2 ,,
,, 28 N.W.	,, 3 ,,
,, 28 N.E.	,, 4 ,,
,, 20 S.W.	,, 5 ,,
,, 20 S.E.	,, 6 ,,
,, 28 S.W.	,, 7 ,,
,, 31 N.W.	,, 8 ,,
,, 31 N.E.	,, 9 ,,
,, 23 N.W.	,, 10 ,,
,, 31 S.E.	,, 11 ,,
,, 23 S.W.	,, 12 ,,
,, 28 S.E	,, 13 ,,

REFERENCE.

..... Indicates sheets already published.

..... ,, ,, ,, in progress.

INDEX TO THE SHEETS
OF
BALUCHISTAN

On the Scale of 1 Inch = 2 Miles.

REFERENCES.

Sheets published in preliminary form.....

Surveyed during 1883-84.....

Area triangulated in advance.....

Cities Surveyed on large scale, names underlined as.....JACOBABAD

NOTE

The two Northern sheets numbered 11 and 12 (2 degrees in Longitude by ½ degree in Latitude) are those appertaining to the Afghanistan series of maps on the Scale of 1 Inch = 4 Miles.

The figures XVI, X, &c., refer to sheets one degree in Latitude by one degree in Longitude. The published sheets on the scale of 1 Inch = 2 Miles are half of these & are numbered thus XVI N., XVI S.

Figures and lines in dots represent the numbers and limits of the engraved sheet of the Atlas of India.

Scale 1 Inch = 32 Miles.

50 40 30 20 10 0 50 Miles

Published under the direction of Colonel G. C. De Prée. S.C. *Surveyor General of India.*
Survey of India Offices. Calcutta. February
1885

Photozincographed at the Survey of India Offices, Calcutta

both banks of the Dirju and Bhoroli rivers, as far as the Tenga river ; beyond this a high ridge to the north of the villages of Mehdi and Labi (two Aka Chiefs) was visited, from whence a widely extended view of the country towards the lofty snowy peaks of Tibet was obtained and sketched, but military considerations did not allow of the surveyors visiting much of the Aka country, for on the 29th January the whole expedition commenced its return journey *vid* Dirju Mukh to Balipara.

26. The work in the Aka Hills being now at an end, it was decided in consultation with the Chief Commissioner that a portion of the survey party should be employed for the remainder of the season on an exploring expedition in the Daphla country, in company with Mr. Penny, an energetic tea-planter, who had had much experience in dealing with these wild and independent tribes. Some valuable information was obtained by Lieutenant-Colonel Woodthorpe during this expedition to the Daphla hills, regarding the existence of the Kameng river, a large branch of the Bhoroli. At the same time a detachment under Mr. Ewing was sent to fill in a blank in the Bhutan hills. The result of the season's operations in the Aka and Daphla hills, including the portion of country mapped in the Bhutan hills, is 1,934 square miles of detail survey on the scale of 1 inch=4 miles, in addition to 622 square miles on the scale of 1 inch=2 miles and 143 linear miles of route and river survey done by native explorers within our own borders.

27. The Aka and Daphla work has been fair drawn and incorporated in one map, showing also the work previously done on these hills, all on the scale of 1 inch=4 miles. The work done on the scale of 1 inch=2 miles has also been incorporated with the work previously done on this scale, and reproduced in two sheets. In addition to this, three fair maps of South Sylhet have been completed and sent for publication.

28. The health of the party was unfortunately bad ; cholera carried off a large number of the followers, and many more died, or were incapacitated from pneumonia, fever, and other diseases, due to exposure and hard work.

29. The party, as provided for in the programme of operations of the Survey of India, will be employed during the ensuing field season on the survey of the country beyond the Lakhimpur inner line and the unexplored portions of the Patkai range, or in prosecution of the programme of the last season, abruptly abandoned on the occurrence of the Aka raid.*

BALUCHISTAN SURVEY.
(No. 3 Topographical Party.)

30. During the year under review the charge of this party was held by several officers. Major Holdich, R.E., who was in charge at the commencement of the field season, went on furlough on the 6th March 1884, when the charge devolved on Mr. Claudius, Surveyor, 4th grade, who held it until the 28th April, when he was relieved by Lieutenant the Hon'ble M. G. Talbot. This officer remained in charge until the 18th August, when he joined the Afghan Boundary Commission, and made over the party to Lieutenant Wahab, R.E. : on this officer being transferred to the Military Department for service in the Zhob expedition, the charge again devolved on Mr. Claudius, who held it from the 1st September up to the date of this report.

Personnel.

Major T. H. Holdich, R.E., in charge up to 5th March 1884.
Lt. the Hon'ble M. G. Talbot, R.E., in charge from 28th April 1884 up to 18th August 1884.
Lt. R. A. Wahab, R.E., in charge from 19th to 31st August 1884.
Mr. T. E. M. Claudius, Surveyor, 4th grade, in temporary charge.
Mr. J. T. U. Coxen, Surveyor, 4th grade, from 23rd December 1883.
Mr. A. Kitchen, Assistant Surveyor, 1st grade.
" G. R. Copping, ditto, 2nd do.

Sub-Surveyors.

Abdul Rasul. | Barkat Ali.
Kadur Sharif.

13. During the season under review, this party was divided into three sections, the one under Major Holdich, R.E., was employed on the Takht-i-Suleman expedition, the second under Lieutenant Talbot, R.E., accompanied Sir Robert Sandeman's Mission in South-West Baluchistan, whilst the third under

* Lieutenant-Colonel Woodthorpe speaks in the highest terms of the services of Mr. Ogle, who held charge of the party during his absence on privilege leave. Mr. Ewing has also shown much determination and energy. The sub-surveyors Shah Nasiruddin and Muhomed Hussain are both reported as having done well.

Mr. Claudius took up the regular detail survey, and was further strengthened after the Takht-i-Suleman expedition by the arrival of Mr. Coxen and sub-surveyor Hira Sing.

32. The programme for the season's work, which had been decided on by Major Holdich, had to be considerably modified on submission to the Political officers. Hence Mr. Claudius, after consultation with Mr. Bruce, C.I.E., adopted other measures whereby the risk of operating in that unsettled country was minimized, but the field of operations was curtailed, and the detail surveyors were unable to take up the plane-tabling of a large portion of the previously triangulated ground.

33. The triangulation carried on during the season covered an area of 6,100 square miles: it consisted of two series, one undertaken by Mr. Copping, starting from the base Dragal to Siah Koh in the south-east portion of Degree Sheet No. IV, covers the whole of Sheet No. V, and extending westward, connects on to a series previously carried east from the Baluchistan Series.

Later on in the season Mr. Coxen carried a second series westward from the side Makhan Baila to Manju of the Baluchistan Series, closing on a triangulation carried over the highlands of Kalat in 1882-83.

Mr. Claudius triangulated about 2,100 square miles, the greater portion of which consisted of the Kachi desert. Mr. Copping was employed exclusively on triangulation throughout the field season: starting from the outpost of Harrand on the Dera Ghazi Khan frontier he covered an area of 3,500 square miles, fixing 17 new stations and 76 intersected points, comprising the whole of the Bagti Dera territory which extends over portions of Degree Sheets IV, V, VI and VIII. In addition to the above, Mr. Coxen also took up a portion of the triangulation of the Kachi desert covering an area of 500 square miles, aggregating in all an outturn of 6,100 square miles of triangulation for the season.

34. The season's topography on the $\frac{1}{2}$-inch scale was carried on in the Thal Chotiali territory and the Kachi desert, which was for the most part flat, easy country: many difficulties, however, had to be overcome and the large outturn of 4,840 square miles in the face of these, cannot but be considered most creditable to all concerned.

35. Two most interesting reports on the work of the other sections of this party will be found in the appendix—one by Major T. H. Holdich, R.E., of the Takht-i-Suleman expedition, and the other by Lieutenant the Hon'ble M. G. Talbot, R.E., of the mission in South-West Baluchistan under Sir R. Sandeman.

36. The programme for the ensuing field season is to take up the detail survey of half Degree Sheet No. IX south, which includes the whole of the Harnai route. In addition, half Degree Sheets VII north and south and VIII north will be completed, and No. V north will be taken in hand. The triangulation of Degree Sheet XI will, if possible, be completed and that of Sheet No. XVI in the neighbourhood of Nushki commenced.*

CUTCH TOPOGRAPHICAL SURVEY.

37. The operations of this survey were carried on as before under Lieutenant-Colonel Pullan. The outturn comprises 2,154 square miles of topography on the 2-inch scale, 1,086 square miles on the $\frac{1}{2}$-inch scale, an area of 2,100 square miles triangulated in advance, comprised in sheets 31, 33, 34 and 35, and 203 linear miles of traversing, covering 450 square miles of the Rann: 467 linear miles of traversing were also run to check the season's topography.

Personnel.

Lieutenant-Colonel A. Pullan, S.C., Deputy Superintendent, 3rd grade, in charge.
Mr. N. C. Gwynne, Surveyor, 4th grade.
" W. A. Fielding, Assistant Surveyor, 1st do.
" G. T. Hall, ditto, 1st do.
" P. F. Prunty, ditto, 2nd do.

Sub-Surveyors.

V. R. Gadbole, N. D. Patwardhan, G. R. Bhopatkar, and seven others.

38. The sheets topographically surveyed were 25 to 29 inclusive, a portion of 24, and a margin covering altogether about 300 square miles, along the northern

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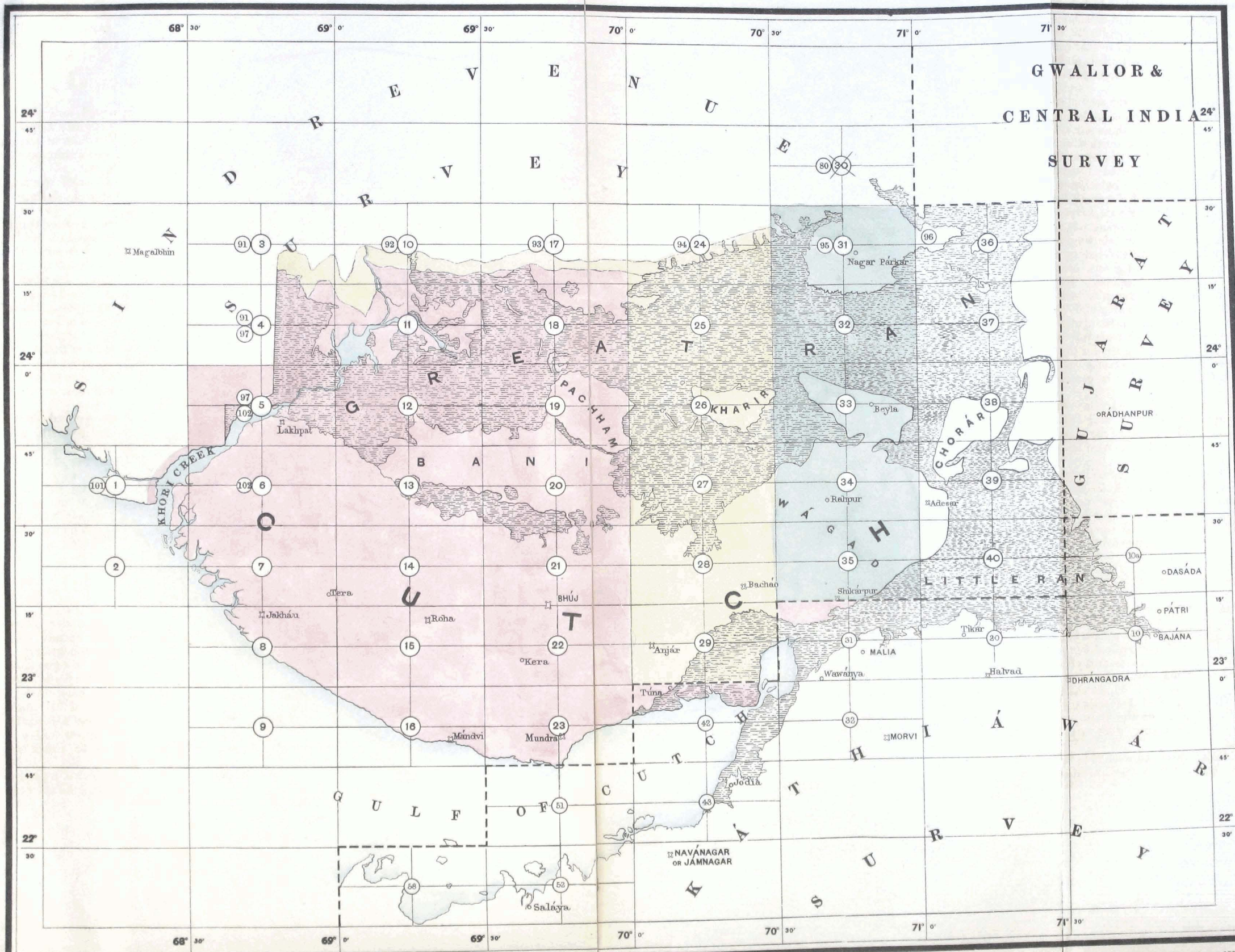
* Lieutenant the Hon'ble M. G. Talbot, under whose charge the work of this party was carried on during the recess, reports in the highest terms of Mr. Claudius' administration during the time he was in temporary charge. Messrs. Kitchen and Copping are also spoken of as having given entire satisfaction.

TRIGONOMETRICAL BRANCH, SURVEY OF INDIA.

INDEX CHART OF THE CUTCH TOPOGRAPHICAL SURVEY.



The numerals (1) (2) (3) &c., indicate the sheets on the scale of 1 inch to the mile.

The smaller numerals as (92) or (51) indicate the sheets of adjoining surveys.

The originals of the 1-inch sheets are drawn on the 2-inch scale and are divided into 4 sections, known as **N. E., N. W., S. E.,** and **S. W.**

Sheets 3, 4, 10, 11, 17, 18, 24, and 25, have been surveyed on the scale of ¼ inch = 1 mile.

C. F. Guthrie, Photo.

Published under the direction of Colonel G. C. DePrée, S.C., *Surveyor General of India.*

Scale 1 inch = 18 miles — 10 5 0 10 20 30 40 50 — = 1/1140480

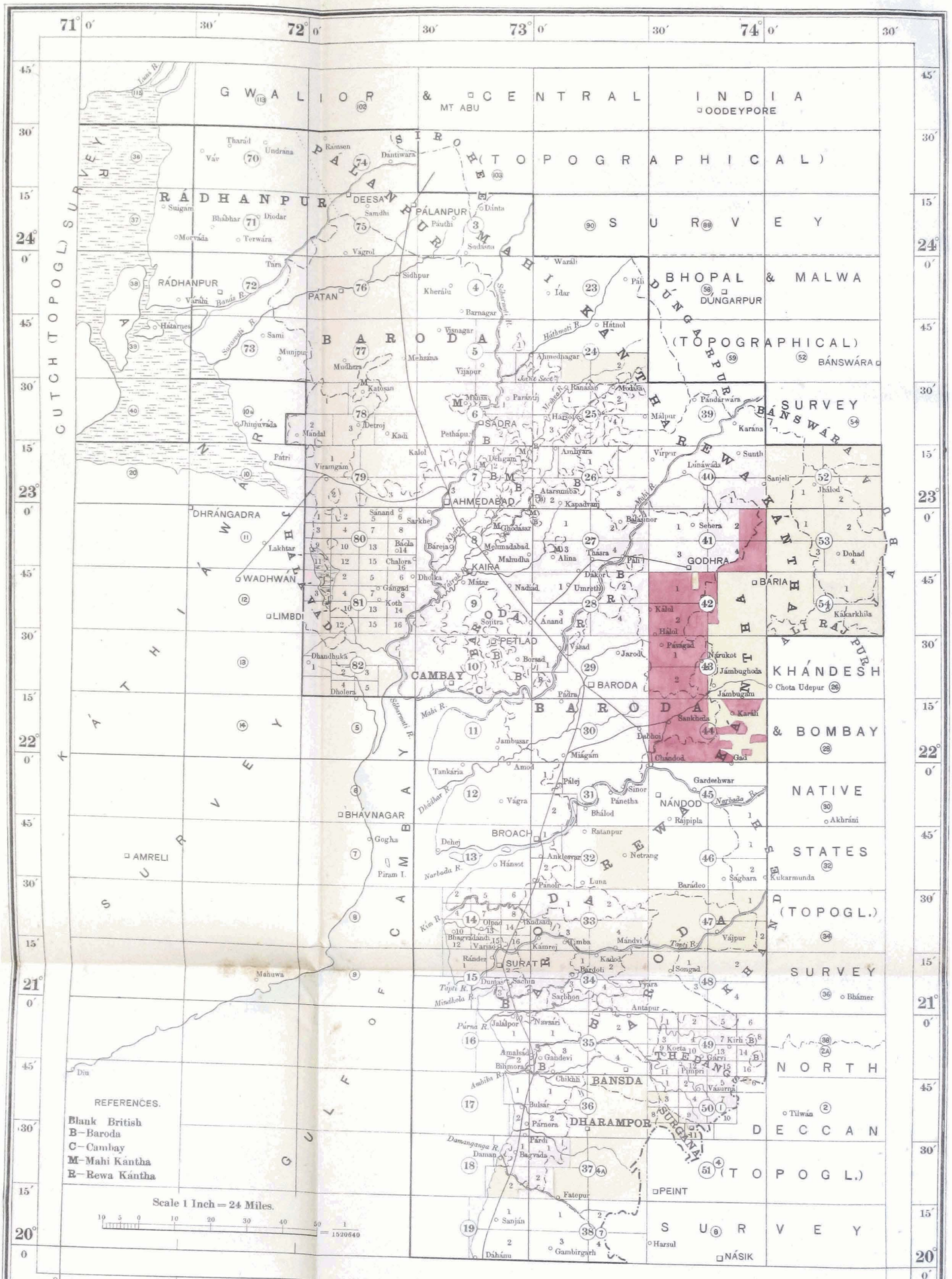
Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, December 1884.

Denotes country Topographically Surveyed up to 1882-83
,, ,, ,, in 1883-84
,, ,, Triangulated and Traversed in advance

C. G. Gliesbach, Zinco.

SURVEY OF INDIA.

INDEX CHART of the GUJARÁT SURVEY.



R. W. Foster, Photo.

Published under the direction of Colonel G. C. DePrée, S.C., Surveyor General of India.

C. G. Ollenback, Zinco.

Note.—Sheets 1 and 2, 20 to 22 and 55 to 63 are wanting, because of transfers to other Surveys and a revision of the numbering, which have been made since the last edition of this Index was prepared.

The numerals (3) (4) &c., indicate the sheets of the Survey on the scale of 1 inch to the mile.

The small numerals thus (5) indicate the sheets of adjoining surveys.

The originals of the 1-inch sheets are drawn on the 2-inch scale and are divided into 4 sections, known as N. E., N. W., S. E., and S. W.

Numbered sections in sheets 14, 49, 50, 80, 81 and 82 indicate publications on scale of 4 inches to the mile.

Ditto 1, 2 & in other sheets indicate 2-inch scale publications of British Territory.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun, December 1884.

Denotes country Topographically Surveyed up to 1882-83.

Do. do. do. do. in 1883-84.

Do. do. Triangulated in advance.

boundary of the Rann, previously surveyed in sheets 3, 10, and 17, to effect a proper junction with the survey of Sind. Of the surveyed area, about 1,800 square miles were featureless Rann, but about 700 square miles of this were surveyed on the 2-inch scale for convenience of squaring off the field sections containing country necessarily surveyed on that scale. In sheet 25 the only feature besides the salt Rann is a bare basalt rock known as Meruda Bet (Bet meaning island), rising 55 feet above the plain, affording a shady halting place on the march between Sind and Cutch. Sheet 26 contains the rocky and wooded island, Kharir Bet, with an area of about 140 square miles, the largest village having a population of 555. The portion of Cutch proper falling in sheets 27, 28, and 29 contains the towns of Chaubári, Bhachau, and Anjár. The latter is the most ancient in Cutch, and was at one time the seat of the British Residency and a military station, and has at present a population of 12,557.

In the centre of this area the ground is undulating and flecked by ranges of basalt, and to the south the country is some of the most fertile in Cutch. No river of importance crosses the surveyed area, but four miles south-south-east of Anjár is the lake of Shinaya, upwards of four miles in circumference.

39. The area triangulated and traversed in advance comprises sheets 31 to 35, inclusive.

40. There is a large increase in the area of topography over that of the previous season, owing to the large proportion of the Rann. The area triangulated is much the same as in the previous season.

41. There are no arrears of mapping, but this party is preparing second editions of many of the Kattywar maps, the work of which is still in progress. Sheets 6 and 9 have been entirely redrawn, and the necessary corrections and additions have been made to eleven sheets during the past recess. The necessity for these second editions arises from the sheets having been published before the boundaries of the petty States, which are very intricate, had been fully demarcated; and advantage has been taken of the opportunity to introduce new roads and railways, making the maps complete up to date in every respect.

42. It is proposed that, during the ensuing field season, the large scale survey of the town, cantonment and fort of Bhuj be executed on 12 inches to 1 mile, that the triangulation of sheets Nos. 36, 37, 38, 39 and 40 be undertaken, and the topography of sheets Nos. 31, 32, 33, 34 and 35 be surveyed.*

GUZERAT TOPOGRAPHICAL SURVEY.

43. The operations of thisparty have consisted of the ordinary topographical survey of Native States executed on the 2-inch scale, for publication on the 1-inch scale, and the survey of the Panch Mahals on the 4-inch scale, including village and forest boundaries.

Personnel.

Colonel C. T. Haig, B.E., Deputy Superintendent, 1st grade, in charge till 13th March 1884.
Lieutenant-Colonel W. F. Badgley, S.C., Deputy Superintendent, 3rd grade, in charge from 24th March 1884.
Lieutenant G. B. Hodgson, S.C., Assistant Superintendent, 2nd grade.

Mr. A. D. L. Christie,		Surveyor, 3rd grade.	
,, C. H. McA. Fee,		ditto,	4th do.
,, C. Tapsell,	Assistant	ditto,	1st do.
,, S. F. Norman,	ditto	ditto,	2nd do.
,, C. A. Norman,	ditto	ditto,	2nd do.
,, A. George,	ditto	ditto,	3rd do.

Sub-Surveyors.

Gopal Vishnu.
Bhan Govind,
Govind Gopal, and 27 others.

44. The topographical operations on the 4-inch scale completed the survey of the Godhra, Kálol, and Hálol talukas of the Panch Mahals. The work on the 2-inch scale completed the topography of the foreign territory in sheet 41 and in the western halves of sheets 42 and 43, with a small projection into the eastern half of sheet 42 and about three-quarters of sheet 44.

45. In sheet 43 are the hill of Páwágarh and the old city of Chámpáner, now mostly in ruins, which ogether cover an area of about 4 square miles. This being a place of great historical and archæological importance, abounding with Jain and Hindu temples and Muhammadan fortifications and buildings in various stages of ruin and decay, great care was taken to fill in every detail of which the scale was capable; and as the features of the hill are precipitous

* Colonel Pullan reports favourably on the work performed by all his assistants.

on three sides, and the summit 2,300 feet above the base, its survey on the 4-inch scale was no ordinary undertaking. Partly to this, partly to increased density of forest, particularly in the Hálol Mahál where the underwood was entwined with the creeper *kawánch* (cow-itch), and partly to sickness in the more densely forest-clad parts, the outturn of topography compares unfavourably with that of the previous season if reference be made only to the areas. On the 4-inch scale, the area being 452·4 square miles, and on the 2-inch scale 710·7 square miles, against 602·6 and 729·1 square miles respectively in the previous season. The water-level was employed as before over all suitable ground on the 4-inch scale.

46. The operations of the past season bring up the total area topographically surveyed in Guzerat to 18,191 square miles, leaving about 12,350 square miles to complete the province. An area of 2,199 square miles was prepared in advance by triangulation and traversing, for final survey, comprising sheets 47, 52, 53 and 54, which, added to the balance still unsurveyed, gives a total of about 4,140 square miles ready for topography.

47. The mapping stated in last year's report to be considerably in arrears is now nearly all worked off, and the party has practically only current work to cope with.

48. The survey will be carried on as hitherto during the coming field season, and no special remarks are necessary.*

MALWA SURVEY.

(No. 2 Topographical Party.)

49. This party resumed work in the Central India Agency in November 1883, under the charge of Major T. T. Carter, R. E. On 5th August 1884 this officer proceeded on privilege leave, being relieved of the charge of the party by Mr. W. H. Patterson, Assistant Superintendent of Survey.

Personnel.

Major T. T. Carter, R.E., Deputy Superintendent, 1st grade, in charge.
Mr. J. A. Barker, Assistant Surveyor, 1st grade.
„ G. Vanderbeck, ditto, 1st do.
„ C George, ditto, 2nd do.

Sub-Surveyors.

Sheik Omer, | Hyder Ali,
Mr. F. Rozario, | and six others.

50. The season's operations lie between the parallels of $\frac{23° 15'}{24° 00'}$ north latitude and the meridians of $\frac{73° 30'}{74° 30'}$ east longitude, and include portions of Banswara, Oodeypore and Dungarpur, Native States; also a small area of the Mahikanta and Rewakanta Agencies of the Bombay Presidency. The out-turn of work during the field season was the triangulation of 1,390 square miles in Standard Sheets Nos. 58 and 59, and the detail survey on the 1-inch scale of 1,587 square miles in Standard Sheets Nos. 50, 52 and 54. In addition to this, the triangulation and traversing for the large scale survey of the Dungarpur city and Kherwara cantonment were completed.

51. The triangulation was executed by Mr. Vanderbeck with a 10-inch theodolite, and is based on the Oodeypore Series of the Great Trigonometrical Survey, and was connected on to the triangulation executed by the Guzerat Survey on the west and the Gwalior and Central India Survey on the north, with a very satisfactory result. The triangulation stations have all been marked by the usual circle and dots on stones, sunk flush with the ground. The country triangulated is for the most part intricate, hilly, and covered with dense jungle.

52. The country plane-tabled on the scale of 1 inch=1 mile is drained by the Mahi river, which runs in a south-westerly direction through sheets Nos. 50, 52 and 54, forming the boundary between the Banswara and Dungarpur Native States, the hills being densely wooded, and the valleys open and well cultivated, and containing some large villages. The general features of the country present great difficulties to the detail surveyor, the ground being intricate and much cut up by small streams and innumerable little hillocks, so situated that considerable care and patience have to be exercised in surveying them correctly.

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* Colonels Haig and Badgley report favourably of all their assistants, special mention being made of Mr. S. F. Norman, to whom was entrusted the survey and mapping of Páwágarh and Chámpáner.

No. 2 PARTY.

INDEX TO THE SHEETS OF THE BHOPAL & MALWA TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.

To accompany Surveyor General's Report, 1883-84

REFERENCES.

Sheets published 12

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

Surveyed during 1883-84, on Scale of 1 Inch = 1 Mile .....

Area Triangulated in advance .....

Cities Surveyed on large Scales, names underlined as..... INDORE

NOTES.

The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Atlas of India..... 54

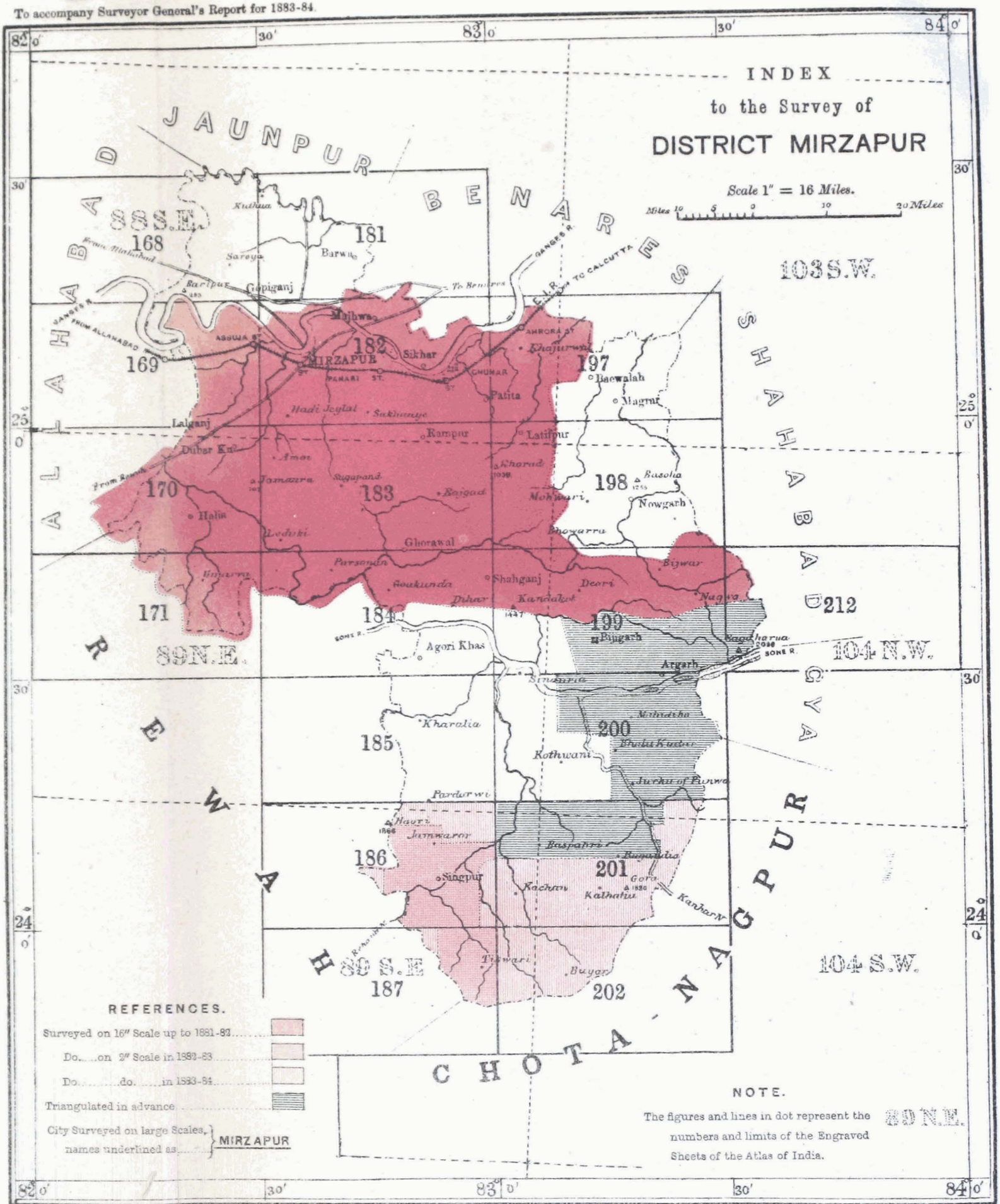
Triangulation Chart Degree Sheets are numbered thus..... IV

Published under the direction of Colonel G. C. DePrée, S.C., Surveyor General of India,
at the Survey of India Offices, Calcutta, January 1885.

N. W. PROVINCES SURVEY.

No. 5 TOP.. PARTY.

To accompany Surveyor General's Report for 1883-84.



Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., Surveyor General of India.

Survey of India Offices, Calcutta, February.

1885

In the appendix will be found an interesting description of the country under survey, with particulars and of its inhabitants, chief towns, roads, rivers, &c., by Major Carter.

53. Degree Sheet charts Nos. v, vi, and viii of the Khandesh and Bombay Native States Survey are in course of completion. The data for Degree Sheet No. ix (Bhopal and Malwa Survey) have been furnished to Major Wilmer, in charge of No. 5 Topographical Party, who will complete the report on that sheet.

54. The work made over to this party for survey, as mentioned in paragraph 50 of the General Report for 1882-83, will be completed during the ensuing field season, the programme of which will embrace the detail survey on the 1-inch scale, of portions of Oodeypore, Dungarpur, and Mahikanta, and 1,200 square miles falling within sheets Nos. 58 and 59, the triangulation of which was completed during the year under report. In addition to this, large scale surveys will be made during the ensuing season of the city of Dungarpur and the cantonment of Kherwara, situated in sheet No. 58, the triangulation and traversing for which has been done in advance.*

55. Mr. R. D'Silva, writer, worked steadily and well in the field, but unfortunately died within eleven days of his return from thence. Mr. D'Silva served about 13 years in this department, and was always well reported on.*

MIRZAPUR SURVEY.

(No. 5 Topographical Party.)

56. The operations of this party were of two distinct kinds—the one being a survey on the scale of 2″=1 mile of that portion of country in the Mirzapur district, left unfinished by No. 5 Revenue Survey Party under Colonel Anderson, and the other theodolite traversing round all the village boundaries of the Dudhi pargana for plotting on the 16-inch scale, and also round the villages of certain hilly tracts of Robertsganj, a pargana of the same district, which had not been completed by No. 5 Revenue Party.

Personnel.

Major J. R. Wilmer, Deputy Superintendent, 4th grade, in charge.
Mr. W. H. Patterson, Officiating Assistant Superintendent, 1st grade.
„ C. F. Hamer, Surveyor, 4th grade.
„ E. A. Wainright, Assistant Surveyor, 1st grade.
„ H. T. Kitchen, ditto, 1st do.
„ W. H. Lilley, ditto, 1st do.
„ R. F. Warwick, ditto, 2nd do.

Sub-Surveyors.

Azim Khan, | Harlal Sing,
Prem Raj, | and four others

Two native non-commissioned officers were also attached to this party during the field and recess season, for instructions in practical surveying.

57. An area of 334 square miles was reconnoitred and triangulated by Major Wilmer himself, completing all the triangulation that is required for this part of the district. This provides an area of 814 square miles in advance for the ensuing season. The area of detail survey completed on the 2-inch scale is 436 square miles of a portion of the Dudhi and Singrauli parganas south of the Keymour range. In addition to the above, Mr. Patterson was employed on the village traverse survey of certain tracts of country which, owing to their hilly and jungly nature, were not taken up by the Revenue Survey Party formerly working in this district. The detail field plans were rigorously tested by 75 linear miles of partals, and almost every plane-table was tested *in situ*, either by Major Wilmer himself or by one of his assistants, and the results have been most satisfactory. Heights of 79 stations were trigonometrically determined, giving an average of about one height to every four square miles.

58. The ground gone over is hilly, undulating, and much cut up by ravines along the banks of the streams, which are densely covered with jungle, making the traverse and detail survey a most laborious task, as lines have to be cut, and rays cleared for every station laid down. This, in addition to the unhealthiness of the district and the comparative scarcity of water throughout these hills, adds much to the costly nature of the survey. During the recess, Standard Sheets 202 N.W., 201 S.E., and 186 N.E. were drawn for reproduction on the 2-inch scale, and also for reduction to the 1-inch scale. The triangulation chart of Degree Sheet ix of the Bhopal and Malwa Survey,

* Major Carter reports well of his assistants and sub-surveyors. Mr. Barker has worked steadily and well, both in the field and office. Mr. Vanderbeck has done a large outturn of triangulation very satisfactorily, and is very trustworthy and reliable in his duties. There has been a marked improvement in Mr. George's work, and sub-surveyors Sheik Omer and Hyder Ali have both done large areas.

which was handed over to this party at the end of the last recess by No. 2 Topographical Party, remains to be completed.

59. The programme for the ensuing season is to continue the 2-inch survey in Standard Sheet No. 200 and to complete the unsurveyed portion of Standard Sheet No. 201, and the traverse survey of the villages of the Dudhi pargana and the forest reserves; also, if possible, to commence the traverse survey of the villages belonging to the family domain of the Raja of Benares, which are situated in the Budohi pargana of this district.

60. As an experiment two native non-commissioned officers* were attached to this party to be instructed in surveying. Major Wilmer reports very favourably of the progress they have made, and suggests that a set of survey instruments should be presented to each of these men, to enable them to carry on the practice of surveying after they return to their respeotive regiments, so that they may be able to impart to their comrades the knowledge they have acquired. The suggestion is doubtless worthy of consideration.*

* Havildar Kanak Sing, 5th Goorkhas.
Naik Melat Sing, 1st Sikhs.

MYSORE SURVEY.

(No. 8 Topographical Party.)

61. The party took the field, in the early part of November 1883, to continue the topographical survey of the Mysore province on the scale of 1″=1 mile, and to carry out the survey of the city of Mysore on the scale of 12″=1 mile.

Personnel.

Lieutenant-Colonel H. R. Thuillier, R.E., Deputy Superintendent, 1st grade, in charge up to 12th February 1884.
Major J. R. McCullagh, R.E., Deputy Superintendent, officiating 3rd grade, in charge from 20th March 1884.
Lieutenant H. M. Jackson, R.E., Assistant Superintendent, officiating 1st grade, joined 11th October 1883; in charge from 13th February to 19th March 1884.
Mr. E. S. P. Atkinson, Surveyor, 3rd grade, transferred, 1st August 1884.
Mr. L. J. Pocock, Surveyor, 3rd grade.
„ A. J. James, ditto, 4th do.
„ W. Stotesbury, ditto, 4th do. transferred, 11th June 1884.
„ F. Kitchen, ditto, 4th do.
„ H. Todd, ditto, 4th do.
„ J. Kennedy, Assistant Surveyor, 2nd grade.
„ J. A. Higgs, ditto, 3rd do. transferred, 12th July 1884.
and 10 sub-surveyors.

62. The triangulation has been extended over an area of 1,417 square miles, mostly in the eastern part of the province, but it also included what was required as the basis for the Mysore city survey.

To supplement the triangulation, theodolite and compass traversing to the extent of 187½ miles was conducted within the limits of the Bangalore and Mysore cities, and also in the forest tracts of the Heggaddevankote and Gundlupet taluks which had been triangulated the previous season.

63. The final topography covers an area of 3,975 square miles in the districts of Shimoga, Kadur, Mysore, and Bangalore, and the survey of all this country was as close and minute as the scale would admit of, the average number of plane-table fixings being 11·8 per square mile, in addition to which chain measurements were in some places largely resorted to. It underwent a searching examination by 569 miles of check line, as well as by testings *in situ*. The Mysore city survey was, from the nature of the work, almost entirely carried out by traversing with plane-table and chan. A very large number of supplementary heights were determined, which materially aided in giving a correct delineation of the ground.

64. The country topographically surveyed during the season presents the same variety of features as have been experienced in previous years, from mountains and dense forest to barren, rugged, and rocky hills, merging into open and undulating plains dotted here and there by isolated mounds, and now and again by patches of scrub jungle of considerable size and density. Though in many places more than usual difficulties had to be encountered, they were cheerfully met and overcome by all concerned, and to this circumstance, as well as to the general good health maintained by the party, is attributable the large and successful outturn.

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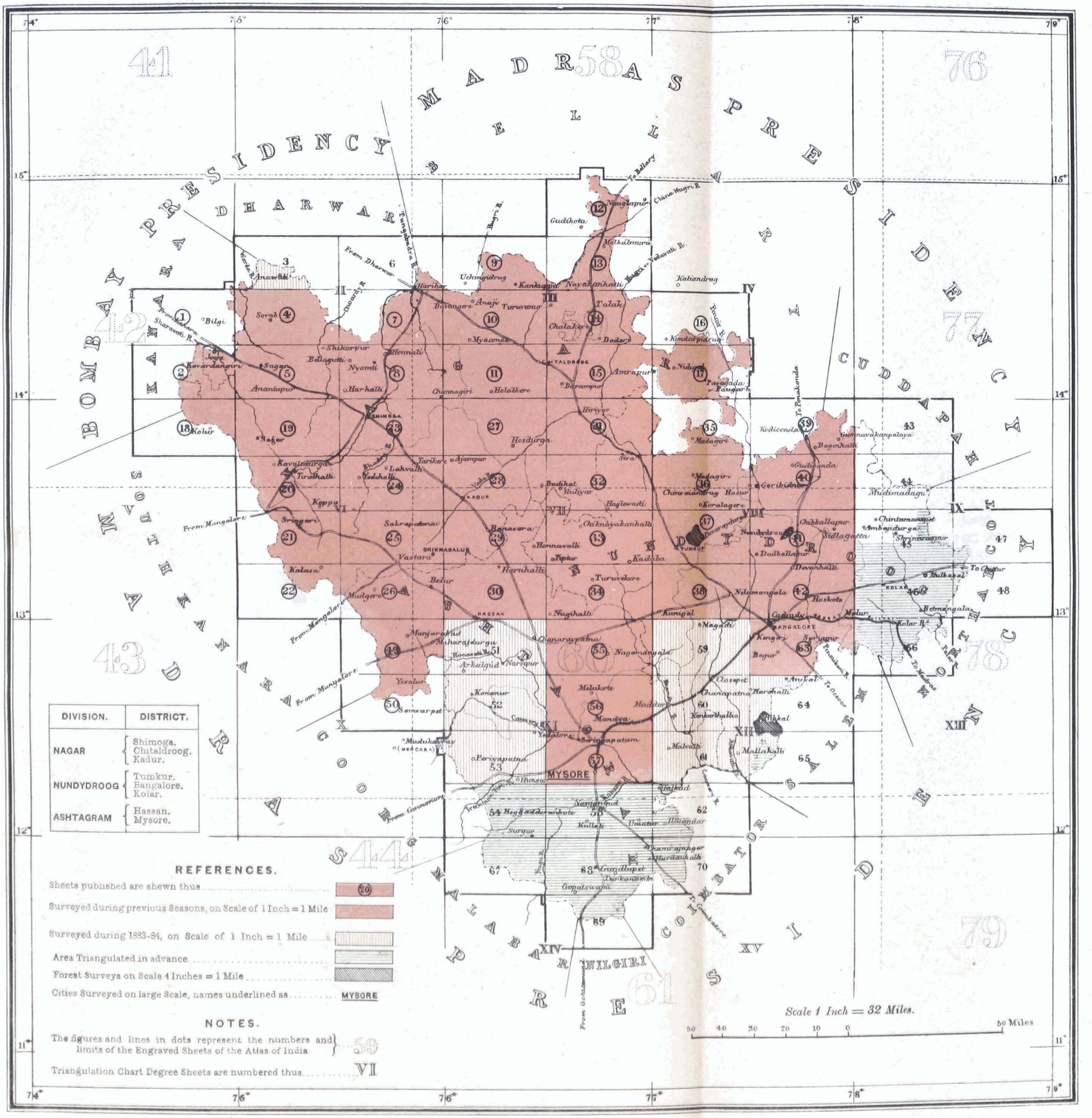
* Major Wilmer reports very favourably of Mr. Patterson's services, Messrs. Hamer, Wainright, Kitchen, and Lilley have also given valuable assistance, and the others have done good work.

INDEX TO THE SHEETS OF THE MYSORE TOPOGRAPHICAL SURVEY,

To accompany Surveyor General's Report for 1883-84.

On the Scale of 1 Inch = 1 Mile.



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

REFERENCES.

Sheets published are shewn thus 20

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

Surveyed during 1883-84, on Scale of 1 Inch = 1 Mile

Area Triangulated in advance

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 } 59

Triangulation Chart Degree Sheets are numbered thus VI

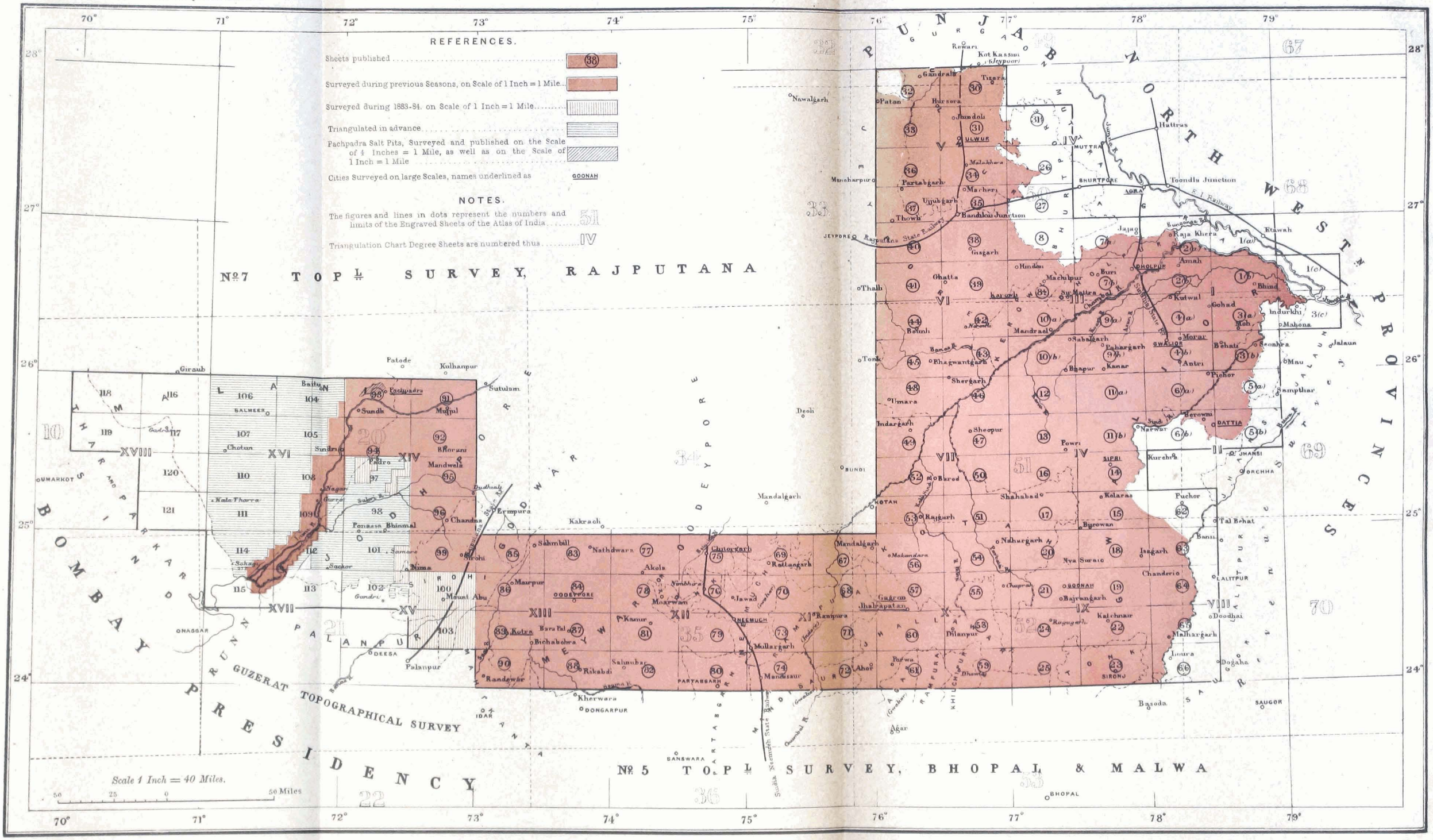
Published under the direction of Colonel G. C. DePrée, R.C., Surveyor General of India,
at the Survey of India Offices, Calcutta, January 1885.

No. 1 PARTY.

INDEX TO THE SHEETS OF THE GWALIOR & CENTRAL INDIA TOPOGRAPHICAL SURVEY,

On the Scale of 1 Inch = 1 Mile.

To accompany Surveyor General's Report for 1883-84.



Published under the direction of Colonel G. C. DePrée, S.C., Surveyor General of India,
at the Survey of India Offices, Calcutta, January 1885.

65. During the recess the mapping of Standard Sheets Nos. 3, 51, 52, 53, 59, 60, 61, and 64 has been completed, and a very large amount of computations has been brought up to date. The boundaries on 29 of the published sheets underwent revision, which was necessitated by the alterations made in the limits of taluks and districts in the years following the rendition of the province. Three degree charts and a chart of the special triangulation for the Mysore city survey were got out of hand, and in addition to the ordinary recess duties a satisfactory commencement was made with the large scale survey of the town and cantonment of Bangalore.

66. During the next season the triangulation for the whole of the province will be pushed to a completion. Topography will be continued in the difficult country to the south of the Mysore district comprised in sheets Nos. 54, 58, 62, 67, 68, 69, 70, and No. 65 in the Bangalore district. The large scale survey of Bangalore will also be proceeded with.*

RAJPUTANA SURVEY.

(No. 1 Topographical Party.)

67. This party as proposed in last year's report, was employed on the extension of the triangulation of Degree Sheets Nos. XVI and XVIII, covering an area, in round numbers, of something over 4,000 square miles, a small portion of which was allotted to Mr. Tate, and the remainder was taken up by Major R. Beavan and Mr. A. J. Wilson, who extended the triangulation of a large area in advance of the topography lying near Barmer in the Malani district, and connected the Barmer series with the Jodhpur Meridional series by a network of triangulation.

Personnel.

Major R. Beavan, Deputy Superintendent, 4th grade, in charge.
Mr. A. J. Wilson, Surveyor, 1st grade.
„ W. J. Cornelius, Assistant Surveyor, 1st grade.
„ G. P. Tate, ditto, 2nd do.
„ M. Gastaud, ditto, 3rd do.
„ P. Beechey, ditto 3rd do.

Sub-Surveyors.

Abdul Gafur, Golam Mahomed, | Abdul Aziz, and 6 others.

Two military students were also attached to the party for instruction in practical surveying—Dafladar Abdul Rahman, 9th B.C., and Naick Lekram, 5th N. L. I.

68. The bulk of the party was employed on the regular survey on the scale of 1 inch=1 mile, of portions of districts Sirohee and Palanpur, including the sanitarium on the Abu range. It also undertook, at the special request of the political officers, a survey of the Sunda and Dorra ranges of hills on an enlarged scale of 2 inches=1 mile. In addition to the above, the revised survey (for the municipality) of the city and environs of Ajmere on the scale of 12 inches=1 mile was carried on and nearly completed. The triangulation was also executed for the large scale surveys of the cities of Jeypore and Amber, the detail survey of which will occupy a portion of the party during the ensuing field season. This is an extensive survey, but only about one-third of the whole area will be surveyed on the large scale of 12 inches to the mile, the remainder being done on half that scale.

69. The field season lasted six months, from 25th October to 25th April, the result being an outturn of 1,211 square miles of completed detail survey on the scale of 1 inch=1 mile, and 120 square miles on the scale of 2 inches=1 mile, together with the 12-inch survey of the city of Ajmere, and 4,133 square miles of triangulation, a portion of the detail survey of which has been taken up this year, but the greater portion remains as advance work for the ensuing field season. Considering the difficulties of the country to the surveyors on account of the scarcity of water, the paucity of supplies, the dense jungle and the rugged nature of some of the hill features, these results are on the whole very satisfactory.

70. During the ensuing field season the party will be employed on the completion of the revised map of Ajmere, the detail survey of the large scale

* Major McCullagh reports very favourably of the energy and activity of Lieutenant Jackson, R.E., and of the aid he has received from him, and he highly commends the exertions of all his assistants, and especially brings to notice the meritorious manner in which Messrs. Pocock, James, Stotesbury, F. Kitchen, H. Todd, and Kennedy have conducted their duties. The sub-surveyors (with one exception) have done their work very satisfactorily, and the following are mentioned by name:—Janki Dass, Raghavayengar, Tiruvenkatsami, Govindraju, Srinivasayengar, Luchman Daji, Baluji Dhondiba, and Ramasami; also Krishna Rao, the writer of the party.

map of Jeypore city extending to Amber, of which the triangulation has been already done, and the regular detail survey on the 1-inch scale of Standard Sheets Nos 97, 98, 101, and 102; of these No. 97 was partially surveyed last season, but No. 98 has to be done *in toto*. Of Nos. 101 and 102, a portion of which consists of the Sunda hills, and of which the 2-inch survey done last field season can be utilized by reduction to half scale, the remainder of these two sheets will have to be surveyed in detail. Also, if time allows, the topography of the unfinished portions lying between the meridian of 72° and the Luni river survey will be taken up. No further extension of the triangulation will have to be made, as the portion already completed embraces all that is required; but more points will have to be fixed in sheets 97 and 113, and a number of extra secondary and tertiary points fixed for the detail survey of these sheets.*

SOUTH DECCAN, BOMBAY PRESIDENCY.

(No. 11 PARTY, REVENUE BRANCH.)

71. This party was employed in continuing the topographical survey of the South Deccan on the scale of 2 inches to a mile. Field operations were resumed on 1st November 1883 in the Satara district under the direction of Major Andrew, and were continued till the end of May 1884 when the party returned to recess quarters at Poona.

Personnel.

Major D. C. Andrew, Deputy Superintendent, 3rd grade.
Mr. J. Hickie, Assistant Surveyor, 1st grade.
„ R. Todd ditto, 1st do.
„ P. White ditto, 2nd do.
„ G. A. Knight ditto, 2nd do.
20 Sub-Surveyors, and others.

72. The tract of country which has been topographically surveyed during the season comprises an area of 1,831·9 square miles, chiefly within the Standard Sheets Nos. 57, 64, and 65. The survey includes portions of several districts and dependent States, as is shown in the following statement:—

	Square miles.
Sholapur district	11·5
Satara „	1,326·3
Ratnagiri „	159·3
Aundh State	47·7
Vishalgad „	4·5
Sangli „	168·3
Miraj, Senior „	31·1
Miraj, Junior „	28·5
Kurundvad „	25·6
Kolhapur and Southern Mahratta Agency	29·1
Total ...	1,831·9

73. In addition to the above area of detail survey, 1,158 square miles have been triangulated and traversed in advance ready for topographical work next season: a further area of 287 square miles has been triangulated only. The triangulation stations have been well marked by stones embedded in the ground over which rubble platforms have been raised. The traverse stations have been fixed on the trijunctions of fields, which are demarcated by stones about 2½ feet long and 9 inches square: those used as stations have been marked with a cross.

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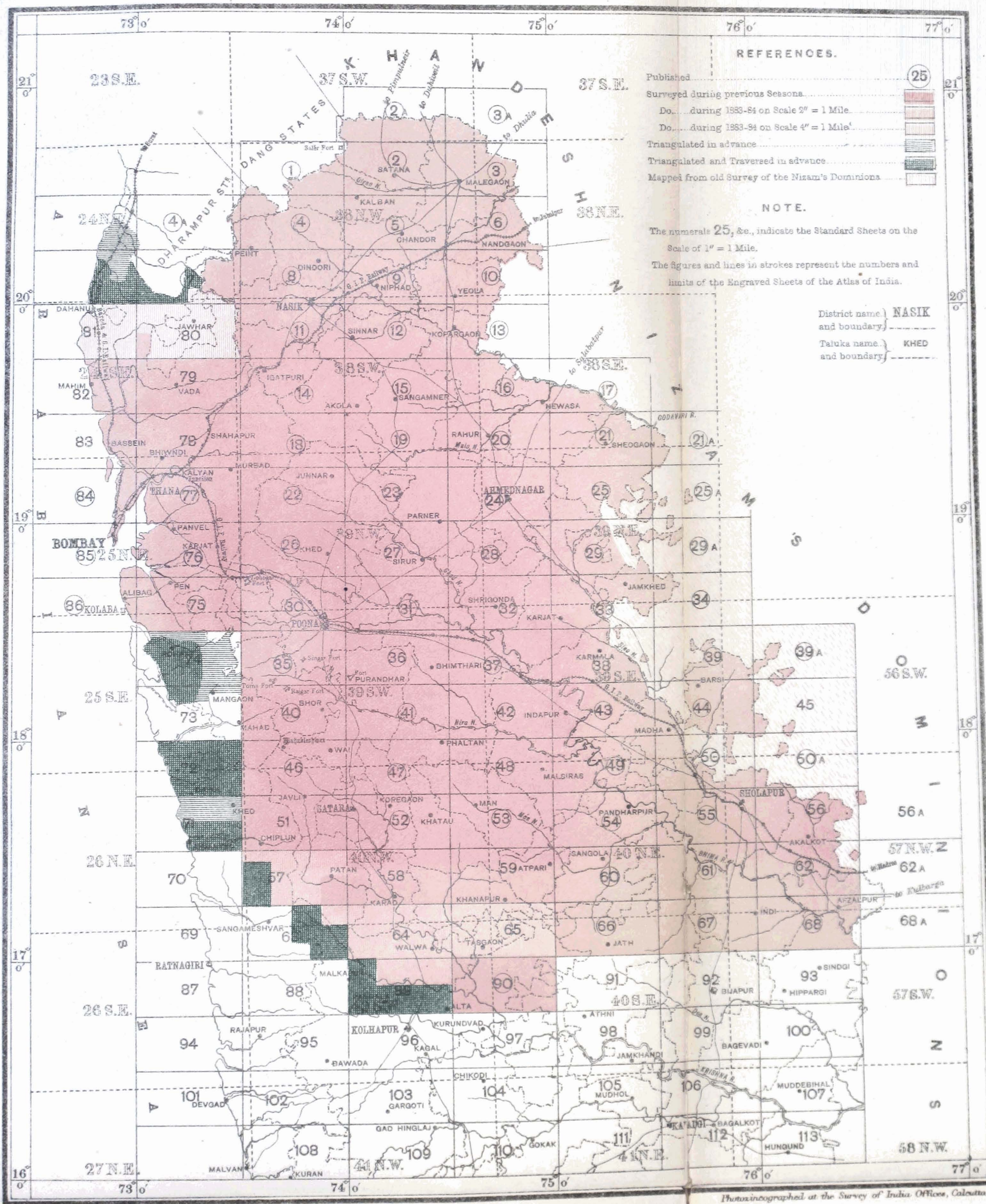
* Major Beavan reports well of all his assistants. Messrs. Wilson and Cornelius, as well as Mr. Tate, have specially contributed by hard and steady work to the success of the season's operations: the sub-surveyors Abdool Gafur, Golam Mahomed, and Abdul Aziz have also done good work.

INDEX TO THE SHEETS OF THE DECCAN AND KONKAN TOPOGRAPHICAL SURVEY.



Photozincographed at the Survey of India Offices, Calcutta.

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*

Survey of India Offices, Calcutta, March.

1885

INDEX TO THE SHEETS OF THE BURMA TOPOGRAPHICAL SURVEY

On the Scale of 1 Inch = 1 Mile.

BRITISH BURMA.

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

1	NW 2	1	NE 2
3	4	3	4
	80		
1	SW 2	1	SE 2
3	4	3	4

REFERENCES.

Sheets published are shown thus..... 98

Surveyed during previous Season.....

.....Do.....do.... 1883-84.....

Area Triangulated and Traversed in advance.....

NOTES.

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

Scale 1 Inch = 16 Miles.

10 8 6 4 2 0 10 20 30 40 *Miles*

Published under the direction of Colonel G. C. De Prée, S.C., *Surveyor General of India.*

Survey of India Offices, Calcutta April 1885

Photozincographed at the Survey of India Offices, Calcutta.

74. The survey of the town of Pandharpur, on the scale of 80 inches to a mile, has been continued at the expense of the municipality of that town: 8 more sheets have been surveyed, and 15 sheets have been examined in the field.

75. The topographical survey has been carried out on the same lines as in previous years; the limits of cultivation and waste have been shown, and all features represented that the scale would admit of. All village boundaries have been surveyed, and those of the forest also, as far as they were demarcated. The accuracy of the topography has been carefully tested by 160 linear miles of measured check survey in the more level ground, and in the hills by the examination of the field sections *in situ*. Heights have been obtained for all the points fixed by the triangulation, amounting in number to 262, and in addition the heights of several traverse stations have been determined. The country surveyed this season is reported to be more mountainous and difficult than any the party has previously met with. The establishment of sub-surveyors suffered considerably from sickness.

76. The fair maps of the area completed have been prepared, comprising 11 standard-sized sections. The survey of the city and cantonments of Sholapur on the scale of 8 inches=1 mile has been mapped in four sheets, and the reductions to the scale of the Atlas of India have been brought up to date.

77. On the completion of the forest tracts in the Satara district it had been the intention to withdraw this party from the Bombay Presidency for revenue survey work in other provinces. It was expected that the Satara district would have been completed during the last field season, but this could not be accomplished, and as the party is not required for revenue surveys elsewhere, it will complete the Satara district and continue the survey of the Ratnagiri district and adjoining dependent States, and further extend the 2-inch topographical survey of the Bombay Presidency southwards as far as the parallel of latitude 16°. The amount of country that thus remains allotted to this party for survey is estimated at 15,200 square miles, which will probably take the party, as at present constituted, about eight years to accomplish.*

MOUZAWAR AND FOREST SURVEYS.

BURMA FORESTS.

(No. 7 Topographical Party.)

78. This is the second annual report of the operations of this party in Burma. The object of the work, which has been undertaken at the wishes of the Chief Commissioner of British Burma and the Conservator of Forests, is to obtain a first class topographical survey.

Personnel.

Mr. H. Hörst, Deputy Superintendent, 3rd grade, in charge.
Mr. J. H. Wilson, Assistant Surveyor, 1st grade.
„ C. P. Torrens, ditto, 1st do.
„ R. A. Gibson, ditto, 1st do.
„ E. Graham, ditto, 2nd do.

Sub. Surveyors.

M. S. Dutt, | Venkat Swamy,
M. Shoay Gyoke, | and 24 others.

(1). Of the reserved forest tracts in British Burma on the scale of 4 inches=1 mile.

(2). Of unreserved forest and ground likely to be brought under cultivation at some future period, on the scale of 2 inches=1 mile.

(3). Of hilly tracts not coming under the above heads, on the scale of 1 inch=1 mile.

79. The area surveyed lies on the western slope of the Pegu Yoma range in the Tharrawaddy district between parallels of latitude $\frac{17°\,37'\,3''}{18\ \ 11\ \ 15}$ and longitude $\frac{95°\,49'\,45''}{96\ \ 7\ \ 30}$ and embraces 211 square miles on the scale of 4 inches=1 mile, extending over the Thonze, Konbilin, Kadin Bilin, Mokka, and Minhla reserves,

* Major Andrew reports that "the European Assistants, with the exception of Mr. Todd, worked well in the field; all did excellent work during the recess, particularly my Senior Assistant, Mr. Hickie, of whom I cannot speak in too high terms. The sub-surveyors have also greatly improved, particularly in drawing, and are now nearly all qualified to survey accurately in hilly ground."

all of which are completed, except the one last-named, and 52 square miles on the scale of 2 inches=1 mile, including narrow strips of unreserved forest tracts situated between the first class forest reserves and the plains which have been cadastrally surveyed.

80. The area prepared in advance during the first season covered only 108 square miles, and during the season under report 476 square miles were prepared, or 584 square miles in all. Of this, 263 square miles were finally completed, leaving 321 square miles in advance for the ensuing field season.

81. An estimate has not been made of the entire area remaining for survey, but there are about 4,000 square miles of reserved forest lands in the province, which alone would occupy the party some years. Up to date the detail survey of about 350 square miles has been completed. The nature of the country presents extraordinary difficulties to survey operations on account of the almost impenetrable undergrowth. The Pegu Yoma range, forming the eastern limit, is rugged and in many parts inaccessible, and attains a maximum elevation of 2,661 feet at Kambalulaung in the Thonze reserve. There are several high ridges running parallel to the Yoma range, some of which completely overlook it, forming a belt of about six miles in width, west of which there is a sudden fall of from 1,500 to 1,000 feet, covered with primæval forest and cut up with innumerable streams, making the survey of it a most laborious, slow, and tedious task. The Yoma or backbone of the range stands up like a wall above the lower hills, showing a comparative height in a part of the Thonze reserve of more than 2,000 feet in a little more than a mile from the crest. Most of the forest reserves derive their names from the principal streams which flow through them, eventually falling into the great Irrawaddy river.

82. The Commissariat arrangements involve serious responsibilities, as over 600 men have to be provided with all the necessaries of life, which have to be conveyed from great distances on elephants, and stored at central depôts along the line of survey operations. Happily there has been no breakdown hitherto, but there is always more or less risk of such a misfortune occurring.

83. In comparison with the previous field season, during which 26 men out of 364 died, and 40 per cent. of the establishment were prostrated with fever and dysentery, the health of the party this season was fair. The Sub-Surveyors, however, suffered much, and the klassies still more: out of 560 men there were 498 admissions to hospital, of whom 5 died. The greater freedom from sickness this season was owing to the precautions taken to have the camps on elevated spots and to make the men build machans to sleep on.

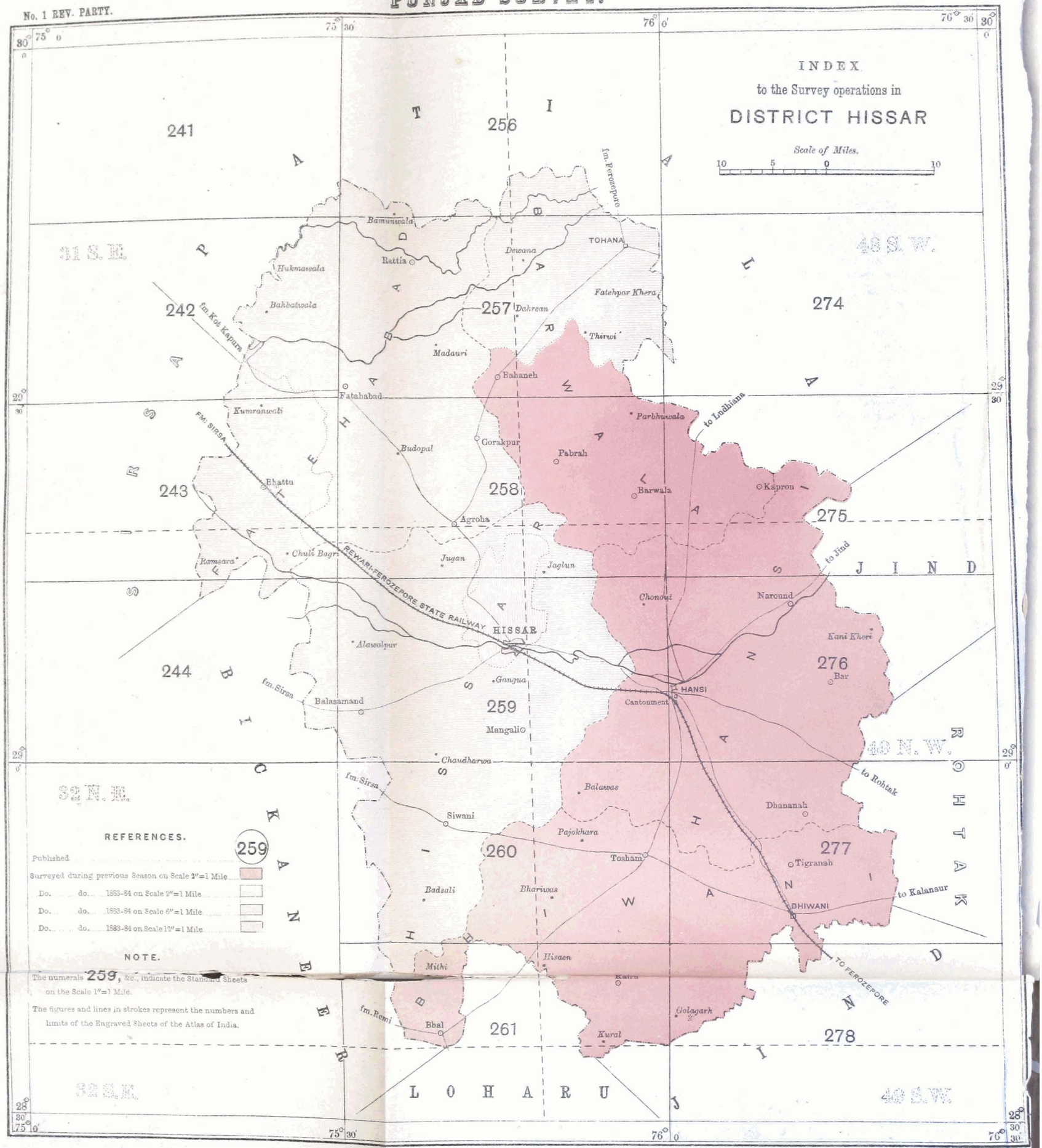
84. The work executed by the assistants and the senior surveyors is of superior quality both as regards accuracy and draftsmanship. Test lines have been run in the work done, and the result is reported by Mr. Hörst as satisfactory. Permanent marks have been left over the ground at half-mile intervals, besides which every tenth traverse post is marked with an iron plate having a number in the Burmese character cut on it: these plates are numbered consecutively from 1 to 1,000, and are supplied by the Forest Department. There is, however, a difficulty about the protection of these traverse stations on the Yoma range, along which wild elephants have formed a track and have pulled up a number of the traverse posts. A narrative report of the country surveyed will be found at page .

85. The programme for the ensuing season will be as follows. As there is no triangulation in advance of the traverse survey, the area to be triangulated will proceed *pari passu* with the traverse survey, chiefly in the Prome civil district, including Shwele, Myodaung and the Shwedaung townships, comprising 125 square miles. The detail survey on the scale of 4 inches=1 mile will be continued from where it was left off last field season, and will be almost entirely confined to the Tharrawaddy district, including a number of forest reserves, embracing an area of between 300 and 400 square miles, and if time permits, the detail survey of the hilly tracts in the Shwedaung township of the Prome district will also be proceeded with.*

* Mr. Hörst reports very favourably of his assistants, Messrs. Wilson, Torrens, Gibson, and Graham, and that the sub-surveyors generally, under the circumstances, did fairly well, although the areas turned out by each individual were necessarily very small on account of the heavy line cutting and jungle clearing.

No. 1 REV. PARTY.

PUNJAB SURVEY.



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Survey of India Offices, Calcutta, February

1885

Photozincographed at the Survey of India Offices, Calcutta.

HISSAR DISTRICT, PUNJAB.

(No. 1 Party, Revenue Branch.)

86. This party left its recess quarters at Murree on the 10th October under the charge of Colonel D. Macdonald, who conducted the field operations up to 2nd March 1884, when he proceeded on furlough, and was relieved by Lieutenant-Colonel F. Coddington, under whose supervision the party has since remained.

Personnel.

Lieutenant-Colonel D. Macdonald, Deputy Superintendent, 2nd grade, in charge up to 2nd March 1884.
Lieutenant-Colonel F. Coddington, Deputy Superintendent, 2nd grade, in charge from 3rd March 1884.
Mr. W. S. Buttress, Surveyor, 3rd grade.
„ A. J. Gibson, ditto, 3rd do. up to 31st December 1883.
„ G. Campbell, Assistant Surveyor, 1st grade.
„ E. B. M. Drew, ditto, 2nd do.
„ J. P. Barker, ditto, 3rd do. from 23rd December 1883.
24 Sub-surveyors and others.

87. The survey has been continued on the procedure adopted under the orders of Government in the previous year, the operations comprising a topographical survey on the scale of 2 inches to a mile, combined with a system of skeleton traverses to aid an approaching settlement survey. Full particulars of this system were given in last year's report of the operations of this party: briefly stated, the traversing follows village boundaries, in the interior of which sub-traverses are run at distances of about half a mile apart, furnishing fixed points at short intervals, all of which are permanently marked. From the data obtained of these points skeleton plots can be prepared on any required scale, and these will furnish an efficient frame-work for the cadastral survey of fields to be undertaken by the *patwaris* of the district under the superintendence of the Settlement Department.

88. Operations were commenced on 15th October 1883, and brought to a close on 10th April 1884, on the completion of the survey of the Hissar district, which has thus been successfully carried out in two years, according to the original estimate, although considerable drains had to be made on the establishment during the field season to assist in the formation of a detachment demanded for special urgent operations in Rajputana.

89. In addition to the 2-inch topographical survey of the district, the Government Cattle Farm at Hissar has been surveyed on the scale of 6 inches to a mile for the Commissariat Department, and the civil station and city of Hissar on the 12-inch scale.

90. The areas surveyed on the different scales during the past season are given in the following statement:—

Hissar district	...	...	2-inch scale—1,782	square miles.			
„	farm	...	...	6	„	„	64	„
„	station and city		...	12	„	„	4	„

An overlap survey of a belt of country, half a mile in width, was also made in the adjoining districts to ensure a good connection with the surveys thereof.

91. The nature of the country in which the topography has been executed is similar to that met with in the previous year, being for the most part very open, with few topographical features, and is essentially easy for survey. The plane-tabling has been tested by 249 linear miles of check survey, and the comparison proved the work to be good. Twenty-one miles of spirit-levelling were also run to connect the levels of the Irrigation Department and of the Railway with those of the Trigonometrical Survey.

92. The village boundary traversing covered an area of 811 square miles, while the internal sub-traverses embraced 2,011 square miles. No fresh stations of the Trigonometrical Survey fell within the area of the year's operations; consequently there are no comparisons of distances available. The connections, however, that were made during the previous season, with 29 trigonometrical stations, secured an accurate basis for the extension and completion of the traverse work.

93. Previous to the commencement of survey operations, the trijunctions of village boundaries were marked by "boorjas," or high conical pillars. These were found to be unsuitable for use as traverse stations, and were therefore removed and replaced by masonry platforms which have been used throughout for theodolite stations. The permanent marking of the stations of the boundary traverses, and of the extra traverses for the Settlement Department has been systematically carried out. On this subject Lieutenant-Colonel Coddington reports as follows:—

"During the previous year, in an area of 3,000 square miles, the traverse stations had been marked with concrete blocks, in size 18″ × 6″ × 6″, at a cost of Rs. 11,512-10-4. The remaining portion of the district was similarly marked during the past year, at a cost of Rs. 1,338-7-10. Thus the total cost of marking all the traversed points in the district has been Rs. 12,851-2-2, at an average cost per square mile of Rs. 3-10-7. For this outlay 19,623 concrete blocks have been embedded. Of this number 8,218 are situated on village boundaries, and 11,405 in the interior of villages. The cost per block, including manufacture, conveyance, and embedding, has averaged 10 annas."

Copies of the data of all the permanent points on the village boundaries, as well as those on the internal lines, have been prepared for the Settlement Department, together with an index plot, on which every marked point has been shown.

94. The mapping of the season's 2-inch topography in Hissar is embraced in 28 standard-sized sections which have been prepared in duplicate, one set being for reproduction to scale, and the other for reduction to the 1-inch scale. The cattle farm on the 6-inch scale has been drawn in nine standard-sized sections, and the city and civil station on the 12-inch scale in two similar sized sections.

95. The publication of the maps of the Murree and Kahuta tahsils of the Rawal Pindi district on the 4-inch scale, the survey of which was executed by this party prior to the Hissar survey, has been deferred for the insertion of the boundaries of the forest reserves which are in the course of adjustment by the Settlement Department. The necessary information has been received for 15 sheets, which number has now been completed. It is anticipated that the boundaries in the remaining 19 sheets will be decided, and the maps finished during next year.

96. Owing to the want of orders regarding the future employment of this party, no preliminary traversing has been prepared. It was originally intended that the survey of the Ferozpore district should be taken up in succession to, and on the same system as that carried out in Hissar. From the experience gained there, however, it is considered that in the plains of the Punjab, where the country is open and the physical features simple, such an elaborate system of traverses is not necessary, and that fewer fixed points will be sufficient to base subsequent cadastral operations.

97. The Punjab Government, on financial grounds, also demanded the restriction of the scientific work to the lowest necessary limit. Proposals were made by the Settlement Commissioner changing materially the scope and nature of the future operations in the Punjab.

The principal features of the procedure recommended are—

I.—A modified skeleton traverse survey, utilizing trijunction platforms for stations and fixing two in each village.

II.—The topography for revised 2-inch maps of the province, to be taken from the settlement maps, the details being tested and added to where wanting.

III.—A scientific survey of all the riverain tracts in the Punjab which are subject to fluvial action.

These proposals have received the sanction of the Government of India, and during the next field season detachments of this party will be engaged in the districts of Ferozpore, Umballa, Jallandhar, and Ludhiana on the various operations detailed above.*

* Colonel Coddington reports favourably of his assistants, both European and native, and commends the exertions of Messrs. Buttress, Campbell, and Barker. The following members of the native establishment are said to deserve mention, viz.- Ramtonor Chakerbutty, Elahi Bux, Ayid Muhomed, and Sirajudin.

THANA DISTRICT, BOMBAY PRESIDENCY.

(No. 10 Party, Revenue Branch.)

98. The field operations of this party were resumed on the 5th December 1883, under the direction of Major J. Hill, R.E., who remained in charge till 5th May 1884, when, his services being required for the exclusive superintendence of the Tidal and Levelling operations, Mr. A. M. Lawson, the senior assistant, was placed in temporary charge, and under his supervision the field operations were brought to a close and the recess duties conducted till the 2nd October 1884, when Major Hill resumed the charge.

Personnel.

Major J. Hill, R.E., Officiating Deputy Superintendent, 3rd grade, in charge up to 5th May 1884.
Mr. A. M. Lawson, Surveyor, 2nd grade, officiating in charge from 6th May 1884.
Mr. J. Newland, Assistant Surveyor, 1st grade.
„ W. M Kelly, ditto, 1st do.
„ R. R. Dickinson, ditto, 1st do.
18 Sub-surveyors and others.

99. The operations of this party have been of two descriptions during the year: 1*st*, the survey of the Thana Collectorate on the 4-inch scale, which has been continued under the same conditions as in the previous season, which are described in paragraph 130 of the last Annual Report; and 2*nd*, the 2-inch survey of the Jáwhár State, situated within the Thana Collectorate, wherein close survey has been made of the topographical details, omitting village boundaries. The index map will be found at page 22.

100. The area surveyed on the 4-inch scale in the Thana district is 612 square miles, and on the 2-inch scale, 288 square miles in the Jáwhár State has been completed. In addition to the area which has been mapped, preliminary triangulation and traversing has been extended over 460 square miles for the detail survey next season, and triangulation alone has been executed over a further area of 220 square miles in advance.

101. The country surveyed lies between the Western Ghats and the sea and between the parallels of 19° 45′ and 20° latitude. It includes the Mokáda sub-division and a portion of the Dáhánu taluka of the Thana district and of the Jáwhár State. Regarding this tract Mr. Lawson reports as follows:—

"The country surveyed last season was exceedingly difficult. With the exception of a strip along the coast, it was very hilly and intricate, being cut up in all directions by deep gorges, the sides of which are covered with forest. This part is notoriously unhealthy for two or three months after the rains. It became necessary therefore to employ the Surveyors as much as possible in the more open tracts during the early part of the season, but although the party undoubtedly benefited by this arrangement, there was still a great diminution in the outturn during December and January owing to the prevalence of malarious fever."

A description of the country by Mr. Lawson is given in the appendix to this report, and conveys a good idea of the difficult tract over which the operations have been extended.

102. Throughout the survey on the 4-inch scale all the village boundaries have been determined by actual survey: the comparison thereof with the settlement maps confirms the result obtained during the previous season, viz. that the provincial maps are reliable in flat country, but that those in hilly ground are very inaccurate.

103. The traverse survey has fixed 2,992 points, of which 432 are village trijunctions, and stones are embedded at the remaining points with a special mark cut on them. The heights of 372 points in the Thana district and 94 in the Kolába district have been determined trigonometrically, and verified by connection with the bench marks of the Tidal and Levelling operations. The accuracy of the detail survey has been tested in the plain country by 190 linear miles of check survey, and in the hilly country by *in situ* examination of the details from selected points.

104. The plan adopted during the previous year by Major Hill of utilizing the original field sheets of the 4-inch scale sections, as the means of reproduction, so as to avoid the labour of re-drawing them during the recess, and to obviate the danger of the mapping falling into arrears, has been kept in view during the past season and with good results. On the whole outturn of field work on the 4-inch scale, 74 per cent. has been passed as fit for reproduction. The great saving in the labour of drawing thus obtained has enabled the publication of the maps to keep pace with the survey.

105. The following maps have been prepared during the recess:—44 sections of the standard size on the 4-inch scale comprised within sheets Nos. 79, 80, 81, 82, for reproduction to scale; 7 sections of sheets Nos. 79 and 82 on the 2-inch scale for reduction to 1 inch. In addition to the above, 52 skeleton maps on the 4-inch scale, showing village boundaries and traverse stations, have been prepared for the Settlement Department.

106. The work remaining for this party in the Thana and Kolába districts will be completed during the next season, after which, according to present arrangements and the orders of the Government of India, it will be employed in the portion of the Bombay Presidency, south of the parallel of 16°, which comprises Belgaum, Dhárwár and Kárwár.

107. Mr. Lawson acknowledges the valuable assistance obtained from His Highness the Raja of Jáwhár while the party was employed in his State.

108. The recess office of this party was inspected by the Surveyor-General at Poona in November 1884, who formed a favourable opinion of the mapping and the careful and business-like arrangements of Major Hill's superintendence.*

CADASTRAL OR FIELD SURVEY.

AJMERE-MERWARA DISTRICT, RAJPUTANA.

(DETACHMENT FROM NOS. 1 AND 3 PARTIES, REVENUE BRANCH.)

109. The revision of the settlement of Ajmere-Merwara having become necessary, the assistance of the Survey Department was asked for to ensure the construction of sufficiently accurate maps. A meeting was held at Nusseerabad between the Surveyor-General and the Commissioner, and the Settlement Officer of Ajmere-Merwara, to discuss the question of the system of survey to be adopted, when the following facts were elicited :—

(1) In Ajmere, over a large area there are no permanent fields, the cultivated area being always shifting, while in Merwara, among the hills, the fields are more permanent, but there also the cultivation is continually being added to.

(2) The area to be dealt with is—

Ajmere (exoluding *istimrar* and *jagir* estates)...	560	square miles.
Merwara	640	ditto.

The problem to be solved was to obtain a survey which should furnish maps that can be reproduced. It was clear that a cadastral survey, however accurate, would, owing to the shifting nature of the cultivation, soon became obsolete in most of its features, and was therefore inapplicable. It was considered that the only other method suitable would be a traverse and village boundary survey, under which system fixed points would be established by professional traversing, and skeleton maps provided showing the boundaries of each village and the position of each permanent mark within it, and on these data the local surveyors (*patwaris*) would be able to map in the cultivation at the time of their survey. The skeleton maps would be reproduced by photo-zincography or lithography, so that whenever maps of the time of survey became obsolete, fresh skeleton maps would be available on which the *patwari* could carry out the new field measurements.

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* Major Hill has reported on the services of his assistants as follows :—

"Mr. Lawson's work during the field season was, as usual, most satisfactorily performed. * * * * During the time he held charge he has carried on the work remarkably well. He has now held charge of the party on three different occasions, and in each instance I have had every reason to be well satisfied with the way in which he performed his duties.

"Mr. Newland performed his duties most efficiently and satisfactorily.

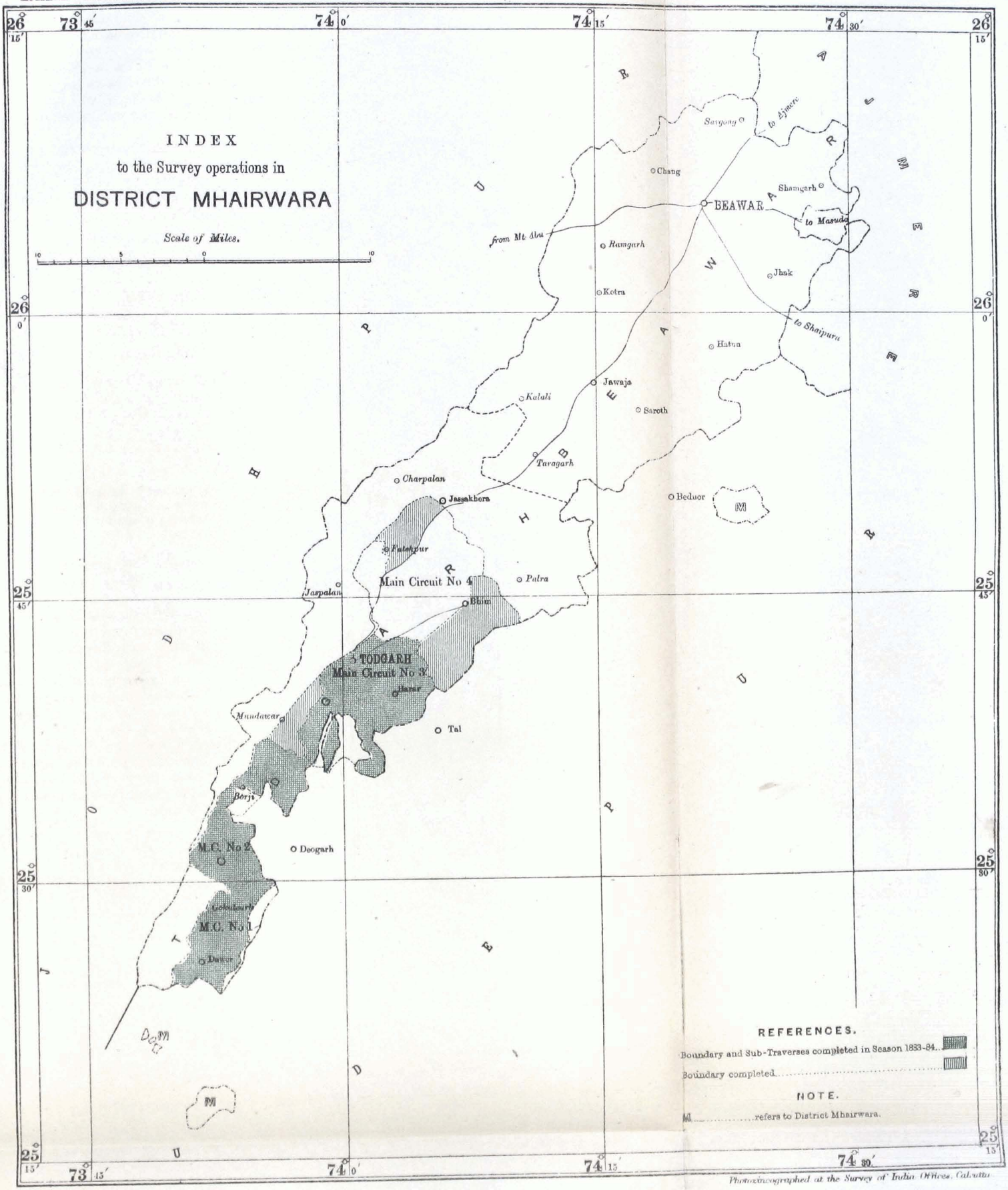
"Mr. Kelly has worked well, and has turned out a considerable amount of work, all of which is carefully executed.

"Mr. Dickinson has, as usual, worked very satisfactorily, both in the field and in office * * * and is well deserving of promotion."

Of the native establishment, "the office assistant and sub-surveyors, with the exception of one traverse surveyor, have all done good work."

AJMERE DETACHED PARTY.

AJMERE MHAIRWARA.



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Survey of India Offices, Calcutta, February.

1885

110. This system of survey, which appeared to be the most suitable one for the special circumstances of the country, was approved by the Government of India. The Deputy Surveyor-General reported that surveyors were not available to be sent to Ajmere, as their withdrawal from other districts would seriously interfere with the work in progress, and recommended that for the current field season the work in Ajmere should be resricted to the demarcation of the village boundaries and the cultivated tracts by the district authorities, and that a strong survey party should undertake the survey at the beginning of the next season. The Government of India, however, considered the survey of Ajmere of great urgency, and directed that a small party should be immediately deputed there.

111. Orders were then issued on 13th December 1883 to the officers in charge of Nos. 1 and 3 Revenue Parties to arrange for a detachment to proceed to Ajmere to undertake the work.

Field operations were commenced on 7th January 1884 by the first portion of the detachment in tahsil Todgarh, at the extreme south of Merwara, and the remainder of the detachment broke ground on 17th idem. The strength of the full detachment is given in the margin, and the Deputy Superintendent, in charge No. 1 Party, was directed to exercise general superintendence over the work. This superintendence was subsequently transferred to Major E. H. Steel, Deputy Superintendent, 4th grade, who has supervised the operations since 27th January 1884. The field work was continued till 13th April.

Personnel.

Mr. A. J. Gibson, Surveyor, 3rd grade, in charge.
Mr. C. W. Seyers, Assistant Surveyor, 1st grade.
Seven Sub-surveyors.

112. The area completed in both boundary and interior traverses amounts to 91 square miles, while an area of 63 square miles in advance has been partially traversed. The boundary traversing comprises 288 linear miles, and the interior traversing 145 linear miles. The triple junction marks of villages and other boundary pillars have been utilized as far as possible for theodolite stations. All the stations, 742 in number, of the interior traverses have been permanently marked by stones projecting about a foot above the ground.

113. The main traverses have been connected with trigonometrical stations and the measurements made to accord therewith. For this purpose some minor triangulation has been carried out by Mr. Gibson, in which four new stations were fixed. Azimuth observations have been taken at 11 stations to check the angular work of the traverses.

114. A good deal of trouble and delay arose from a disturbance between the villagers of Birjal in British territory and those of Deogarh in the Oodeypore State regarding a disputed boundary, which they would not allow to be surveyed. The Assistant Commissioner requested that the survey parties might be withdrawn, which was done, and the boundary still remains unsurveyed.

115. The outturn of work is small, but it is as much as could reasonably have been expected considering the small and inadequate establishment that was employed, and that it was hurried into the country late in the season, whereby it worked under great disadvantage, and that the operations were limited to a short field season of three working months. Moreover, the country was very difficult for traverse operations, the ground being hilly and very rough in parts, and some delay was experienced in clearing jungle for the traverse lines.

116. Skeleton maps, on the scale of 16 inches to a mile, of the season's work, which comprises 19 villages in 45 sheets, have been forwarded to the Settlement Officer.

117. As the settlement survey of Ajmere district is to be finished by March 1886, it was requisite that the Survey Department should complete the boundary and traverse survey during the season of 1884-85 and furnish the Settlement Officer with skeleton maps of all villages by October 1885. To enable this work to be completed, a full party under the immediate charge of Major E. H. Steel has been deputed to Ajmere for the current season.*

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* Major Steel speaks in favourable terms of Mr. Gibson, who, he says, is a very hard-working and painstaking assistant.

Mr. Gibson reports as follows:—"Mr. Seyers has worked during the field season in a most energetic manner . . . and has at all times been most willing to assist me." "The sub-surveyors have all worked fairly, but they were inexperienced in the kind of work they were employed on."

BASSEIN AND HENZADA DISTRICTS, BRITISH BURMA.

(No. 8 Party, Revenue Branch.)

118. This party, the strength of which is given in the margin, continued under the superintendence of Major Hutchinson throughout the year. The traversing section left Rangoon for the field on 15th November, and the cadastral sections followed on the arrival of the establishment from India on 24th November and 10th December 1883. Field operations were resumed in the Bassein and Henzada districts, and were continued until 15th May 1884, when the party returned to recess quarters in Rangoon.

Personnel.

Major H. S. Hutchinson, Deputy Superintendent, 4th grade.
Mr. H. R. Littlewood, Surveyor, 2nd grade.
„ H. Dowman, ditto, 3rd do.
„ R. B. Smart, ditto, 4th do.
„ T. H. Dunne, Officiating ditto, 4th do.
„ W. H. Penrose, Assistant ditto, 1st do.
„ W. H. D. Ewing, „ ditto, 3rd do.
28 Sub-surveyors and others.

Temporary Establishment

136 Field surveyors and others.
2 Levellers.

119. The cadastral survey in the Bassein district has been nearly completed, and it has been extended in the Henzada district. The completed areas in the different townships in each district and the total areas are shown in the following statement:—

Districts.	Townships.	Number of kwins.	Area in square miles.
Bassein	Kyone-kazin	3	4·60
	Lemyet-hna	60	76·99
	Ye-gyi	44	72·34
Henzada	Zaloon	34	194·23
	Henzada	131	259·52
	Oke-po	46	150·29
	Total ..	318	757·97

In addition to the above, preparatory boundary traversing for the cadastral survey next season has been extended over an area of 693 miles. In the cadastral operations, a much larger proportion of cultivation to the waste land came under survey this season. Of the 758 square miles of cadastral work, 470 square miles is rich cultivation, containing 7,23,810 fields, nearly two lakhs in excess of last year, having an average area of 0·41 of an acre. The country is said to be perfectly flat and much intersected with water. A portion on the right bank of the Ngawun river, in the Bassein district, along the foot of the Yoma hills, contained much jungle and swampy land, and was a difficult piece of work.

120. By request of the local Government a special survey of the Oke-po coal field, situated in the hills near Oke-po, was attempted by a small detachment which commenced operations at the end of October. The ground, however, presented great difficulties, and was so covered with dense jungle that extensive line cutting had to be undertaken for the survey. The locality, moreover, was very unhealthy, and after a month's hard work the survey had to be abandoned, as all the men were prostrated by fever.

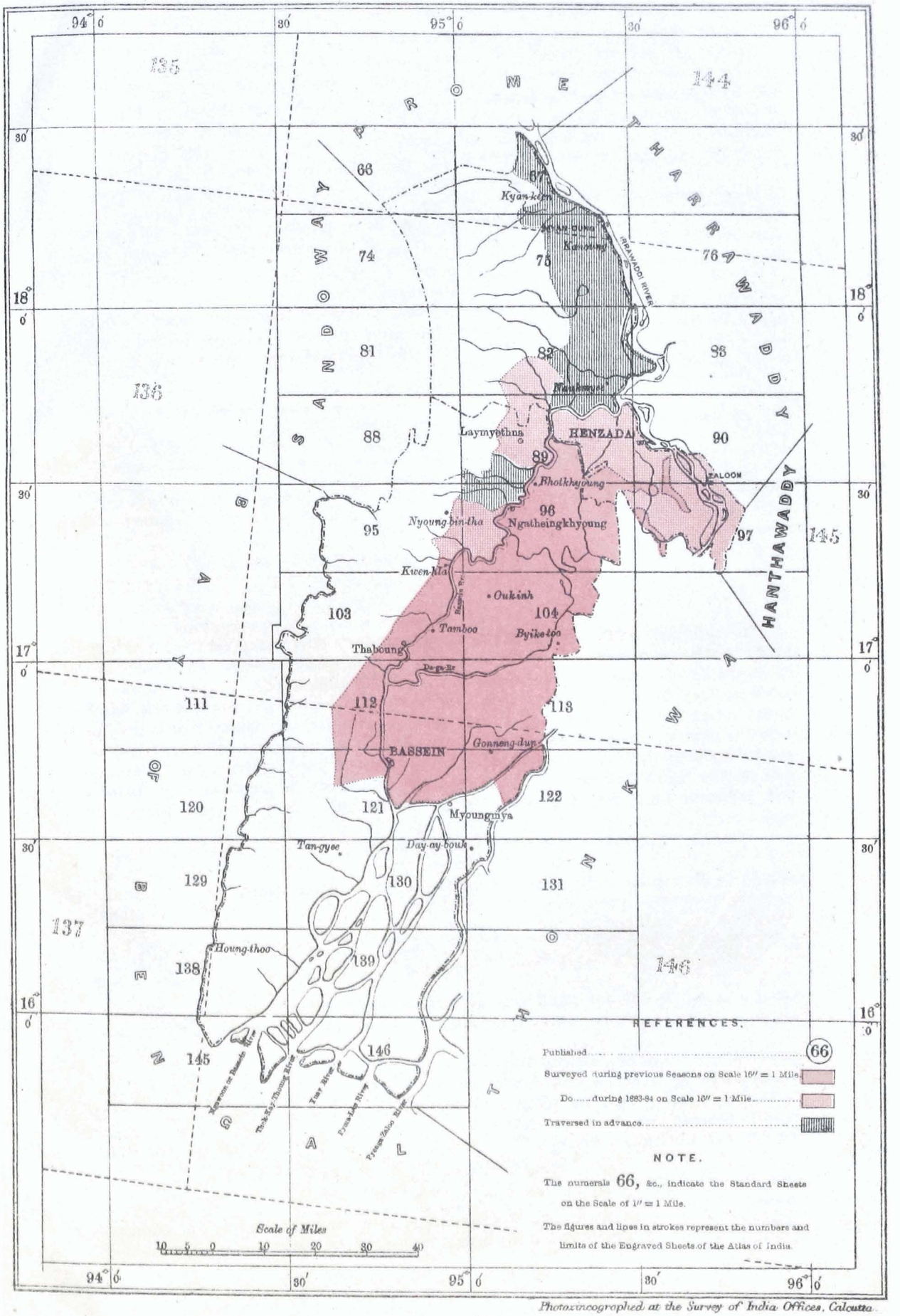
121. The revision survey of 648 square miles of previous survey, to bring the maps into accord with the settlement papers, entailed even greater labour than was experienced in the previous season, when that work was considered a heavy one, and led to a special provision by the settlement department to assist in the process: 37,644 new fields have been surveyed, and the boundaries of 31,884 old fields revised, making a total of 69,528 fields operated in, or 11 per cent. of the old work. On this subject Major Hutchinson reports:—

"Only one who has done this work can estimate the labour it involves; it has been a very heavy drag upon our season's outturn of new survey * * * * and was indeed the main cause of my not being able to complete the ground on the right bank of the Ngawun river, which I had been particularly anxious to accomplish."

122. The cadastral survey has been thoroughly tested by 1,068 linear miles of check survey, of which 281 miles were measured by European officers and

INDEX TO THE
BRITISH BURMA CADASTRAL SURVEY.

No. 8 REV. PARTY. DISTRICTS BASSEIN & HENZADA.



REFERENCES.

Published ..... (66)

Surveyed during previous Seasons on Scale 16″ = 1 Mile.

Do ..... during 1883-84 on Scale 16″ = 1 Mile.

Traversed in advance.

NOTE.

The numerals 66, &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.

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Survey of India Offices, Calcutta, March.

1885

787 miles by native agency. The Deputy Superintendent constantly visited the field camps and inspected the field surveyors as much as possible. The traverse work has been connected with six stations of the great trigonometrical survey, and the chain measurements made to agree with the triangulation distances. The angular work has been checked by azimuth observations at 82 stations. The correction on the chain measurements averages 12 links per *mille*, and the angular correction averages one minute per 10 stations. The traverse work in the Henzada district has been connected with the work of the Prome and Tharrawaddy cadastral survey near the junction of the three districts, with very satisfactory results; the linear difference being 1·52 chains and the angular difference 2′ only.

123. Permanent marks consisting of pottery cylinders have been embedded at all the traverse stations, and special arrangements have been made this year to ensure their proper protection. On this subject Major Hutchinson reports:—

"Every traverse surveyor has kept a field plot of his work on the 2-inch scale, and as he passed from village to village, he handed over a trace from this plot to the headman of the village, telling him that so many marks had been placed on his boundary for which the Government would hold him responsible, and taking his signature as a token that he had received this warning. From these field plots a chart was kept up in the survey office, and as each circle was completed a copy of the same was furnished to the Deputy Commissioner's and settlement offices.

"One copy of each individual village was separately prepared on Government stamped paper bearing the settlement officer's signature: these were sent as soon as possible to the settlement office for distribution to the village headmen, together with a copy of the Government order under which they are made liable for the protection of these marks. It is hoped that these precautions will do much to preserve our stations, but the inherently mischievous character of the Burman has, I fear, already in some instances rendered them futile."

124. The instruction of Burmans in surveying has been continued with marked results. Eighty pupils have been attached to the party, and of these 63 qualified for survey certificates. This was considered very satisfactory by the local Government, and elicited the thanks of the Chief Commissioner to Major Hutchinson and to his assistant, Mr. Littlewood. The training of the indigenous agency by this survey party was started, however, by Major Steel three years previously, and continued in the following years by Lieutenant-Colonel Wilkins. The general question of the capabilities of Burmans for survey employment has been recorded in previous reports of this party, and Major Hutchinson states that it does not call for further comment. The general employment of Burmans as field surveyors, Major Hutchinson considers, "has only to be tried in order to be abandoned." Burmans seem to succeed better as theodolite surveyors, for Major Hutchinson reports that "six men worked with us through the season: three of these did first class work, and three fair work. Their rate of progress was slow, but it was sure and accurate."

125. A survey school was opened at Henzada. Major Hutchinson writes:—

"It does not seem to have attracted very many scholars, and might with advantage, I think, be dispensed with, certainly after this survey party leaves the district, as the Bassein school suffices for the Irrawaddy division."

126. Two squads of levellers have been attached to the party, and their work is reported on with the other levelling operations of the department, at page 54.

127. The 16-inch sheets, 773 in number, of the area where the settlement and revision survey operated, have been submitted to Calcutta to be photozincographed, as well as 48 sheets of the Bassein town survey. The manuscript traces with field area statements of the cadastral maps of the present survey have been supplied to the settlement officer. The general maps on the 2-inch scale of this season's area have not yet been completed.

128. This party is to continue operations at reduced strength to complete the survey of the Henzada district during the next season. The boundary establishment which had completed its work in Henzada was therefore withdrawn, and it has been absorbed among other parties in India. The reduced

party, according to present orders, will be withdrawn from Burma in October 1885, leaving a small detachment behind to excute the settlement revisions during 1885-86.*

BENARES AND BASTI DISTRICTS, NORTH-WEST PROVINCES.

(No. 4 PARTY, REVENUE BRANCH.)

129. This party resumed the cadastral survey of the Benares district, which has been completed, and commenced similar operations in district Basti. Major Barron's health having failed, he was granted furlough to Europe, and the party was conducted into the field by Mr. G. H. Cooke, who superintended the field operations till 10th December 1883, when he was relieved by Major Cowan, under whose charge the subsequent operations have been carried on.

Personnel.

Major W. Barron, S.C., Deputy Superintendent, officiating 2nd grade, in charge from 1st to 31st October 1883; on furlough from 9th November 1883.
Major S. H. Cowan, S.C., Deputy Superintendent, 4th grade, in charge from 11th December 1883.
Mr. G. H. Cooke, officiating Deputy Superintendent, 4th grade, in charge from 1st November to 10th December 1883. Doing duty from 11th December 1883 to 16th August 1884.
Mr. H. T. Hanby, Surveyor, 3rd grade.
,, W. C. Price, ditto, 4th do.
,, S. O. Madras, Assistant Surveyor, 1st grade, up to 26th April 1884.
Mr. E. P. S. Hill, Assistant Surveyor, 1st grade, joined 3rd May 1884.
Mr. L. F. Berkeley, Assistant Surveyor, 2nd grade
Mr. G. S. Willes, Assistant Surveyor, 3rd grade, up to 1st October 1884
Mr. B. R. Hughes, Assistant Surveyor, 3rd grade, joined 15th October 1883.
Mr. W. E. Johnson, Assistant Surveyor, 3rd grade, joined 18th August 1884
25 Sub-surveyors and others.

Temporary Establishment.

338 Field surveyors and others.

130. In Benares the field work commenced on 20th October 1883, and progressed steadily throughout until the completion of the survey on 27th April 1884, when the main party returned to recess quarters at Naini Tal. In district Basti operations were commenced in January 1884, but as the conditions there were less favourable than in Benares, the area taken up for detail survey was not completed till the end of May, a small detachment remaining in the field throughout that month.

131. In the Benares district the survey of the Chandauli tahsil, on the right bank of the Ganges, had been completed during 1882-83, with the exception of a line of villages along the river: this year these villages were surveyed, and also the tract remaining for survey on the left bank, including the city of Benares. One hundred and nineteen square miles of the Maharaja of Benares' family domains lie in this part of the district, and it had been the intention to survey this area on the 2-inch scale only; but on the Maharaja undertaking to pay the cost of a cadastral survey, the Board of Revenue, North-West Provinces, sanctioned it, and this part of the family domains was included in the 16-inch survey of the district. One village of district Ballia lying on the right bank of the Ganges, consisting of a large tract of riverain land, has also been surveyed on the 16-inch scale: it had been included in the 4-inch survey of 1882-83, as part of district Shahabad within the jurisdiction of which it is situated, but as the revenue therefrom is paid in Ballia, the Settlement Officer required a field-by-field survey and *khasra*. In Basti, the survey broke ground at the south-west corner of the district in pargana Amorah: a good outturn of traversing was obtained, and two complete *tuppas* (sub-divisions) and part of a third have been surveyed cadastrally.

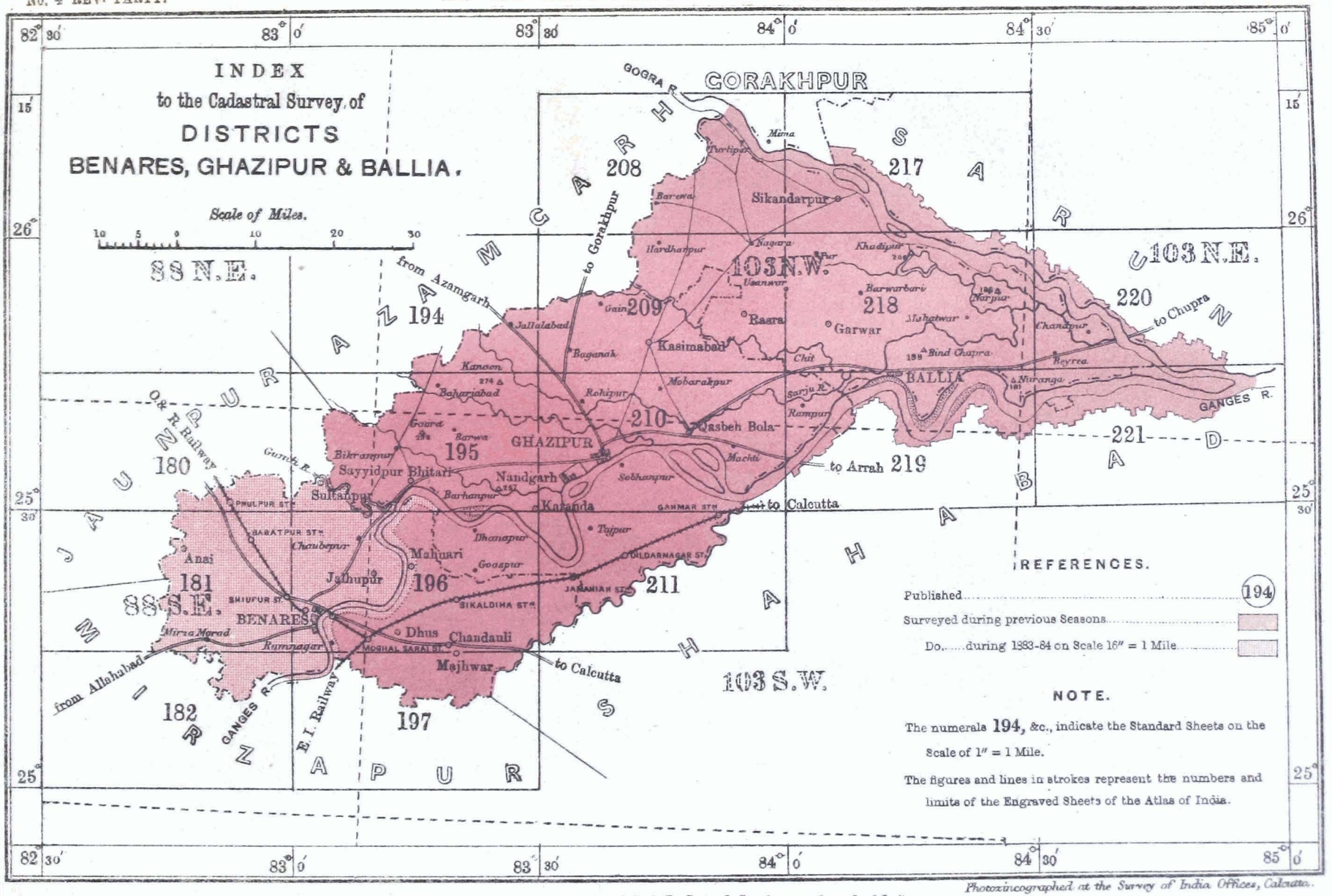
132. The separate areas surveyed, in the several districts mentioned, are shown in the following statement:—

DISTRICTS.	Scale of survey.	Number of villages.	Area in square miles.
Ballia	16 inches = 1 mile	1	11·41
Benares	Ditto ditto	1,420	611·09
Ditto	32 inches = 1 mile	44	10·98
Basti	16 inches = 1 mile	309	100·66
	Total ...	1,774	734·14

* Major Hutchinson again reports most favourably of Mr. Littlewood as follows:—"He is most judicious in his management of natives, is possessed of sound judgment, and has on all occasions displayed tact, patience, and perseverance in his work;" and adds that he is well fitted for the senior department. Mr. Dowman is said to have shown himself zealous and able in his work, and Mr. Smart to have sustained his reputation as a first class and zealous surveyor. Mr. Dunne has again conducted the duties of the revision camp with much credit. Messrs. Penrose and Ewing are reported to have worked well and given satisfaction.

No. 4 REV. PARTY.

N. W. PROVINCES SURVEY.



REFERENCES.

Published 194

Surveyed during previous Seasons .....

Do. ..... during 1883-84 on Scale 16″ = 1 Mile .....

NOTE.

The numerals **194**, &c., indicate the Standard Sheets on the Scale of 1″ = 1 Mile.

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No. 4 REV. PARTY.

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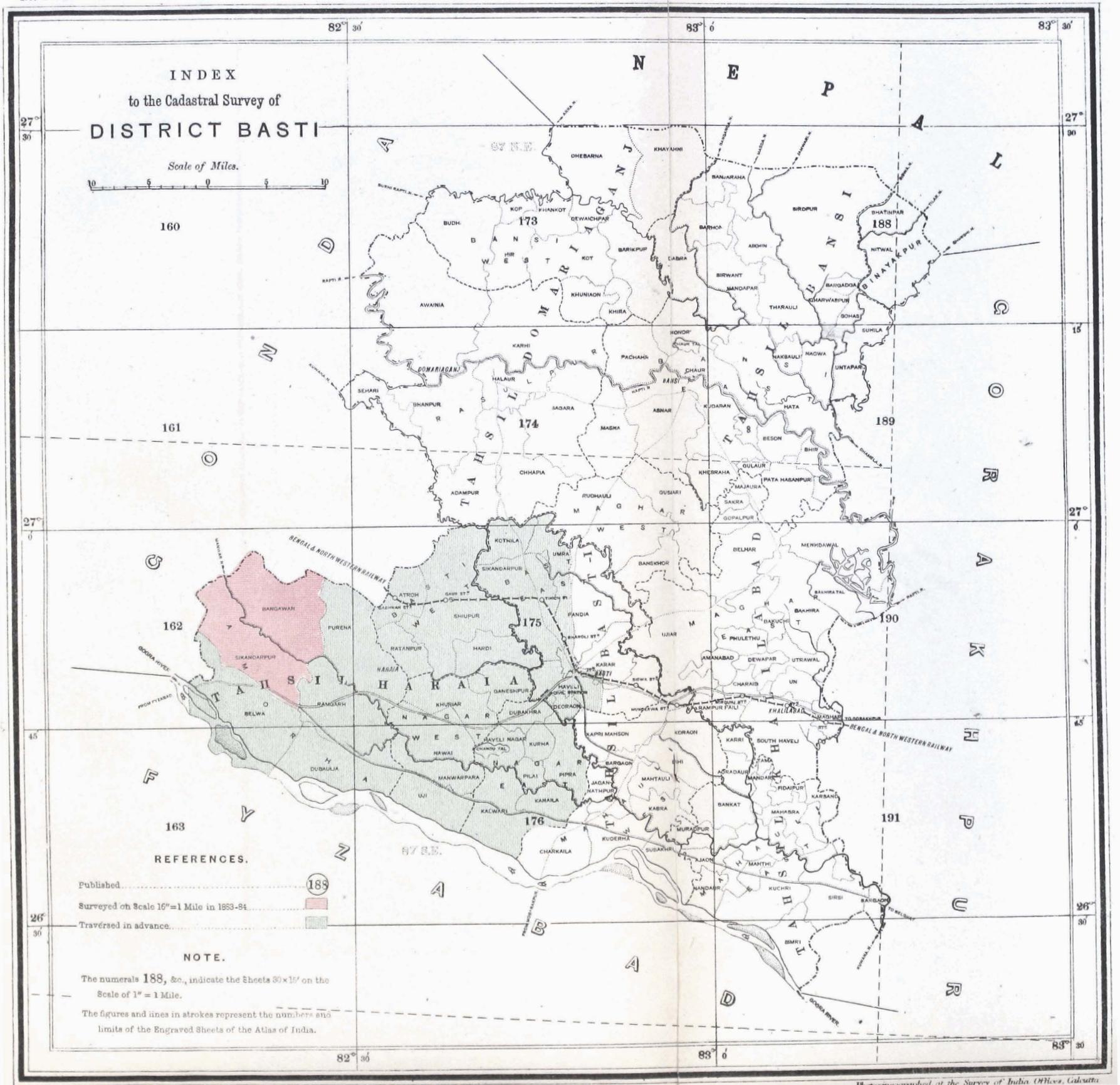

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Survey of India Offices, Calcutta. February 1885

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133. The area surveyed on the 32-inch scale includes the city of Benares and suburbs, which was a very intricate and laborious piece of work. The number of fields surveyed is 872,144, the average size of which in the Benares district is 0·59 acre, and in Basti 0·34 acre.

134. The joint operation of survey and preparation of settlement records has been continued, as in the previous year, under the system known as the Benares system, the procedure of which was described in the Annual Report for 1882-83, pages 26-27, and appendix, page 88. The work has been carried on according to the hand-book of instructions compiled by Major Barron, as mentioned at page 27 of the same report, except that in the Basti district, where some changes were introduced in the division of labour which threw more work on the Survey Department. The results of this year's work have confirmed the favourable anticipations of greater expedition, and reduced cost under the combined system of survey and record-writing; but a complete statement of the actual expenditure on the Survey and revised Record-of-Rights of district Benares cannot be furnished until the work of the Settlement Department is finished.

135. Regarding the operations of the season, Major Cowan reports as follows:—

"The great difficulty in former seasons used to be the obstructiveness of the villagers in not giving the information and the free labour required; but this has been much diminished since the department began to write the *khasras* (field registers). This season the chief hindrances to the work have been:—

(1) The weakening of the establishment by the detachment sent to make a cadastral survey of the Debra Dún and by the repeated drafts of inspectors and *amins* requisitioned for the same survey.
(2) The want of a sufficient area traversed in advance to admit of only one *amin* being told off to each *patwari's* circle, and in Basti the necessity for completing a defined limited area, which made it unavoidable that three and occasionally four *amins* should be kept at work within a *patwari's* circle.
(3) In most of the Maharaja of Benares' villages throughout the district his *kárandas* (agent) gave a great deal of trouble by not furnishing the labour required, and by making a point of contesting every claim to occupancy rights.
(4) The absence of boundary marks in the villages of the Maharaja's family domain and the consequent disputes and confusion. In other parts of the Benares district also the demarcation was imperfect and disputes numerous.
(5) The opposition of the Settlement Officer of Basti to the "new system" (of the Survey Department writing the records).

136. The work was, as usual, subjected to thorough test in all its branches. Correct bearings for the traverses were secured by observations for azimuth at 60 stations, of which 36 were on the main circuits at an average distance of seven miles apart. In the Benares district no stations of the Great Trigonometrical Survey fall within this year's area; but in Basti four principal stations were connected with, and the trigonometrical data has been used for correcting the traverses. The largest error of the chain measurements, shown by comparison of the direct distances between the stations with the distances given by the Trigonometrical Survey is — 3·04 feet per mile, and the least error is + 0·57 feet. The detail survey was tested by 2,018 linear miles of check survey, of which 674 miles were run by the European assistants and 1,344 miles by the native inspectors. Out of 872,144 fields that have been cadastrally surveyed, the *khasras* and *jamabandi* (rent roll) slips of 31,213 fields were tested on the spot by the Europeans, and those of 129,833 by the inspectors.

137. The theodolite stations have all been permanently marked; those in Ballia and Benares by pottery cylinders, where the total number of stations marked is 4,332, at an average cost of 5 annas per station. The stations in Basti, which number 6,716, have been marked by prism-shaped stones $2\frac{1}{2}$ feet long with 5 inch sides. These stones were procured from Chunar and Mirzapur, and the cost of marking the stations therewith, after deducting the amount recoverable from land-owners, has averaged $9\frac{1}{2}$ annas per station.

138. Three junior Civilians, Messrs. Oakeshott, Rice and Brereton, were attached to this party during a portion of the field season for instruction in surveying, in accordance with the orders of the Government of the North-West Provinces.

139. The mapping of the present season includes 1,310 sheets surveyed on the 16-inch scale, and 62 sheets on the 32-inch scale: none of these have yet been sent to Calcutta to be printed, as until the work of the Settlement Department, including the final attestation of the records, is finished, small alterations and corrections are frequently required. The smaller scale maps consist of 6 sections on the 2-inch scale (for reduction by photography to 1-inch) of district Benares, and a compilation of the general maps on the scale of the Atlas of India of districts Ballia and Benares has also been made. In the original 4-inch sheets of the tracts lying along the banks of the Ganges and Gogra rivers, which were kept back for reasons mentioned in paragraph 146 of the Annual Report, the village boundaries according to the former surveys of 1842-44 and 1863-64 have been inserted: thus a direct comparison has been provided on one record of the boundaries as they existed at the dates of the several surveys.

140. Valuable assistance was rendered to the party by Mr. F. W. Porter, the Settlement Officer of Benares, who facilitated to the utmost the work both of survey and of the *khasra*-writing.

141. The recess office of the party was inspected at Naini Tal during October 1883 by the Deputy Surveyor-General in charge Revenue Branch. He considers that Major Cowan deserves credit for the state of efficiency in which he found all branches of his large establishment, and for the manner in which his establishment carries out the new duties connected with writing the village *khasras*.*

CHHATTISGARH DIVISION, RAIPUR DISTRICT, CENTRAL PROVINCES.

(Detachment from No. 3 Party, Revenue Branch.)

142. This detachment was deputed to the Central Provinces in October 1883, under the orders of the Government of India, Revenue and Agricultural Department, in their letter No. 394S, dated 11th September 1883, for the primary purpose of conveying practical instruction in surveying to *patwaris*.

143. The history of the employment of a survey party in the Central Provinces is somewhat peculiar. It was originally proposed that the survey party, which had been engaged on the topographical survey of the Doab, between the Ganges and Jumna rivers in the North-Western Provinces, should be transferred to Sambalpur in November 1883, to commence a cadastral survey of that district. After a careful consideration of all the circumstances of the case, the Chief Commissioner arrived at the conclusion that the Sambalpur district was not yet ready for a cadastral survey, and he then proposed to employ the party in making a mouzawar survey, on the 4-inch scale, of that portion of the Bilaspur district which had been left unsurveyed by the Revenue Survey Party, when formerly in Bilaspur. The area of this portion is said to be over 2,000 square miles, considerably more that half of which is under cultivation. The Survey Department deprecated the resuscitation of the old mouzawar system of employing a professional survey party to make a survey as a check on a settlement survey, and advocated that any survey which is required for settlement purposes should be undertaken by professional agency. The idea of the mouzawar survey was, however, immediately given up by the Chief Commissioner for the reason of the disproportion between the cost of the survey and the land revenue of the district. Finally, two small parties were asked for with the object, it was understood, of their being employed, as far as possible, on work which will be of utility to the administration of the provinces, at the same time that advantage is taken of them as a means of instructing *patwaris* in anticipation of the general survey of the district. The method on which such survey should eventually be conducted was left open for further discussion.

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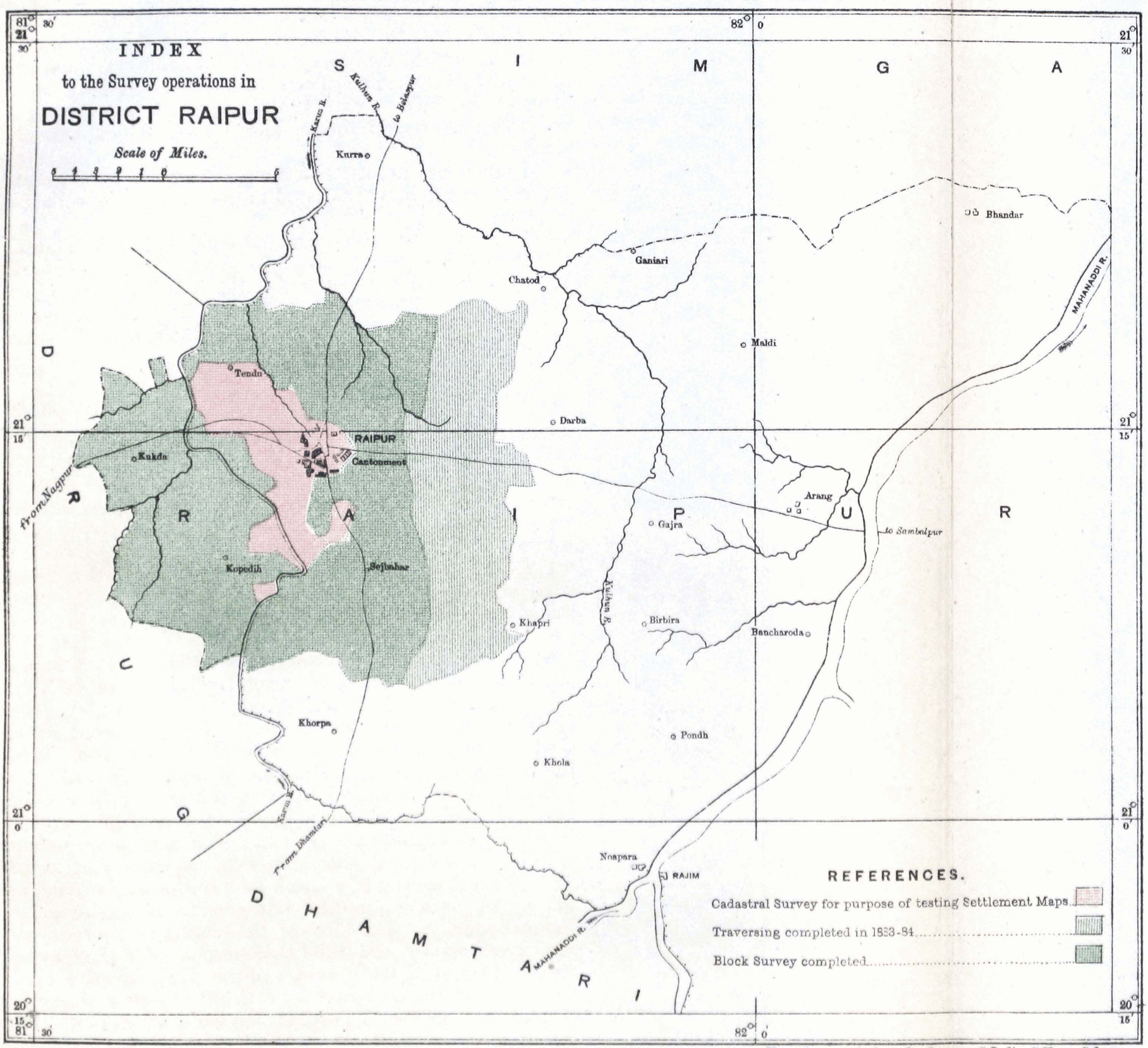
* Major Cowan reports very highly of the cordial and efficient assistance given by Mr. G. H. Cooke, officiating Deputy Superintendent, and of the services rendered by Messrs. Hanby and Price, who had charge of cadastral camps and who spared no labour or pains to secure a large outturn of reliable work: Mr. Price's work includes the Benares city survey. The other European assistants are also very favourably reported on, and the following members of the native establishment are mentioned as having worked conspicuously well:—Computers, Lalmohan Gangopadhya, Shew Narain, and Kanaya Lal; Sub-Surveyors, Jamaludin and Bhawani Parshad; Draftsmen, Asjad Ali and Syadudin Ahmad; English writer, Ibu Hasan.

CENTRAL PROVINCES SURVEY.



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Survey of India Offices, Calcutta, February.

1885

144. With the above object in view it was arranged that a strong detachment, in lieu of the two small parties, should be organized for the Chhattisgarh division for the field season of 1883-84, and that Major E. H. Steel, Deputy Superintendent of Survey, should superintend the professional work of the detachment, and be deputed to Nagpur to confer with the Chief Commissioner, Central Provinces, on the method of survey which would best suit the requirements of the province. Major Steel arrived at Nagpur on 20th October 1883, and after considerable discussion with the Revenue Secretary, and a clear expression of opinion on the part of the Chief Commissioner that the revenues of the provinces were not sufficient to bear the cost of a professional cadastral survey, it was decided—(1) to adopt the "field block" system for the general survey of the district, *i.e.*, the skeleton survey of the boundaries of villages, together with those of moderately sized blocks of fields, the interior fields of which are afterwards to be filled in by *patwaris*, who should also write the Records-of-Rights; the supervision of the Survey Department to end with the survey of the field blocks; further, that the Survey Department should supply maps showing the boundaries of villages and of the field blocks, and furnish the area of each block; (2) to make a cadastral survey of a certain number of villages in order to test the accuracy of the former settlement maps; (3) to organize a survey class for the instruction of covenanted civilian officers, native officials and *patwaris*; and (4) that the above operations should be confined to the Raipur district.

145. A detachment therefore of the strength as per margin was withdrawn from No. 3, Revenue Party, and placed under the direct charge of Mr. P. A. G. Cowley, Surveyor, 1st grade, who received definite orders on 15th November 1883 for the work required. The field operations were continued till 20th April 1884, when the party proceeded to Nagpur for recess.

Personnel.

Mr. P. A. G. Cowley, Surveyor, 1st grade, in charge.
Mr. G C. Swiney, Assistant Surveyor, 1st grade.
6 Sub-Surveyors and others.

Temporary Establishment.

25 Field Surveyors and others.

146. The area surveyed is given in the following statement :—

Pargana.	Description of Survey. Scale 16 inches=1 mile.	Number of villages.	Number of blocks.	Area in square miles.
Raipur	Boundary traverse in advance ...	152	584	275
	Boundaries of field blocks	94	1,133	200
	Cadastral survey	22	130	31
	Total ...	268	1,847	506

A minute survey of the city and civil station of Raipur was also made at the request of the Chief Commissioner.

147. The village circuits were traversed and then sub-divided into blocks varying from 60 to 80 acres; the field surveyors surveyed the boundaries of the fields contiguous to the lines forming these blocks. The angular work of the traverses has been checked in the usual way by a number of observed azimuths, and the chain measurements have closed well, but no trigonometrical stations were available to connect them with for the purpose of affording a rigorous test of their accuracy. The survey of the "field blocks" has been tested by 275 linear miles of check survey run by the inspectors and subsurveyors, and as a further proof on these tests the European Assistant has carried a check line through very nearly every village that has been cadastrally surveyed.

148. The Deputy Surveyor-General strongly protested against the adoption of this "field block" system for the general survey of the Central Provinces for reasons which may be here recapitulated. By this method two agencies for the construction of the final maps must be employed. The faults of the principle of such a system must generally be allowed, for under it the professional surveyors, who are the most competent to turn out a complete map, are required to leave part of the work undone, though passing over the ground and taking measurements for their share of the undertaking, which requires to be only slightly supplemented to permit of a complete map

being constructed, and such a system can only be justified by a large saving of expenditure which may accrue through the employment of a low-paid agency to carry out the subsequent measurements. This is a point, however, which yet remains to be determined, and even if the result is in its favour, the accuracy of the maps must remain an undeterminate quantity. Other disadvantages follow from the rendering of an incomplete map. (1) The maps as they stand are of no practical value for assessment purposes, and it would be hardly advisable to print them in their incomplete state, while it would be obviously inexpedient to hand over the original maps to village officials to be retained until the measurements could be completed. (2) The professional area statements are of an incomplete character, which would have to be discarded when the final statement to correspond with the final maps could be worked out. (3) The first set or professional surveyors cannot be employed in writing the *khasra* or field register, which it has been proved by practical experience in the North-West Provinces surveys they can do with very great advantage as to economy, accuracy, and rapidity of execution of the joint operations of survey and settlement. The survey and settlement of a tahsil in Gorakhpur worked under this combined system has lately been completed in 18 months—a work which under the previous ordinary method would have occupied from four to six years.

149. The system under which the survey of the Hissar district, in the Punjab, has been carried out for subsequent cadastral survey by local agency is one of an entirely different character, as the professional survey there has been confined to the determination of the co-ordinate distances of points on the boundaries of villages and in the interior of village lands which provide for the projection of purely skeleton maps only, on which all the details of the fields and other features will afterwards be filled in by one establishment of local surveyors. This system is at least professional, in so far that it avoids the mixing up of the work of two sets of surveyors in mapping the fields, but it can hardly be considered a wise proposal to restrict the work of a staff of professional surveyors under highly-trained officers to the preparation of a mere skeleton map, while the really important part of a settlement survey, viz. the mapping of the fields, the determination of the areas, and the writing of the Record-of-Rights are left to be undertaken by local surveyors under local supervision. Such a system can never be attempted, unless the thorough training of the local surveyors has been fully provided for.

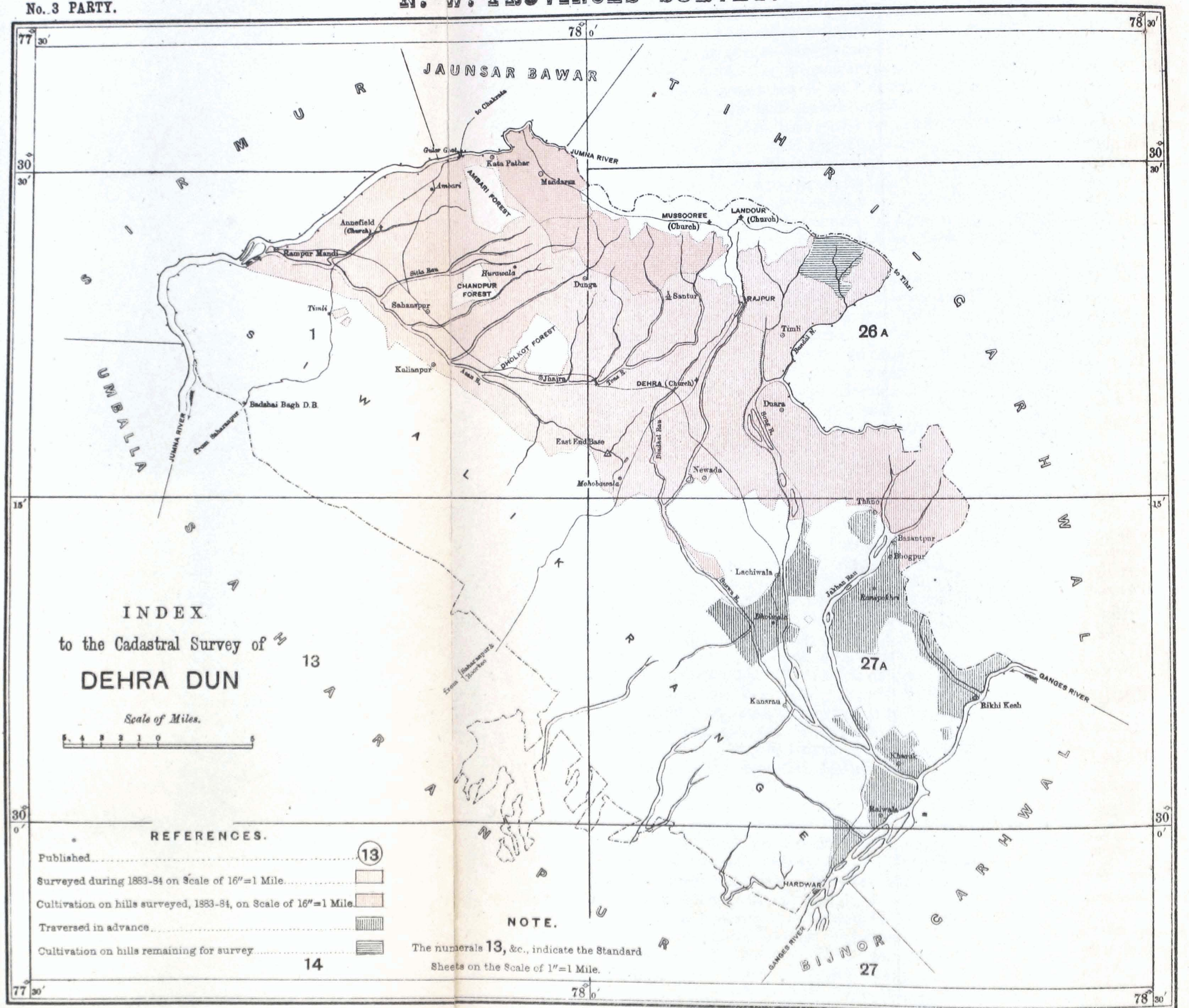
150. The radical fault of both these systems lies, *firstly*, on the assumption that numerical data and a series of lines on a sheet of paper are an efficient substitute for the control exercised by highly-trained European surveyors; and *secondly*, in the supposition that a correct map or index is the sole aim of a cadastral survey, instead of an accurate Record-of-Rights of the people and the conditions of the land. The value of the Survey Department undertaking the writing of the records is now recognized by the fact of the European supervision, which they are able to give in testing the entries. In the "field block" system of the Central Provinces the writing of the Records is to be relegated to the *patwari*, who is usually appointed by the landholder, and who, as cheapness is the essential feature of the system, will be but little, if at all, under European control.

151. To return to the operations of the party, it had been arranged that the demarcation of the field blocks should be marked out in advance by the Settlement Department, but Mr. Cowley found on commencing operations that this had not been effected, as the civil authorities were unprepared for a survey. The Boundary Surveyors therefore laid out their own blocks at first, and it was subsequently found that by this arrangement the work progressed much faster, and as it also saved the cost of an expensive demarcating establishment, the civil authorities gladly acquiesced in its continuance. The permanent demarcation of the boundaries was excellent, and all theodolite stations, excepting those of a few villages surveyed at the commencement, are on stone boundary pillars which have been marked by a cross or circle cut into the stone. The interior or field block stations have also been marked by stones in a similar manner.

152. The principal duty of the European officers of the detachment has, however, consisted in the instruction of *patwaris* in surveying, as the Chief

No. 3 PARTY.

N. W. PROVINCES SURVEY.



INDEX

to the Cadastral Survey of

DEHRA DUN

Scale of Miles.

5 4 3 2 1 0 5

REFERENCES.

Published ..... (13)

Surveyed during 1883-84 on Scale of 16″=1 Mile .....

Cultivation on hills surveyed, 1883-84, on Scale of 16″=1 Mile .....

Traversed in advance .....

Cultivation on hills remaining for survey .....

14

NOTE.

The numerals 13, &c., indicate the Standard Sheets on the Scale of 1″=1 Mile.

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Survey of India Offices, Calcutta, February 1885

Photozincographed at the Survey of India Offices, Calcutta.

Commissioner requested that Mr. Cowley should devote as much of his time as possible to this work, with the view of utilizing this *patwari* agency in the general survey of the province. Regarding this work Major Steel reports:—

"A survey class was opened by Mr. Cowley, who worked on a very good system, and when his material was promising, as in the case of the European officers, the results are encouraging; but the amount of knowledge of surveying, and the thousand and one details which go to make up the acquirements of a good executive officer of any grade can hardly be gained in a fortnight or three weeks, which was the average time spent in the survey class."

In all 185 candidates passed the examination: of this number, six were European officers, five were Extra Assistant Commissioners, 78 were tahsildars, naibs, &c., and 96 were *patwaris*. Of these *patwaris*, eight were employed as field surveyors in the regular survey, in order to give them a good practical training for the posts of *patwari* inspectors. Their work has been classed as equivalent to that of slow second class *amins*. The value of the working power of the remaining 88 *patwaris* has not been tested and remains to be proved. The average cost of the survey instruction of each student is given at Rs. 30-2-7. Major Steel remarks:—

"This plan of teaching *patwaris* does not seem a very promising method of introducing a better style of surveying into the Central Provinces. The men in many instances are too old to learn new ways, and are wedded to methods and customs which cannot be swept away by the *fiat* of the legislature, or by the exaction of heavy penalties."

153. The cadastral maps of four of the villages of which a re-survey was made, have been reduced to the scale of the old settlement survey, which was about 12 inches to the mile, to enable a comparison to be instituted. The villages, however, which have been selected are small ones, the periphery of which should easily have been accurately delineated, but the old survey, when tested even under these favourable circumstances, was found inaccurate both in boundary and in the interior detail. Besides these differences, which are doubtless due to faulty survey, there are large differences in the cultivation, which, however, may have so altered and increased since the time of the settlement survey. Of the value of the old survey as an index to the records, no estimate could be formed, as it was found impracticable to write a new *khasra*, owing to the pre-occupation of Mr. Cowley in instructional duties and to the difficulty of securing the necessary attendance of the parties concerned, due to the fact of a settlement survey not being in progress.

154. The season's outturn of 16-inch survey has been mapped on 222 sheets, of which 42 sheets appertain to the cadastral survey of the tested villages, including the city and civil station of Raipur, and 180 sheets to the field block survey.*

DEHRA DUN DISTRICT, NORTH-WEST PROVINCES.

(Detachment from No. 4 Party, Revenue Branch.)

155. Under the orders of the Government of India in the Revenne and Agricultural Department No. 387S, dated 5th September 1883, a detachment, was withdrawn from No. 4 Revenue Party, working in the Benares district, to undertake a cadastral survey of the cultivated lands in the Dehra Dún district. This department was asked to arrange for the survey of about 80,000 acres (125 square miles) in that district in one season, and estimates and arrangements for establishment were made accordingly. A detachment of the strength given in the margin was placed in charge of Mr. W. A. Wilson, an experienced Revenue Surveyor, to carry out the survey under the general superintendence of Major W. Barron, the officer then in charge of No. 4 Party. The arrangement for

Personnel.

Mr. W. A. Wilson, Surveyor, 2nd grade, in charge.
„ E. F. Berkeley, Assistant Surveyor, 3rd grade.
6 Sub-surveyors and others.

Temporary Establishment.

30 Field surveyors and others.

* The Deputy Superintendent, Major Steel, testifies to the zeal and ability with which Mr. Cowley has conducted the operations, and to his really able method of imparting instruction. The services of Mr. Swiney are highly spoken of, and the sub-surveyors have all worked well.

the superintendence was subsequently changed, and this detachment, together with two others employed in Rajputana and the Central Provinces, was placed under Major E. H. Steel, Deputy Superintendent, 4th grade, on 2nd November 1883, and the operations have been executed under that officer's supervision from that date.

156. Owing to the late date on which the orders relating to the constitution of the detachment was received, the preparations were necessarily much hurried. Mr. Wilson arrived in Dehra on 12th October, and commenced the preliminary traverse survey on the 23rd idem. The field operations were continued in the Dún until the 25th May, and in the hills until the 15th September 1884.

157. It was soon discovered that the area for survey had been much underestimated, for though the area actually under cultivation did not probably exceed the estimated amount, yet the lands under cultivation were so situated, and so intermixed with jungle, that in mapping the cultivation the whole village in the majority of cases required to be surveyed. Moreover, in December 1883, the cultivation in the higher hills, which had been altogether omitted from the original project, was added to the work to be undertaken by the detachment. Thus the area to be dealt with cadastrally was greatly increased, and necessitated an increase in the strength and equipment of the detachment, which, however, owing to the reduced state of the department, could only be done gradually and towards the end of the field season, when officers and men could be spared from the various other field parties. During April and May the strength of the detachment stood as follows:—Eight European surveyors and assistant surveyors, 10 sub-surveyors, 130 field surveyors and others.

158. The total area that has been surveyed cadastrally on the 16-inch scale is 268·59 square miles; in addition preparatory traverse work has been extended over 97 square miles in anticipation of the cadastral survey in 1884-85. The number of fields surveyed on the cadastral area is 98,687, having an average size of 0·78 of an acre, the cultivated area of actual fields being comprised in about 120 square miles.

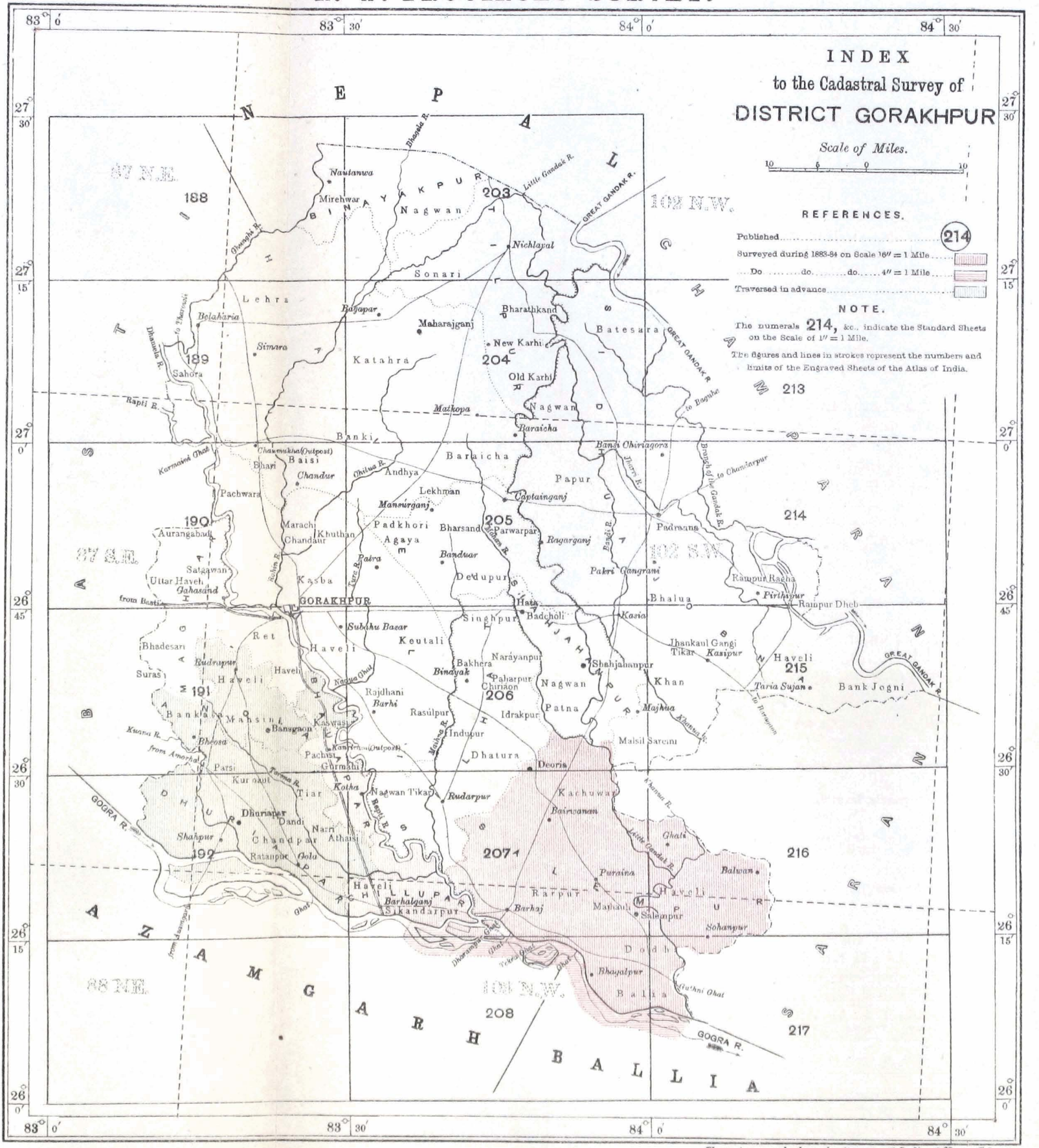
159. The cadastral work has been carried out under the Benares system, in which the field register (*khasra*) is written up in *Urdu* by the *amin* in the field, simultaneously with the preparation of the map, while the village *patwari* prepares a similar record in *Nagri*, writing also, concurrently, in the *jamabandi* slips the numbers of the fields as they are surveyed. The *patwari's* copy of the *khasra* and the *jamabandi* slips are then sent on to the Settlement Office. On the completion of the map, the computation of field areas is carried out and entered in the *amin's* copy of the *khasra*, which is then made over to the Settlement Department, together with two traces of the village map. The field measurements were plotted directly on the board plans, without recording them in field books. Out of 316 villages that were traversed, 279 were completed in detail cadastrally, and in the remainder only the cultivation, together with any contiguous features was surveyed, the topographical details beyond the cultivation being entered on the plans by pentagraph from the 4-inch scale maps of the Dún, the survey of which was executed in 1873-76.

160. The work of the field surveyors has been thoroughly tested by check lines aggregating 319 miles in length, carried out by the native inspectors, and by frequent inspections made by the Deputy Superintendent and European officers. Azimuth observations were taken at 32 stations as a check on the angular work of the traverses, while the numerous points which had been determined trigonometrically by the previous 4-inch survey furnished an admirable check on the chain measurements, which, owing to the rugged nature of the country, were prosecuted under a great disadvantage.

The villages, numbering 44, on the higher hills, could not however be surveyed in the usual manner with theodolite and chain; and in these the cultivation alone has been surveyed, the boundaries and other topographical features being transferred from the maps of the previous survey. The survey of this hill cultivation is stated to have been an exceedingly arduous and difficult task, but it was much facilitated by the use of the trigonometrical points of the former survey, from which additional stations were interpolated into the cultivated areas, and supplied the frame-work for the detail survey of the fields. Three assistants—Messrs. Hamer, Coxen, and Lilley of the Topographical Branch—were deputed in the latter half of March to assist in this hill work.

No. 5 REV. PARTY.

N. W. PROVINCES SURVEY.



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Survey of India Offices, Calcutta, March.

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161. The country operated in during the season is exceedingly difficult for cadastral operations, and presents ground of very varied character from the flat cultivated land in portions of the Western Dún to the crest of the Mussooree range, which rises to a height of 5,000 feet above the valley. The low spurs and broken ground about the foot of the Himalayas, being covered with thick *sâl* forest and intersected by deep ravines, gave an infinity of labour and trouble in surveying. Major Steel reports that all the European officers and many of the native establishment were laid up with fever and dysentery during April and May.

162. All the tri-junction points of villages, as well as many other points on their boundaries, were found marked with masonry pillars, which were utilized as far as practicable for traverse stations. In addition to these boundary marks, 3,000 theodolite stations have been permanently marked by stones 15 inches × 6 inches being embedded in the ground. The numerical records contain the co-ordinates of each of these points and the requisite data for finding them when required. There are also the trigonometrical stations of the 4-inch survey which were marked by masonry pillars at the time of that survey, so that the district is well supplied throughout with permanent marks, which at any future time will be available for reference.

163. The area surveyed cadastrally has been mapped on 525 sheets, and duplicate traces of all these sheets, comprising 348 villages, have been supplied to the settlement officer.

164. It will be gathered from this report that the Dehra Dún survey has proved a very much larger undertaking than this department was led to anticipate. The area for survey proves to be three times greater than the original area applied for, and notwithstanding that the establishment was increased by transfers from several other parties, and the work prolonged far into the hot weather, the survey could not be completed. An area of about 100 square miles remains unsurveyed, which the detachment will complete during the current season.*

GORAKHPUR DISTRICT, NORTH-WEST PROVINCES.
(No. 5 Party, Revenue Branch.)

165. This party, having completed its operations in the Mirzapur district during the previous year, was transferred to the Gorakhpur district, in accordance with the Resolution of the Government of the North-West Provinces, communicated in their letter No. 961, dated 17th April 1883, together with the decisions, that the system of survey and record writing to be adopted in Gorakhpur, should be that followed in Benares, where the settlement establishment work along with the survey establishment; and in addition, that the classification of soils should be left to the Survey Department. The Benares system of survey and preparation of settlement records was described in paragraphs 141 and 142 of the last annual report.

Personnel.

Major J. E. Sandeman, Deputy Superintendent, 3rd grade, in charge.
Lieutenant F. B. Longe, R.E., Assistant Superintendent, 1st grade, joined on 14th December 1883.
Mr. E. G. Little, Surveyor, 3rd grade.
„ T. F. Freeman, Assistant Surveyor, 1st grade.
„ T. Shaw, ditto 1st do.
„ J. Murphy, ditto 1st do.
„ O. D. Smart, ditto 3rd do.
„ N Bedford, ditto 3rd do.
14 Sub-surveyors and others.

Temporary Establishment.

250 Field surveyors and others.

166. The cadastral operations were commenced in the last week of October 1883, under the superintendence of Major Sandeman, who took charge of the party on Colonel F. C. Anderson's retirement; and they were closed in the middle of May 1884, when the party returned to recess quarters at Naini Tal.

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* Major Steel reports very highly of Mr. Wilson's administrative powers and of his knowledge of cadastral work, and states that with a very inadequate establishment he has prosecuted the survey of a most difficult piece of ground with exceptional vigour. Messrs. Hamer, Coxen and Lilley are said to have performed their duties zealously and well, and were of much assistance in the hill survey; Mr. Hamer being specially praised.

Mr. Wilson commends Mr. E. F. Berkeley's services, and says that he gives every promise of becoming a first-class surveyor.

167. A survey has been made on the 4-inch scale of the low-lying villages opposite to district Gorakhpur on the right bank of the Gogra river in districts Ballia and Azamgarh. The boundaries of the villages in Ballia were transferred from the maps of the recent survey of 1874-76, in accordance with the views of the Collector of that district, but in Azamgarh, where the last professional survey was made so far back as 1836, the village boundaries have been resurveyed.

168. The separate areas on the different scales, and in the different districts which have been under survey, are given in the following table:—

Districts.	Tahsil.	Description and scale of survey.	Number of villages.	Area in square miles.
Gorakhpur	Deoria ...	Cadastral; 16 inches=1 mile.	1,455	586·81
Ditto	Bansgaon ...	Ditto ...	428	157·50
Total of Cadastral Survey ...	.....	.....	1,883	744·31
Ballia, Azamgarh	.....	Mouzawar; 4 inches=1 mile.	31	49·00
Total of Mouzawar Survey ...	.....	.....	31	49·00

An overlap of 16·50 square miles has been surveyed in the Sarun district on the 2-inch scale. In the cadastral area 891,996 fields have been surveyed, thus giving an average area for each field of 0·53 of an acre. In addition to the above outturn, preliminary traversing has been extended in advance over an area of 401 square miles for cadastral survey next season.

169. Several important changes on the method adopted in Benares have been introduced in the Gorakhpur work, the principal ones being—

(1) The Survey Department completes the records and is responsible for their accuracy.

(2) The attestation is made after the completed records have been lodged.

The details of the procedure and of the division of labour between the Survey and Settlement Departments are fully described in the following papers, which are given at pages CXXV to CXXIX of the appendix, viz. a joint note drawn up by Mr. J. D. LaTouche, Settlement Officer, and Major Sandeman, Deputy Superintendent of Survey, dated 18th January 1884; a note by Major Sandeman, dated 8th February 1884; and a report No. $\frac{72}{I.\ I}$, dated 11th February 1884, from the Settlement Officer to the Commissioner of the Benares Division. The great defect of the Benares system is that attestation of the records has to be done before the areas are entered. This has been remedied in the Gorakhpur system. The basis of this system is that the Survey Officer should furnish along with the map a correct record of all undisputed facts of ownership and tenancy, together with a complete list of all disputes, and should classify the soils. The Revenue Officer fills up the dispute list and checks the soil classification: the attestation of the records and the assessment of revenue is his work also.

170. The great advantage claimed for this system over the Benares one is that it permits of the attestation of the records being completed during the season of survey on records which give the areas, and that the assessment follows immediately afterwards; further, that the record-writing and soil classification is under the same strict supervision as the survey. There is a great check on bribery and corruption from the fact that the *patwari* prepares a duplicate record on the spot for every field, and a duplicate of the dispute list. Under this system the areas are all entered in the survey office under European supervision, and their classification for the Settlement Officer multiplies the checks over them to such an extent that the statistics should be as faultless as it is possible to make them.

SOIL MAP
OF
TEHSIL DEORIA
DISTRICT GORAKHPUR

Surveyed in Season 1883-84.

Scale 4 Miles = 1 Inch.

5 4 3 2 1 0 5 10

PA. SHAHJAHANPUR

PA. SIDHUAJOBNA

PA. SILHAT

R. LITTLE GANDAK

DEORIA

N. KHANUAN

N. SIAHI

N. JHARAHI

BASEHRA

PA. CHILLUPAR

R. RAPTI

Kaparwar

Barhaj

R. GOGRA

MAJHAULI

SALEMPUR

Sohanpur

Lar

R. LITTLE GANDAK

R. GOGRA

AZAMGARH

BALLIA

RANA

REFERENCES.

- Doras (Clay and Sand)
- Matiar (Clay)
- Balua (Sand)
- Bhat (Cretaceous soil)
- Kachhar (New alluvium)

Lithographed at the Survey of India Offices, Calcutta, March 1885.

171. The Board of Revenue, North-Western Provinces, have acknowledged the improvements made by Mr. LaTouche and Major Sandeman on the Benares system, and admit the success of the present combined system of survey and settlement. The Board's letter No. $\frac{136}{IX.\ 10}$, dated 7th March 1884, on this subject will be found at page CXXIX of the appendix.

172. With regard to the classification of the natural soils, which has been undertaken for the first time by the Survey Department, Major Sandeman reports as follows:—

"The natural soils are easy of recognition. They are, *doras* (sand and clay), *matyar* (clay), *balua* (sand), *bhát* (cretaceous), and *kachhár* (new alluvium). The responsibility for accuracy with regard to the above rests entirely with the Survey Department. These soils, however, are again divided into conventional tracts, first, *goind* or home lands, which are easily manured; next *miyana* or *manjhar*, or the middle lands; and third, *palo*, or outlying lands. These classes are entered in the same column as the natural soil by enquiry from the *patwari*, and every endeavour is made to arrive at the class for each field as it is locally known, but as these divisions affect rent, the Settlement Officer takes the precaution of having the survey trace, which shows the survey demarcation of soil tracts, examined and corrected according to the opinion of a special soil *munsarim*. The final examination of the double demarcation is done by the Settlement Officer, who is thus greatly helped by having before him the expert's demarcation and that from local enquiry; the final decision as to a safe and just line resting with himself."

A soil map, on a small scale, of the Deoria tahsil is attached, as an illustration of what has been done.

173. The statistics for assessment purposes are also compiled in the survey office. The Settlement Officer in deciding to entrust this work to the survey department, wrote:—

"The Survey can do this work much better than the Settlement Department, and much cheaper. They have a staff of eight European assistants to check the work, and their men are much more expert at figures than any whom I could employ."

174. These statistics comprise the soils, irrigated and dry; the details of soils under cultivation; the tenures of the holdings; the culturable and barren areas; the areas under different crops; the cultivators, showing the numbers in each caste and the areas cultivated by each caste; and all agricultural statistics with respect to wells, ploughs, cattle, &c. The duties and responsibilities of the survey officers by these arrangements have been very materially increased; but there is every reason to hope that there will be a corresponding increase to the accuracy of the records and to the gain of the Government and the people. The old cost rate for field survey unaccompanied by records used to be 4 annas an acre. The rate for the work done by Major Sandeman in Gorakhpur, which comprises survey, soil maps, and completed records ready for attestation and assessment, is only 4 annas and 6 pies an acre. The cost of the settlement for the corresponding area is not yet known, so the rate for the complete operations cannot be given; but as the Survey Department (with the slight addition to its old rate of 6 pies an acre) has done such a large extent of the ordinary work of the Settlement Department, the rate for the latter must be considerably reduced, and a very large saving is expected to result by the cordial interworking of the two departments.

175. Major Sandeman reports:—

"We met with several difficulties this first season, many of which will not recur. We were all new to the work; the establishment was not a good one; the instrumental equipment was defective; the area that was prepared in advance during the previous season (owing to the orders for the Gorakhpur Survey having been issued late) was so small that often two or more *amins* were crowded into one *patwari's* circle; the Deputy Collectors and their subordinates were at first not favourably disposed towards the new order of things; and finally, we could not hit upon a final plan of operations till we had gained some experience. To add to the difficulties, the tenures were nearly all *pattidari* (held in severalty by proprietors), which enormously increases the work both in field and office, and the cultivators' fields were small, averaging 0·53 of an acre only."

Further extracts from Major Sandeman's narrative report, giving details of his operations, will be found at page XXI of the appendix.

176. The field survey has been tested by 1,359 linear miles of check surveys, of which 181 miles were measured by European officers and 1,178 by native inspectors. To check the angular work of the traverses, azimuth

observations were taken at 65 stations. The traverses have been connected with five trigonometrical stations, and the result of the comparison gives an average error of 1·84 feet per mile in the chained distances. To test the records, 5 per cent. were verified by European assistants and 20 per cent. by *munsarims*. The Deputy Superintendent personally tested a small percentage, and in addition there was the check of the Settlement Officer and his Deputy Collector, one of whom was attached to each Survey Camp.

177. All the theodolite traverse stations have been marked by stone prisms, 2 feet 9 inches long, of which 6,163 have been embedded during the season at the rate of 7 per square mile, and wherever practicable the stations have been fixed on the actual boundaries of villages, so that ample permanent marks have been provided for any future additions to the present survey, as well as for the identification of the boundaries. The cost rate of this permanent marking, after deducting recoveries from land-owners for stones embedded actually on boundaries, is Rs. 2-6-8 per square mile.

178. Regarding the boundaries of the Gorakhpur district, Major Sandeman reports that the survey of the boundary with the Sarun district has been made according to possession, but that a territorial boundary has still to be decided by the Governments of the North-West Provinces and of Bengal, and that some boundary disputes remain unsettled. Another question awaiting decision is the boundary on the Gogra river with the districts of Azamgarh and Ballia. On this subject Major Sandeman writes:—

"In the last survey maps of Ballia, those of 1877, this boundary is shown in mid-channel, whereas by law it should be the deep stream. Pending the settlement of the question, and by the Settlement Officer's directions, the mid-channel has been adopted as the limit of the villages on the Gorakhpur side, and the deep-stream boundary is also shown on the maps in dots.

"A great number of boundary disputes arose between villages within the district: the direct cause of these is very evident, for the old settlement maps were found to be very defective and to overlap each other."

The Settlement Officer, to remedy this difficulty in future, has advised that accurate surveys, where they do not exist, should be made in all cases of disputed boundaries, and his letter on the subject, No. $\frac{55}{1.C.2}$, dated 15th November 1884, is given at page CXXIX of the appendix.

179. Two junior Civilians, Messrs. Guthrie and Saunders, were attached to this party for three months, for instruction in surveying, under the orders of the Government. This duty was undertaken by the Deputy Superintendent, as no assistant was available.

180. From the experience that has been gained by the work of this season, certain alterations in the division of labour and in other matters of procedure have been made for the working of the two departments next season, which, it is expected, will tend to improve the results. The important changes, as far as the Survey Department is concerned, are —

(1) That disputed entries are to be made in all the records in red ink, on the responsibility of the *patwari*, instead of being left blank.

(2) The demarcation of soils, both natural and conventional, is to be made over entirely to the Survey.

(3) The papers now will not be sent backwards and forwards between the survey and settlement officials.

The revised rules for the working of the Survey and Settlement in Gorakhpur during 1884-85 are printed in full at pages CXXXI to CXXXIII of the appendix.

181. The Cadastral Survey in Gorakhpur has been mapped on 1,500 sheets on the 16-inch scale. A separate series of standard sheets of the 4-inch survey, comprising the area between the permanent line of village boundaries on both banks of the Gogra river, is in course of preparation. The compilation of the 2-inch topographical maps by reduction from cadastral maps will not in future be undertaken by the field parties. It has been found advisable to have these geographical maps prepared in the Calcutta office under the superintendence of the Assistant Surveyor-General. The cadastral sheets of Mirzapur, which remained incomplete at the time of the last annual

No. 6 REV. PARTY.

ASSAM SURVEY.

INDEX

to the Cadastral Survey of

DISTRICT KAMRUP

Scale of Miles.

10 8 6 4 2 0 10 20 30

BHUTAN

DARRANG

NOWGONG

GOALPARA

GAUHATI

KHASIA & JAINTIA HILLS

GARO HILLS

BRAHMAPUTRA R.

Diwangiri
Goshain Garh
Kakolabari
Khagorabari
Manikpur
Tamolpur
Bojhali
Gobindpur
Chapala Kuchi
Domkah
Bhobanipur
Kaljhar
Kotial Kuchi
Gamurimari
Nalbari
Rangia
Kamalpur
BARPETTA
Chenga Soru
Hajo
Ramdiah
Gundomow
Manusmari
Shogunbai
Chamoria
Dheknabai
Shakhati
from Jalpaiguri
from Goalpara
from Shillong
to Nowgong
to Nowgong

15 24 37
16 25 38
17 26 39
18 27 40
28 41
29
52

118 124 119 125

REFERENCES.

Published 26

Surveyed during 1883-84 on Scale 16″=1 Mile.

Traversed in advance

NOTE.

The numerals **26**, &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.

90° 0′ 90° 30′ 91° 0′ 91° 30′ 92° 0′ 92° 30′ 93° 0′

27° 0′ 26° 30′ 26° 0′ 25° 30′

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Survey of India Offices, Calcutta, February 1885

Photozincographed at the Survey of India Offices, Calcutta.

report, have been sent to Calcutta to be printed, with the exception of those of a few villages which have still to be kept back pending the settlement of boundary disputes. The 2-inch reductions of the area which has been surveyed cadastrally in Mirzapur are still in the field office under completion, but are nearly finished and ready for despatch to Calcutta. The preparation of these geographical maps has been delayed for want of the topography of the hill portions in 81 of the 16-inch cadastral sheets. This was surveyed during 1883-84 and tested by the Topographical Survey party now employed in the southern portion of the Mirzapur district.

182. The recess office of the party was inspected by the Deputy Surveyor-General in charge Revenue Branch at Naini Tal in September 1883, who was highly satisfied with the arrangements that Major Sandeman had instituted to cope with the vast amount of extra work which now devolves on the party by the additional duty of writing and completing the records and of compiling statistics for the Settlement Department, a work which was new to himself and to all his subordinates. The success of the new procedure in Gorakhpur is largely due to the excellent management of the party by Major Sandeman, and to the energy and professional ability which he has devoted to the work.

183. Major Sandeman acknowledges the very great assistance he has received from the Settlement Officer, Mr. La Touche, in the new and important work now entrusted to the Survey Department, and to whose cordial co-operation in the joint inter-working of the survey and settlement much of the success of the undertaking is due.*

KAMRUP DISTRICT, ASSAM.

(No. 6 Party, Revenue Branch.)

184. This party, on the completion of the operations connected with the Hooghly river survey, was directed to undertake the cadastral survey of the Kamrup district in Assam, which was authorized by the Government of India in letter No. 257—10S, dated 9th June 1883, from the Secretary to the Government of India, Revenue and Agricultural Department, to the Surveyor-General.

Personnel.

Mr. E. C. Barrett, Deputy Superintendent, 4th grade, in charge.
„ J. S. Pemberton, Surveyor, 2nd grade.
„ J. H. O'Donel, ditto, 4th do.
„ J. Connor, ditto, 4th do.
„ J. McCay, Assistant Surveyor, 2nd grade, died 24th September.
„ C. S. Kraal, Assistant Surveyor, 2nd grade.
„ J. C. Kelly, ditto, 3rd do.
27 Sub-surveyors and others.

Temporary Establishment.

108 Field surveyors and others.

The professional establishment left Calcutta for Assam on the 28th October 1883, and the boundary traverse operations were commenced on the 10th November: the field survey was started on the arrival of the cadastral establishments from Calcutta on the 17th December. Field work was finally closed on the 22nd May 1884, when the party started for recess quarters at Shillong.

185. Operations were confined to the right bank of the Brahmaputra river, and the most highly cultivated tract in the district, lying between latitude $\frac{26°-15'}{26°-37'}$ and longitude $\frac{91°-13'}{91°-53'}$ was selected for the commencement of operations. At the request of the Chief Commissioner the system recently adopted for the cadastral survey in the Benares district, North-Western Provinces, of requiring the field surveyors to write the field registers (*khasra*) in concert with the *mundal* or village official simultaneously with the measurement of

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* Major Sandeman reports on the European officers and native establishment attached to his party as follows :—

"Lieutenant F. B. Longe, R.E., has been zealous in the performance of his duties. Messrs. Little and Shaw, in charge of cadastral camps, have shown marked capacity and resource in adapting themselves and their establishments to a new procedure involving many new and responsible duties.

"Mr. Freeman deserves great credit for the manner in which he has worked his Traverse Camp. I have no harder working or more trustworthy assistant. Messrs. Murphy, Smart, and Bedford have all worked well.

"Of the native establishment, the English writer Puran Chand has given great satisfaction, and the following men are deserving of mention :—Lachman Sing, Nidha Lal, Laljimal, Golamgous Khan, Joala Pershad, Fazaldad Khan, Abdul Hadi, Jairam Sing, Hari Sing, Amanat Hosein, Abdul Hamid, Jai Narain, Shib Shai, Har Shai, and Majibullah."

fields has been carried out. The details of the procedure are given in the appendix to this report.

186. The area of cadastral survey completed is 228·16 square miles, comprising 148,438 fields, the average area of which is 0·98 acre. In addition to the completed area, 340 square miles of traverse survey has been prepared in advance for cadastral survey next field season. The unit of survey in the Kamrup district is the "field," which, however, is different to the field unit of other cadastral surveys, as it includes all contiguous plots of the same class of land owned by the same individual.

187. Three stations of the Great Trigonometrical Survey have been connected with the work, and their values have been used for correction of the measured traverses. Azimuths were observed at 36 stations to check the angular work. The field survey has been carefully tested by 556 linear miles of check lines, of which 224 miles were done by the European assistants and 332 miles by inspectors and sub-surveyors.

188. The triple junctions of village boundaries were marked previous to survey by the district staff with stone prisms measuring three feet long and one foot sides, and beyond these marks no demarcation of the boundaries was attempted. The boundaries were surveyed on information obtained on the spot. In addition to the trijunction marks, all the theodolite stations of the boundary traverses have been marked by the surveyors with cylinders of baked clay, measuring from nine inches to one foot in length and from three to four inches in diameter, buried just below the surface of the ground.

189. The cadastral establishment was at first composed chiefly of Hindustanis. Several Bengali *amins*, who had been employed in the late settlement of Cachar, were entertained early in the season; but as they were unacquainted with the professional system of surveying, they had to be put into training for some weeks before they could be entrusted with independent work. Towards the end of February, the establishment of field surveyors consisted of 29 Hindustanis and 42 Bengalis. The daily average outturn of the Hindustani surveyor was 24·5 acres, while the Bengali only accomplished 14·7 acres. No natives of Assam proper have as yet offered themselves for employment as field surveyors; but as survey classes have been opened in the Kamrup district, under the charge of the Deputy Superintendent of Survey, it is expected that some of the pupils may offer themselves for service during the next field season.

190. The work was carried out under conditions of considerable difficulty. On this subject Mr. Barrett reports as follows:—

"Such is the natural fertility of the soil that every square yard of country not under the plough was found closely covered with tall grass and reeds through which the surveyors had to cut their way. The villagers at first offered considerable opposition to the progress of the survey: they refused to point out their boundaries and to clear lines for the traverses, and even objected to the Mahomedans of the survey party remaining in their villages. A considerable amount of friction was the natural result, and it was only owing to the energy and determination of Mr. Stack, the Director of Agriculture, that *mouzadars* and others came to understand that opposition on their part would not be tolerated. The surveyors, however, had to contend against an equally potent cause of delay in the natural sluggishness of the people. The Assami is the most slothful of mortals. His wants are few, and are easily met, and as he considers it degrading to carry a load or to work for any one, the difficulty in securing the labour necessary for clearing the traverse lines may be imagined."

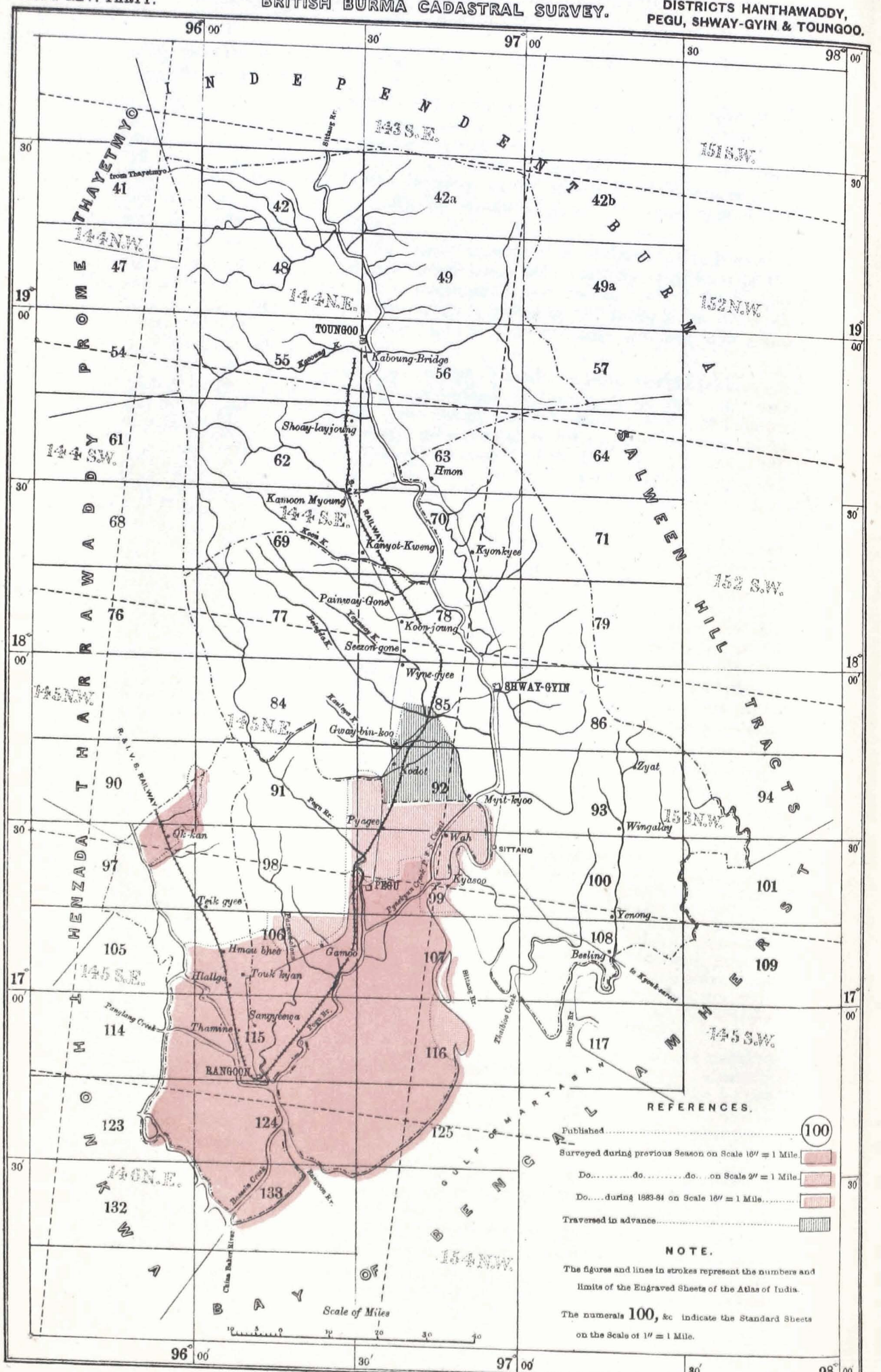
A worse enemy, however, appeared later in the season in the shape of sickness, which materially interfered with the progress of the survey. Towards the end of March fever of a virulent type set in, and within a fortnight 30 per cent. of the establishment was incapacitated for work: only six deaths occurred, but 79 men were invalided, many of whom, it is believed, would have died had they not been sent away.

191. The outturn of cadastral survey has been mapped for reproduction on 381 sheets. *Khasra* and trace maps of all villages have been made over to the Settlement Department for examination. Differences in classification and area between the records of the survey and of the old settlement have been made over to revision parties for examination in the field. A revision squad consists of a settlement *munsarim* and a survey inspector or sub-surveyor: the joint working of settlement and survey is thus maintained. The work of

No. 2 REV. PARTY.

INDEX TO THE BRITISH BURMA CADASTRAL SURVEY.

DISTRICTS HANTHAWADDY, PEGU, SHWAY-GYIN & TOUNGOO.



REFERENCES.

Published 100

Surveyed during previous Season on Scale 16″ = 1 Mile.

Do. ..... do. ..... do. ..... on Scale 2″ = 1 Mile.

Do. ..... during 1883-84 on Scale 16″ = 1 Mile. .....

Traversed in advance .....

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revision has progressed slower than had been expected during the recess, owing to sickness, but it is still hoped that most, if not all, of the survey records will be finally passed by the settlement before the close of the year.*

HANTHAWADDY, PEGU, AND SHWEGYIN DISTRICTS, BRITISH BURMA.

(No. 2 Party, Revenue Branch.)

192. Up to the 19th February this party remained under the charge of Major J. R. McCullagh, R.E., when, on his transfer to the Mysore survey, the charge devolved on the Assistant Superintendent, and under Mr. Jackson's supervision it has since remained. The boundary section took the field from head-quarters at Rangoon on the 22nd November 1883; the cadastral sections on the 22nd December.

Personnel.

Major J. R. McCullagh, R.E., Deputy Superintendent, 4th grade, in charge to 19th February.
Mr. E. J. Jackson, Officiating Deputy Superintendent, 4th grade, in charge from 20th February.
„ F. Grant, Surveyor, 1st grade.
„ D. A. King, ditto, 4th do.
„ J. McHatton, Assistant Surveyor, 1st grade.
„ G. E. Parker, ditto, 1st do.
„ P. A. Peters, ditto, 2nd do.
21 Sub-surveyors and others.

Temporary Establishment.

153 Field surveyors and others.

193. The field operations were continued till the 1st June 1884, when the main party returned to recess quarters, but in the hills some of the squads remained at work till the 15th June, in order that the Pegu district might be completed: the incessant rain subsequent to the 15th May was the cause of the work being protracted.

194. The cadastral survey has been carried on in the Pegu and Pounglin townships of the Pegu district and in the Okkan circle of the Hlaing township, which has been completed. The area surveyed is shown in the following statement:—

Districts.	Townships.	Number of kwins.	Area in square miles.	Remarks.
Pegu ... ... / Hanthawaddy ...	Pegu	188	508·19	
	Pounglin	31	44·31	
	Hlaing	31	32·24	
	Total ...	250	584·74	

In addition to this area, boundary traversing has been extended over 184 square miles, in preparation for the cadastral survey next season. A larger area of advance work would have been completed had not the Chief Commissioner intimated that no further cadastral operations were to be undertaken by this party after the completion of the survey of the Pegu district.

195. Hitherto the revision of the maps to accord with the settlement papers has been made in the season following the survey, but on the 15th February the local Government, taking in view the revised programme of survey operations in British Burma, by which this party was to be withdrawn in October 1884, requested that in addition to the revision of the past season's work, that

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* Mr. Barrett makes particular mention of the great assistance he has received throughout the field season from Mr. Stack, the Director of Agriculture in Assam, to whose hearty co-operation he considers much of the success of the season's operations is due. He also cordially acknowledges the assistance received from the district officials generally.

Mr. Barrett reports on his establishment as follows:—

"Mr. Pemberton has maintained the high character he has always held in the department. He completed his work in good time, and has given general satisfaction.

"Mr. O'Donel is a very superior cadastral officer. He worked his camp with judgment and skill, and exhibited considerable tact in the management of the native establishment.

"Mr. Connor had charge of the boundary camp. He was new to field work, having been employed during the previous 13 years in the head-quarters' office, Calcutta. He has rapidly acquired knowledge of his duties, and promises, to make an excellent camp officer.

"Mr. Kraal is a willing assistant, and Mr. Kelly has worked carefully and steadily."

Among the sub-surveyors and draftsmen the following are commended as having done good service:—

Golam Hyder Khan, Sakhawat Hossein, Khurshed Hossein, Mohan Sing, Janardhan Rao, Tajjuddin, Fida Hossein and Ganga Ram.

Among the temporary establishment, the services of Baboo Sitanath Chuckerbutty are brought prominently to notice.

of the current season's maps should be undertaken. This necessitated the withdrawal of 30 field surveyors from the regular cadastral operations, and thus the outturn of survey has been considerably reduced.

196. The field work of the revision camp began on the 12th December 1883, and by the 9th May 1884 the whole of the two seasons' work, aggregating an area of 1,182 square miles, was revised, and traces of the cultivated portions made over to the Settlement Officer for settlement.

The revisions are due to the usual causes, viz:—

1*st.*—Errors of survey.
2*nd.*—Changes in the boundaries of fields and kwins.
3*rd.*—Imperfect or indistinct demarcation, especially of garden land.
4*th.*—Extension of cultivation.

But the percentage of errata under the above heads is not given.

197. Mr. Jackson reports that—"The demarcation maps were perfectly useless; in fact, they were no guide whatever:" consequently the boundary surveyors were compelled to divide the ground into conveniently sized blocks of 1 to 2 square miles each. All the boundaries thus demarcated by the professional survey have been approved and accepted by the Settlement Department as *kwin* boundaries.

198. The traverse stations of the boundary survey have been made permanent by embedding burnt clay cylinders, and to ensure their due protection, printed notices, with a sketch showing the position of the stations, have been issued to the head men of villages who are made responsible for the preservation of these marks.

199. The country under survey this season was in some places very difficult: one part of the Mayin-zayah circle is described "as a net-work of drainage and swamps, covered with grass 20 feet high, devoid of habitation, and infested with snakes." Mr. Jackson reports that it was with the greatest difficulty that the Mayin-zayah hills were surveyed: the field surveyors were inexperienced in hill surveying, and required to be instructed. These hills are said to be covered with "trees, bamboos, and dense under-growth of cane intertwined with various kinds of creepers, which made the operations exceedingly difficult."

The operations of the season were much scattered, which caused considerable trouble and harassment in superintending the different establishments.

200. The field survey was carefully tested by the European assistants and native inspectors, the amount of check survey by the European officers being 149 linear miles, and by the native agency 347 miles. The work was found to bear the test well. The native surveyors working in the hilly portions were also constantly visited by the assistants. Azimuth observations were taken at 18 stations as a check on the angular work of the traverses: the traverses have been connected with five principal stations of the Great Trigonometrical Survey, and the chain measurements corrected to accord with the triangulation distances. The number of fields in this season's work is 241,744, and the average area of each field is 0·36 of an acre.

201. With regard to the employment of Burmans, Mr. Jackson reports as follows:—

"This season Burmans were employed, of whom 13 did good work in office as calculators, printers, and tracers, and 58 were attached to the field parties and instructed in cadastral surveying: of these 46 passed the survey test and received certificates. They did fairly well in open country, but were found incompetent for surveying in the hills. Twenty-five apprentices also learnt a little surveying and were granted certificates.

"The object of the Burmans is to obtain a survey certificate to qualify themselves for a Thugyiship, &c.; but unless they take to surveying as a profession, there can be but little hope of their ever acquiring that knowledge which is essential for surveying."

202. The 16-inch cadastral sheets, 1,559 in number, of the area finished by the settlement and revision survey—that is, of the area surveyed in the two field seasons 1882-83 and 1883-84—were forwarded to Calcutta for publication between the end of January and the early part of November 1884. Of the general maps on the scale of two inches to the mile, 24 sections have been completed and submitted to be photo-zincographed.

203. The health of the establishment was somewhat better than in previous seasons, which Mr. Jackson attributes to the men having blankets and

No. 7 REV. PARTY.

BRITISH BURMA SURVEY.

INDEX

to the Cadastral Survey of

DISTRICT AKYAB

Scale of Miles.

127 S.E.

133 S.W.

129 N.E.

134 N.W.

125 S.E.

135 N.W.

134 N.E.

134 S.E.

CHITTAGONG

ARAKAN HILL TRACTS

BAY OF BENGAL

UPPER BURMA

from Chittagong

Kaladan R.

Kaladan

Mahamuni

Moungdaw

Bootheedoung

Kyauktaw

Naaf R.

Sarakoongbong

ARAKAN

RATHEDAUNG

Minbya

Urittaung

Myu R.

Pauktaw

AKYAB

KALADAN R.

HUNTER'S BAY

CHANGDAMMA R.

Tedin R.

8 9 12 13 14 16 17 18 19 20 21 22 23 24 25 26 28 29 30 32 33

92° 0′ 92° 30′ 93° 0′ 93° 30′ 94° 0′ 94° 30′

21° 30′ 21° 0′ 20° 30′ 20° 0′

REFERENCES.

Published ..... (28)

Surveyed during 1883-84 on Scale 2″=1 Mile .....

Surveyed during 1883-84 on Scale 16″=1 Mile .....

Traversed in advance .....

NOTE.

The numerals 28, &c., indicate the Standard Sheets on the Scale 1″=1 Mile.

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Survey of India Offices, Calcutta, February.

1885

Photozincographed at the Survey of India Offices, Calcutta.

No. 7 PARTY.

BRITISH BURMA SURVEY.

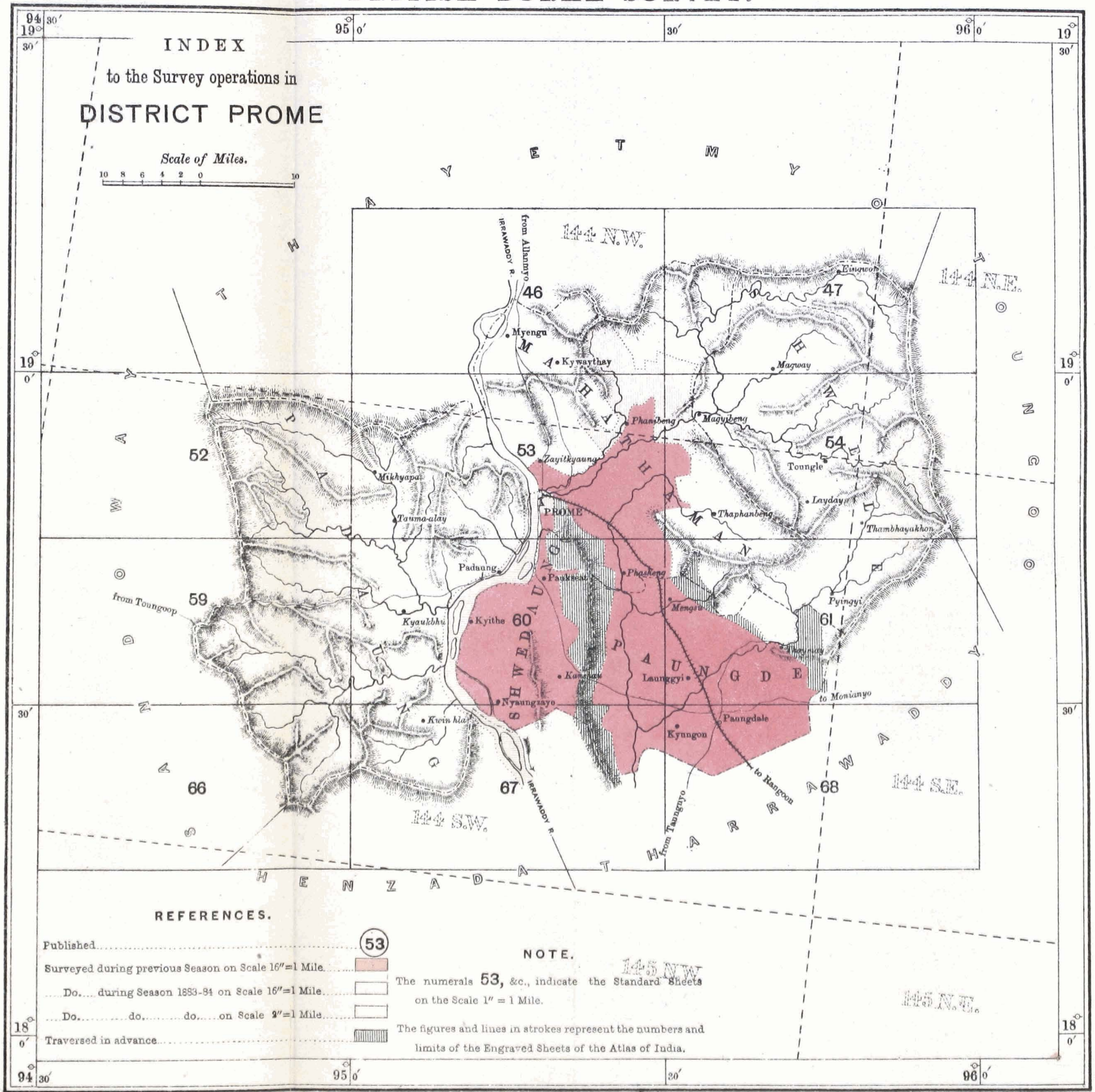
INDEX

to the Survey operations in

DISTRICT PROME

Scale of Miles.

10 8 6 4 2 0 10



REFERENCES.

Published ..... (53)

Surveyed during previous Season on Scale 16″=1 Mile.

Do. during Season 1883-84 on Scale 16″=1 Mile.

Do. do. do. on Scale 2″=1 Mile.

Traversed in advance

NOTE.

The numerals 53, &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.

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Survey of India Offices, Calcutta, March.

1885

sleeping under tarpaulins instead of being exposed to the heavy dew, but there was still a good deal of sickness this year, and the European assistants suffered considerably.

204. The levelling squads which had been attached to this party in previous field seasons was transferred to the Henzada district survey.

205. As the cadastral operations of this party have been stopped in accordance with the request of the Chief Commissioner, consequent on his inability to grant any provincial money towards its cost, the organization of the party has been changed to suit it for topographical operations, on which it is to be employed in British Burma under the orders of the Government of India. The trained cadastral establishment has been broken up, and the *amins* have had to seek employment elsewhere. This is much to be regretted, as such establishments take considerable time and trouble to train, and by its disbandment the value of the party for cadastral surveys has been lost.*

PROME AND AKYAB DISTRICTS, BRITISH BURMA.

(No. 7 Party, Revenue Branch.)

206. This party has remained under the charge of Mr. H. B. Talbot throughout the year. Cadastral operations were resumed in the beginning of December 1883 in the Prome district and were commenced in the Akyab district: the field work was continued until the end of May 1884, when the party returned to recess quarters at Rangoon.

Personnel.

Mr. H. B. Talbot, Deputy Superintendent, 4th grade.
„ F. W. Kelly, Assistant Superintendent, 2nd grade.
„ G. W. Jarbo, Assistant Surveyor, 1st grade.
„ J. R. Scott, ditto, 1st do.
„ J. S. Swiney, ditto, 1st do.
„ A. W. Smart, ditto, 1st do.
„ D. J. Collins, ditto, 2nd do.
22 Sub-surveyors and others.

Temporary Establishment.

84 Field surveyors and others.

207. The work in the Prome district was assigned to a detachment under the immediate superintendence of Mr. F. W. Kelly, Assistant Superintendent, while the main party under the Deputy Superintendent carried on the work in the Akyab district.

208. The remaining portion of the Prome district, for which a cadastral survey was required, has been completed, and a topographical survey on the 2-inch scale of the Irrawaddy river has been made from the town of Prome southwards, extending into the Tharrawaddy district up to the point where the river leaves the tract which has been brought under cadastral survey. The cadastral and 2-inch area completed in the Prome district is thus distributed:—

Township.	Scale of survey.	Number of *kwins*.	Number of fields.	Average size of fields.	Cultivation.	Waste.	Total Area.	
							Acres.	Square miles.
				Acres.	Acres.	Acres.		
Mahathaman	16-inch	31	62,551	0·26	16,433	49,873	66,306	103·6
Irrawaddy river	2-inch	.....	.....	.....	... ..	.....	.. ...	100·0
Total ...	.....	31	62,551	0·26	16,433	49,873	66,306	203·6

209. A large scale survey of the town of Prome, covering 355 acres, which is included in the above cadastral area, has been made on the field-book system, as in the case of the Bassein town survey. The measurements were

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* Mr. Jackson reports on his establishment as follows:—

"Mr. F. Grant, Surveyor, conducted the duties of cadastral camp No. 1 most satisfactorily, and it gives me pleasure to report very highly of this officer.

"Mr. D. A. King, Surveyor, was in charge of cadastral camp No. 2, and did well in completing the work allotted to him.

"Mr. J. McHatton, Assistant Surveyor, superintended the division camp with credit and to my entire satisfaction.

"Messrs. Parker and Peters, Assistant Surveyors, are excellent assistants, and I have pleasure in reporting favourably of their working powers and the cheerful way they attend to their duties.

"The sub-surveyors, inspectors, and *amins* worked very well."

recorded in field-books kept on the scale of 128 inches to a mile, from which the fair sheets were plotted on the 64-inch scale. This survey has been done in minute detail. Proprietary rights, which had been demarcated by baked clay cylinders, have been carefully fixed and clearly shown on the maps. The Assistant Superintendent and his assistant tested the accuracy of the work by 5½ miles of check survey.

210. The principal work of this detachment, however, was the revision survey, *i.e.* the survey of the changes and extensions of cultivation in the area of 819 square miles surveyed during 1882-83 in districts Tharrawaddy and Prome, and which had been brought under settlement during the current year. This work proved unusually heavy, and occupied 12 Field Surveyors under two Inspectors for five months. The revision survey includes 69,081 fields, of which 37,973 come under the head of changes and 31,108 of extensions since the first survey. The area statements and trace maps were all corrected during the field season, and returned to the Settlement Officer by weekly despatches.

211. The cadastral survey in Prome has been tested by 182 linear miles of check survey, of which 32 miles were executed by European officers, and 150 miles by native inspectors.

212. Regarding the training of Burmans, Mr. Kelly reports as follows:—

"At the request of the Deputy Commissioner of Prome, 14 Burman lads were received for instruction in surveying—9 from Prome and 5 from Tharrawaddy. They were taught the use of the plane-table, chain, and optical square, and practised in the survey of fields: in office they were also taught how to calculate field areas with the acre comb. The Deputy Commissioner's object for this training was to make these lads qualify for Thugyiships; but as it is not possible to make a Surveyor in a few months, certificates of proficiency could not be granted, though the most was made of the limited time allowed for their instruction."

213. The season's outturn of cadastral survey in Prome has been mapped in 110 sheets, of which the traces and area statements have been supplied to the Settlement Officer for his operations in 1884-85. These sheets have been kept back to complete the revisions thereon. A trustworthy Inspector and a few Field Surveyors will be placed at the disposal of the Settlement Officer during the ensuing field season for this object. The original sheets, 1,007 in number, of the area cadastrally surveyed in 1882-83 have been finally examined and despatched to Calcutta for publication. Of the 19 Standard Sheets of district Tharrawaddy on the 2-inch scale, 15 sheets have been completed and sent to Calcutta, and the remaining four are well advanced.

214. In the Akyab district no preparatory traversing had been done in advance, as the orders for this survey were not received in time to utilize the Boundary Surveyors there, while the party was working in the Prome district during the previous year. It had been intended to withdraw this party from Burma in order to employ it on the cadastral survey in Assam; but this arrangement was subsequently counterordered, unfortunately, too late, as the boundary camps had been broken up and the traverse surveyors sent on leave. For the first month of the season under report, therefore, the operations had to be confined to preliminary operations. These were commenced on the 20th November 1883, and the detail survey was started about the end of December.

215. In January 1884, when the work was in full swing, the Chief Commissioner announced the necessity of stopping all survey expenditure from the 1st October following, in consequence of the want of funds. The Deputy Superintendent then received orders, in a letter No. 75—6S, dated 10th January 1884, from the Secretary to the Chief Commissioner, not to take up more work than could be conveniently completed by the end of October. The programme originally laid out for the season was thereupon altered, and the survey of certain waste land grants, which was considered of the first importance, was directed to be undertaken. The necessary movements of the surveyors on this change of programme had no sooner taken place than fresh orders were received from the Chief Commissioner rescinding the former order, and stating that since survey operations in the Akyab district will not be stopped in October next, the original programme for the season was to be carried out. The surveyors had therefore to be sent back again to their former ground, and thus between two and three weeks of work was lost.

216. The separate areas of the different townships, and the total area which has been surveyed in the Akyab district on the different scales, are given in the following statement:— .

Township.	Scale of survey.	Number of *kwins*.	Total Area.	
			Acres.	Square miles.
Kyele	16-inch	37	33,544	52·41
Urittaung, West	.....	85	76,184	119·04
Rathaydaung	.....	75	58,531	91·46
Kalapanzin	.....	11	24,962	39·00
			193,221	301·91
Mayu river	2-inch	3	40,320	63·00
Total ...	.....	211	233,541	364·91

By the cadastral survey, 580,000 fields have been surveyed, having an average size of 0·18 acre on the cultivated area. In addition to the above, boundary traversing has been extended over an area of 263 square miles in advance, in preparation for cadastral survey next season. The area of completed survey is small, but it is as large as could be expected under the circumstances. The small outturn is due to the following causes:—(i) in the want of preparatory traverses for the detail Surveyors; (ii) the delays caused by the several changes of programme; (iii) the small size of the fields; and (iv) the large number of men sick in April and May.

217. The field survey has been carefully tested by 552 linear miles of check surveys, of which 255 miles were executed by the European assistants and 297 miles by the native inspectors. The work was found to be honestly and carefully done. The angular work of the traverse survey has been checked by azimuth observations taken at 46 stations; and connection with 12 stations of the Great Trigonometrical Survey enabled the chain measurements to be adjusted to agree with the trigonometrical distances.

218. The temporary demarcation was very defective, especially in the Ambari circle, and of little use to the Boundary Surveyors, who were further hampered by the want of assistance from the headmen of the villages. The theodolite stations have all been marked with stone prisms, which will serve as permanent reference points for future changes and extensions. The posts by which the waste land grants in Akyab had been demarcated by Mr. H. Dowman in 1881-82 have not been disturbed, as the Deputy Superintendent thinks there is no necessity to make them more permanent: the posts, being of iron wood, called *pyingado*, are likely to last for the next ten years.

219. Mr. Talbot reports as follows on the Arakanese:—

"There were in all 26 Arakanese under training during the field season: six of these passed the examination required of them, and were given survey certificaties; some of the remainder are now at work learning office duties, and it is hoped that 15 of these men will be employed in plane-tabling during the coming season, and that at least 30 or 40 more will be in training.

"The Arakanese, compared with the Burmans, are not so independent: they do not dress so well, nor squander as much money in amusements, and are ertainly not so hospitable. They are decidedly more intelligent than the Burmans, but they are equally fond of drinking and gambling, and are just as lazy and vindictive."

220. The 16-inch sheets, 460 in number, on which the season's outturn in Akyab has been mapped, have been drawn, with the exception of a few sheets in which the hilly portions are incomplete. The area statements and traces of the 208 *kwins* will, it is expected, be made over to the Settlement Officer in due time to commence the revision.

221. According to the revised programme of survey operations in British Burma, this party is to be retained for the completion of the survey of the Akyab district at full strength up to the end of 1885-86, and in 1886-87 at half strength. The cadastral operations therefore will be resumed by the entire party in Akyab in the ensuing season.*

GEOGRAPHICAL AND MISCELLANEOUS.

SIKKIM, DARJEELING, AND NEPAL BOUNDARY SURVEY.

222. The following shows the different descriptions of work performed by this party, and the officers who have been employed thereon:—

Personnel.

Brevet-Colonel H. C. B. Tanner, S.C., Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. E. C. Ryall, Assistant Superintendent, 1st grade.
Mr. J. Peyton, Surveyor, 1st grade.
„ W. J. O'Sullivan, do., 4th do.
„ W. Robert, Assistant do., 1st do.
„ W. C. G. Barckley, do. do., 1st do.
„ R. W. Senior, do. do., 3rd do.

Sub-Surveyors.

Sahai Din and others.

(1) Sumeswar Hills Survey, Mr. E. C. Ryall, Assistant Superintendent, and Mr. Senior, Assistant Surveyor;

(2) Daling Hills Survey, Mr. Peyton, Surveyor, and Mr. Robert, Assistant Surveyor;

(3) Sikkim Survey, Mr. Robert and Rinzin Nimgyl, explorer;

(4) Triangulation and distant sketching of Himalayan topography, Colonel Tanner, Mr. O'Sullivan, Mr. Robert, Mr. Barckley, and Mr. Senior;

(5) Demarcation and surveys on the Nepal-Bengal Boundary, Mr. E. C. Ryall and Mr. Senior;

(6) Explorations in Tibet, the Lama.

223. The survey of the Sumeswar hills on the scale of 1 mile=1 inch embraces an area of 685 square miles, and was effected by Messrs. E. C. Ryall and R. W. Senior. Along the watershed which forms the Nepal boundary stone prisms are being set up at those places where the ridge is not well defined. The tract embraced by the two sheets of the Sumeswar survey is similar in all respects to the Sewalik range which forms the southern limit of Dehra Dún, except that the peaks are generally of less altitude and the *cheer* or *pinus longifolia* is almost entirely absent. A strip of the Nepal territory which skirts the boundary has been sketched as far as circumstances would permit, and large errors in the existing engraved atlas sheet have been corrected. The operations were of the most tedious nature owing to the innumerable deep ravines and sandstone scarps which intersect the tract in all directions.

224. The survey has not been extended beyond Tribeni Ghat on the Gunduk river, and it is in contemplation to complete the work during 1885 down the Gunduk river to pillar No. 1 of the North-Western Provinces Nepal boundary.

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* Mr. Talbot reports on his assistants as follows:—"Mr. F. W. Kelly, Assistant Superintendent, completed the survey of the area that remained in the Prome district to my entire satisfaction. He is well up in all his duties, and will give satisfaction whenever appointed to the charges of a party."

Messrs. Jarbo, Scott, Swiney, and Smart are reported to have worked well, and to have given satisfaction; but the Deputy Superintendent regrets he cannot write in the same terms of Mr. Collins.

The native establishment on the whole worked well. The following members are specially mentioned:—Computers, Dindyal and Shashi Bhusan Ghosal; Sub-Surveyors, Faiz Buksh, Mr. LeRive, and Isan Chunder Ghosal.

225. The Daling hills survey on the scale of 8 inches=1 mile embraces an area of 29½ square miles: it was undertaken to map and demarcate certain lands in the outer hills which had been set apart by Government for tea cultivation. A trigonometrical survey was first made of the tract, and afterwards the lands were cut up into convenient blocks which were traversed and then topographically surveyed. The permanent demarcation of the tea estates is now being carried out—natural features only—such as streams and ridges being utilized as boundaries. Pillars are being built wherever the natural features do not sufficiently indicate the exact boundary. These maps will prove of the greatest use in clearly defining, without possibility of doubt, the estates of tea-planters. The work was effected by Messrs. Peyton and Robert, and was much retarded by the hazy or cloudy weather. Dense jungle clothes the hill sides and proved a serious obstacle to progress. The rectangular co-ordinates of the trigonometrical stations have been referred to the centre of the degree which embraces the work.

Area 29½ square miles mapped in 7 sheets on the scale of 8 inches =1 mile.

226. The eastern extremity of the Daling hills touches Bhutan territory, and advantage has been taken of this to sketch a considerable amount of topography in Bhutan.

227. Mr. Robert's survey of North Sikkim is the most important piece of work effected by this party during the season under review: it is on the scale of ½ inch=1 mile and embraces an area of 760 square miles. We now have a map of the whole of the southern slopes of the Himalayas which skirt Sikkim to the north and which cut the outlying tract of Chumbi (Tsumbi) from the remainder of Tibet. Except a small three-cornered bit north-west of Kinchinjinga, we have the whole of the great spurs and snow fields which compose the group of that name. Every pass leading out of Sikkim into Bhutan, Tibet and Nepal has now been fixed, and all the routes have been entered on the map. Mr. Robert's operations were carried on under the hardships always experienced by surveyors in the higher Himalayas. Besides the new surveys brought in by Mr. Robert, Captain Harman's section of Independent Sikkim has been enlarged and incorporated with the remainder of the topography. North of the Donkia pass, Hooker's topography has been utilized.

228. Every opportunity of extending our knowledge of the Himalayas has been taken advantage of, and up to the end of November almost every peak and ridge that could be seen from the plains of Bengal has been fixed by Colonel Tanner by triangulation between Sikkim on the east and the Durbhunga district on the west: besides this a large amount of work of the same nature has been carried out by Mr. Barckley from the tower stations in the Chumparun district. The gap between the work of Colonel Tanner and Mr. Barckley will probably be filled up during the ensuing year. Smoke, haze, cloud and fog greatly retarded the operations.

229. The demarcation and surveys on the Nepal-Bengal boundary have been completed from the Koosee river to Tribeni Ghat on the Gunduck, and the renumbering of all pillars and posts is now in progress.

230. Mr. Ryall executed certain large scale surveys of small newly-settled portions of boundary, where owing to the erosion of rivers the marks of Wyatt's survey of 40 years ago were constantly being washed away, and these small portions of boundary are now being permanently demarcated with iron posts. The excavation of the ditch and repair of the boundary pillars between the Koosee and Beknatori was carried out by Messrs. O'Sullivan and Barckley.

231. The interesting tract of country comprised by sheet No. 6 of the new trans-frontier maps has been plotted from the field-books of the Lama, and we now have very complete knowledge of the whole of the country between Darjeeling and Lhasa. The Lama's surveys include a close reconnaissance of the interesting Yámdok or Palti Lake of D'Anville, of the newly-discovered lakes of Tigu-tso and Pho-Mo-Chang-Thang, and of many passes and valleys between Bhutan and Lhasa, which previous to the Lama's exploration were altogether unknown.

TIDAL AND LEVELLING OPERATIONS.

THE TIDAL OPERATIONS.

232. The recording of the tidal curves by the self-registering gauges, their reduction, and the publication of the tables of predicted tides have continued as usual during the past year. Major Baird, requiring six months' leave on urgent private affairs, was relieved of his charge during that period by Major Hill from 4th April to 20th August, when he was relieved by Mr. H. E. T. Keelan, Surveyor, 1st grade, who retained charge till Major Baird's return.

Personnel.

Major A. W. Baird, R.E., Deputy Superintendent, 3rd grade, in charge to 4th April 1884.
Major J. Hill, R.E., Deputy Superintendent, 3rd grade, in charge from 4th April to 20th August 1884.
Mr. H. E. T. Keelan, Surveyor, 1st grade, in charge from 20th August 1884.

(Tidal.)

Mr. T. H. Rendell, Surveyor, 4th grade.
" E. J. Connor, ditto, 4th do.
Sub-Surveyor Dhondu Venayek.

(Revision of Heights and Levelling.)

Mr. H. E. T. Keelan, Surveyor, 1st grade.
" G. Belcham, ditto, 3rd do.
Sub-Surveyor Narsingdass and three recorders.

233. The tidal observations were continued at 19 stations, viz :—

Aden.	Galle.	Diamond Harbour.
Kurrachee.	Negapatam.	Kidderpore.
Bombay.	Madras.	Rangoon.
Marmagão.	Vizagapatam.	Elephant Point.
Beypore.	False Point.	Amherst.
Colombo.	Dublat (Saugor Island).	Moulmein.
		Port Blair.

Of these, Marmagão, Galle, and Colombo are new stations. Two stations, Kárwár and Pámban, have ceased to exist. Five years' observations had been secured at Kárwár, while at Pámban, on account of the long break which must necessarily have followed the damage done to the observatory by the storm of the 26th December 1882—and as four years' observations were completed—the instruments were taken down and the observatory removed.

234. The whole of the observatories were visited and inspected once, or oftener, during the past year, either by Major Baird or by an assistant, and every instrument was thoroughly overhauled and cleaned during the inspection of each observatory.

235. The reductions of the observations have progressed steadily, and the final results have been determined, so that the co-efficients should be presented in the manner recommended by Professor Darwin and explained in the report submitted last year (*see* appendix). The new computation forms for the analysis of all the short-period tides which were drawn up by Mr. Roberts in accordance with the modifications proposed by Professor Darwin were received in time to be used in the reductions of last year's observations; but the new forms for the long-period tides have not yet been completed by Mr. Roberts, and meanwhile the old forms are still in use.

236. The account of the working of each tidal observatory will be found in the appendix. They all appear to have worked satisfactorily, with only the ordinary accidental stoppages, excepting at Port Blair, where unfortunately the Port Officer, not understanding the scope of the operations, suspended them for six weeks, and at Amherst again the windows of the observatory were twice broken open and the gauge put out of gear by some mischievous, unknown persons. A similar statement had to be made in last year's report (p. 45). The Secretary to the Chief Commissioner has been appealed to and requested to prevent the recurrence of such wanton mischief.

237. Major Baird's office at Poona has during the past year had an unusual burden thrown upon it. This officer reported last year (*vide* p. 18 of appendix to Annual Report 1882-83) that Professor Darwin had pointed out that there had been a slight error in the determination of the tidal co-efficients, viz. the omission to take cognizance of the variation of the inclination of the place of the moon's orbit to the equator, and as this varies from year to year, the computed amplitudes of the lunar and luni-solar constituents required slight modification to render them strictly comparable year by year; consequently a mass of new computations had to be undertaken to present the

co-efficients in a modified and strictly accurate form. This is reported on in detail by Major Baird in the appendix to the present volume.

238. Due notice of this modification of the method of presenting the co-efficients is given in the prefaces to the tide-tables for 1885, which contain predicted tides for 20 ports, the same number as in the tables for 1884. The usual interesting statements showing the errors in the predicted heights and times of high and low water for 1883 will be found in the appendix. The predictions for 1883 must be considered very good, and may be summarized as follows:—

Percentage of predictions within 15 *minutes of actuals.*

	High water.	Low water.
Open coast stations ...	... 72 per cent. ...	70 per cent.
Riverain ,, ...	... 70 ,, ...	66 ,,

Percentage of predictions within 8 *inches in height of actuals.*

	High water.	Low water.
Open coast stations ...	... 92 per cent. ...	96 per cent.
Riverain ,, ...	... 66 ,, ...	64 ,,

The same remark applies regarding the Moulmein and Amherst predictions as was stated last year. The predictions at the former station were better than those at Amherst, and similarly the predictions at Kidderpore and Diamond Harbour were better than those for Dublat. Thus it will be necessary to treat Amherst and Dublat in the predictions as riverain ports, and not as open coast stations.*

SPIRIT-LEVELLING OPERATIONS.

1.—THE OPERATIONS EXECUTED IN CONNECTION WITH THE TIDAL OBSERVATIONS.

239. In paragraph 246 at page 52 of the Annual Report for 1882-83 will be found a brief but interesting notice of the longest line of levels ever run between two seas, viz. that from Kurrachee *viâ* Mithankot, Ferozepore, Agra, Allahabad, Monghyr, and Calcutta to False Point, a distance of 2,300 miles, of which the last connecting link was completed in the season then under review. During the past season a similar connecting link has been interpolated between Sironj and a station 32 miles north of Manmád, on the Bombay and Agra Road, completing a line of levels between two sea-coast stations, second in length, by very little, to the chain above referred to, and consisting partly of that same chain, *i.e.*, from Kurrachee to Agra, but thence to Bombay; and the error was only ·624 of a foot, or less than four inches per 1,000 miles.

The length of the link completed during the past season was over 425 miles, over ground with rises and falls amounting in aggregate to nearly 22,000 feet, constituting a very satisfactory outturn.

240. At Kurrachee a short line of levels was run between the tide-gauge station and a benchmark on Trinity Church which had hitherto derived its value (as had indeed all the stations on the great line of levels emanating from Kurrachee) from the value of mean sea-level determined in 1855 by a short series of observations extending over two semi-lunations. The result of the comparison is eminently satisfactory, exhibiting a discrepancy of but one hundredth of a foot between the old (1855) and present values of mean sea-level.

241. In addition to the spirit-levelling operations, the revision of the heights on the Khánpisura Series has been continued and brought within four stations of completion. The whole would have been completed but for Mr. Keelan,

* Major Baird reports favourably on the services rendered by Mr. Rendell, and also of Dhondu Vinayek and the other sub-surveyors, and of Hanmantras Bajoojee, mechanic, connected with the field works.
Mr. Connor is highly commended for the way in which he and his staff of computers grappled with the work.

to whom the work was entrusted, being compelled to take 1½ months' leave during the field season on account of a severe attack of inflammation of the eye.

242. The total cost of these operations is as under:—

	Rs.
Tidal	28,197
Spirit-levelling	17,248
Trigonometrical	11,217
Total ...	56,662

This gives average cost-rates of Rs. 1,484 per tidal station, Rs. 40½ per linear mile of double spirit levelling, and Rs. 701 per principal station of which the height has been trigonometrically determined.*

2.—THE OPERATIONS IN CONNECTION WITH THE REVENUE SURVEY.

243. The small party of levellers in British Burma, which had been attached to the Hanthawaddy district survey party, was transferred to that working in the Henzada district under the superintendence of Major Hutchinson, and resumed its operations in December 1883 near Henzada in continuance of the programme arranged for the plan of levels in the Irrawaddy valley. The Ngawun Valley Series was commenced at the junction of the Irrawaddy and Ngawun rivers. Starting from bench mark No. 8 of the Irrawaddy Valley Series, this section has been carried along the embankment on the left bank of the Ngawun river as far as Ngathein-gyoung: from this point a tie-line has been carried eastwards *viâ* Kyônpyaw and Ataung to Danúbyú on the Irrawaddy, and a connection again made on the Irrawaddy Series. The length of this section is 89 miles, and the closing error is 0·0217 foot per mile, which is a very satisfactory result. Having assured the accuracy of the work as far as Ngathein-gyoung, the Ngawun River Series was extended therefrom, and it has been carried as far as Ngaputaw, about 20 miles below Bassein. At this point the operations had to be closed on account of the setting in of the rains. The total length of line of levels measured is 169 miles, with double levelling throughout. The number of bench marks fixed is 169. It is intended to continue the Ngawun Series as far as Pagoda Point, at the mouth of the Bassein river, during the ensuing season, and to endeavour to carry a cross line from Bassein to Pantanaw, closing again on the Irrawaddy Series. This will complete the scheme of levels as far as it has yet been projected.

GEODETIC.

ELECTRO-TELEGRAPHIC LONGITUDE OPERATIONS.

244. The two astronomical parties were engaged in the extension of the Electro-telegraphic Longitude Arcs eastwards of Calcutta, and measured during the season the six arcs, Akyab-Calcutta, Akyab-Chittagong, Prome-Chittagong, Prome-Akyab, Moulmein-Prome, and Moulmein-Akyab, thus completing the link between Kurrachee and Moulmein.

Personnel.

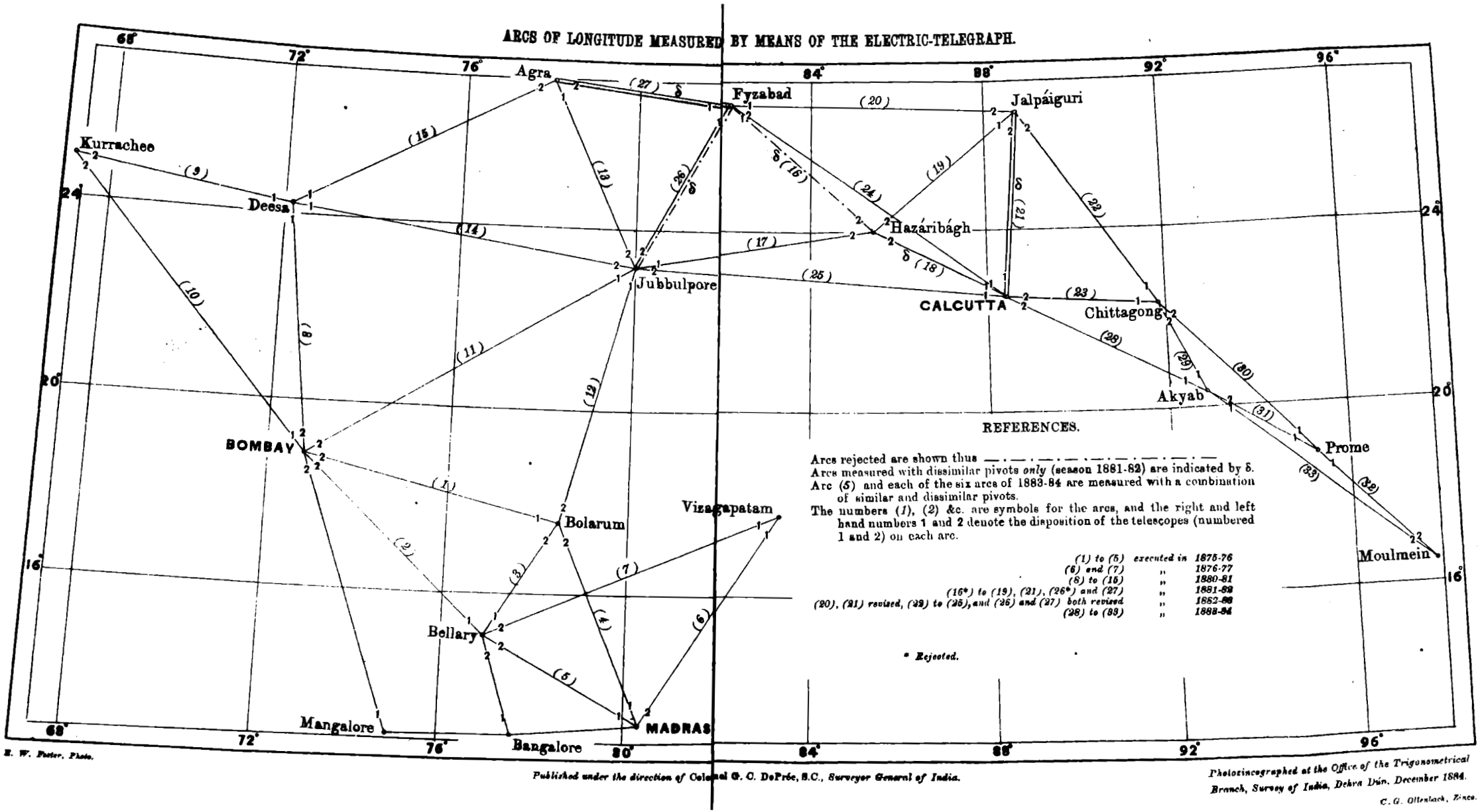
(No. 1 Astronomical Party.)
Major W. J. Heaviside, R.E., Deputy Superintendent, 3rd grade, in charge.
Mr. D. Atkinson, Surveyor, 1st grade.
Sub-Surveyors.
Baboo Dhondo Balwant Joshi.
„ Tikha Ram.

(No. 2 Astronomical Party.)
Major G. Strahan, R.E., Deputy Superintendent, 2nd grade, in charge to 29th April 1884 (on subsidiary leave and furlough thereafter).
Major W. J. Heaviside, R.E., Deputy Superintendent, 3rd grade, in charge from 30th April.
Sub-Surveyor.
Baboo Harsahai.

245. Unusual delays were met with owing to bad weather, to the changes from station to station being dependent on weekly coasting steamers, and to the failure on more than one occasion of the Madras-Penang cable, which threw the whole of the China and Straits traffic with countries to the west on to the main lines through Burma, and so choked them with traffic that the line could not be spared for the longitude work.

* Major Baird makes special mention of Mr. Belcham, to whom the work was entrusted, and also of his assistant Narsing Dass.

ARCS OF LONGITUDE MEASURED BY MEANS OF THE ELECTRIC-TELEGRAPH.



REFERENCES.

Arcs rejected are shown thus — · — · — · — · —

Arcs measured with dissimilar pivots *only* (season 1881-82) are indicated by δ.

Arc (5) and each of the six arcs of 1883-84 are measured with a combination of similar and dissimilar pivots.

The numbers (1), (2) &c. are symbols for the arcs, and the right and left hand numbers 1 and 2 denote the disposition of the telescopes (numbered 1 and 2) on each arc.

(1) to (5)	executed in	1875-76
(6) and (7)	,,	1876-77
(8) to (15)	,,	1880-81
(16*) to (19), (21), (26*) and (27)	,,	1881-82
(20), (21) revised, (22) to (25), and (26) and (27) both revised	,,	1882-83
(28) to (33)	,,	1883-84

* Rejected.

E. W. Foster, Photo.

Published under the direction of Colonel G. C. DePrée, R.C., *Surveyor General of India.*

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún. December 1884.

C. G. Ottenbach, Zinco.

246. The computations have all been brought up to date, some slight revision required for the work of 1882-83 has been completed, and the manuscript of the details of the observations for the three seasons 1881-82 to 1883-84 has been arranged for print.

247. The existence of defects in the two transit instruments has been commented on in the annual reports of the past two years; and in last year's report will be found, at pages 53 to 57, a discussion of the errors resulting therefrom, proving that they changed sign with a reversal of pivots, and affording ground for suspicion that the *locale* of the defects is in the Ys. During the past season observations were taken (in accordance with the intention expressed in paragraph 260, page 58 of last year's general report) with a combination of what has been termed (*see* paragraph 251 of last year's report) *similar* and *dissimilar* pivots, for the purpose of eliminating, as far as possible by differences, these residual errors in the determination of the differential arcs of longitude, and of determining their values for each instrument by the exhibition of their sum and difference; and, in addition, independent observations were taken specially for the purpose of determining the residual errors in each instrument separately. The method of taking these latter observations will be found described in Major Heaviside's report, and the results of the observations, both regular and special, have been drawn up, tabulated, and discussed by him in conjunction with Mr. Hennessey, and will be found in the same report. The magnitudes of the residual errors have now been pretty accurately ascertained for each instrument, and very accordant results are obtained by the application of corresponding corrections; but as the defects causing these errors were likely to prove a source of continued anxiety to observers, and moreover as their exact *locale* has not been definitely discovered—there being other possible causes of instability besides that suspected by Mr. Hennessey (page 58 of last year's report)—it was resolved to send both instruments to England to be thoroughly examined and have the defects rectified by the makers; and Major G. Strahan, being now on furlough in England, has been invited to inspect the instruments, on the maker's report of completion of repairs, and to see that the defects are removed before the instruments are returned to this country.

248. The instruments having been sent to England for repairs, longitude operations are at a standstill, and the combined parties will be employed under Major Heaviside in observing astronomical latitudes about the meridian of 80° along the Madras, the Jubbulpore, and the Amua Meridional Series to within 30 or 40 miles of the Himalayas.

249. Major Heaviside acknowledges the cordial assistance rendered by the officers of the Telegraph Department.*

* Major Heaviside reports favourably of Mr. D. Atkinson and of Baboo Dhondo Balwant Joshi.

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 Office at Dehra.

There has been no change in the general arrangement of these offices during the year under report: in all the work has increased, as will be found by reference to the separate reports of each office. The amalgamation of the clerks of all the branches into one general list has been completed, a step rendered necessary by their being all brought into one establishment.

Personnel.

Colonel J. Sconce, S.C., Deputy Surveyor-General, in charge Revenue Surveys up to 4th March 1884.
Lieutenant-Colonel H. R. Thuillier, R.E., Deputy Surveyor-General, in charge Revenue Surveys, from 5th March 1884.
Major C. Strahan, R.E., Deputy Superintendent, 2nd grade, Assistant Surveyor-General.
Lieutenant-Colonel W. H. Wilkins, S.C., Deputy Superintendent, 3rd grade, officiating in 2nd grade, from 14th March 1884.
Major M. W. Rogers, R.E., Deputy Superintendent, 3rd grade, Assistant Surveyor-General.
G. H. Cooke, Esq., Assistant Superintendent, 1st grade, Officiating Deputy Superintendent, 4th grade, from 17th August 1884.
Captain St. G C. Gore, R.E., Assistant Superintendent, 1st grade, Officiating Deputy Superintendent, 4th grade, up to 14th August 1884.

SURVEY OF INDIA OFFICES.

Mr. T. W. Babonau, Registrar.

SURVEYOR-GENERAL'S OFFICE.

Correspondence Section.

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

Account Section.

Mr. E. D. Algar, Head Accountant.
Babu Bama Churn Chuckerbutty.
„ Raj Krishna Mookerjee and six others.

General Section.

Mr. T. E. Ware, Examiner.
„ J. A. Vallis.
Babu Bheeeum Singh.
„ Gopal Chunder Doss and six others.

REVENUE SURVEY BRANCH OFFICE.

Mr. A. C. Cunningham, Head Clerk.
Babu Kali Pado Banerjee.
„ Ram Kristo Chunder and two others.

TOPOGRAPHICAL SURVEY BRANCH OFFICE.

Mr. F. A. D'Rozario, Head Clerk.
Babu Doorga Narain Ghose and one other.

MAP RECORD AND ISSUE OFFICE.

Mr. A. E. Byrn, Head Assistant.
„ P. C. H. Smart, Map Curator.
„ H. R. Vallis, Map Salesman, and six others.

DRAWING OFFICE.

Mr. A. Chamarett, Chief Draftsman, up to 1st June 1884.
Mr. G. A. McGill, Chief Draftsman, from 2nd June 1884.
Mr. S. M. Smylie, Head Draftsman.
„ R. C. D. Ewing, Draftsman.
„ W Green, ditto.
„ J. R. Adels, ditto.
„ A. J. Musgrove, ditto.
„ R. Sinclair, ditto.
„ W. P. Smith, ditto.
„ A. S. Bateman and two others.

Native Draftsmen.

Munshi Sunaullah.
„ Nabi Buksh.
Babu Harihur Sen.
„ Mohesh Chunder Shaw.
Munshi Muttiullah.
Babu Purna Chandra Sein.
„ Radhicaprosad Doss, and 36 others.

Surveyors and Assistant Surveyors on duty.

Mr. G. A. McGill, Surveyor, 1st grade, up to 1st June 1884.
Mr. W. Todd, Surveyor, 2nd grade.
„ J. A. May, ditto, ditto.
„ F. Adams, ditto, ditto.
„ W. Stotesbury, Surveyor, 4th grade, from 24th June to 31st August 1884.
Mr. P. J. W. Doran, Assistant Surveyor, 1st grade.
„ S. O. Madras, Assistant Surveyor, 1st grade, from 7th May 1884.
Mr. E. J. Martin, Assistant Surveyor, 1st grade.
„ B. M. Wilson, Assistant Surveyor, 2nd grade.
„ T. J. J. Mills, Assistant Surveyor, 3rd grade, from 14th March.
Mr. P. J. Serrao, Assistant Surveyor, 3rd grade, from 24th April.

Additional Establishment.

Mr. W. Stotesbury, from 1st September 1884, and eight others.

ENGRAVING OFFICE.

Mr. C. W. Coard, Superintendent, on furlough from 15th April 1884.
Mr. W. Donaldson.
„ G. G. Palmer.
„ D. L. Mitchell, on furlough from 1st April 1884.
„ J. Fulford.
„ T. B. Rodger.
„ A. G. Palmer, on furlough from 1st May 1884.
„ S. M. Coard.
„ A. W. N. James.
„ A. R. Coard.
„ A. D. M. Chamarett.
„ E. C. Oilenbach and 25 native Engravers.

Copper-plate Printing Section.

Mr. W. T. Collins, Copper-plate printer, and 15 native printers and pressmen.

2. In the Map Record and Issue Office great efforts have been made to provide for the proper storing and arrangement of the vast amount of maps which are in the custody of this section.

3. The duties of the Surveyor-General's and the Topographical Branch Offices have been carried on by Major M. W. Rogers, R.E.*

4. The Revenue Branch Office was supervised by Colonel J. Sconce, the Deputy Surveyor-General in charge Revenue Surveys, up to 4th March 1884, and subsequently by Lieutenant-Colonel H. R. Thuillier, R.E.: these officers have carried on all the duties connected with the accounts as well as the correspondence of the branch.†

Lieutenant-Colonel W. H. Wilkins on his return from furlough on 14th March 1884 was posted to the head-quarters offices, and assisted the Deputy Surveyor-General in charge Revenue Surveys in general administration. In addition to this duty he has been in charge of the Map Record and Issue Office from 19th March 1884.

5. Captain St. G. C. Gore, R.E., officiated as Personal Assistant, and was also in charge of the Map Record and Issue Office from 10th January to 18th March 1884. He accompanied the Surveyor-General to Simla, and assisted him in general administration duties up to 14th August 1884, when he was attached to the Afghan Boundary Commission, and in his place Mr. G. H. Cooke was appointed Personal Assistant to the Surveyor-General from 17th August 1884.

Map Record and Issue Office.

6. The work done by the Map Record and Issue Office during the past year ending 30th September 1884 is shown in the following statement:—

Maps issued.	No.	Value.
		Rs.
General maps to Government officials ...	50,727	57,431
Ditto to India Office, London ...	2,920	4,172
Ditto to agents	3,077	4,170
Total ...	56,724	65,773
Cadastral maps to Government officials ...	142,333	1,06,749
Grand Total ...	199,057	1,72,522

7. The number of applications received during the past year for extracts from original records of the revenue surveys was 535, for copying which Rs. 3,989 were received and paid to the copyists.

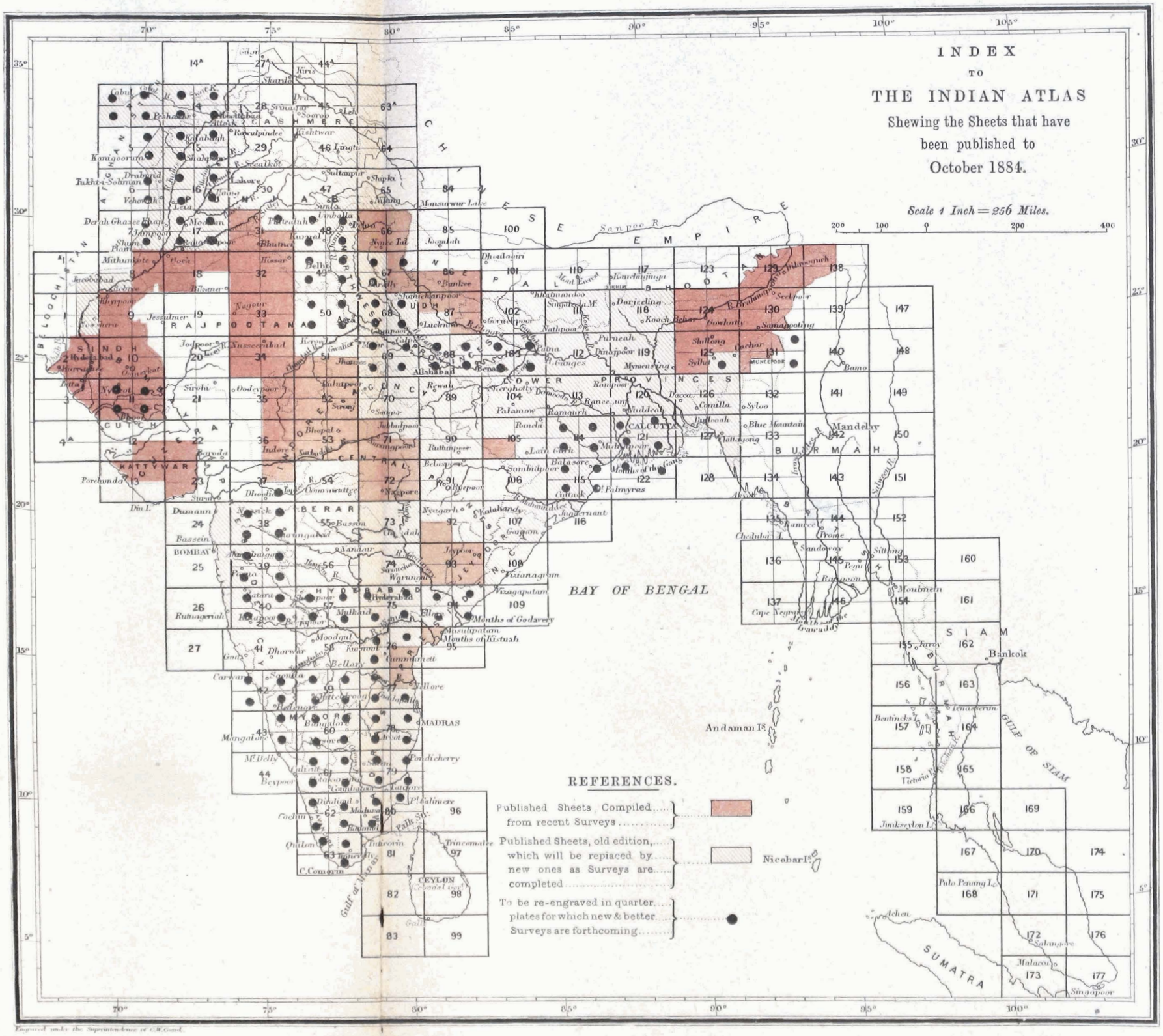
	Rs.
Amount realized from the resident map salesman and paid into the Government treasury	4,386
Ditto mofussil agents ditto	4,184‡
Total ...	8,570
Applications received for maps by letters, indents, and telegrams	2,684
Letters issued	1,955
Invoices and receipts issued	1,646
Packets, parcels, and town despatches	2,450
Sheets coloured for sale and issue	24,643
Ditto for other departments	4,437

* Major Rogers reports as follows:—
"Mr. Babonau, the Registrar, has continued to discharge his duties satisfactorily and energetically.
In the Surveyor-General's and Topographical Branch Offices Messrs. Francis and D'Rozario and Babus Banee Madhub Banerjee, Doorga Narain Ghose, Bama Churn Chuckerbutty, Chuni Lall Dey, and Mohendro Chunder Aich are deserving of special notice. Mr. J. A. Vallis, Babus Bheecum Singh, Rajkissen Mukerjee, Gopal Chunder Doss, Okhoy Coomar Dutt, Hemnath Dutt, and the rest of the clerks have given satisfaction."

† In the Revenue Survey Branch Office, the Deputy Surveyor-General specially mentions the services of Messrs. A. C. Cunningham, E. D. Algar, and Babu Kali Pado Banerjee who have worked assiduously and well. Babus Ram Kristo Chunder, Raj Coomar Dutt, with the rest of the clerks, have given satisfaction.

‡ Includes portion of value of maps sold during 1882-83.

To accompany Surveyor General's Report for 1883-84.



Published under the direction of Colonel G. C. DePrée, R.C., Surveyor General of India, at the Survey of India Offices, Calcutta, February 1885.

8. The total number of maps issued is nearly 200,000, and their value over a lakh and a half. These figures are somewhat below those of previous years, and may be attributed to the introduction of a more judicious system in the issue of published maps. Formerly they were issued broadcast to all military and civil officers, but now they are issued only on application, except in the case of certain departments which should possess all maps directly they are published.

9. Great care is taken that all trans-frontier and other confidential maps are issued only to those officers who are entitled to receive them under special orders of the Foreign Department, and they are stamped "absolutely confidential," with a foot-note directing that all such maps are to be returned to the Registrar, Survey of India Office, directly they are no longer required. The necessary arrangements to keep all confidential maps securely locked are nearly completed, and they will in due course be entrusted to the officer in charge of the Map Record and Issue Office.

10. During the past year the resident map agent died shortly after his resignation. The work devolved on the officer in charge of this office, who made suitable arrangements for carrying it on by improved agency. The work of the map salesman has considerably increased since the abolition of Messrs. Thacker Spink & Co.'s agency.*

11. Considerable progress has been made in the arranging and sorting of original maps and records, and it is hoped that this important work will be finally completed during 1885. In addition to the work of re-arranging the records, a revised and comprehensive catalogue of published maps is under preparation, but its compilation will take considerable time. The chaos which has existed ever since the entry of the Survey of India Office into the new building, from the insufficient rack accommodation, as well as from the want of a sufficient establishment to arrange the maps, is rapidly disappearing. The racks have all been arranged in methodical order, admitting of the proper classification of published maps. Every available inch of space has been or will be occupied by additional racks reaching to the ceiling, fixed at a small cost in comparison to the great improvement made, as the accommodation will be more than doubled, which is necessary in view of the coming cadastral surveys.†

DRAWING OFFICE.

12. The two sections of the drawing office, viz. that which is principally employed in new compilations, and passing topographical maps on to the Photographic Office for reproduction and publication, and that which deals with all maps connected with revenue surveys, have done equally well. The statement given in the appendix shows the very large amount of work turned out. All details will be found in that statement, but particular attention may be called to the following which have been dealt with in section I. The district maps of Bengal, Assam, the North-West Provinces and Oudh, and the Punjab on the scale of 1 inch=8 miles for administration reports, all of which had to be specially drawn, with the exception of a few in the North-West Provinces, were commenced: the final orders and full instructions as to how these were to be prepared were only received in June 1884, and sanction was obtained for the entertainment of a small temporary establishment, the office not being able to cope with so large a task without the employment of extra hands. It is hoped that these maps will all be ready for printing by about March 1885, or earlier.

Rough preliminary editions of these maps had been prepared last year, but for reasons stated in that year's report were found to be unsuitable. As soon as they have been finally passed and approved by the local authorities, they will be engraved on copper by one of the new processes.

13. Provincial index maps for Assam, Bengal, the North-West Provinces and Oudh, the Punjab, Rajputana, and Central India are now completed, and all maps henceforth published will be furnished with these new numbers. Fresh

* The agency for the sale of maps was withdrawn from Messrs. Thacker, Spink & Co. during the year, partly on account of their persistent refusal to submit their accounts in proper time, and partly because this office is now able to undertake the sale of its own publications without the intervention of an agent.

† Colonel Wilkins reports that Mr. Byrn has given every satisfaction. Mr. Smart has performed the duties of map curator most efficiently, and Mr. Vallis has carried on the duties of map salesman most satisfactorily. Mr. Doran has had the charge of the re-arrangement of the printed records, and has shown intelligence and industry in carrying on work.

editions of all old maps will also have these new numbers given to them, and in this way the old, irregular indexes will be gradually superseded. Some of the sheets of Central India along the eastern boundary have been either redrawn altogether or have been filled up to margin, the blanks being copied from the revenue surveys of our territory, so that the series of 1-inch standard maps may be unbroken and complete: these will be renumbered according to the new index. One sheet on the 4-inch scale of the Andaman survey has been published, as well as maps of the two volcanic islands of Narcondum and Barren. The map of the Paropamisan mountains, by Pottinger, was redrawn and printed by photo-zincography for the use of the Boundary Commission, the whole process only occupying six days.

14. Of Afghanistan, a preliminary edition of sheet No. 12 was prepared for the use of the Zhob expedition, whilst sheets Nos. 5, 6, 8, 9, and 11 were redrawn and published in two colours, the outline in black and the hills in brown. Of Baluchistan, sheets Nos. 10 N, 10 S, and 7 N were published.

15. The old topographical sheets of the Nizam's dominions have been redrawn in the regular standard form on the 1 and $\frac{1}{2}$ inch scales, and in a style fit for reproduction by photo-zincography. The materials are very old, but they form the only maps of that part of the country. The following sheets have been completed and published:—11 sheets of Suggur, 1 sheet of Pangul, 1 sheet of Ghanpurra, 11 sheets of Raichur, 9 sheets of Golkonda, and 7 sheets of Koolberga. A 16-mile map of Guzerat, Kattywar, and Cutch has been completed in outline as far as materials exist: this, as well as the Punjab and North-West Provinces maps, on the same scale, will be eventually engraved. The North-West Provinces map is still in the hands of the draftsmen.

16. Some of the special maps drawn for the Calcutta International Exhibition have been prepared for publication: those exhibiting trade routes, distribution of languages, and river basins have just been printed: the rainfall, railway, and telegraph maps were already published. Those showing density of population, distribution of the different religions and missionary stations are under preparation. It has been found impossible without a very great expenditure of labour to prepare the forest map in such a way as to enable it to be printed; and the data forthcoming for the crop map occupies, comparatively speaking, so small a portion of India, and it is so laborious a map to draw, that it has been set aside for the present.

The maps of India, atlas sheets, and other engraved maps have been kept up to date as far as possible. The regular examination of maps before sending for reproduction, the correction of boundaries according to published orders, &c., have been carried on as usual. Besides this, a new edition of the military cantonment of Saugor on the 8-inch scale has been commenced; the necessary corrections having been obtained from the Executive Engineer's office. Standard Sheets on the 1-inch scale of districts Mozufferpore and Durbhunga in Bengal, and of Gogaira in the Punjab, have been drawn, and proofs have been sent to the local authorities for insertion of roads and canals, and for the examination of boundaries.

17. Eighty-seven 4-inch and 2-inch diagonal sheets of districts Bhagulpur, Durbhunga, Gonda, Bharaich, Kheri, and Terai, abutting on Nepal, were corrected and prepared for reproduction to scale by photo-zincography for the Foreign Office. These are intended especially to illustrate the boundary between Nepal and British territory, and are to be bound up into volumes for easy reference. The necessary computations for recompiling the old Bengal district maps into the uniform 1-inch Standard Sheets have been steadily carried on, but it is a very tedious and difficult matter making the necessary connection between the old maps and the modern triangulation. The final drawing of these maps is done by the Lithographic Office.

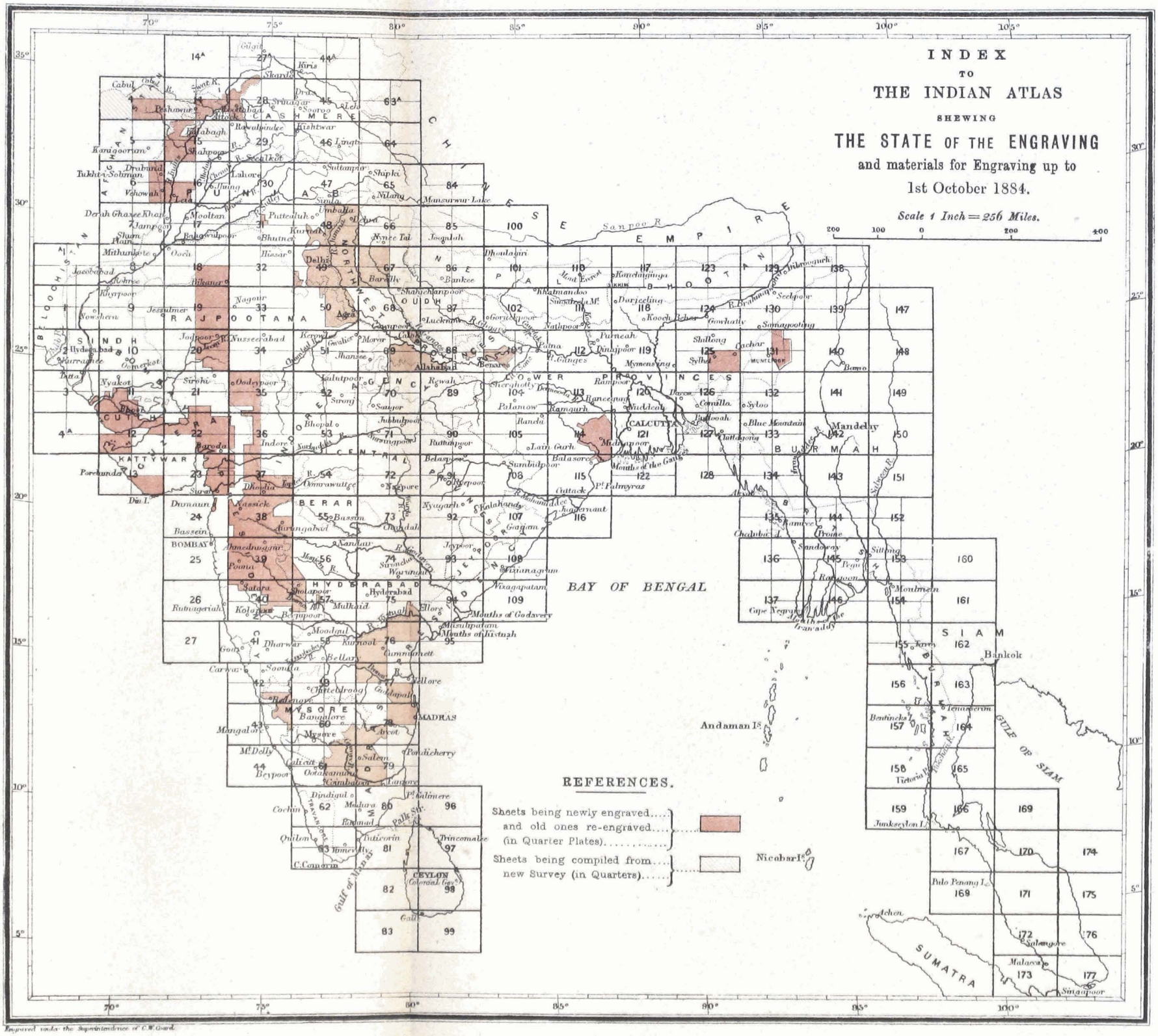
18. A good deal of extra pressure has been thrown on this section by the transfer of two of the assistants, both of whom were obliged to leave Calcutta on account of ill-health just as they had learnt their work in this office.*

* Major Strahan reports that Mr. Chamarett, the head draftsman in the Topographical Branch of this office, retired on a pension after 31 years' service, during which he had distinguished himself by zeal and ability. He was succeeded by Mr. G. A. McGill, who has performed his duties in a very satisfactory manner. Mr. Adams has been in charge of the examining section and to his exertions may be attributed its successful outturn.

Mr. Smylie, in charge of the Revenue section of the Drawing office, has done his work thoroughly.

Mr. Ewing, in charge of the Cadastral Examining office, is a very zealous assistant, and the remaining assistant Surveyors have all worked very satisfactorily.

To accompany Surveyor General's Report for 1883-84.



Published under the direction of Colonel G. C. DePrée, R.C., Surveyor General of India,
at the Survey of India Offices, Calcutta, February 1885.

ENGRAVING OFFICE.

19. The work in this office may be divided into three classes—(1) the lettering and outlining, (2) the hill etching, and (3) the copper-plate printing. The outturn in (1) and (3) is decidedly greater, but in (2) it is less than that of last year. The staff of hill-etchers is at all times small, and this year it has been seriously reduced by the death of one and the prolonged illness of another of the native engravers, in addition to the absence on furlough of two of the Europeans. To this alone is due the smaller outturn of work in class (2).

20. The work of the Printing office annually increases, and is likely to continue to do so with the introduction of heliogravure. This process will enable us to engrave on copper, at a comparatively small cost and in a very short time, maps which it would have been quite impracticable to engrave by hand. Several heliogravure plates of articles exhibited at the Calcutta International Exhibition last year have been printed, and the system is being gradually introduced as the assistants in the Photographic office become more expert.

21. The 64-mile map of India and the Himalayan route map have been published, and good progress has been made in the 32-mile map of India; sheet No. 4 of the latter (Bengal) has been completed, and the hills are being etched on sheet No. 1 (Punjab and North-West Himalayas), sheets Nos. 5 and 6 have been already completed, and sheet No. 3 is finished in outline. Four plates have been machine-ruled for section paper, and twelve plates of latitude and longitude scales on 1-inch and $\frac{1}{2}$-inch for all India have been engraved; one plate for projecting maps on the 1-inch scale has also been finished, thus completing the whole series of these graticule plates.

22. Seven quarter atlas sheets have been finished, forty-eight are in progress, and thirty-eight have been repaired and added to, showing an increase of work generally over that of last year.

23. The total number of plates in hand during the year was 210. The total outturn was as follows:—1,527 square inches of hill-etching; 50 square inches of jungle etched; 4,081 square inches of outlining and 259,202 letters cut. The Printing office pulled 19,054 impressions, of which 384 were transfers.*

THE LITHOGRAPHIC OFFICE.

24. Major J. Waterhouse was in charge of this office throughout the year.

Personnel.

Major J. Waterhouse, s.c., Assistant Surveyor-General, in charge.
Mr. H. L. Lepage,* Head Assistant.
„ L. C. Cunningham, Head Draftsman.
Munshi Mahommed Azim, „ Subhan Buksh, and 24 others, } Draftsmen.
Mr. D. Deas, Head Lithographic Printer.
„ B. Wilson, Assistant ditto, and 74 others.
„ E. DePyvah, Head Type Printer, and 25 others.
Five clerks and 12 others.
Mr. G. A. LeFranc. " E. Dowling. } Apprentices.

* Returned from furlough on 5th July.
Mr. A. G. Palmer officiated for him until 1st May, and Mr. L. C. Cunningham till his return.

The number of maps, plans, drawings, &c., printed off during the year amounts to 702, of which 202 (including 49 forms) were departmental and 500 extra departmental. The type work shows a large increase both in subjects printed and in the number of impressions.

25. A third edition of the map of India, scale 1 inch=32 miles, in six sheets, has been prepared and published during the year, with additions and corrections to date. A map of Afghanistan on the scale of 1 inch=4 miles has been commenced, and one sheet, with hills drawn on stone, is nearly completed.

26. A commencement has been made of lithographing the series of maps showing the material state and progress of India, which was exhibited at the Calcutta Exhibition. Maps of India on the scale of 1 inch=96 miles, illustrating the Distribution of Languages and the Principal River Basins, have been prepared and printed. An Irrigation Map on the 32-mile scale and a Missionary map on the 64-mile scale have been prepared, but not printed.

27. Further progress has been made with the Contour Map of India, but it is not yet printed off.

28. Among the provincial maps is one of the Nizam's Dominions, in two sheets, on the scale of 1 inch=16 miles, drawn on stone by Mr. Cunningham, the head draftsman. The drawing of one sheet was completed, but it has not been printed.

* Major Strahan reports that Mr. Coard, the head engraver, took furlough for 6½ months, and Mr. Palmer was appointed temporarily to the vacant post till the end of the year. Mr. Coard Mr. Palmer, and the European and native assistants have continued to perform their duties satisfactorily.

29. Ten sheets of the new edition of standard sheets of Oudh on the 1-inch scale have been drawn, and four published during the year. Six new district maps, viz. Jubbulpore, Lakhimpur, Howrah, Chanda, Cachar, and Hoshungabad, have been prepared by transfer from the engraved sheets of the Atlas of India, and the three first have been printed off: three sheets of the Indian Atlas have also been transferred to stone and printed off.

30. The amount of extra departmental work again shows an increase; 496 subjects, comprised in 500 sheets, were received, and 108,146 copies printed, the value of the work being Rs. 23,213.

31. The Rainfall Chart of India, noticed in last year's report, was completed and printed.

32. A crown-size lithographic machine, suitable for working by hand, indented for last year, was received at the close of the year. After some necessary repairs it has been set up, and is likely to prove very useful for printing jobs of the full size of a sheet of foolscap, such as forms and the new provincial and district administration maps, of which large numbers will constantly be required. The outturn, when working by hand, is about 300 an hour.

33. A series of specimens of maps and drawings executed in the office was exhibited at the Calcutta International Exhibition and gained a gold medal.*

THE PHOTOGRAPHIC OFFICE.

34. The outturn of the Photographic Office is shown in the annexed abstract. The number of original drawings, &c., sent in for reproduction was 211 less than last year, and consequently there is a falling off in the outturn of the presses, especially in the item of departmental maps. The extra departmental work shows, however, a slight increase. The total number of cadastral maps reproduced was 5,202, or 89 more than last year, but the number of copies printed off was 6,825 less than last year. In addition to the ordinary photo-zincographic work of the office, a much larger amount of silver printing has been done than usual, and the collotype and heliogravure processes have been developed and utilized in connection with the Calcutta International Exhibition.

Personnel

Major J. Waterhouse, B.S.C., Assistant Surveyor-General in charge.

NEGATIVE SECTION.

Normal Establishment.

Mr. J. Mackenzie, Photographer, 11th January to 30th September 1884.
„ Mr. A. W. Turner, Officiating Photographer, 13th November 1883 to 10th January 1884.
C. DeCruze, Assistant Photographer.
Ismail Khan, ditto.
2 Negative Retouchers, 2 Glass-cleaners, and 1 Bhistee.

Cadastral Establishment.

Mr. C. Marshall, Photographer.
„ L. Lagnier, ditto.
„ T. Lloyd, Assistant Photographer.
„ J. B Mackenzie, Assistant Photographer, 1st September 1883 to 31st July 1884.
3 Assistant Photographers, 3 Negative Retouchers, 5 Glass-cleaners, and 1 Bhistee.

PHOTOGRAPHIC TRANSFER PRINTING SECTION.

Normal Establishment.

Mr. J. Harrold, Photographer.
Habibul Hossain, Assistant Photographer.
2 Labourers.

Cadastral Establishment.

Mr. R. George, Photographer.
2 Assistant Photographers, 4 Labourers.

SILVER PRINTING SECTION.

Normal Establishment.

Mr. G. G. Dempster, Photographer.
1 Assistant Photographer and 1 Labourer.

HELIOGRAVURE AND COLLOTYPE SECTION.

Normal Establishment.

Mr. A. W. Turner, Photographer, from 1st May 1884, for 8 months.
Baboo Kally Das Seal, Draftsman and Engraver, transferred from the Marine Survey Office, 1st September 1884.
1 Assistant Photographer, 4 pressmen, and 1 copper-plate printer.

ZINC PRINTING SECTION.

Normal Establishment.

Mr. B. Mackenzie, Zincographer.
1 Writer, 4 zinc-correctors, 5 zinc-printers, 4 spongemen, 14 pressmen, and 3 grainers.

Cadastral Establishment.

Mr. J. Watson, Zincographer.
„ E. A. LeFranc, ditto.
„ J. B. Mackenzie, Assistant Zincographer, 1st August to 30th September 1884.
1 Writer, 9 zinc-correctors, 9 zinc-printers, 6 spongemen, 30 pressmen, and 11 zinc-grainers

GENERAL OFFICE ESTABLISHMENT.

Normal Establishment.

Mr. W. Moore, Store-keeper.
Baboo Kanny Lall Sen, Clerk and Accountant.
1 Clerk.

Cadastral Establishment.

Mr. H. Maward, Head Assistant, from 11th January 1884.
Mr. J. Mackenzie, Officiating Head Assistant, 1st September 1883 to 10th January 1884.
1 Clerk.

APPRENTICES.

Normal Establishment.

C. J. Meade.
J. T. Meade.
S. U. Ravenscroft.
P. C. Michael.

35. Statements showing the comparative outturn of the various sections of the office during the present and

* Major Waterhouse reports favourably of the conduct of the European assistants, Mr. H. L. Lepage, Head Assistant, Mr. A. G. Palmer, Officiating Head Assistant, Mr J. Watson, Officiating Head Printer, Mr. D. Deas, Head Printer, Mr. L. C. Cunningham, Head Draftsman, Mr. B. Wilson, Assistant Lithographic Printer, and Mr. E. DePyvah, Type Printer. The native draftsmen and clerks have also worked satisfactorily.

past year, of expenditure and value of work done, and of work done for other departments are given in the appendix.

36. The value of the printed maps and other subjects printed during the year has been—

	Rs.
Departmental	23,986
Extra departmental	24,568
Cadastral	73,358
Other receipts	4,721
Total ...	1,26,633

37. The expenditure for establishment and stores has been heavy during the year owing to the cost of new presses and apparatus, as well as increased establishment and house-rent, and amounts to Rs. 1,27,763, or Rs. 1,230 in excess of the receipts.

38. Mr. H. Haward, who was appointed Head Assistant by the Secretary of State for India, arrived in January, and as he was specially skilled in working the photo-collotype processes, and brought out with him a fresh supply of the necessary apparatus and stores, a commencement was again made with this useful but delicate and difficult process. Mr. Haward has succeeded fairly well in overcoming many of the difficulties which beset such work in this country, and has reproduced and printed off 1,150 copies of the gold medal award certificates for the Calcutta International Exhibition, and has also, by way of practice and training for his assistants, printed several plates from a series of negatives of Indian art-work taken during the Exhibition. The process is exceedingly well adapted for delicate work of this kind, and for other purposes where copies of ordinary photographs are required in large numbers.

39. The heliogravure processes have also made good progress during the year. With the aid of Mr. A. W. Turner, Major Waterhouse has introduced a new process which has some advantages over the one hitherto in use, and appears likely to be successful and particularly useful for map work. In the ordinary heliogravure or photo-electrotype process, described in full in the appendix to the annual report for 1881-82, the engraved copper plate is obtained by developing a positive pigment print, or relief in hardened gelatine, on a silvered copper plate, and then depositing copper upon it so as to form a new copper plate which bears the design in intaglio and is capable of being printed in the copper-plate press.

In the new process a *negative* pigment print is developed on a copper plate, and the intaglio image is obtained direct on the plate by biting in with a chemical solution which penetrates the gelatine film comparatively easily in those parts representing the shadows of the picture or lines of a map, where there is little or no gelatine, and bites the copper to a considerable depth; whereas, in the parts representing the light of the picture or the ground of a map, where the gelatine is thicker, it penetrates with more and more difficulty as the thickness of the gelatine increases, and in the highest lights should leave the copper untouched. The operation of biting does not take more than five minutes, and the engraved images are marvellous in their delicacy of gradation and richness of effect. The greatest care has, however, to be taken with such delicate work, and it is difficult to get sufficient depth to stand printing without the loss of the finest tints. Much may, however, be done by rebiting, especially in line work, such as maps, and it is in this direction that the process seems most likely to be useful, and has already been employed in reproducing some of the new administrative maps of districts. Its great advantage is its rapidity, a day or at most two being sufficient to prepare the etched plate, whereas by the photo-electrotype it takes three weeks or

a month to deposit a printing plate of sufficient thickness. Full details of the new method as worked out by Mr. Turner are given in the appendix.

40. Besides the preparation of a series of specimens of the work produced by the various processes employed in the office, for the Calcutta International Exhibition (for which a gold medal was awarded to the office), a good deal of work was done in connection with the Exhibition by heliogravure and collotype in printing the award certificates and photographing and reproducing a series of 200 photographs of some of the principal objects of Indian art-work exhibited from various parts of the empire. The photographs were taken by Mr. Turner at the cost of the Government of Bengal, and it is proposed to publish a selection of them in a permanent form as soon as a sufficient number of plates can be got ready. Several sets of silver prints of these photographs have been printed in the office.

41. The operations of the office were interfered with by a fire which occurred on the 1st November in the upper story of No. 1, Wood Street, and necessitated the repair of the premises, besides entailing considerable loss and damage to public property, as already fully reported.

42. Under the orders of Government, four apprentices have been entertained in the office, viz. C. J. Meade, J. T. Meade, and S. U. Ravenscroft from the 1st August, and P. Michael from the 1st September. The lads are of a good stamp, industrious and steady, and seem likely to be useful.*

A.

Abstract of Work performed in the Photographic Office, Survey of India Department, from 1st October 1883 to 30th September 1884.

	Original sections or sheets.	Negative plates.	Photographic transfer prints.	Number of plates.	Number of pulls.	Number of printed sheets of each subject.		Silver and other prints.	Collotype prints.	Heliogravure plates.	Cost.
						Single.	Combined.				Rs. A. P.
General maps	16	49	53	52	3,840	2,748	1,203	...	...	...	1,570 11 4
Provincial maps	5	10	10	5	708	708	604	...	...	...	255 15 10
Divisional ,,	4	16	16	...	...	...	...	...	...	...	164 4 0
District ,,	40	60	60	19	1,809	2,160	1,719	8	...	...	1,053 14 4
Plans of cities and cantonments	8	24	24	11	1,130	1,130	980	...	...	...	562 15 10
Atlas sheets	1	6	6	1	50	50	50	...	...	...	73 1 9
Standard sheets	253	583	592	129	21,381	21,431	19,398	...	...	...	11,330 13 11
Index maps	11	15	24	16	4,548	8,518	4,318	...	...	...	580 6 1
Technical charts	5	8	8	3	80	105	105	...	...	...	117 13 8
Miscellaneous maps and plans—departmental	208	248	175	108	7,746	7,763	6,655	646	790	10	4,292 15 4
Ditto ditto— extra departmental	390	852	961	369	57,918	60,222	78,620	1,557	2,523	4	21,374 12 9
Transfers and proofs	...	...	...	...	2,262	...	...	...	...	...	.....
Total	941	1,869	1,929	713	101,472	133,844	113,452	2,211	3,313	23	41,383 12 10
Cadastral—North-Western Provinces.											
Photo-zincographs	805	805	873	876	9,335	9,335	5,158	...	...	...	13,439 14 0
Zincographs	916	...	...	916	9,446	9,446	7,700	...	...	...	9,263 8 0
Total	1,721	805	873	1,792	18,781	18,781	12,858	...	...	...	22,703 6 0
Cadastral—British Burmah.											
Photo-zincographs	1,347	1,349	1,321	1,154	19,136	19,136	18,510	...	...	...	18,680 6 0
Zincographs	512	...	...	512	17,397	17,397	7,775	...	...	...	5,724 1 0
Total	1,859	1,349	1,321	1,666	36,533	36,533	26,285	...	...	...	24,404 7 0
Cadastral—Bengal.											
Photo-zincographs	824	824	801	827	33,626	33,626	7,092	...	...	...	15,056 3 0
Zincographs	798	...	...	798	33,604	33,604	11,739	...	...	...	11,491 5 0
Total	1,622	824	801	1,625	67,230	67,230	19,731	...	...	...	26,547 8 0
Transfers and proofs—Cadastral maps	...	...	...	...	10,647	...	...	...	...	...	.....
Cadastral Maps Total	5,203	2,978	2,995	5,083	133,191	122,544	68,874	...	...	...	73,655 5 0
GRAND TOTAL	6,143	4,847	4,924	6,796	234,663	256,388	172,326	2,211	3,313	23	115,039 1 10

* Major Waterhouse reports favourably of his European assistants: Messrs. J. Mackenzie, B. Mackenzie, J. Watson, J. Harrold, C. Marshall, R. George, L. Lagnier, A. E. LeFranc, and G. G. Dempster, also of the Head Clerk Baboo Kanny Lal Sen, who have all worked with their usual zeal and steadiness. Mr. A. W. Turner, who was appointed temporarily as special assistant, has done good service, and been most useful in developing the heliogravure processes and doing work connected with the Exhibition. Mr. H. Howard has worked hard and steadily in overcoming the difficulties of collotype-printing.

MATHEMATICAL INSTRUMENT OFFICE.

43. During the financial year 1883-84 this office has been fully employed in supplying the ever-increasing demands for instruments and repairs which are made on it by all the departments in India.

Personnel.

Major R. V. Riddell, R.E., from 1st to 18th April 1883.
Major M. W. Rogers, R.E., from 19th April.

Workshop Branch.

Mr. T. Bolton, Mathematical Instrument-maker.
„ F. Marshall, Assistant ditto.
64 Artificers on the permanent establishment.
91 (on an average) artificers on the contingent establishment.

Store Branch.

Mr. G. R. Alderman, Instrument Store-keeper.
Babu Womesh Chunder Chowdhry, Material Store-keeper.
1 Packing sircar.
2 Packers.

Office Establishment.

Mr. M. O'Brien, Head Clerk.
„ C. O. Grey, 2nd clerk.
6 Other permanent clerks.
1 Extra clerk, from 1st April to 16th July 1883, made permanent from 17th July 1883.

The equipment of two new cadastral survey parties caused a large demand for new instruments, and an extra grant of Rs. 5,000 was obtained from Government and fully utilized.

44. As was mentioned in last year's report, the increased demand for current repairs necessitated a corresponding diminution in the manufacture of new instruments and in the repairing for re-issue of any portion of the great stock of repairable instruments which has been accumulating in the Store Branch. A representation of this was made to the Surveyor-General by the officer in charge, and sanction was obtained from Government for a temporary extra grant of Rs. 300 per mensem for the workshop establishment, by means of which it is hoped that some impression will be made on the large accumulation of repairable instruments. The effect of this grant is not, however, apparent in the year under report, as the money was not sanctioned until its close.

45. A great change was introduced in the system of keeping the workshop accounts, and the procedure was greatly simplified, with the result of diminishing the clerical labour without impairing its accuracy and the constant check which it is necessary to keep on the issue and consumption of materials.

46. The stock was increased by a total receipt of 35,375 instruments, amounting in value to Rs. 1,30,059, the detail of which is as follows:—5,746 instruments, in value about Rs. 55,934, were received from England; 10,888 were locally purchased at a cost of Rs. 10,495; 14,866 were manufactured in the workshop at a cost of about Rs. 22,833; 3,875, valued at Rs. 40,797, were received by departmental exchange, of which 559 were serviceable and 3,316 were repairable. Further, 1,428 instruments, forming part of the repairable stock, were repaired on the premises and rendered fit for future issue at a cost of Rs. 10,721, which, after repair, were valued at Rs. 36,296. This, for the reasons above stated, is a considerable decrease from last year.

47. The issue of instruments to various departments during the year amounted in number to 33,365 and in value to Rs. 1,61,529. Their distribution was as under—

	Number.	Value.
		Rs.
Survey of India Department	19,954	66,155
Public Works „	4,560	50,258
Marine „	67	4,104
Telegraph „	20	737
Military „	1,098	8,080
Educational „	432	2,122
Forest „	952	4,306
Miscellaneous „	4,854	22,430
Road Cess Committees, &c., on payment ...	894	2,194
Workshops to complete repairs	575	1,377

Thus the total number of instruments issued was in excess of last year by more than 12,000, their value being Rs. 34,000 greater.

48. The average number of theodolites and levels issued annually during the previous three years ending 31st March 1883 was 96 for the former and 135 for the latter instruments. During the year under report the numbers were

respectively 103 and 100, of which one-third were instruments repaired and made serviceable from the stores of the office.

49. The number, class, and cost of the principal instruments purchased were as follows:—

	Number.	Value. Rs.
Compasses, magnetic, for plane-tables	40	240
Glasses, binocular	7	259
Levels, dumpy	1	260
Plane-tables, deal	370	2,590
Ditto stands	377	2,969
Pins for chains	9,300	869
Rules, sight, for plane-tables	375	1,125
Scales of various sorts	53	111
Squares, optical	100	750
Tapes, measuring	86	537

It will be seen on comparison with former years that there has been a considerable increase in the purchase of articles of country manufacture, such as plane-tables, sight-rules, &c., which were required to compensate for the decreased manufacturing powers of the workshop alluded to above.

50. The chief articles manufactured in the workshop and the cost of their manufacture were as under:—

	Number.	Value. Rs.
Apparatus for earthquake observation	1	600
Bars, standard, steel	6	190
Boards, drawing	48	645
Chains, measuring	671	5,725
Clinometers, survey pattern	50	1,440
Compasses, magnetic, for plane-tables	59	810
Glasses, tracing	5	293
Plane-tables	57	526
Pluviometers	32	440
Pins for chains	4,800	700
Rules, flat, ebonite	450	250
Do. for plane-tables, metal	14	262
Scales, ivory, offsets	851	386

51. The total number of instruments repaired in the workshop was 3,257, and the cost of the repairs Rs. 26,613. The principal instruments repaired were as follows, viz:—

Anemometers	8
Arithmometers	1
Barometers	63
Chains	160
Clinometers	15
Compasses, drawing	399
Ditto, magnetic	126
Ditto, prismatic	214
Ditto, surveying	107
Glasses, binocular	32
Heliographs, &c.	35
Hydrometers	35
Instrument boxes, 1st, 2nd, and 3rd sorts	39
Levels, dumpy, &c.	143
Machines, hand and map-printing	15
Plane-tables	41
Rules, flat, parallel, and sight	202
Range-finders	15
Squares, optical	139
Sextants	16
Stands for various instruments	390
Staves, levelling	139
Tapes	56
Telescopes	67
Theodolites	118
Thermometers	39

The number of theodolites and levels, which require the greatest care and good workmanship, was 261, being a small decrease from last year, when the number was exceptionally great. The system of local manufacture mentioned in paragraph 297 of last year's report was carried on with good results, careful inspection being made of all articles supplied.

52. The profit and loss account of the workshop shows a profit of Rs. 14, the charges having amounted to Rs. 51,208, whilst the work done was calculated at Rs. 51,222. This shows that the percentages for supervision and the prices charged for the work were very correct. The cost of the remaining portion of the establishment, including supervision, packing expenses, office accommodation, &c., was about Rs. 18,548, which may be considered as representing the expenses connected with the receipt and issue of about 69,491 instruments, valued at about Rs. 3,08,000.

THE TRIGONOMETRICAL BRANCH OFFICE.

Dehra Du'n.

53. The principal work of this office is the final reduction and publication of the triangulation of all parts of India, including the principal and secondary operations of the Great Trigonometrical Survey, and also the publication of the Topographical Surveys executed by the Trigonometrical Branch of the Department, as well as by the Forest Survey Department. Most of the publications being necessarily of a technical nature, and the office being located at Dehra Dún, at a considerable distance from Calcutta, it has small drawing, photo-zincographing, and printing establishments of its own; it is thus independent of all extraneous assistance in publication, excepting as regards book-binding, which is done mostly at Calcutta and Roorkee. The office has also a depôt of instruments and stores attached to it, chiefly of the higher class of instruments appertaining to the Great Trigonometrical Survey, of which it was long the head-quarters office.

Personnel.

W. H. Cole, Esq., M.A., Offg. Deputy Superintendent, 3rd grade, in charge.

Computing Branch.

Mr. C. Wood, Surveyor, 1st grade.
„ H. W. Peychers, Surveyor, 3rd grade.
Baboo Ganga Pershad, Computer
„ Cally Mohan Ghose, Computer.
„ Kally Coomar Chatterji, Computer, and 10 other computers, &c.

Printing Branch.

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

Correspondence, Stores, &c.

Mr. J. Bond, Offg. Surveyor, 4th grade.
2 Native writers.

Photo-zincographic Branch.

Mr. C. G. Ollenbach, Zincographer.
„ C. Dyson, Photographer.
2 Native draftsmen.
1 Do. Assistant draftsman.
1 Do. Map-keeper.

Drawing Branch.

Mr. G. W. E. Atkinson, Surveyor, 2nd grade.
Mr. H. Sindon & 5 other draftsmen.
19 Assistant draftsmen and map colorists.

Solar Photography.

Mr. L. H. Clarke, Surveyor, 2nd grade, Solar Photographer.
Mr. C. F. Guthrie, Assistant to ditto.

54. The final reduction and publication of the various operations of the Great Trigonometrical Survey have been proceeded with; but the progress has not been so great as could be desired, owing to much extraneous work having fallen on the computing branch. This consisted in the preparation of A—K's narrative of his explorations and tabular data for the press, and the reading of the proofs as they were printed; in the translation and preparation for the press of a report on Dardistan for the Foreign Office; in the equipment of the Afghan Boundary Survey Party, on which much time and labour were expended; and, lastly, in affording assistance to the two Astronomical Parties, besides minor duties.

55. The reduction of the astronomical latitude observations has continued to be carried on. It was at one time hoped that the actual calculations would have been completed under the able superintendence of the late Deputy Surveyor-General, Mr. Hennessey; but there is still a good deal to be done before the results can be prepared for publication.

56. A commencement has been made with the final reduction of the principal triangulation of the South-West Quadrilateral; but it is not intended to do more at present than can be accomplished by one pair of computers, because

Major Rogers reports most favourably on the services of Mr. T. Bolton, the Mathematical Instrument-maker, and of his Assistant Mr. F. Marshall; the Instrument Store-keeper has not altogether given satisfaction, but with this exception the store and office establishment have continued to work well.

so much remains unfinished in connection with those quadrilaterals, of which the principal triangulation already stands reduced, especially in connection with the secondary triangulation. The synoptical volume of the Assam Longitudinal Series, comprising also the Assam Valley Series, and a considerable amount of secondary work, has been made ready for the press.

The remaining work performed by the Computing Branch is of a somewhat miscellaneous character, as will be seen by reference to the appendix.

57. As regards the publications of this office, those synoptical volumes—*i.e.*, volumes furnishing abstracts of trigonometrical data suitable for local wants—which were in the hands of the binder last year, have since been published, as have also volumes XIX, XX and XXI of the N. Párasnáth, N. Málúncha, the Calcutta and Brahmaputra Meridional, and the E. Calcutta Longitudinal and Eastern Frontier Series. A pamphlet of levels from False Point to Howrah has also been published.

The synoptical volume of the S. Pársanáth and S. Málúncha Series is nearly ready for the binder.

58. Of works in the press, there are the details of the principal triangulation of the Southern Trigon; the details of the Eastern Sind and Jodhpore Meridional Series; the Electro-Telegraphic Longitude operations of season 1881-82; the synoptical volume of the Assam Longitudinal Series; the spirit-levelled heights between Bombay, Madras and Karwar, and sundry other publications.

59. The time of the Drawing Office has been also much occupied with extraneous work; and the publication of the level charts—on which are shown the results of the levelling operations for canals, railways, and other public works, after having been connected with the main lines of levels of this survey and reduced to mean sea-level—has been impeded. Those sheets now in hand, of which some will very shortly be published, are Nos. 6 (2nd edition), 12 (3rd edition), 67, 81, 83 and 88. The importance of these charts is very great.

60. A revised map in 3 sheets of A—K's explorations, with an index showing a sketch of the Jángtháng, and also a plan of Lhása, was prepared and published; and maps for the use of the Afghan Boundary Commission were compiled and printed.

61. All the new maps received during the current year from the Guzerat and Cutch Parties were examined and published, as also several second editions of maps of Kattywar. For the Forest Survey Department, 14 maps were printed, and an ancient classic, called Janum Sakhi, a book of 460 pages in the Gurmukhi language, was reproduced for the Punjab Government.

62. The protection of the principal stations of the Great Trigonometrical Survey has been a subject of care as heretofore. There are now 3,590 stations in 339 districts on the lists. Of 317 district officers from whom annual reports were due, 68 failed to submit them.

63. Solar photographs for the Solar Physics Committee, South Kensington, have been taken throughout the year as directed by the Secretary of State for India. The sun was invisible on 78 days, and three other days were lost owing to the illness of the photographer.

64. The large photo-heliograph for taking sun-pictures, 12 inches in diameter, has not given satisfactory results. It has recently been reported on by a Committee, consisting of Colonel Haig, Major Waterhouse, and Mr. Cole, who have investigated the causes of failure, and have recommended that the object glass and enlarging lenses should be sent to England for examination, both as to their absolute powers and their relation to each other, which it is feared is faulty.*

* Mr. Cole makes special mention of Messrs. Wood, Atkinson, Peychers, Bond, and Baboo Ganga Pershad, and speaks favourably of the services rendered by Messrs. Clarke, Hughes, Ollenbach, Dyson, and Guthrie, and of Baboos Cally Mohan Ghose, Shivanath, and Shoshee Bhushan.

APPENDIX.

EXTRACTS

FROM

THE NARRATIVE REPORTS OF THE EXECUTIVE OFFICERS

IN CHARGE OF

THE SURVEY PARTIES AND OPERATIONS.

Extract from the Narrative Report of MR. A. D'SOUZA, *Surveyor, 1st grade, in charge Secondary Triangulation Party;—season 1883-84.*

THE station pillars and beacons which were built were made over to the village officials for safe custody, and receipts for them, in due form, were obtained.

Mr. Potter was engaged throughout the season on the approximate work, cutting rays, and building beacons and stations.

Locale.
Coast of Orissa.

I had provided myself with a large wooden trestle (which I had constructed at the Jobra workshop at Cuttack) 12 feet in height, on which the usual instrument trestle could be placed for observations, thus giving me a height of 17 feet to make my observations from; and the signals were shown from a scaffolding 14 feet high, made of bamboos, over the station mark. Yet, with all these appliances, rays had to be cut in every case in order that the stations may be mutually visible. Ray, cutting in such a country as this is a most trying work, for not only is the country covered with dense jungle, consisting generally of tangled thorny bushes, bamboos, and the jungly date (*hartal*), but it is subject to the overflow of the tides, and is so swampy that the men had on several occasions to wade knee-deep in slush while engaged in cutting the rays. Numerous tidal creeks, dangerous to cross without a boat, and in many cases embanked so as to form deep permanent channels, added to our difficulties, and we were obliged to construct rafts to carry the men across—a course which entailed much waste of time, inasmuch as no ray took less than from 10 to 12 days to cut, and one at Jambu very nearly a month.

Sickness.—Although the country has the reputation of being very unhealthy, the party suffered but little from sickness. There was, however, one case of sporadic cholera at Jambu, to which the patient succumbed within 48 hours. Every precautionary measure was taken to prevent the disease spreading, and the party was removed as soon as possible to a more healthy part of the country. Three other men were attacked with the same disease in the railway train while on their way to their homes. One of these died at Benares, but the others recovered.

Description of country.—The country through which the survey operations were carried on is the coast of Orissa from Pooree to Balasore, about 170 miles in length and 3 miles in breadth, covering an area of about 510 square miles. This tract may be divided into three parts, as each has a distinct natural aspect which is very remarkable. The first is the coast line from Pooree to the mouth of the Devinadi. This tract, lying in the Pooree district, is an open, barren, sandy strip of land, having on one side a range of sand-hills of the average height of 30 feet skirting the sea-coast, and on the other rich arable lands.

There are two rivers which flow through it—one the Kusbhadra and the other the Nunnadi; the former a distributary of the Kaokye, from which it branches off at about 13 miles south of Cuttack, and flowing in a southerly direction enters the sea west of the Devinadi; the latter is a deep river, navigable by country boats, which passes by Telikud thana, and flowing parallel along the coast joins the western branch of the Devinadi before it debouches into the sea.

No difficulties of any kind were experienced in this portion of the work, as carts can be used everywhere, and provisions and labour were readily supplied by the zemindars through whose lands the triangulation was carried on.

The coast line from the mouth of the Devinadi to the Dhamra river, the greatest portion of which is in the Cuttack district, is very unhealthy and presented serious obstacles to the progress of the work, being covered with dense jungle and intersected with rivers and tidal creeks. It resembles the margins of the Sunderbuns bordering the sea-coast, which are subject to the overflow of the tides, and are notoriously malarious. This tract is almost destitute of inhabitants, and boats had to be resorted to as the only means of communication and carriage. Provisions and labour had to be procured from villages in the interior, in some instances many miles from our work, and building materials had to be brought from towns such as Pooree, Cuttack, and Balasore—chiefly by boats—the distance from any of them to the places where they were required often exceeding one hundred miles. Depôts were formed in different portions of the work, so that no time was lost in supplying the materials as they were wanted.

The third or remaining portion of the coast line from the mouth of the Dhamra to Balasore is a barren strip of salt waste (a few small muddy streams crossing it here and there, whose banks are fringed with mangrove jungle and subject in some places to the overflow of the spring tides): portions of this tract are taken up for the manufacture of salt. Carts and pack bullocks can be used here, but these are with difficulty obtained, as they are very much in demand for conveying grain to the different ports, and for the construction of the new canal from Charbatia to Midnapore.

Kanarak Temple or Black Pagoda.—One of the most noteworthy places in this tract is the temple at Kanarak $\frac{\text{Lat. } 19^\circ\ 53'\ 12''\cdot4}{\text{Long. } 86^\circ\ 8'\ 15''\cdot0}$. It is now in ruins and forms a conspicuous land-mark for coasting vessels. This ruined temple, known also as the black pagoda, is dedicated to Jagannath. There seem to have been two buildings, the outer and inner hall: of these, the former only remains; the other has been destroyed and lies in a heap of stones covered with trees and tangled creepers.

Rivers and estuaries.—Besides the Budhabalanga, on the bank of which is the town of Balasore, there are three noble estuaries by which the three great rivers, viz. the Dhamra, the Mahanadi, and the Devinadi, empty themselves into the sea. The Dhamra, with its branch the Maipara, is the largest river in Orissa. It receives the combined waters of four large rivers, the Baitarni, the Brahmini, the Kharsua, and the Matai, all of which are navigable to a certain extent by craft of 100 to 200 tons burden. The channel of the Dhamra is broad and deep, and is capable of admitting vessels of 500 tons burden up to Chandbali. Point Palmyras palm, an intersected point of the old triangulation, was formerly used as a land-mark by vessels entering the harbour, but it has been blown down. Two beacons have now been built here, one on Budara station of *paka* masonry 15 feet high, obelisk-shaped, a little south of the old position of the palm; the other a wooden cross of about 12 feet in height, embedded in a masonry pillar on Gordon island: both of these will be of great assistance to vessels making for the harbour. The beacon on Shortt's island, where it is proposed to build a light-house, has also been fixed by triangulation together with the buoys in the harbour. Passing close to the False Point light-house where it debouches into the sea, there is a sandy shoal across the mouth of the river Mahanadi through which a passage was made by the stream in 1863, and another in 1874, called the southern entrance, which is in a line with the direction of the course of the river as it leaves Barkud. The channel is deep and broad for a considerable way up, but the sand bar and heavy breakers at the mouth present serious difficulties to vessels entering it, though country and cargo boats and small river steamers do ply continually up and down, conveying grain and salt to the different marts, and to False Point harbour by the Barkud creek for shipment to other ports.

The Devinadi, a branch of the Kathjori, falls into the sea in $\frac{\text{Lat. } 19^\circ\ 87'}{\text{Long. } 86^\circ\ 23'}$. It is broad and deep for some considerable distance inland. This estuary would make an excellent harbour but for the shifting shoals and heavy surfs at the mouth. At about 10 miles from the mouth is a trading river port of some importance; and when the canal thereto from Cuttack is complete, I have no doubt it will form one of the principal trading centres of the district. From the Devinadi to False Point and from False Point to the Dhamra, there is a continuous waterway through tidal creeks and by canals.

Harbours.—There are six harbours on the coast between Pooree and Balasore, viz. False Point, Chandbali, Dhamra, Churaman, Laichanpur, and Balasore.

False Point harbour, $\frac{\text{Lat. } 20^\circ\ 24'}{\text{Long. } 86^\circ\ 49'}$, is, however, considered to be the best and safest on the coast. Although the capabilities of this port were known many years ago, it was not made much use of either by Government or the mercantile public till 1866. A port was then required for the importation of grain for the relief of the famine-stricken people of Orissa, when False Point harbour was found to be, not only a convenient, but a safe one for the purpose. Since the opening of the Kendrapara canal, by which direct communication was effected with Cuttack, a great impetus has been given to the trade in grain and other produce. The anchorage is commodious and well sheltered by Dowdeswell and Long islands, and vessels of large tonnage can anchor here in perfect security during all weathers. There are two channels that lead into the interior from the harbour—one by the Jambu river into the Kendrapara canal to Cuttack, the other by the Barkud creek into the Mahanadi to Butmundi. To the east of the harbour is the barren sandy Dowdeswell island, also called Hookey-tollah, about 5½ miles in length by about one thousand yards in breadth in its widest part, on which reside the Port and Custom House officers, and where there is also a traveller's bungalow, a refuge house, a tide gauge, and a post and telephone office. As there are no bazars on the island, supplies have to be brought from Jambu.

The place is unhealthy; all who have resided there for any length of time having suffered more or less from malarious fever. A settlement was formed some years ago at Jambu, on the mainland opposite to False Point harbour, where some very nice bungalows were built; but they have since been abandoned, and the community at present consists of a native merchant, engaged in exporting rice, and a small village of Coringies, who have settled down there. Besides the country rice sloops and vessels of heavier burden that call at this port, the British India Steam Navigation Company's steamers touch here every week and the Inland steamers twice a week.

False Point Light-house, $\frac{\text{Lat. } 20^\circ\ 19'}{\text{Long. } 86^\circ\ 45'}$, lies six miles south of the harbour.

Chandbali, $\frac{\text{Lat. } 20^\circ\ 46'\ 20''}{\text{Long. } 86^\circ\ 49'\ 0''}$, is on the left bank of the river Baitarni in the Balasore district. It is about 18 miles inland from the mouth of the river Dhamra. This town has risen to some importance only within the last few years, since the opening of the canal which connects it with Cuttack. There now reside there at present, besides a number of native traders and two European firms exporting grain and other country produce, a Sub-Collector and Port Officer, who is also a Magistrate. Three weekly steamers ply between this port and Calcutta, conveying merchandise and a large number of passengers to and fro, mostly pilgrims on their way to the famous Hindu shrine of Jagannath at Pooree, and domestic servants and palki bearers who resort to Calcutta in numbers in search of employment.

Dhamra, $\frac{\text{Lat. } 20^\circ\ 46'}{\text{Long. } 86^\circ\ 59'}$, is situated on the left bank and close to the mouth of the river Dhamra. It has a good and safe anchorage, but is not of much importance, as the trade of the country is taken up mostly by Chandbali, which is but a few miles up the river. A number of native craft call here for freight, which is chiefly rice. It is under the superintendence of the Port Officer of Chandbali and has also a Custom House officer.

Churaman, $\frac{\text{Lat. } 21^\circ\ 7'}{\text{Long. } 86^\circ\ 49'}$, is a small sea-port town on the Gammi river, about 26 miles north of the mouth of the Dhamra, and is under the supervision of the Port Officer of Chandbali.

It is reported to have been at one time one of the best trading ports on this side of Calcutta. The river has, however, silted up now, and vessels cannot enter it, but have to anchor 5 or 6 miles from the shore. The only vessels that are able to make the port are rice sloops of 200 tons burden or thereabouts. The canal connecting Charbatia with Midnapore, which is now being excavated, passes by this port as well as Laichanpur, and will soon transfer the entire trade to Oolaberiah on the Hooghly, as it is more accessible to vessels and steamers than either of these ports.

Laichanpur, $\frac{\text{Lat. } 21^\circ\ 18'}{\text{Long. } 86^\circ\ 53'}$, is 5 miles north of Churaman on the Kusban river. It is a small collection of temporary huts on the bank of a small muddy creek which is almost dry at low tide. The only vessels that are able to enter it are rice sloops, larger vessels having to anchor out 12 miles from shore. This port, like all the others on the coast, has been ruined by the common enemy silt, and it is now only accessible to a jolly boat by carefully watching the tides.

Balasore, $\frac{\text{Lat. } 21^\circ\ 30'}{\text{Long. } 87^\circ\ 0'}$, is on the Budhabalanga river and about seven miles inland. The channel leading to the entrance of the river is obstructed by a sand bar which requires very careful navigation and watching the tides to get over it. Two steamers ply between this and Calcutta weekly: a very large trade is carried on here in the exportation of rice.

Extract from the Narrative Report of CAPTAIN J. R. HOBDAY, *Assistant Superintendent, Survey of India, in charge No. 4 Party, Andaman Topographical Survey;—season* 1883-84.

BY Surveyor-General's Notification No. 187, dated 21st August 1883, I was appointed to the charge of this party.

The available datum on which to base the survey was the position of a point on Chatham Island in the harbour of Port Blair, the latitude and longitude of which had been determined astronomically in 1863 by Mr. Nicholson of the Great Trigonometrical Survey, so that in order to undertake a systematic triangulation it was necessary to measure a base line and determine an initial azimuth.

Commencement of field season.

The party arrived at Port Blair on the 27th November, and from that date till the 30th December we recorded 21·14 inches of rain, or an average of 0·62 inches per diem, so that we found the country in a very swampy state, the nature of the soil being such that, whether riding over the hills or in the valleys, our ponies sank into the mud up to their hocks, whenever an attempt was made to leave the metalled road. The valleys cleared of forest were studded with rice fields, on which the water did not dry up till the month of February.

Remarks on the country and inhabitants.

The whole of the islands, with the exception of the small cleared patches fringing the harbour of Port Blair, are covered with dense primeval forest. Some of the trees exceed 200 feet in height, and most of them grow perpendicularly up for about 100 feet before the branches commence. The Padouk is the most valuable tree found in these forests. The amount of undergrowth varies; in some parts it is found very thin, whereas elsewhere it is almost impenetrable.

Bamboo jungle is abundant in some parts, the reed being always hollow. There are two conspicuous ranges of hills in the South Andamans, one skirting the eastern coast, and the other running down the centre of the island as a sort of backbone. The highest point on the eastern range is known by the name of *Koyab* (red earth, with which the aborigines smear their bodies), 1,510 feet above sea-level, and *Cholunga* (spring), 1,057 feet elevation on the central range.

Creeks, with mangroves on either side drooping down to the water's edge, run for considerable distances into the interior of these islands. The northern portion of Rutland Island is very mountainous; Ford's Peak or Kala Pahar, the highest point, attaining an elevation of 1,426 feet.

The Andamanese are a race of Negritos, with very dark skins, of very small stature, but well made. There are said to be nine distinct tribes, each speaking a different dialect, and inhabiting the islands as follows:—

Aka-Chariar	...	North of North Andaman.
Aka-Jaro	...	South-east of North Andaman.
Aka-Kédé	...	South-west of North Andaman. Interior Island, and north-west of Middle Andaman.
Aka-Juwai	...	Centre and west of Middle Andaman.
Aka-Kawi	...	North-east of Middle Andaman.
Aka-Bojigyáb	...	Between Homfray's and Andaman Straits.
Aka-Balawa	...	Archipelago.
Aka-Bojigngiji	...	Eastern parts of South Andaman and north of Rutland Island.
Aka-Járawa	...	Little Andaman, North and South Sentinals, south-west and south of South Andaman, south of Rutland Island, Cinque Island, &c.

The tribe British rule has succeeded in training is known as the Bojigngiji in the immediate vicinity of Port Blair. Our relations also with the remaining tribes, with the exception

of the Járawas, are said to be on a friendly footing, especially with the Aka—Chariar, Jaro, Kédé, and Balawa ; but nothing is known of the interior of these islands, and the information is generally of a very scanty and doubtful nature.

The Andamanese appear to be a wandering race, moving from place to place, building temporary shelters of a lean-to type, formed of a few branches or leaves, and living chiefly on pigs (the *sus Andamanensis*), fish, turtles, &c.

The Járawas, or Little Andamanese, have ever been openly hostile : they are in short professional wreckers, and within the last 15 years two or three expeditions have been sent to punish them for barbarities committed on ship-wrecked crews. Notwithstanding these castigations, they still hold aloof, and retain their reputation for treachery and cruelty. Of late years visits have been paid them annually by the Chief Commissioner, when presents have been given with a view to bring about a more amicable relationship. But their language is quite unintelligible, even to our tame Andamanese, and after accepting our presents, they have been known to come down and charge on the party when returning to the boats. On the occasion of our visit mentioned further on, several hundreds of them showed themselves on the beach in Hut Bay, on the east of the island. After taking the presents we deposited on the beach, they appeared sulky, and hid themselves in the forest, when it was thought expedient not to press them further, as they evidently meant mischief.

The Járawas, inhabiting the Little Andamans, appear to be a more populous tribe than those found in the other islands, and are thus supposed to have been the dominant tribe. They also build large, substantial, thatched huts, dome-shaped, at least 60 feet in diameter and 30 or 40 feet high. We landed and entered one of these huts on the north of the island when the occupants were absent, or had fled at the sight of the steamer.

I should fancy these huts afford shelter for about 30 or 40 people. The thatching is propped up by long poles, which are set up in three circles within the hut. Small cots were found on which they slept ; also a rocking cradle. The cooking is evidently carried on inside the hut, and the eatables are slung up above. All round the interior of the hut, about 3 feet from the ground, were closely arranged pigs' skulls, trophies of the chase, beautifully cleaned and neatly bound up. It is believed that the Little Andamanese obtained the notion of building these dome-shaped huts from the Car Nicobarese; the only difference between the huts of the Nicobarese and Little Andamanese being that, whereas the former are built on piles, the latter rest on the ground.

The hostile Andamanese, who inhabit the western and southern portions of the South Andaman, are also termed Járawas, and it is surmised, though not yet satisfactorily proved, that they are identical with the tribe inhabiting the Little Andaman, having migrated northward by the Brothers, Sisters, Rutland Island, &c., &c.

Whilst the station of Cholunga was being cleared under the superintendence of Mr. Campbell, some of these Járawas laid an ambush on the track that had been cut between the camp and the station. When the clearing party arrived at the spot, a flight of arrows was suddenly discharged from a very close distance at the leading man, who happened to be a Pathan sepoy belonging to the police force at Port Blair. One arrow pierced his back near one shoulder blade, the head of the arrow re-appearing close to the other. Shots were fired, but without any apparent result, the enemy having fled down the slopes of the hill into the forest. Punitive expeditions were organized the day after, and one party came across the colony of Járawas to the west of the central range, when a man and boy were captured, one of our tame Andamanese having put an arrow into the man's thigh.

After treatment for some months at the hospital, the Járawa at length recovered, but I have since heard that he has succeeded in effecting his escape.

Some self-supporting convicts were also killed by the Járawas in the south of the South Andaman Island, within a few miles of the settlement, but it is a very difficult matter to catch, or even trace, them in these forests. The arrows of the Andamanese have broad, diamond-shaped heads, made of iron, with barbs. Thus an arrow wound is generally a very ugly one. The arrow heads of the little Andamanese are made of tough wood, well pointed.

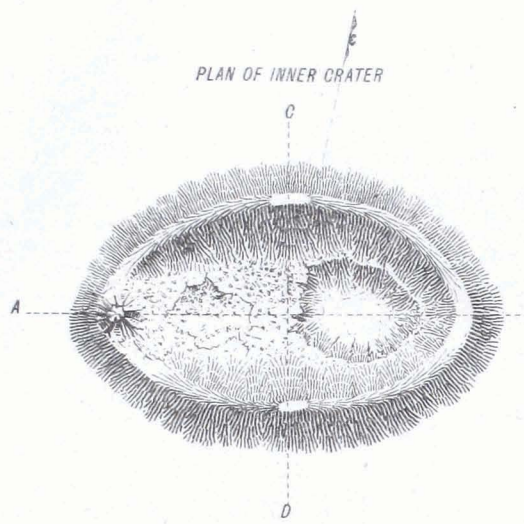
Survey of the volcano of Narcondam and Barren Island.

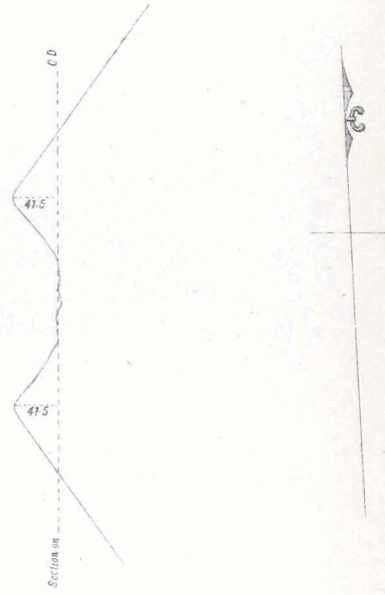
At the end of January, Mr. F. R. Mallet, Deputy Superintendent, Geological Survey, arrived in Port Blair to investigate the mineral resources of the Andamans. It was supposed that a workable supply of sulphur might be found on the volcano of Barren Island, and an expedition was accordingly planned in order to ascertain the quantity and quality of that substance in deposit.

I took the advantage of accompanying this expedition, which started at night on the 2nd February in the S. S. *Celerity*. We arrived the following day, and after much difficulty, owing to the heavy sea then running, managed to effect a landing on a small beach situated on the west of the island, where there is a breach in the outer crater, which allows the comparatively recent lava from the inner cone to flow into the sea. On the beach we discovered a hot spring, the temperature of the water being about 115° Fahrenheit. The water was decidedly brackish, but drinkable when placed in vessels and allowed to cool during the night.

Mr. Mallet and myself pitched our camp on a small hillock of ash, close to the landing place, and the same afternoon I managed to measure a base line with the crinoline wire chain, on which the subsequent survey of the island depended. We remained on the island till the 8th February, by which time I completed the survey of the interior. An attempt to run a circuit round the coast with the crinoline wire proved unsuccessful. One of the ship's officers and myself started off in a Rob Roy canoe with one end of the crinoline wire, when a large shark came up to the surface of the water in unpleasant proximity to the

PLAN OF INNER CRATER





THE VOLCANO OF BARREN ISLAND BAY OF BENGAL

Approx. Lat. 12°-15′-N.
Long. 93°-50′-E.

Scale 4 Inches = 1 Mile.

Area 3·07 Sq. Miles.

Photozincographed at the Survey of India Offices, Calcutta.

Surveyed under the direction of Colonel G. C. DePrée, Surveyor General of India, by Captain J. R. Hobday, S.C.;
Hill Shading by Captain J. R. Hobday, S.C.; Names, &c, Typed at the Survey of India Offices.

Published under the direction of Colonel G. C. De Prée. S. C. *Surveyor General of India.*

Survey of India Offices, Calcutta, February.
1885

NOTE.—Surveyed on the Scale of 8 Inches = 1 Mile and reduced by Photography to 4 Inches = 1 Mile.

THE VOLCANIC ISLAND OF NARCONDAM BAY OF BENGAL

Approx. Lat. 13°-26'-N.
Long. 94°-16'-E.

Scale 4 Inches = 1 Mile.

Chains 10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 Furlongs

Area 2·73 Sq. Miles.

Surveyed under the direction of Colonel G. C. DePrée, Surveyor General of India, by Captain J. R. Hobday, S.C.;
Hill Shading by Captain J. R. Hobday, S.C.; Names, &c, Typed at the Survey of India Offices.

Photozincographed at the Survey of India Offices, Calcutta

Published under the direction of Colonel G. C. De Prée, S. C., *Surveyor General of India.*

Survey of India Offices, Calcutta, February
1885

NOTE.—Surveyed on the Scale of 8 Inches = 1 Mile and reduced by Photography to 4 Inches = 1 Mile.

canoe, causing us to paddle back: in the meanwhile the wire had sunk, and getting entangled with the coral below, snapped.

We returned to Port Blair on the 9th February, and organized another expedition to the island of Narcondam, situated about 75 miles north-north-east of Barren Island. We started at midnight of the 11th February, arriving the following day. After steaming round the island we found an anchorage close into shore near a small rocky eminence on the north-west coast. About 3 P.M. the same afternoon, Mr. Black, one of the ship's officers, and myself, started to ascend the mountain; after cutting our way through dense undergrowth, and clambering over enormous boulders of rock, we at length gained the summit, just at sunset, and fixed a flag on a tree. When the moon arose we attempted to descend, but after advancing some dozen paces found it quite impracticable owing to the deep chasms between the boulders of rock: so nothing was left to us but to bivouac on the rocks, without food or drink. During the night the thermometer read as low as 64°, and owing to the heavy dew we were often compelled to dry our clothes before a fire we had lit. An aneroid barometer gave us 2,320 feet as the height of the summit above sea-level, which agreed within 10 feet of the computed value afterwards obtained by measured base. I believe we were the first Europeans who had ever succeeded in gaining the summit. A Mr. Ball of the Geological Survey made the attempt some years ago, but after three hours' clambering was forced to retire.

During the next two days I succeeded in completing an omnimeter traverse round the island, in order to define the coast line. The instrument was set up on outlying rocks, and the interior details of the island sketched in on a plane-table as we proceeded; the computation of the distances being conducted in a boat, in which we were pulled from station to station.

On the evening of the 15th February we started for Barren Island, arriving the following morning. In two days I completed an omnimeter traverse round the coast in the same manner as before explained. Without this instrument it would have been impossible to plot, with any degree of accuracy, the coast line of these islands, which consists for the most part of precipitous, inaccessible cliffs, running down to the water's edge. We were also fortunate as regards weather, for with any sea on this method would not have availed. One day there was a slight swell on the ocean, when it was found that getting the instrument on to the rocks, and then observing whilst the sea occasionally dashed up and washed over ones legs, kept the observer constantly on the *qui vive*. My best thanks are due to Mr. Black, the chief officer of the *Celerity*, who took a great interest in the work, and who, paddling on in a private canoe, acted as my forward man with the 10-foot pole.

We left Barren Island on the evening of the 15th February, arriving at Port Blair at daybreak the following morning. The two islands were surveyed on a scale of eight inches to the mile, and the maps when published will, it is to be hoped, possess a peculiar interest both from a geological and geographical point of view. For want of time and means, the positions of these islands were not determined astronomically, nor were the Andamans ever visible from their summits; but as far as we were able to deduce from observations with the ship's sextants and chronometers, their positions as denoted on the marine charts are approximately correct. It is hoped that their positions will be more accurately determined during the ensuing field season, when the Andaman triangulation is extended northwards.

Barren Island is situated in the Bay of Bengal in approximate latitude 12° 16′ north and longitude 93° 50′ east. The total area of the island is 3·07 square miles: it is circular in shape, the greatest length being about two miles in a north-north-easterly direction. The main crater is in the form of an ellipse, whose major axis in a north-north-easterly direction is 1½ miles, and minor axis one mile. In the centre rises a cone to an elevation of 1,015 feet above sea-level. The base of this cone is about 300 feet to the east, and to the west 100 feet above sea-level. The walls of the main crater are from 700 to 800 feet elevation on the north, and increase to about 1,150 feet to the south. The slopes of the central cone vary from 32° to 34°; fine volcanic ash lies on the surface, rendering the ascent a laborious undertaking. The same loose volcanic ash lies to some depth on the summit and slopes off the northern part of the main crater, as well as on its summit to the south. A small crater exists on the top of the cone, also elliptical in shape; major axis 300 feet and minor axis 190 feet; greatest depth 74 feet from summit. When looking at the island from the west, two small knobs of equal height rise, forming the north and south walls of the small crater on the cone: between these a rock of lava is plainly visible, as shown in the margin. Steam or smoke was issuing from the northern knob.

When digging for sulphur on the summit of the cone we found the temperature of the rocks, &c., very high, the heat being felt through our boots. There was evidence of three distinct outbursts of lava from the sides of the cone, situated at about one-third to half the distance down the slopes: one to the north, another to the east, and a third to the south. The most recent and extensive flow emanated from the outlet to the north. Sulphur was found deposited on the northern knob above quoted, and a greater quantity near the exit of the lava flow on the slope to the north.

The comparatively recent lava emanating from these lateral vents lies around the base of the cone, and extends as far as the water's edge on the west of the island, presenting the appearance of loose cinders or scoriæ of various sizes, heaped together in confused masses.

The main crater is formed of old lava, its outer slopes being covered with thick vegetation, the principal tree being a species of fig. South-west of the cone, and between the recent lava and the inner slopes of the main crater was found a short tongue of alluvial soil, on which grass was growing to a height of 2 or 3 feet. A similar tract of smaller dimensions occurs to the north-east. There is a good anchorage to the south-west of the island, opposite a narrow line of beach. The island appears to be infested with rats from foot to summit. They show themselves in great numbers at dusk, and even during daylight. Not being accustomed to the presence of man, they appear almost tame, and can easily be knocked over with a stick. A specimen was caught and sent to the Calcutta Museum, but I have not heard whether it has been classified as a distinct species. Bats and large crabs were found on the summit of the outer crater. The beautiful Nicobar pigeon, with white plumage and black points, was also seen both on Barren Island and Narcondam. I am told these pigeons are not to be found on the Andamans.

By constructing an elevation from the plan of the island, and continuing the outer slopes of the main crater, it is found that the lines meet in a point immediately above the present flue of the cone, by which it is conjectured that at some remote period the shape of the island was almost that of a perfect cone, and that its height was about double that of the existing cone above sea-level, after which a prodigious eruption is supposed to have taken place, blowing off the upper portion of the cone and leaving the present truncated crater; the existing central cone having generated since in the usual manner from successive overflows of lava and ash.

The volcano is known to have been in an active state at the close of the last, and beginning of the present century, but beyond this no records are, I believe, at hand by which its age can be determined. The temperature of the water issuing from the hot spring above mentioned is considerably lower than that given by explorers who have previously visited the island, by which it is inferred that the volcano is rapidly cooling.

The island of Narcondam is situated approximately in latitude 13° 26′ north and longitude 94° 16′ east. The total area of the island is 2·78 square miles; it is almond-shaped, its greatest length in a north-easterly direction being 2½ miles and greatest breadth 1¼ miles. Its general appearance is that of a lofty conical mountain, 2,330 feet above sea-level, and covered with dense forest. The whole island is composed of trachytic lava, which lies in huge boulders on the steep slopes near the summit. No trace, however, of a crater was anywhere found, by which it is assumed that the island was merely thrown up by some violent convulsion of nature at some very remote period.

Flocks of hornbills, or toucans, uttering a peculiar shrill note, followed us during our ascent and descent. A large iguana or lizard with long prehensile claws, was captured, and now adorns the Calcutta Museum; and numerous Nicobar pigeons were also seen flying about the rocks, close to the anchorage. No water was found on the island, not an uncommon failing in volcanic regions, owing to the porous nature of igneous rocks.

The currents running round these islands are very strong, and the soundings very deep. Fish seem to be very plentiful. A sort of rock-fish, coloured green and blue, and beautifully marked, was caught off Barren Island, weighing 90lb, and measuring 4 feet 4 inches in length, 8 inches broad, and 20 inches in depth. Off Narcondam an enormous black skate of unprepossessing appearance, and generally known by the name of Devil-fish, appears to be very plentiful. Some rare orchids were also found on Narcondam.

In the meanwhile the South Andaman Island triangulation was progressing under Messrs. Keating and Campbell, but on account of the denseness of the forest, the gigantic proportions of the trees, and the peculiar difficulties connected with convict labour, the progress was slow.

On the 25th February the station steamer *Celerity* left for Calcutta, and was finally sent to Bombay and sold. The *Quangtung* was sent to take her place, but did not arrive in Port Blair till the 10th April, so that it was impossible to make any protracted expeditions by sea in the two steam launches, which are only intended for harbour purposes, and which, moreover, are constantly breaking down through defective machinery, &c. On the 18th April, the Chief Commissioner, Colonel Cadell, v.c., started on an expedition to the Little Andaman Island, and with a view to extend the triangulation southwards, if possible, I accompanied the party. We landed on the Brothers, then steered across to the South Sentinel, then back again to the north of the Little Andaman, and finally steamed completely round that island. We rowed up two creeks on the north and one on the west of the island, leaving presents in the canoes of the savages.

All these islands are very flat, and covered with thick forest growth. On the Brothers we found innumerable pigeons of lovely plumage, one beautiful bird with long, bronze hackles; also the Nicobar and Imperial pigeons. From the South Sentinel we took away specimens of the Burgos Latro, an uncommon and large crab. On the return journey we landed on the Two Sisters, arriving at Port Blair on the 23rd February. Owing to the short time we were able to spend on the islands, and the main object of the expedition being to offer friendly overtures to the Little Andamanese, I was only able to complete a rough reconnaissance, fixing the positions of the islands and the general run of the main creeks in the Little Andaman.

The Chief Commissioner left in the *Quangtung* for the Nicobar Island on the 27th April, returning on the 10th May, on which date the monsoon commenced.

On Messrs. Keating and Campbell completing the triangulation allotted to them, they were deputed to plane-table in order to complete the detail survey of sheet 14.

From the 26th to the 30th April I succeeded in completing my observations for the azimuth of Chatham Island, G. T. S., the weather being favourable. Observations were taken with a 14″ transit instrument on four zeros to two circumpolar stars at maximum elongation, one elongating east, and the other west of the meridian. The resulting azimuth, as deduced during the recess from the means of both elongations, gives a difference of only 0·1 second.

Extract from the Narrative Report of LIEUTENANT-COLONEL R. G. WOODTHORPE, R.E., *Officiating Deputy Superintendent, Survey of India, in charge No.* 6 *Party, North-East Frontier Topographical Survey;—season* 1883-84.

THE original programme of this party was to explore the extreme north-east corner of Assam, including the sources of the Noa Dehing and the Patkai range; but as we were proceeding to our destination, news of the Aka raid on Balipara was received, and in accordance with the wishes of the Chief Commissioner of Assam, we arrested our steps at Tezpur to await the course of events. When the military expedition to rescue the captive Babus carried off by the Akas was decided on, we received orders to join the force proceeding into the hills.

While waiting for the expedition to be organized, we employed ourselves in observing from the three great trigonometrical stations, Singri, Sildubi, and Kamakia, and in clearing and observing from two points on a low range in our own territory, called the Guinuja and Sonai hills. From all these we were able to fix a few points and identify others already fixed, and also to do a little preliminary sketching to help us when the advance took place. We had a large establishment of coolies with us, engaged for the Singpho exploration work; but under the altered circumstances we did not require them all, so when Mr. Elliott considered that it was necessary that an advance should be made before all the transport and commissariat arrangements had been completed, I was able to place 150 coolies at the disposal of the military authorities, and a start was made from Dirju Mukh on the 17th December. This advanced force was under the command of Major Beresford, 43rd Assam Light Infantry. The morning was wet, and we were all soaked through very shortly: the afternoon, however, was bright, and we pitched camp in a fairly open spot, just within the hills, on the banks of the Dirju, up which our path lay. Here cholera attacked our party, and we lost several coolies and two klassies within 24 hours. We continued our journey on the 18th; but cholera accompanied us, and we did not get rid of it for several days. It demoralized our coolies, and much as the Mikirs dreaded the Akas, they dreaded the cholera still more, and on the 23rd, at the Maj Bhoroli, fifteen decamped, and were no more seen. We reached the Maj Bhoroli (*Maj*, Assamese, for "middle" portion, this part being the middle link of the big bends made by the Bhoroli in the hills) on the 19th. Here the stream is from 60 to 80 yards wide and very deep, with a swift current and strong rapids occurring frequently.

This river detained us on its south bank for several days making rafts on which to cross the camp. On the 23rd we were all across, and that night the Akas attacked us in force; they were beaten off, and on the 26th we advanced again. On the 27th we descended to the Tenga river, and found the Akas in great force, drawn up to oppose our passage. As our supplies were running short, and we were at some distance from our reinforcements, Major Beresford fell back to our last camp, only ¾ mile from the Tenga and about 1,300 feet above it. There we received orders from General Sale Hill to carry on reconnaissances only till he himself should arrive from Dirju Mukh with two mountain guns. General Hill arrived on the 5th January, and till that date we employed ourselves in doing what work we could in the neighbourhood of the camp, and with reconnoitring parties, and from a point on the road where it crossed the ridge between the Bhoroli and Tenga rivers. There was here a natural clearing which we enlarged, and from this point, which was on the edge of a deep precipice, and commanded an extensive view from south-east round by south to south-west, we did a good deal of work, and established heliographic communication with Dirju Mukh and Maj Bhoroli camps. Mr. Ogle's knowledge of military signalling, which he acquired in his leisure hours in Shillong in 1882 when a class was formed there, here proved of the greatest service, and enabled him to supervise the native signallers who always accompanied us. Mr. Ogle also displayed great skill in the construction of stockades, in which he materially assisted Major Beresford.

The passage of the Tenga river was forced on the 8th January, and from that date to the 23rd January, when the evacuation of the country was commenced, we were stationed at Labi's village. We visited and cleared two points on the high ridge to the north of Mehdi's and Labi's villages, whence we obtained a widely extended view of the country lying between us and the lofty snowy peaks of Tibet. Military considerations did not allow of our visiting much of the Aka country, or we might in a few days have very largely increased our topographical knowledge. When we left the hills, a small force under Major Beresford took an alternative route from Labi's village to Dirju Mukh, keeping entirely on the right bank of the Bhoroli river. This was found to be a better route on the whole than the one adopted for the advance. I was suffering from the sting of some insect, which lamed me, and I was unable to accompany Major Beresford, but Mr. Ogle went with him, and did some very good work. I returned by the way we had gone with the rear guard. While we were in the hills, Mr. Ewing had cleared Natkari, which I subsequently visited, and had surveyed as much as he

could of the country as far as Maj Bhoroli, on the half-inch scale. Shah Nasirudin and Mahomed Hossein had been employed in traversing various new roads, boundaries, &c., of which the Chief Commissioner wished to have records. We all met again at Dirju Mukh on the 28th January.

Mr. Ogle and I returned to Balipara on the 29th January, leaving Mr. Ewing to carry on the survey of the low hills at the head of the Mansiri river, while the two sub-surveyors continued their work in the plains.

Our work in the Aka hills being now at an end, it behoved me to consider what would be the best way to employ ourselves for the remainder of the season. Just before leaving Labi's village, Mr. Elliott had sent me a rough sketch map showing generally the route taken by a tea-planter, Mr. W. Penny, when on a visit in the previous month to some Daphla villages lying just between that portion of the Daphla hills surveyed by Colonel Godwin-Austen's party in 1874-75 and the Aka hills just surveyed by us. Mr. Penny, during his adventurous journey, had been very well received by all the Daphlas, many of whom he knew well, having had commercial transactions with them on occasions when they visited the plains to sell rubber, and I at once saw an opening for furthering our knowledge of these hills and filling up some important gaps in our map of Assam. I therefore communicated with the Chief Commissioner, and after consulting with him and with Mr. Penny it was finally arranged that Mr. Penny should accompany Mr. Ogle and myself with a small party into these hills; and some influential Daphlas, who were with Mr. Penny when I first visited him, assured him of their willingness to take us up to their villages. At my request the Chief Commissioner further procured the services of Dr. D. St. J. Grant, a young, clever, and energetic Surgeon, who had accompanied the advance under Major Beresford, into the Aka Hills. Apart from the great advantage and relief to us to have a skilled medical officer with us, I knew how acceptable his services would often prove to the people we were going amongst.

While sanction was being obtained for this expedition, and all the necessary arrangements were being made, I went down to Udalguri with Messrs. Ogle and Ewing to see if it were possible for the latter to be usefully employed in sketching the outer Bhutan hills. We visited the winter settlement of the Bhutias at Shergaon, about three miles above the Doimari stockade, and I am of opinion that a good deal of useful work might be done by clearing some of the higher peaks along the outer ranges. These peaks vary from 9,000 to 11,000 feet in height above sea-level, and would not be very difficult to reach from the plains, as far as I can see. The Bhutias, I imagine, might easily be induced to consent to this; and I do not think they would object to our penetrating even further. A good deal might be done without consulting them at all; the hills are quite uninhabited, and as the paths by Doimari and Amratul are the only beaten tracks from their hills, the Bhutias would probably never know that anything was being done. Those we questioned at Shergaon were not at all reticent about the paths and passes into their country, and gave us a good deal of, I believe, perfectly reliable information. Unfortunately we were not then prepared to visit a hill a little way above their settlements, from which we thought a good view could be obtained, but they expressed perfect willingness to let us go there. Had we known what we could do earlier, so as to make proper arrangements, I have no doubt Mr. Ewing could have done some valuable work; but as he was restricted to working from the plains and from the very low hills within our own boundary line, he was unable to accomplish very much in the month that remained to him, and the weather, moreover, was very unfavourable, the clouds seldom lifting from the mountain tops and obscuring all details beneath them. While we were in the Daphla hills, sub-surveyors Shah Nasirudin and Mahomed Hossein were employed on route and river surveys, and on such half-inch work as they could do without crossing the border.

On the 23rd February the party named in the margin left Balipara for Dibru Mukh, where they were joined on the 28th by Mr. Penny, and on the 29th we all commenced our march into the hills, leaving a naik and six of the Frontier Police in charge of a depôt of provisions at Dibru Mukh. From sickness and hardships, our coolie establishment had become very much reduced in numbers, and we were obliged to travel very light indeed, lighter even than during the Aka expedition. We had no tents; but for the officers a small "lean to" was constructed every evening and roofed with a water-proof sheet, and under this we spread our beds side by side, a pleasant enough arrangement in fine weather, but somewhat uncomfortable when it rains, which it did a good deal both night and day. The sepoys and coolies all hutted themselves roughly.

Lieutenant-Colonel Woodthorpe, R.E.
Mr. M. J. Ogle.
Dr. D. St. J. Grant.
1 Jemadar ... } 43rd A. L. I.
20 Rank and file ... }
1 Subadar ... } Frontier Police.
20 Rank and file ... }

Our first march was a very rough one, over big boulders along the banks of the Bor Dikrai, a fine fishing stream, through which we had to wade five times nearly waist-deep. We encamped on its banks, and next day, painfully, in heavy rain, which made the path very slippery, ascended a steep and lofty ridge on which we had to encamp away from any water. Fortunately Mr. Penny knew and had warned us of this, and we had provided to a certain extent for it. The next day's march was still more trying, a succession of ups and downs (sometimes as much as 1,300 feet at a stretch) along this ridge, and a final long and very steep descent to a little stream where we bivouacked. The advanced guard only reached this spot at nightfall, and most of the coolies and escort did not arrive till the next morning, when we moved on a short distance to the Bor Dikrai, allowing every one a little time to rest and refresh in a pleasant spot after the hardships and exertions of the past three days. On the 4th of March a long climb and a steep descent brought us to the pretty little Passu

stream, crossing which, and ascending the opposite hill, we found ourselves, late in the afternoon, at the first villages of the Tagen Abors. Here we were well received, and we encamped for the night in the fields close by: the next morning Dr. Grant had many applicants for relief, and disposed of all cases which could be treated simply and quickly, while Mr. Ogle and I went up above to a new clearance to determine our whereabouts. The dense jungle, through which our path had run hitherto, had prevented our seeing very much, and our want of carriage for provisions had prevented our remaining anywhere to make clearances, and we had not done much work up to the time of our arrival at these villages, situated advantageously on a promontory running out from the main range to the north into a curious, flatly open valley, an unusual feature in this country, of steep hills and narrow confined valleys. I had, fortunately, one evening, from the signalling station above the Maj Bhoroli, by the light of the afternoon sun, just caught a glimpse between the intervening hills of these Tagen Abor fields, and had taken a plane-table ray to them. We had thus a check for our position in latitude, and a trigonometrically fixed peak nearly due south gave us another for longitude, and enabled us to fix our position; we could then do a large amount of sketching and laid a good foundation for our work in advance.

On the 5th we advanced into the "Miri Pothar," so called, I am told, from the fact that under the oppressive rule of the Assam Rajas some Miris migrated to this fertile valley from the plains. This valley is long, flat, and open, another surprise in these hills. It is very swampy, and the villages and cultivation occur principally on the slopes just rising out of the plain on either side of the populous valley through which runs, with many a curve, the Papu river, its banks fringed with castor-oil plants. We encamped under the village of Badri, a very influential Daphla, and the next day moved down to the Papu river. We passed through the village *en route*, and a point above it afforded an excellent view of almost the entire valley; and while Dr. Grant treated the sick with medicine and entertained the whole with musical-boxes, &c., Mr. Ogle and I did a large amount of sketching, or rather Mr. Ogle did the sketching, I merely looking on and assisting him with "guesses at truth." The weather was so exceedingly cloudy and dull that it was very difficult to determine the direction of some of the smaller valleys. A comparison of our different views, and a discussion thereon, generally, however, resulted, I believe, in settling the question with a very fair degree of accuracy. On the 7th we halted, as our supplies needed replenishing, and without halting we could not expect to get in anything from the village. The halt was productive of much good owing to Mr. Penny's exertions and powers of bargaining; and on the 8th we resumed our onward march and reached the Kameng river, the easterly branch of the Bhoroli, on the 9th. Here we were detained for a few days making rafts whereon to cross this wide stream, 60 yards broad here, with strong currents, and receiving visits from chiefs on the other side. The Daphlas who had taken us to the Kameng were anxious that we should not cross, naturally wishing to divide all the presents we had brought, among themselves. Thanks, however, to Mr. Penny's experience and skilfull treatment of these trans-Kameng chiefs, we were ultimately able to make several excursions across the river, and do as much as the very bad weather would allow. It was most unfortunate that we had no clear weather just then, as we were quite unable to form any idea of the geography of the country around the upper course of the Kameng. Had we not been pressed either for time or provisions, and had the time of year been earlier, I believe we might have penetrated much further than, under the circumstances, we were able to do. On the 14th March we visited the village of Sin kole, the principal chief across the Kameng, and did a good slice of work; and on the 15th, our supplies being nearly at an end, and not sufficient being forthcoming from the villages to justify our further stay in the hills, we turned our faces towards Assam again. We travelled back along nearly the same route as that by which we had gone into the hills, and our increased knowledge of the country enabled us to fill in many important gaps which we had been obliged to pass over during our hurried advance. We reached Dibru Mukh again on the 22nd, not having an ounce of provisions left when we reached our godown; and on the 24th we were once more at Balipara, having been out of all communication with the great world beyond the Daphla hills for just one month.

Mr. Ewing finished what he was able to do early in April, and by the middle of that month the whole party was back in Shillong, with the exception of Mahomed Hossein, who had been deputed for some work in Dehra-Dún.

All through the season we had been unfortunate in the weather, which seems to have been much the same as was experienced in the Daphla Expedition in 1874-75 and as Lieutenant Harman and I encountered in the Miri hills in 1877-78, which leads me to imagine that on the north bank of the Brahmaputra, in Assam, the winter season is never one of uninterrupted sunshine, and that after November the higher ranges are seldom free from cloud or rain. This state of things is especially annoying when, as in the Aka and Daphla hills last season, every moment is of importance, and the Surveyor cannot afford to wait anywhere till the weather clears.

Our visit to the Daphla hills gave us important information about a branch of the Bhoroli river, namely the Kameng, of the existence of which no one had ever previously dreamed. This is a large stream, by far, I should imagine, the larger of the two feeders of the Bhoroli, and in order to assign it a sufficient drainage area to account for its volume it will be necessary to restrict considerably that hitherto assigned to the Khru. Had the weather been clearer when we were working on the Kameng, we might possibly

have been able to mark with some definiteness the actual position of the water-parting between the Kameng and the Khru.

Triangulation.

From the foregoing remarks it will have been gathered that the amount of triangulation done was exceedingly small; indeed, the number of points fixed in previous seasons rendered work of that sort almost unnecessary, even if it had not been rendered impossible by the weather and the conditions under which we were obliged to work.

Concerning the Daphlas, I have little to add to the able reports of Colonel Godwin-Austen and Lieutenant Harman in 1874-75, though it is necessary to state that confusion seems then to have existed in the public mind as to the proper application of the terms "Abor" and "Daphla," and it is necessary in reading these reports to substitute Abors for Daphlas and *vice versâ:* for instance, where it is said that "the Daphlas always tattoo, but the Abors never," just the reverse is the case. The Daphlas never tatoo, the Abors generally do, though Mr. Penny told us the custom is gradually dying out. It seems to have been really with an "Abor" chief and not with a "Daphla" that we had our quarrel in 1874-75. However, the right men appear to have been settled with, so it mattered little what we called them. "What's in a name," Shakespeare asks, adding—"a rose by any other name would smell as sweet;" and no doubt our "Abor" enemy got quite as much out of us, and was every whit as satisfied with the results of the expedition as if we had never called him a Daphla. There is this much to be said, that "Abor" is a very vague term, and among the Assamese, as I have often before pointed out, means only a "foreigner." It is a term applied equally to tribes in the Aka, Daphla, Miri, Mishmi, and Naga Hills, and acknowledged by the so-called Abors themselves only out of deference to the ignorance of those applying the term to them, and who, as they know, would fail to recognize them under any other name.

Extract from the Narrative Report of MR. T. E. M. CLAUDIUS, *Surveyor, 4th grade, Officiating in charge No. 3 Party, Baluchistan Topographical Survey;—season* 1883-84.

Remarks on the country triangulated and plane-tabled.

THE country triangulated and plane-tabled has on various occasions been traversed by others and reported on previously, so that it is needless to recapitulate what has already been ably described. But a few remarks on the Kachi or desert country may prove interesting. Being an immense expanse of all but treeless waste, it was with difficulty that triangulation could be carried on. The refraction and mirage were sufficient in themselves to delude even the most experienced. Objects invisible at one moment would at the next be seen far above the eye of the spectator, and it was only after a little training in such ground that the triangulator, watching his opportunity, would be able to take horizontal readings to a signal which at other moments it would simply be impossible to observe. The soil of the Kachi, however, is excellent, composed as it is of loam, and where the inhabitants after strenuous efforts have been able to irrigate the land, the cereals that spring up are most excellent in quality, far exceeding in size and substance those of the same species grown even in favourable localities of India. Water is, however, extremely scarce, and the inhabitants in most cases are obliged either to cart or convey it from a distance of 15 to 25 miles to supply the wants of their households. But as peace is gradually settling over the land of Baluchistan, more especially over that portion which has been assigned to the care and direction of the Government, but which previously was the most lawless and turbulent, the lowlands of Kachi are commencing to be thickly studded with hamlets, numerous wells are being sunk, and once again the people can boast of immense herds of cattle without the dread that at any moment they may be snatched away by the daring and inexorable raiders of the Marri and Bugti hills. The lowlanders are all tall and robust in stature. Longevity with them seems to be the rule, and in one instance a Patriarch was seen at the village of Dhinar, who had with him his lineal issue of the fourth generation.

The hilly ground plane-tabled was generally in no respect very remarkable. The main ranges, such as the Bambhor and Dunghan, are composed of limestone, while the other surrounding features comprise rolling sandstone. Markhor and Oorial are the only fauna which thrive on these arid and desolate hills.

The petroleum springs, which are in existence near the hill of Mourani in the Marri hills, are most important, as the supply has been pronounced to be unlimited by Mr. Townsend, who analysed and examined them on the part of Government last winter. The following is from notes by Mr. Copping, whose triangulation embraced the whole of the Bugti Dera territory, and which is nearly all of a hilly and broken nature, ranging in height from 300 feet near Dhrinak to about 6,000 feet on the Siah Koh mountain. There were only three permanent settlements met with. Bugti Dera, the chief town of the Bugtis, in the valley of the Sehaf river, is pleasantly situated near the source of that stream in a broad expanse of cultivation, and is about 1,800 feet above sea level, where the climate is temperate all the year round, the lowest reading recorded by the thermometer in February, the coldest month in winter, being 56° Fahrenheit. The water is conveyed to the place by artificial channels from the hills to the north-east, and is always abundant and good, from a spring near a shrine dedicated to Suri Pir; at its exit from the hillside it always maintains a temperature of 72° Fahrenheit. Loti, another fixed settlement, lies about eighteen miles to east-south-east of Bugti Dera, with which it is connected by a very good road, first made by the troops comprising Wilkinson's Brigade in

their passage through the country during the late Afghan campaign, and is still kept in fair order by the Bugtis, as it is a portion of the principal trade route which traverses their territory from Rojhan in the plains of Sind on the east, to Lehri in the Kachi at the foot of the western limit of these hills. Loti is a small, fortified village, which has only lately been built and occupied by Kechi Khan and his followers, who do not recognize the authority of the Bugti chief, but are on friendly terms with him at present. This settlement was formerly situated in the valley of the Pathr about 20 miles north, but was so harassed then by the Marris that it moved to a place further south, called Thusso, where a fortified village was built, but it was compelled to move again further south owing to the confined nature of the situation which did not allow of a sufficient space of ground being cultivated for its purposes. Kahan, the third place, is the capital of the Marri tribe, and lies about 24 miles north-west of Bugti Dera: two roads connect it with that place, one by the Shartaf pass to the west, and the other by the Barboj pass, which is 12 miles north-east. Of these, the latter is preferable as presenting less difficulties for laden animals, and with a little improvement would be quite practicable for wheeled conveyances all the way from Bugti Dera to Kahan. The Shartaf pass, on the other hand, is traversed with difficulty by laden camels, and it was at the summit of this pass that an engagement took place between the British and the Marris in 1850, where our troops were first repulsed, but eventually carried the pass with some difficulty: the absence of any water at the top added to their hardships.

The most marked features of the country are, first, the Geandhari hill, which is the southern limit of the Suleman range, and from here gradually dies away into the Sind plain; the next, the Zin range, bounds the Sehaf valley on the south, and is only about 50 miles in length, commencing from the Dasht-i-Goran plain, in the middle of which Loti village is situated, proceeding due west and terminating the Kachi near Lehri. This portion of the country is particularly rich in fossil remains, every portion being covered with sea shells, and very slight excavations revealing the remains of sea animals, clearly indicating that the whole country was under water at a comparatively recent date. Some beds of fossils, situated near Bugti Dera, were examined by a geological surveyor, and pronounced by him to consist of the remains of rhinocerii and some species of elk. North of Bugti Dera another noticeable range, called Pir-ka-roh, runs parallel with Zin, and is very similar to it in contour, round and undulating on the north face, but precipitous and craggy on the south. The Siah Koh range bounds the Sham plain on the west and the Sulemans on the east. This plain is very rich in pasturage, has numerous perennial springs, and is visited annually during the dry weather by large numbers of the neighbouring tribes, who bring their flocks and herds here for grazing purposes. The chief route from Sind to Thal Chotiali, and thence to Quetta, traverses this plain, entering it on the east by the Chachar pass and going out at the north-west corner over the Vianck pass, which crosses a shoulder of the Siah Koh range at an elevation of about 2,000 feet: this pass presents no difficulty for laden animals, and water is abundant all along this route to Thal Chotiali. Vitakri, an abandoned cantonment of ours, lies immediately beyond this pass, close to the fertile valley of Barkham, which is thickly studded with small fortified villages and thals (towers), and is cultivated over its whole extent.

The chief of these villages is Nahar-ka-kot, where the sirdar (Khetrani) resides: from this plain on the west rises the high mountain range of Jondran to an elevation of 6,700 feet. It is very difficult of access from this side, but is more practicable on the west face from the Kolu valley. The Bugtis are chiefly a pastoral people now, cultivating only sufficient cereals for their own absolute wants, and those of the coarsest and hardest kind, such as jawar and bajra, with a little wheat, which require but little care or irrigation. The exports are chiefly sheep skin and wool, which are, however, imported again from India in the shape of poshtins and blankets.

Extract from the Narrative Report of LIEUTENANT-COLONEL C. T. HAIG, R.E., *Deputy Superintendent, 1st grade, in charge Guzerat Topographical Survey;—season* 1883-84.

DURING the past season about 155 square miles in sheet 41, rather more (about 34 square miles more) than half of sheet 42, half of sheet 43, and about three quarters of sheet 44 have been finally surveyed, completing the topography of sheet 41 and the 4-inch scale survey of the Godhra, Kálol, and Hálol talukas in that sheet and in 42 and 43, and adding about 200 square miles to the credit of our account with the Baroda State, leaving us with a surplus of over 250 square miles towards next year's account. Besides the topography, sheets 52, 53, 54 and 47 have been prepared for final survey by triangulation and traversing.

In sheet 43 is the hill of Páwágarh, which, with the remains of the old city of Chámpáner at its base, forms an object of considerable historical and archæological interest, as it abounds with old Jain temples, more recent Muhammadan fortifications, mosques, buildings and tanks, and still more recent Hindu temples. These have been abundantly described in various works, but judging from a correspondence I had with the late Sir E. C. Bayley, K.C.S.I., no map of the place had been previously made to enable the historian to give an adequate topographical description of it. The late Professor Dowson left behind him an unfinished history of Guzerat, which Sir E. C Bayley undertook to edit, and he was very anxious to get a map of Páwágarh and Chámpáner for insertion into the work, but none was procurable, so he wrote to me about it, and I was

therefore careful to instruct Mr. S. Norman, to whom I allotted the survey of the hill, to be very particular in marking the sites of all old temples and ruins, and in attaching the correct names to all objects of historical and archæological interest, and to survey the hill and the old city with all the accuracy the scale admits. I visited both hill and city in the early part of the season, but was not able to go over it again and inspect Mr. Norman's survey, as it was not quite complete when I left; but this was done by Lieutenant-Colonel Badgley, and I have no doubt that all that can possibly be required for Professor Dowson's history will be found in the map. Unfortunately Sir E. C. Bayley has recently died, and I have not heard who is carrying on the editing of Professor Dowson's work.

Extract from the Narrative Report of MAJOR T. T. CARTER, R.E., *Deputy Superintendent, Survey of India, in charge No. 2 Party, Bhopal and Malwa Topographical Survey;—season* 1883-84.

Remarks on the country triangulated.

THE triangulation carried on this season in sheets 58 and 59 was chiefly in Dungarpur, with portions of Oodeypore and the Mahikanta Agency (Bombay Presidency). Both sheets are for the most part covered with thick jungle, are hilly, and the ground intricate; there are fair tracts almost all over where laden camels may be taken, and no difficulty was experienced in moving camp, except to the eastern limit of the work, near, and to the north of, the villages of Katharia and Valicha, where the ground is very much broken up by deep ravines.

The northern half of plane-table 58E is pretty open, but has some good-sized hills to the north near the junction with the Gwalior and Central India Survey; the southern half is more broken up with small hills, and is rather intricate north of the high road passing from Sagwara to Dungarpur. To the north and west of the Thanna village of Atri are the famous Pals of Hirathu and Mandu, which the detail surveyor must be careful in entering; some difficulty was experienced in poling the ground, and timely notice had to be given to the Dungarpur Durbar, which had to make special arrangements whenever those parts had to be entered.

Plane-table 58W has also some open bits to the north, but the hills are more massed than in the adjoining plane-table; there is a Pal called Padri at the foot of the low range running north and south near the boundary between Dungarpur and Oodeypore, which the plane-tabler must be careful in entering; the southern portion of this table is hilly and covered with jungle, and gets rather intricate to the south and south-west.

The upper half of plane-table 59W is about the most intricate piece in the whole of the work, being a mass of hills with small table-lands covered with thick jungle, and difficulty will be experienced by the plane-tablers in seeing points; the southern portion of this half breaks into low hills and undulating ground, also covered with jungle. With the exception of one range running north and south, the southern portion of this board is a low table-land covered with very thick jungle. Plane-table 59E is also a mass of hills, especially at the north-west corner; the southern portion has low hills and undulating ground covered with thick jungle.

Description of country plane-tabled. Sheet No. 50.

The whole of this sheet consists of hilly ground forming portions of the Native States of Oodeypore, Banswara, and Dungarpur; the river Som, which enters this sheet at the north-west corner, runs due east, half way through the sheet, when taking a bend it flows in a south-easterly direction to its junction with the Jaknam river, near the village of Bilodia: up to this point it forms the boundary between Oodeypore and Dungarpur; it then continues its course nearly due south up to its junction with the Mahi at Benisar, a well-known place where an annual fair is held. The country south and west of the Som consists of low hills intermixed with numerous small valleys, except to the north-west corner, where the hills rise to a height of 1,200 feet, the height of the banks of the Som river, at its juncture with the Mahi at Benisar being 550 feet above sea-level; in the ground rising to the west the slope is considerable, and the general level of the country seems to have been washed away, leaving innumerable small nodular hills, rising about 50 feet above the ground, forming a tangled mass of low hills covered with small pieces of quartz; they are quite bare, but so intricately massed together that much patience and care had to be exercised by the detail surveyor in sketching them. The valleys lying between these hillocks are, however, very fertile, and this portion of the sheet contains several large villages; the valleys are well studded with Moha, *bassia longifolia*, mangoe, *magnifera indica*, and sindi, *phœnix silvestris*, trees; numerous wells also exist, the water of which, together with that of the Som along its whole length, is utilized for irrigation purposes, being raised up to the level of the surrounding country by means of Persian wheels, called in these parts *Rahats*.

Turning to the eastern portion of this sheet, we have the Mahi river entering about five miles from the north-east corner and flowing in a south-westerly direction, which forms for about six miles the boundary between Banswara and Oodeypore, and for the remainder of its course through this sheet the boundary between Banswara and Dungarpur. A portion of Dungarpur (area of 65 square miles) lies between the Jaknam and the Mahi; if it was not for this, the Som up to its junction with the Mahi at Benisar, and thence the course of the Mahi eastwards, would have been the southern boundary of Oodeypore. The whole of the

country represented by this portion of the sheet is wild, while that north of the Mahi river and west of the range of hills forming the water-shed, is almost entirely inhabited by Bhils; but the portion falling within the extreme south-eastern corner of the sheet is very fertile and contains several large villages. The low ground on the left bank of the Som river is undulating, and the intricate nodular hillocks, distinctive of the country on the right bank, are here met with, the river apparently dividing the country into two different formations of rock; the hills on the left bank being composed of igneous rocks, such as granite, &c., and (at Lohargarh, Pansola and Khemera, there are considerable quantities of iron stone) the rocks on the right of the river being more of an aqueous description, silicious rocks as well as limestone formation being chiefly met with.

Sheet No. 52.

The western portion of this sheet consists of small nodular hills, if anything more intricate than those described in sheet 50; another peculiar feature of the country being the numerous tanks formed by the closing up of the water-courses by mud embankments: these tanks are constructed for irrigation purposes, and towards the end of April are for the most part dry. The Mahi river runs through the sheet from north to south, forming the boundary between Dungarpur and Banswara: about two-thirds of the sheet lies in the latter State. At the north-east corner the hills are more massed, rising to a height of about 1,000 feet above the sea; the eastern portion of the sheet surveyed the previous field season under Major Wilmer's supervision is more open, nearly the whole of it being covered with villages, and the land being brought well under cultivation with wheat, gram, sugarcane, &c. The main road between Banswara and Dungarpur passes through this sheet, and a few miles west of Talwara runs a range of hills, which rise to a height of 975 feet at their highest point, containing several Bhil Pals under the petty Thakurs of Amja and Talwara. The inhabitants of these Pals seem to be a marauding gang, and travellers should be on the look out for them; my post bag was twice robbed on this road, and I heard of one Pindari who was robbed of Rs. 600 in the same neighbourhood.

The natural features of the country being hilly and full of streams, it was by no means an easy sheet to survey, requiring great care and patience; fortunately, except on the more lofty hills mentioned, the features were bare.

Sheet No. 64.

This sheet is comprised almost entirely of Banswara territory, with the exception of a small portion of Dungarpur, in the north-west corner, and of Sunth (Rewakanta Agency, Bombay Presidency) in the south-west corner; the boundary of Kusalgarh, which forms a compact domain in the south of Banswara, and the boundary of Khándu, are shown to the east of the sheet. The chieftains of Kusalgarh and Khándu belong to the reigning family of Banswara, being descended from Pretvi Raj, the first Chief of Banswara. Kusalgarh contains 170 villages, and Khándu 40; the Rao of the former holds the position of a guaranteed feudatory to the Ráwal of Banswara. The Khándu chief is a first class noble; the boundary of his domain was shown in sheet No. 53 already published, and has therefore been continued in this year's work; the greater portion of Kusalgarh will enter into the work of the Guzerat party.

A large portion of Banswara entering into this sheet belongs to the Rao of Garhi, the second largest first class noble in the State; he owns 126 villages in Banswara, the majority of them being situated in the tract of country south of the Anás, and between that river and the Sunth State. The whole of this country at one time belonged to Sunth, and was known as the Chilkari district, being together with Kusalgarh and Khándu, almost entirely inhabited by Bhils.

The Garhi territory, however, is not sufficiently compact to admit of its being shown separately. The whole of this sheet, west of the Anas, and its tributary the Haran, is of the roughest description, comprising one mass of hills clothed with dense forest; the surveyor's difficulties were therefore considerable, and their progress slow. East of the Anás, except for about three or four miles from the river bank, the country opens out, and one of the most fertile tracts in Banswara is here met with, extending from about three miles south-west of Banswara City to Kusalgarh, and containing several flourishing villages, the inhabitants of which are all cultivators; the land produces very fine crops of Indian corn, rice, wheat and gram. Although nearly the whole of this sheet is inhabited by Bhils, they appear to be well controlled by the Raos of Garhi, Kusalgarh and Khandu, and in consequence of the judicious management of the surveyors employed, no difficulties arose.

Forts.

There are no forts in this year's work, but at Chandarwara and Shergarh, two thana stations of Garhi, as also at Bhopatpura, a thana of Banswarh, and Partabgarh, thana of Sunth, there are walled enclosures about 40 yards square with towers at their four corners; the walls being about 15 feet high; at Bhopatpura the walls are of mud, but at other places of brick; within the enclosures their block houses are evidently built as places of refuge, for protection in case of any sudden rising of the Bhils.

Towns and cities.

There are no large towns in this year's work, but the following are the principal villages which enter into each sheet:—

Sheet No. 60.

Parsola, Lat. 23° 57′ 6″ / Long. 74° 25′ 34″ population 840, in Oodeypore, a thana station on account of its iron mines, of which there are several, and from which a peculiar description of iron-ore can be obtained, but the manufacture of iron has fallen off considerably of late. At the time of my visiting the place there were only three wind furnaces at work.

Ghatol, Lat. 23° 45′ 20″, Long. 74°27′12″, population 1,138, one of the largest villages in Banswara on the road to Danawad in Oodeypore.

Jagpura, Lat. 23°51′56″, Long. 74°23′22″, population 400 and Doogaria, Lat. 23°51′57″, Long. 74°30′ 0″, population 264. These are here mentioned as they are thana stations situated among the Bhil villages in the northern portion of Banswara.

Motagaon, Lat. 23°48′18″, Long. 74°17′40″, population 1,014 and Gamri, Lat. 23°55′ 2″, Long. 74°20′15″, population 588, are the residences of two of the Choban Thakurs of the first rank; the former holding 7 and the latter 11 villages in the neighbourhood; but like most of the villages the residences of these Banswara nobles are chiefly conspicuous for their having been thoroughly neglected and allowed to fall into ruins.

Bankora, Lat. 23° 49′ 16″, Long. 74° 1′ 38″, population 2,060; 27¾ villages; Salaj, Lat. 23° 54′ 27″, Long. 74° 21′ 39″, population 1,500, 14 villages; Sabla, Lat. 23° 50′ 43″, Long. 74° 13′ 5″, population 1,388, 3½ villages; Nandli, Lat. 23° 55′ 55″, Long. 74° 0′ 49″, population 412, 5½ villages; the residences of four of the first class nobles of Dungarpur.

Aspur, the thana station of the eastern portion of Dungarpur, Lat. 23° 57′ 13″, Long. 74° 7′ 6″, population 1,022.

Loaria, Lat. 23° 45′ 45″, Long. 74° 15′ 44″, population 1,024, at one time a place of considerable importance on account of its iron mines; the iron-ore being obtained from four small hills to the south-west of the village, but the mines are now abandoned.

Banswara, Lat 23° 32′ 45″, Long. 74° 29′ 23″, population 6,000, the capital of the State; a walled city, but the walls in many places have fallen into disrepair; several of the tradesmen's houses are built of stone; the palace stands on rising ground to the south of the city, and is surrounded by loop-holed walls. The kutchery and public offices, which are small, are in a walled enclosure on the level ground to the west of the city, which also contains one of the residences of the Ráwal; on the level ground between the city and the kutchery a fair is held annually in November, the booths are entirely composed of the stock of the shops of the town, which are closed during the fair by order of the Durbar. Cloth, pots and pans, bangles and other cheap ornaments seem to be the chief articles for sale; the fair is well organized, and is orderly and clean; detachments of sepoys from the regiments of the first class Thakurs assist in keeping order; the purchasers seem to be entirely Bhils, who flock to the fair in great numbers.

Sheet No. 52.

The villages as per margin, the residences of first and second class Thakurs, belonging to Banswara, enter into this sheet. The Rao of Garhi has established a school which keeps open for six months in the year, and attempted last year to open a dispensary, but the Hospital Assistant declined to remain after a few days, as the place was very unhealthy.

Garhi, Lat. 23° 35′ 21″, Long. 74° 11′ 24″, population 1,582, 126 villages, with a school during the winter months.

Metwala, Lat. 23° 43′ 12″, Long. 74° 12′ 35″, population 481.

Arthuna, Lat. 23° 29′ 50″, Long. 74° 8′ 15″, population 1,450.

Talwara, Lat. 23° 33′ 52″, Long. 74° 21′ 50″, population 1,573.

Amja, Bhimsur, Bhowasa, Orwara and Umara, the residences of second class Thakurs.

Partabgarh, a large Brahmin village, Lat. 23° 35′ 28″, Long. 74° 19′ 11″, population 1,686, on the road from Banswara to Dungarpur, and the thana station of Tezpur, also enter this sheet. Crossing the Mahi into Dungarpur territory, we have Galia Kot, Lat. 23° 31′ 7″, Long. 74° 3′ 39″, population 1,950; at one time the capital of Dungarpur, before that State was divided into two, about the fifteenth century, where are the matas or monuments erected to the memory of the ancestors of the present Maharawal of Dungarpur; there is also a Mussulman shrine, which is a place of pilgrimage, much frequented by the Boras of Guzerat; a large fair is held at Galia Kot at the end of March. It is the head-quarters of one of the thanas of Dungarpur.

Sagwara, Lat. 23° 40′ 29″, Long. 74° 3′ 55″, population 4,860; at one time a place of considerable importance; in 1857 there was a general flight of the population to Partabgarh, and it is now in a state of disrepair; the Maharawal usually spends some weeks here on his way to and from the Benisar fair, in February; there is a Government post office and school.

Chitri, Lat. 23° 33′ 23″, Long. 74° 1′ 21″, population 803, the residence of one of the first class nobles of Dungarpur enters sheet 52; he owns 7 villages.

The principal places in this sheet are, Tanbesra, Lat. 23° 15′ 42″, Long. 74° 23′ 25″, population 430, the principal village of the largest Rajput Thakur in Kusalgarh; there is a weekly market held here, besides a fair on the 15th of each month. There are 20 villages belonging to Tanbesra, Kalinjra and Bhopatpura, thana stations of Banswara.

Sheet No. 54.

Chinch, Lat. 23° 27′ 55″, Long. 74° 21′ 11″, population 1,650; Wagidora, Lat. 23° 24′ 11″, Long. 74° 18′ 28″, population 1,129, and Nogama, Lat. 23° 26′ 53″, Long. 74° 18′ 5″, population 1,145, are three large villages situated in the fertile tract of country south-west of Banswara.

Talwara Ghât, a pass on the main road from Banswara to Dungarpur, about four miles long; it has always been infested with robbers; the lands about Talwara were given to the Thakur Gopinathji, and he was raised to a first class Thakur to keep the pass open; it is still unsafe for travellers, but is easy to traverse.

Hills and passes, sheet No. 52.

Sheet No. 54.

The Dhani Chaotra Ghât on the road from Sunth-Rampur to Galiakot, an easy pass, but surrounded with densely-wooded hills. The Khargor Ghât leading from Shergarh to Bhukia is easy to traverse, even with carts.

Hills.

The only hills were the Kharjhu range in sheet 54, terminating on the western extremity in the Mangarh hill, a bluff scarped hill, overlooking the thana of Partabgarh at the junction of the Sunth and Banswara boundaries; this hill bears traces of having been once fortified; it is ascended by an easy bridle path from the south, but is inaccessible from any other direction.

Roads.

The only roads deserving the name are, the main road from Banswara to Dungarpur in sheet 52, passable for carts, but unmetalled and unbridged, and the road from Banswara to Kalinjra, at which point three roads branch off, one to Kusalgarh *viâ* Tambesra, the second to Jalod *viâ* Bhopatpura, and the third to Sunth-Rampur *viâ* Shergarh and Fatehpur, none of which are metalled, but are feasible for wheel traffic; the former crosses the river Haran at Kalinjra, and the two latter cross the Mahi river; as these rivers are not bridged, the roads are impracticable during the rains. There is also a fair road from Sunth-Rampur to Partabgarh, thana Kherapa, and thence carts can be taken on to Galiakot and Sagwara, on the main road from Banswara to Dungarpur. There is very little wheel traffic, pack bullocks and donkeys being chiefly used. Camel carriage was entirely used by the Survey Party, and there was no difficulty in moving about any part of the country.

Rivers.

The Mahi, with its tributaries the Jaknam, Chap, and Som; and the Anás, with its tributary the Haran, are the only large rivers which enter into this year's work. They are all unnavigable.

The Mahi.

The Mahi enters sheet 50 at the north-east corner, takes a south-westerly course, and about half-way through the sheet is joined by the Som river at Benisar; sweeping south, it runs through the centre of sheet 52, and passes out of this year's work at the north-west corner of sheet 54; its banks are for the most part very precipitous, rising to 40 and 50 feet above the river-bed, and are also well wooded; the bed is as a rule very rocky, and the banks so steep that it is with difficulty crossed, except at the well-known fords; nine of which crossings, practicable for camels, are shown on the maps; two of these allow of carts passing over, but all may be made passable for carts without much difficulty.

The Anás.

The Anás which enters sheet 54 midway from the south, and takes a northerly course, is met by the Haran about half-way up this sheet; continuing its course to the north it sweeps round to the west, and passing along the upper edge of sheet 54, joins the Mahi at Bhetran; the banks of the Anás are, like those of the Mahi, wooded and very steep; the bed is equally rocky, and the river can only be crossed at well-known spots, four of which are shown on the map.

The Som.

The Som river enters sheet 50 at the north-west corner, and, flowing in an easterly direction, traverses about half the sheet, when it bends sharp to the south and joins the Mahi at Benisar; unlike the Mahi and Anás its banks are for the most part low, and may be crossed at most places without difficulty, except in the rains.

The Jaknam.

The Jaknam enters sheet 50, and flows through a rocky and jungly country, but is crossed with difficulty, except at the usual crossing.

The Haran.

The Haran, which enters sheet 54, is a small stream fordable anywhere without difficulty. With the exception of the Mahi and Som, the rivers mentioned are not perennial, but in the monsoon they become unfordable torrents.

Inhabitants.

In Banswara and Dungarpur the Bhils form the most numerous section of the population; the same may be said of the small portion of Oodeypore and Sunth, entering into this year's work in sheets 50 and 54; the country was originally conquered from them. All Bhils go about armed with bows and arrows; the head-men carry swords; they are very warlike, and their most serious affrays arise from cattle-lifting. The men wear long hair, the women are small and ugly, those of rank being distinguished by the number of brass rings on their legs, often extending from the ankle to the knee.

As a rule they were peaceably inclined, and with the exception of one case where a klassie was severely wounded, and another where a Bhil in Danawad, (Oodeypur) was just stopped by Sub-Surveyor Sheik Oomer, at the very moment of drawing an arrow at one of his klassies, the surveyors were not molested; but then they were always accompanied by a vakil and guard from the durbars, and by one of the latter while out at work. The post was robbed on two occasions; the dominant class are Rajputs; the Chiefs of the first class are called tazimdars; they are for the most part connected by marriage with the Rulers of Banswara and Dungapur, who themselves claim descent from an elder branch of the family which now rules at Oodeypur.

Products, soil, &c.

The following crops are grown in the winter and spring: wheat, barley, gram and sugarcane; opium is grown to a small extent only in Banswara, but in considerable quantities in the Dungarpur State. In the rainy season, Indian corn, til, arad and several kinds of rice are grown; kudra or kodo, a coarse kind of small grain of the rice species, is what is chiefly sown on the hills, and wherever

the soil is poor, and is what the Bhil chiefly lives on. As a rule, the soil in all the villages is very good, being either black or a rich red loam: the lower hills are very bare of soil, but every small valley is dammed up, the natural drainage is stopped, and there is a silting up in all their villages of surface scourings from the hills, and the crops met with are generally very good.

Extract from the Narrative Report of MAJOR J. R. WILMER, *Deputy Superintendent, Survey of India, in charge No.* 5 *Party, Mirzapur Topographical Survey;—season* 1883-84.

Country triangulated.

THE country triangulated extended over a portion of the Kaimur range, north and south of the Son river; it presented a few difficulties, and some of the sides of the triangles were very small. There was a good deal of jungle to be cleared before rays could be obtained.

Country surveyed in detail.

The country surveyed in detail was very much the same as that met with in the previous season, that is hilly, and with many ravines near the rivers, and more or less covered with jungle; sometimes very densely so. This makes the survey of it very laborious and slow. It is also very unhealthy until the cold season has well set in. The mornings are foggy until about 8 or 9; sometimes so much so as to render surveying impossible until the mist has dispersed. Heavy dew also falls at night, making the tents as wet as if they had been rained upon. The manners and customs of the inhabitants are fully described in Mr. Connybear's report of the Mirzapur district, as is also the nature of the soil, produce, &c. No large rivers were surveyed this season, and no large important ranges of hills.

Extract from the Narrative Report of MAJOR J. R. MCCULLAGH, R.E., *Deputy Superintendent, Survey of India, in charge No.* 8 *Party, Mysore Topographical Survey;—season* 1883-84.

Plan of operations.

THE plan of operations included triangulation in degree sheets IX and XIII, also for the large scale survey of the Mysore city, a certain amount of theodolite traversing in degree sheet XIV, the detail survey of standard sheets Nos. 3, 51, 52, 53, 59, 60, 61, 64, and 65, and lastly the detail survey of the city of Mysore on the scale of 12″=1 mile.

Remarks on the country finally surveyed.

The country topographically surveyed this year exhibits the varied and diversified features usually met with throughout the province of Mysore. From the mountainous and thickly covered forest tracts found in the eastern parts of sheets Nos. 61 and 64, and western part of No. 53, to the hilly but bare landscape as seen in sheets 59 and 60, rolling down irregularly to the open but undulating plains dotted here and there by isolated mounds and hills, and now and again by scrub jungle in patches of no inconsiderable magnitude and density as met with in the eastern parts of Nos. 51, 52, and 53. The Cauvery river throughout no small extent of its course, several of its tributaries, notably the Hemavati, Lakshmantirtha, Shamsha, and Arkavati; the falls of the Cauvery at Shivasamudra, of wide known fame, and the great attraction for travellers; another grand fall lower down the course of the river; also the fine falls of the Shamsha and Arkavati rivers, as yet hardly known of, unless perhaps to a few adventurous spirits and sportsmen, all lie within the field of operations and have come under survey this season.

General remarks.

The outturn of the season, though some 700 square miles less than the previous year, cannot, I trust, help being considered other than very good, and it is entirely due to the exertions of the party at large. All ranks, European and native, I think, deserve credit for having worked with a will to secure the results obtained, and what is of equal importance is, that the work has stood the test of a rigorous and searching examination. The 16 sections of the one-inch survey have, with one exception (that of Mr. James), been checked by test lines aggregating 569 miles, as well as by fixings *in situ*. In addition to observations with the clinometer by each of the detail surveyors, a very large number of additional determinations of height were obtained with the theodolite. These heights have materially helped to secure the accurate representation of the configuration of the ground. The eleven sections of the Mysore city survey underwent a searching investigation at my hands, and I have every confidence in their correctness. In this work the contours which represent 20 feet vertical interval have been laid down with great care by means of miniature water-levels, and though perhaps hardly up to the standard of work executed with a spirit-level, they have every pretention to considerable accuracy. The same system of contouring is being adopted in connection with the survey of the Bangalore town and cantonment.

Extract from the Narrative Report of MAJOR R. BEAVAN, *Deputy Superintendent, Survey of India, in charge No.* 1 *Party, Central India and Rajputana Topographical Survey;—season* 1883-84.

Remarks on the country triangulated.

THE country west of the Luni river has little to recommend it. Near Barmer there are some large hills which stand up abruptly from the surrounding country, but the rest of the tract is very flat and sandy; water is scarce, and what little there is, is generally brackish, except that which the villagers store in underground reservoirs or "tankas." This being rain-water, is sweet; it is not, however, used for ordinary purposes, but is kept as a reserve in case of drought in the summer. There is a good deal of cultivation when the rainfall is sufficient, and vast numbers of cattle are to be seen grazing about the country, which is by no means a desert, although the soil is sandy, and if the rainfall was only more abundant, it would be green and fertile.

Remarks on the country plane-tabled.

Standard sheets Nos. 100 and 103 lie principally in the State of Sirohee, and include the well-known sanitarium of Mount Abu. The Rajputana State Railway runs through these two sheets, in consequence of which labour is very high, and it is difficult to get coolies, even for a day's work for clearing jungle or cutting rays. The country is densely wooded, and, excepting the cultivated portions, is covered with thick thorny jungle and spear grass, which is most troublesome to get through; the hills also are very rugged and difficult to climb. There is a good deal of cultivation, however, in the more open valleys, and especially west of Mount Abu. East of the railway line is almost all jungle, the inhabitants of which are chiefly Bhils and Meenas.

Extract from the Narrative Report of H. HORST, ESQ., *Deputy Superintendent, Survey of India, in charge No.* 7 *Party, Burma Topographical Survey;—season* 1883-84.

Remarks on the country triangulated.

THE country triangulated lies between latitude $\frac{18° 0'}{18° 45'}$ and longitude $\frac{95° 45'}{96° 0'}$ and comprises all the reserved forests in the Tharrawaddy district not previously triangulated. The nature of the country is the same as that described heretofore; the work extended along the western slopes of the Pegu Yoma range, which is not very marked, north of latitude 18° 20′, averaging about 1,300 feet above sea-level; but to the south it rises to 2,700 feet at Sanamongtong (elephant-trunk hill), latitude 18° 23′ 5″, longitude 95° 57′ 39″ and 2,650 feet at Kyauklada peak, three miles further. From this peak the range has an average elevation of 2,000 feet until Sanwinguntong is reached, where it rises to 2,260 feet.

The area plane-tabled embraces parts of the Thonze and Konbilin reserves, which are now entirely surveyed, the Kadin Bilin and Mokka reserves which are also completed, and part of the Minhla reserves. The eastern boundary of all the reserves, the Konbilin excepted, is in the Pegu Yoma, which attains a considerable altitude, and rises abruptly like a wall from the low hills to the east, showing a comparative height in the Thonze reserve of more than 2,000 feet in about a mile from the base of the range. Further north there is a series of high ridges running parallel to the Yoma, and in some cases overlooking it: there is a sudden fall then to the west, and the hills become low and intricate. The hill ranges vary from 1,300 to 2,600 feet in height above sea-level.

There are several large streams, impassable during wet weather when they become impetuous torrents, serving admirably the purpose of floating down timber which is collected in the dry season in the dry beds of the chaungs and their feeders, which are generally called Myoungs. The following are the chief: the Thonze chaung, which traverses the Thonze reserve from north to south; the Yetho or Kadin Bilin chaung, flowing through the Khadin Bilin reserve; the Mokka chaung, which passes through the Mokka reserve; and the Minhla chaung through the Minhla reserve, all which take their rise on the Yoma. The country is difficult to travel over, as there are only two or three main pathways practicable to elephants, and it is covered with dense primeval forest. There are a few Tés or Karen habitations, the principal of which are Thanga-za té and Payow té, both of which have been removed to other sites from the localities they occupied when the survey was made; and Chaungwa té and Yetho in the Kadin Bilin. In the vicinity of the latter there are permanent paddy fields; Panlete and Ombwate in the Mokka reserve, the site of the former having also altered since the survey. All are temporary habitations, liable to be shifted every two or three years for sanitary purposes, the Karens being filthy in the extreme, and to be known by other names after the death of the present headman or Sankes, from whom they derive their names. Notwithstanding the hardships to be encountered, life in the forest is not unbearable. The monotony is trying at first, but one becomes accustomed to that, and after a time prefers working there to the bare, hot, and dazzling plains, where there is nothing to relieve the eye. The Bhooia Klassies, who come from the Hazaribagh district, are perfectly miserable out of the forest, and in consequence prefer this to the cadastral parties. With proper precautions one enjoys fair health, still there is always a gnawing feeling of uneasiness, as the attacks of illness are sudden and frequently fatal. Any further description would be only a repetition of what was reported last year.

Pathways and passes.

(*a*) There is a well beaten and cleared path from Way *viâ* Kodugwe (a deserted village site), Chaungyua, Yetho, and Panlay to Seyna, which is situated on the Minhla

chaung in latitude 18° 6′ 12″and longitude 95° 56′ 2″, on the western edge of the reserve of that name. It is practicable to laden elephants, though some parts require widening out every year.

(*b*) Another from Letpadan and Minhla on the Rangoon and Prome Railway line *viâ* Khwe Makain along the Bilin chaung to Yetho through the Kyauktaga pass in latitude 17° 59′ 50″and longitude 96° 2′ 10″, about two miles west of the Yoma, crosses the ridge in latitude 17° 59′ 5″ and longitude 96° 3′ 45″ and leads to Shwe-we-te and Sagalay-te. There is a Burman encamping ground on the Yoma, where perennial springs exist, affording a plentiful supply of water. This path is practicable to lightly-laden elephants after leaving Yetho, excepting a few chains over the Kyauktaga pass, which can, without trouble, be rendered easy by blasting a few rocks. Kyauktaga signifies literally rocky door or opening. from *Kyauk* a rock, and *taga* a door or opening.

(*c*) A third, practicable to elephants from Yetho along the Taung chaung and Kyauklongyi chaung crosses the Yoma in latitude 17° 57′ 7″ and longitude 96° 4′ 36″, about four miles north of Sanwinguntong hill to Sagalay-te.

(*d*) A fourth, impracticable to elephants, from Yetho along the Yetho and Takaupi chaungs, crossing the Yoma in latitude 18° 2′ 35″ and longitude 96° 2′ 23″, and leading to Shew-we-te and Luti-te.

When the survey of the country to the east of the Yoma is taken up, it will be necessary to utilize *b*, *c*, and possibly *d* for the conveyance of provisions from the Rangoon and Prome Railway, a distance of 50 miles or more, as supplies are not procurable on the eastern slopes except from much longer distances, and it will then be necessary to have at least 15 elephants attached to the party, as local carriage is nowhere procurable.

Scarcity of water.

The scarcity of water during the last six weeks of the field season was seriously felt, and time was lost in searching for springs or digging wells, frequently without success. Pools were often met with, but generally poisoned by Burmans for the purpose of killing fish This is a punishable offence, but the delinquents take good care they are not detected, as they usually carry on such practices by moonlight.

Mr. Wilson introduced a system of working by sound instead of flags, which facilitated matters considerably, and the result was most satisfactory. The method adopted was to send a klassie about 15 or 20 chains in the proper direction, and on his taking up a position, he struck together, at short intervals, two dry and hollow bamboos, one considerably thicker than the other, which produced a sharp sound, and if there was no higher ground intervening, which of course had to be guarded against, the ray taken in the direction whence the sound proceeded was seldom out by more than 15 or 20 links, which on the 4-inch scale is not appreciable. After a little practice the ear becomes so perfect that even the chainmen moved along without diverging, and very little clearing was necessary. The system might with advantage be still further utilized by sending men to bends of streams and cutting in from two or more fixings on the ridges. The experiment will be tried, and if it does not give satisfaction for the insertion of features to be rigorously surveyed, it will doubtless prove useful for approximate work.

Notes on the manners and customs of the Karens by Mr. J. H. Wilson, *Assistant Surveyor, 1st grade.*

The marriage ceremony of the Karens is an extremely simple and primitive form, although just as binding as others more elaborate. The hill Karens never intermarry with Burmans: their simple modes of life would ill-harmonize with those of the Burman, who is viewed by the Karen as possessing the punctilious notions of the "Cityman." The invitations to a marriage ceremony are always issued during a previous similar occasion when all are assembled, thus avoiding the expense and inconvenience attendant on sending messengers about. The bridegroom proceeds to the house of his fiancée in the ordinary eastern fashion, heralded with music and a motley throng of revellers, who enter into the spirit of the gaieties most heartily, frequently imbibing copious draughts of their home-brewed whisky as if to whet their lagging spirits, yet, although most of the guests are fairly under the influence of liquor, added to the excitement and jostling of the crowd, anything like a brawl or wrangle among them is unknown. The characteristic feature of this procession, when compared with those organized in India, where the bridegroom is lionized and impromptu ballads composed in his praise, is most singular, as it consists of the bridegroom forming the most insignificant individual in the crowd, where one and all are arrayed in gala attire and this seemingly miserable wretch is conspicuous in his ordinary apparel and by occupying the last place in the procession.

When the house of the bride is reached, the guests ascend the bamboo ladder leading to the guest chamber; on reaching the last rung of which, each man is helped to a cup of whisky before entering the hut, but the bridegroom, who as usual comes last, is utterly denuded of his clothing and favoured by a shower bath from one of the elderly dames, which he receives with the air of a martyr, together with the liberal allowance of whisky. But now the scene changes, and the bridegroom on adorning himself with suitable garments seems already to enter upon a new episode in his little history by assuming the more dignified position of host and benedict combined.

Meanwhile the company inside the building range themselves in two sets, men and women apart, to partake of the feast provided, after which liquor is again requisitioned in order to induce the bashful youths to express their sentiments with reference to the maidens of their choice, which is conducted in the following manner. One of the young men addresses the lady of his selection with three puzzles, which, if replied to with sufficient adroitness, is generally equivalent to a consent to his implied proposal of marriage. But if the challenge to solve the riddle is not accepted, the failure is considered tantamount to a rejection of the suitor. The puzzles invariably consist of an absurdity, and are considered as solved when met by equally ingenious ones. After the interchange of three such questions satisfactorily, the day and hour for the wedding of the parties is appointed, and invitations verbally uttered, thereby forcibly illustrating the advantages of the system of short engagements over more civilized forms of protracted ones, resulting frequently in breach of promise suits.

Notes on the forest reserves by MR. C. P. TORRENS, *Assistant Surveyor, 1st grade.*

THE Minhla forest covers an area of about 60 square miles, and is drained by the Minhla chaung. A long narrow strip of ground running north and south along the length of the forest is given over to the Karens, and contains the following "tes"—Gna-sa-te, Pono-te, Tekwa-te and Poshwezin-te.

The Gamôn forest comprises an area of about 80 square miles; the southern portion is drained by the Gamôn chaung, and the northern by the Taung chaung. This forest has a large patch of ground, which has been given over to the Karens, who inhabit the following tes—Pinding-te and Phomonsi-te.

The Bawbin forest has a larger area than either of the above two, and covers about 110 square miles. The Bawbin chaung, with its tributary the Kyaukpyu chaung, drains this tract. The Karens have two grants in this forest, the northern and larger one contains two tes, Tha-dwe-te and Ko Pan-ai-te, the southern and smaller one has Tone-San-te.

The Minbu forest is very small and contains only 20 square miles; it is drained by the Minbu chaung. The forest is uninhabited, and does not even contain a single Karen te.

The Taungnyo forest covers a very large area, and is drained by the Taungnyo chaung with its tributaries the Nyan-te, Sinzew, Pa-nyo-gale, Mwe-gyi, and Pa-nyogyi chaungs. It is divided into a number of small reserves, of which the following came under survey this year:—Taungnyo, Nyanle, Pazinje and Kani.

The hill of Taungnyo-Myo in the Taungnyo forest has a history attached to it, but beyond the fact of its having been used in days bygone as a Burmese sanitarium, I could gather nothing further regarding it.

Sabataung, a well-known hill in the Taungnyo forest, has also its history. Tradition says that it was here the princess Sabu (after whom the hill is named) took up her abode and hid herself from the king of Ton-ta-long, who was in love with her and persecuted her. It is believed that her jewels and other valuables are yet hid in some part of the hill.

The Taungnyo chaung is a large and important stream; the manufacture of cutch is carried on to a very large extent on its banks. Cutch is chiefly made by men from Upper Burma, who come down in large numbers in December, and take up their residence along the streams. The making of cutch is very laborious, the tree has to be felled and brought up to the place of manufacture; it is then cut up by hatchets into small chips of about $2'' \times 2'' \times \frac{1}{2}''$. These chips are then boiled for about a day in earthen pots, when the cutch is extracted. The cutting up of the wood is done by the men, and the boiling by women. The cutch in an unclarified state is sent to Paungde, where it is subjected to a second process of clarification before being exported. Although cutch making is very tedious, it appears to be remunerative, as from what I could learn a hard working man earns Rs. 25 a month and thus clears Rs. 125 during the season. The work closes about May, when the rains set in, and the men return to Upper Burma.

Notes by MR. R. A. GIBSON, *Assistant Surveyor, 1st grade.*

THE Hle-don Kyan is a low range of hills, which forms part of the boundary between the Kadin Bilin forest reserve and the Etho Karin area. The range is named after a boat which is to be seen on it; the following information regarding which was gathered from a Karen resident of Yetho.

Over fifty years ago, long before the British took possession of the land, there lived a Burman Chief. Desirous of getting into favour with the king, he thought of performing a wonderful feat, and thus gain his ends. For this purpose he had a boat constructed on this hill, out of an immense teak tree, and intended it for a royal pleasure boat. After consulting the astrologers, a day was fixed for launching the boat on a stream which flows some 300 feet below. Grand festivities were held on the occasion, but notwithstanding the number of buffaloes and men employed to drag the vessel, it could not be moved beyond a few feet. All who were engaged in the work of moving the boat died, as the nats (spirits) did not wish the scheme carried out. As the Burmese are very superstitious, the boat was left on the hill, and there it stands to this day, where it can be seen, slightly damaged at one end by jungle fire. Overcome with mortification at his failure, the Burman Chief died.

On the Pegu Yoma range, within the ground allotted to me for survey, there is a beautiful spring, situated about 1,500 feet above sea-level, in latitude 17° 51′ 15″ and longitude 96° 6′ 26″. It is called the Kunyoni Yesan after a betel-leaf plant which grows near it (*Kunyone*, signifying red stalk betel-leaf and *Yesan*, spring). This plant is held in great reverence by the Burmese and Karens of the neighbouring country, and is believed by them to have been planted centuries ago by a good nat (spirit), who is supposed to look after it still. They say the plant will never wither, and it is a fact that the elephants, rhinoceri and other wild animals which frequent the spring for water have never destroyed it. The Burmese will often travel miles to secure a few leaves of this plant for medicinal purposes; it is also believed to possess a charm for lovers, and a Burman firmly believes that if his fiancée would eat a single leaf obtained and given by him, it would increase her affections for him. The plant is about two inches in diameter, and creeps up to the height of about 100 feet over the trees surrounding it, covering the whole of them with its leaves. Bamboo ladders are attached to these trees in order to obtain the leaves, which are procured from a height of 30 to 50 feet.

Extract from the Narrative Report of Mr. A. M. Lawson, *Surveyor, 2nd grade, Officiating in charge No.* 10 *Revenue Party, Konkan Survey ;—season* 1883-84.

Limits of work.

The work of this season lay in the most inaccessible part of the Thána district. The Western Ghats and the sea bounded the work on the east and west; the parallels 20° and 19° 45′ forming the northern and southern limits.

The country surveyed, includes the Mokáda sub-division of the Sháhápur Taluka, the Jawhár State, and a portion of Dáhánu Taluka.

Description of country.

Near the centre of the eastern margin of the work is Bajgad, 3,575 feet, and about a mile to the north the lofty peak of Votur, 4,081 feet. From Votur a spur running north and west forms the Assa table land and the watershed of the Vág and Vál rivers. North and south of Votur peak the Ghats have an altitude of from 2,000 to 2,300 feet; dipping abruptly towards the west to about 1,500 feet, there is a belt of rolling grassy uplands, some six miles wide, seamed by steep rocky ravines. The country again rises to an altitude of 1,700 feet, forming the Suriamal and Kevanála plateaux south of the Pinjal river, and the Jawhár, Kasetwari, and Kokda plateaux on the north. Ten miles further west the country becomes broken up into various forest-clad hill-ranges, until some six miles from the sea there is a stretch of flat country, fringed with palm trees along the coast, and intersected by tidal creeks and broad salt marshes overgrown with mangrove bushes.

The principal hills not already enumerated are Bhopatgad (1,608 feet), south of Jawhár, the hill fort of Asheri (1,689 feet), and the curious funnel-shaped hill Máhálaxmi or St. Valentine's Peak, 1,526 feet.

Rivers.

The watershed of the country being limited by the Western Ghats, none of the rivers drain a large enough area to become of much importance; the largest are the Pinjal, the Vág and the Vál, all of which rise in the Votur hill. The next in importance are the Deherja and the Surya, both of which have their source on the Jawhár plateau. With the ordinary rainfall, all these rivers have a good flow of water up to the end of February; and as their course is mostly between high hills covered with dense forest, the water power now wasted might be utilized in cutting up the timber, which at present is conveyed coastwards with great difficulty, and at much expense.

Roads.

The country surveyed is almost destitute of roads. The eastern portion entirely so. The paths in some parts are nearly impassable owing to the deep rocky banks of the streams to be crossed. There is considerable traffic on pack animals from Jawhár eastwards by way of the Ghond Ghat to Nasik, and by the Dondmari and Shir Ghâts to Igatpuri. The westerly route, from Jawhár to Dáhánu, has a well-made road, descending from the high table-lands, by the Kasetwari and Deng passes. The latter portion of the road from Sava to Dáhánu is in course of construction. There are also a few cart tracks leading from the coast along the valleys of the larger rivers, used during the fair season for the conveyance of wood to the coast and the stations of the Bombay, Baroda and Central India Railway.

Railway.

The Bombay Baroda and Central India Railway runs through the western margin of sheet 81, the following railway stations falling within the limits of the work,—Boisur, Vangaon and Dáhánu Road.

Towns.

There are many hamlets scattered over the country, but no towns or villages of much importance, except along the coast. The largest, Tárápur, on the south bank of the creek of that name, and Chinchni, on the north bank (known by the joint name of Tárápur-Chinchni), has a population of 7,000, and a small export and import trade. Dáhánu, the head-quarters of the taluka of that name, has a population of 3,500. Six miles to the east, on the Dáhánu creek, is Savta *bandar* (landing place) where large quantities of timber are yearly shipped from the Jawhár State. Mokada lies in the hilly country under the Ghats; it is the head-quarters of the sub-division of that name, but otherwise of very little importance. Jawhár, the capital of the Jawhár

State, and the residence of the Raja, is on a table land which runs north and south between two deep gorges. A few years ago Jawhár—with the exception of the Raja's residence—consisted of only a few thatched huts. The Raja, however, has made it a place of some importance by giving free grants of timber for building to induce traders and others to settle there. There are now some well-built dwellings, and the Raja (who administers his own state) has built public offices, a school-house and dispensary, and improved the water-supply. Jawhár is cool and healthy, except just after the rains; the plateau is covered with fine mangoe trees, and its elevation (1,519) and proximity to the sea makes it a most desirable place for camping during the hot season.

Extract from the Narrative Report of MAJOR J. E. SANDEMAN, R.E., *Deputy Superintendent, Survey of India, in charge No. 5 Party, Mirzapur Revenue Survey;—season* 1883-84.

Nature of establishment.

THE establishment of *amins* was a very poor one and the proportion of first class men was very small. The increased grant to enable 800 square miles to be accomplished necessitated the employment of over 200 *amins*. Out of this number only 127, of whom 37 could not read or write Urdu, had been employed the previous season. These 37 men were too ignorant to be entrusted with the records, and for them *muharirs* had to be engaged.

European inspection.

Each camp had one European assistant in the field during the entire season, who checked the survey, and at the same time 5 per cent. of the record entries. The camp officers were also out frequently, and I myself when not kept at my head-quarters for office work was out among the men listening to complaints and seeing to the progress of the work.

Native check.

In addition to the check of 5 per cent. by European assistants, 20 per cent. of the records were checked by the *munsarims*. All complaints, however trifling, were listened to, and access to the papers were given to the ryots, so that opportunities for bribery might be taken away. Generally the complaints were found to be groundless, but occasionally it was found that disputes had not been entered, and in such cases punishment was awarded at once.

The inspecting arrangements for next season have been modified and made stricter to still further reduce openings for bribery, and I trust the records will be in consequence still better.

We had great difficulty in working out for adoption a procedure which would enable the survey and the settlement staff for attestation to be out of the tahsil within the year, and which would at the same time permit of the attestation being done *on records with areas*.

We held many conferences during the field season, and it was only towards the end of January 1884, when the field season was half over, that we came to a final conclusion as to what was best to be done.

The new procedure necessitated quite a novel arrangement during the recess, which has so far answered well, although it has its drawbacks. In order to complete the statistics, an establishment under an Assistant Surveyor was left at Gorakhpur, and thus the carriage of a number of settlement records to recess was saved. Mr. Shaw volunteered to remain; and you were good enough to commend him for his zeal, which he well deserved. He had great difficulty in procuring an office, and had in consequence to hold it in camp till just before the rains set in, when he succeeded in getting a house. I think a similar arrangement must be adopted for the future, as its advantages greatly outweigh its disadvantages, and the native establishment much prefer it.

No account has been previously given of our office procedure by which the records are completed for the settlement officer. The following is briefly extracted from a note by Mr. Little in charge of camp No. 2: the several stages are—

Account of the office procedure.

The dispute list and completed Urdu *khasra* and the soil map having been returned by the Settlement Department—

(1) The Urdu and Hindi *khasras* with their *saffawar* (abstract) and *milan khasras* are first completed with areas.

(2) The areas having been entered in the *parcha jamabandis*, the entries in them are compared item by item with the *khasra* to make sure that they are identical and that every item has its *parcha*.

(3) The *parchas* are then totalled and arranged alphabetically and by tenures in *thoks* and *pattis* into which the *mahal* is divided.

(4) The totals are abstracted into the *terij*, and a grand total having been made, it is checked by comparison with the *saffawar* and *milan khasras*. Column No. 6 of the *milan khasra* checks the cultivated area and column 14 of the *saffawar khasra* checks the uncropped land, the details of the latter being compared with the columns of similar details in the *milan khasra*. If a discrepancy becomes apparent, the error is searched for till found.

(5) The crop statement is now prepared by picking out the areas under different crops from the *khasra*, the cropped areas in the two harvests being checked by columns 9 and 11 of the *saffawar khasra*.

(6) The soil statement is next prepared by extracting the areas held under different tenures and under various soils from the Urdu *khasra*, also the irrigated and unirrigated areas under various soils; the former are checked from the *terij* totals of *sir* land, &c., and the latter from the totals of the same headings on the *milan khasra*.

(7) The area statement of castes is prepared by extracting from the *terij* the areas held by the different castes, and checking the totals by the total in that paper.

(8) The agricultural statistics are collected by the survey staff; the number of wells is checked by the numbers in the *khasra*, and the area irrigated by wells is taken from the *milan khasra*.

The European superintendence over this work is a guarantee that it is done honestly, and the procedure described above multiplies checks on the areas.

Instead of adding any descriptive account of the country surveyed, which is already fully described in the *North-Western Provinces Gazetteer*, I will here give a few statistical extracts from the statements attached to this report (not printed) which I deem will be of some interest.

The Deoria Tahsil, comprising the one pargana of Salempur Majhauli, and the records of which have been completed for assessment purposes, has an area of 375,560·75 acres, or 586·81 square miles, by the summation of the fields contained in it; this includes an area of 6,124·44 acres of the Gogra river; the boundary of the district being taken as mid-channel. The pargana is divided into 23 *tappas*, containing 1,455 villages, which are held under the following proprietory tenures:—

Some important statistics of the Deoria Tahsil.

1088 are	"Pattidari Na-mukamil."
25 „	"Pattidari Mukamil."
2 „	"Bhaya chara."
112 „	"Zemindari wahid."
228 „	"Zemindari bilijmal."

Of the zamindari villages many belong to the Rajah of Majhauli's estate, at present administered under the Court of Wards. Of the total area 289,117·11 acres are under crops, 44,023 19 acres are culturable and 42,420·45 acres are barren.

The irrigated area comprises 153,140·98 acres, of which 124,036·17 acres are irrigated from wells. Proprietors themselves cultivate 92,649·71 acres. There are only 187 ex-proprietory tenants under Act XVIII of 1873 cultivating the small area of 567·91 acres; 3,597 tenants hold 5,839·01 acres rent free. There are 103,312 occupancy tenants who cultivate 126,976·76 acres, and 82,744 tenants-at-will holding 62,972·71 acres. Of the 9,482 masonry wells only 2,124 have been built during the last 10 years.

There are no less than 2,989 inhabited sites in the tahsil, or 5 in each square mile; there are 42,028 ploughs and 86,168 plough cattle.

The area under kharif crops is 173,220·74 acres, of which rice occupies 51,817·83 and kodo 50,762·15 acres, and arhar with kodo 27,424·02.

The area under rabi crops is 159,151 55 acres, of which barley occupies 70,543·66 acres and wheat and barley 33,659·76; the area which bears a double crop during the year is 43,255·18 acres. The food crops in the kharif cover 150,310·42 acres and in the rabi 147,222·33 acres, the whole area covered by food crops being 297,532·75 acres.

Out of a total of 124,645 cultivators, 27,573 are Brahmins, cultivating 75,503·16 acres, and 12,452 Rajputs with 44,792·65 acres; of the other castes, the Ahirs number 16,574 with 35,965·71 acres, and the Koeris 13,502 with 30,856·44 acres of cultivation. There are only 3,483 Mahomedans, and they cultivate 6,032·66 acres.

Of the soils *doras*, elsewhere generally known as *domat*, is the prevailing natural soil, and out of the total cultivated area of 289,117·11 acres it covers 170,260·53 acres; the *goind* or home lands occupy 56,799·16 acres (or about 20 per cent. of the whole), of which 19,361·47 acres are cultivated by proprietors and 37,437·69 by tenants.

I have purposely extracted the above statistics not only as being interesting, more especially to revenue officials and as famine statistics, but because they so clearly illustrate what the work of the party has been. It is not too much to say that in all probability these statistics, owing to their having been extracted in the professional survey office, will be found reliable in a degree that such statistics cannot usually be.

Major Barron's Manual for settlement and survey.

Major Barron's Manual proved an invaluable guide to us, but owing to modifications in procedure a good many alterations in the book are necessary, and, as sanctioned by you, it will be finally corrected during the next recess.

List of records for Settlement Office.

The following records for every village have been made over to the Settlement Department of the Deoria tahsil, which contains 1,455 villages:—

1 Soil trace in Urdu.
1 Ditto in Nagri.
1 Urdu *khasra* with *safawar* and *milan khasra*.
1 Nagri ditto ditto.
1 Dispute list.

Jamabandi slips.

1 *Terij*.
1 Crop statement.
3 Soil statements.
1 Caste statement.
1 Holding statement.
1 Statement of agricultural statistics.
28 Tappawar statistical statements in English in 2 sheets.
1 Abstract of the above by *tappas*.

Training of patwaris.

I may here mention that knowing what importance is attached by the Government of India to the training of *patwaris*, at the beginning of the season I offered to utilize these men for survey purposes and to train them. But the settlement officer was of opinion that they could not do more than they were doing, and that once the professional records were in their hands there would remain little for them to do, and that little they were already qualified to perform.

I would wish you to understand, however, that I am prepared to train *patwaris*, or to survey the country with their assistance as surveyors if required to do so. Whether such a survey could be a success the trial could soon prove.

Aid given by Settlement Department.

To Mr. LaTouche we are indebted for helping us to overcome all difficulties, and now that he has shown us the way, I hope we will be able to walk alone better and to do justice to the important work entrusted to us.

To the Collector, Mr. J. Kennedy, also our acknowledgments are due for all the help he has given us, more especially during Mr. LaTouche's absence in England on six months' leave.

Extract from the Narrative Report of MR. E. C. BARRETT, *Deputy Superintendent, Survey of India, in charge No.* 6 *Party, Kamrup Revenue Survey;—season* 1883-84.

Examination of field registers.

ON the completion of a village the *khasra* and *dag chittas* were forwarded to the survey camp, where the two records were compared by competent survey and settlement officers, and a list of discrepancies forwarded to the inspector and *munsarim*, by whom all differences were adjusted in the field. The *khasra* and *dag chitta* having been signed in turn by the inspector and *munsarim*, were forwarded, the former to the survey office, and the latter to the settlement office. The field areas were now calculated and entered in the *khasra*, and a trace of the field plan was prepared. Both trace and *khasra* were forwarded to the settlement office for examination and attestation.

Revision survey.

A comparison of the areas and classification of all holdings by the professional survey, with those given in the old settlement records, was made in the settlement office. All differences were noted as "points for enquiry in the field" which were made over to a revision party for examination and report. A revision party consisted of a settlement *munsarim* and a survey inspector or sub-surveyor. The duty of the *munsarim* was to ascertain the true limits of the holdings marked for examination, and to endeavour to account for differences. He had to attend to objections, and otherwise to assure himself that the *khasra* was a complete and accurate record of existing rights. The sub-surveyor attended the *munsarim* in all his investigations, and, when necessary, corrected his trace, making a report on each case to the Survey office. After verification of the changes made by the *munsarim* and inspector, a statement showing the required alterations in the original survey record was drawn up by the Settlement, and forwarded to the Survey office, where the necessary corrections were made, and the records considered as finally passed. In Major Barron's "Hand-book of Instructions" attestation of the records is done previous to the entry of areas in the *khasras*. In Kamrup it was found advantageous to enter the field areas before attestation. Owners were able to compare the new with the old areas of their holdings, and if so minded to raise objections which were at once enquired into and disposed of. The new system worked expeditiously, and gave satisfaction to all concerned.

Survey classes.

The cadastral plans and *khasras* may be accepted as absolutely trustworthy records of possession and rights during the year of survey. The intention of Government is that these records should be brought up to date year by year by *mundals*, who will be provided annually with photo-zinco copies of each village in their respective circles, on to which all changes and additions that may have occurred during the preceding twelve months will be entered. It is obviously necessary that before a *mundal* can perform this duty he must have some knowledge of field surveying. It was with a view to training a body of men capable of doing the work that survey classes were established at Barpeta and at Gauhati. On the arrival of the survey party in Kamrup, the Barpeta survey class was brought to Rangia and placed under the charge of the Deputy Superintendent of Survey. This class passed 29 pupils, natives of Assam, in surveying during the season. The result is undoubtedly small, but a start has been made, and better results may be expected during the ensuing season. The Director

of Agriculture had offered rewards of Rs. 25 to each *amin* who would pass his *mundal* in surveying, with a view to securing the efficiency of the existing establishment of *mundals*. At the close of the field season it was found that 12 men were sufficiently advanced to be able to pass the required examination.

Lakhiraj and nisf-khiraj estates and waste-land grants.

The boundaries of all Lakhiraj and Nisf-khiraj estates and of waste-land grants are shown in the plans. The survey of these holdings was started by the professional survey under Mr. Patterson in November 1875, but the work was subsequently made over to Baboo Futtack Chundra Barma, Extra Assistant Commissioner, by whom the survey was brought to a close in July 1883. The result of the examination of Lakhiraj and Nisf-khiraj survey areas with those of the cadastral survey shows a very near approximation to accuracy in the total areas of holdings; considerable differences in classification, however, appear at times. These may possibly be accounted for by changes that have occurred since the earlier survey was effected. The Settlement office has been furnished with detailed areas of all lakhiraj and nisf-khiraj holdings, apart from those given in the village *khasras*.

The area cadastrally surveyed contains 46 lakhiraj estates, area	6,975·67	acres.
517 Nisf-khiraj estates, area	41,125·12	,,
2 Waste-land grants, area	455·00	,,
Total of lands held rent-free or at privileged rates ...	48,555·79	,, or 75·87 sq. miles.

Extract from an account of Dardistan, surveyed during 1882-83 *in connection with the Trigonometrical Branch Survey of India.*

NATURE OF COUNTRY, TREES, PRODUCE AND CATTLE.

THE country is mountainous, and the ground rugged and stony. The mountains are arranged in ridges, and rise, in some cases, to 15,000 feet; the stone of which they are formed is in no way serviceable. Open *maidáns* exist in a very few instances, and the tops of the mountains consist mostly of precipitous peaks. Vegetation is met with only where there is running water; otherwise the country is dry and barren. The higher ranges are well covered with grass and forest, and afford pasturage for goats and sheep. The forest trees consist mostly of *chir*, *kachil*, *chalghoza*, pencil-cedar, and birch. *Chir* and *kachil* are used to cover the roofs of buildings. Weeping willow and *bani* trees grow both in the forest and in the cultivated fields. The latter is of a roundish shape; its leaves are of a dark colour, round, and about an inch in diameter. They are to be had fresh and green from the tree at all times of the year, and afford food for goats. A fine thorn, about ⅓ of an inch in length, grows along the leaf. Grass does not grow below the height of 10,000 feet, but the pencil-cedar is met with more or less at this height. From the height of 12,000 to 13,000 feet, the mountains are covered with small shrubs instead of trees. The principal of these are known as *mithári*, *beúnbiár*, and *sosar*. The *mithári* bush does not rise high above the ground, but spreads out laterally; its leaves resemble those of the *kachil*, and its wood that of the pencil-cedar. The wood burns well even when not dry, and the weight of an average sized bush is about 20 *seers*. The *beúnbiár* rises about two or three feet above ground. Its leaf is like that of the weeping willow, and its stem is of about one finger's thickness. The leaf of the *sosar* is about ½ an inch long, and is hard like that of the *hina* (*Lawsonia inermis*); it gives out an agreeable smell, and does not rise much above the ground, but spreads about; its leaves, if put among woollen clothes, will preserve them against insects. There is no timber trade carried on in the country.

The snow disappears entirely in summer. No cultivation is carried on on the mountain tops, but in the vicinity of each village sufficient to support the inhabitants is raised. The grain produce consists of wheat, barley (of two kinds, one the common sort, and another without husk, like wheat), *bákla* (a bean), *china*, *turumba*, *kangni*, and *maki* (Indian-corn). The land is prepared for wheat in the beginning of September, and the seed is sown at the end of the month. The crop is ready in the month of May following, when it is reaped. The other sorts of grain are sown in April, and their harvest time is in the following September.

The cattle stock consists of cows, bullocks, goats, and sheep; there are no horses in the country, but asses and buffaloes are met with in some places. Ordinarily one family possesses four or five cows, a pair of bullocks, and fifty or sixty goats and sheep. A man who has only one bullock, borrows a second from some other person, and returns the obligation by serving that person for double the time he keeps the bullock. Bullocks are used only for cultivating the land. They and cows are generally of a dark colour and small size.

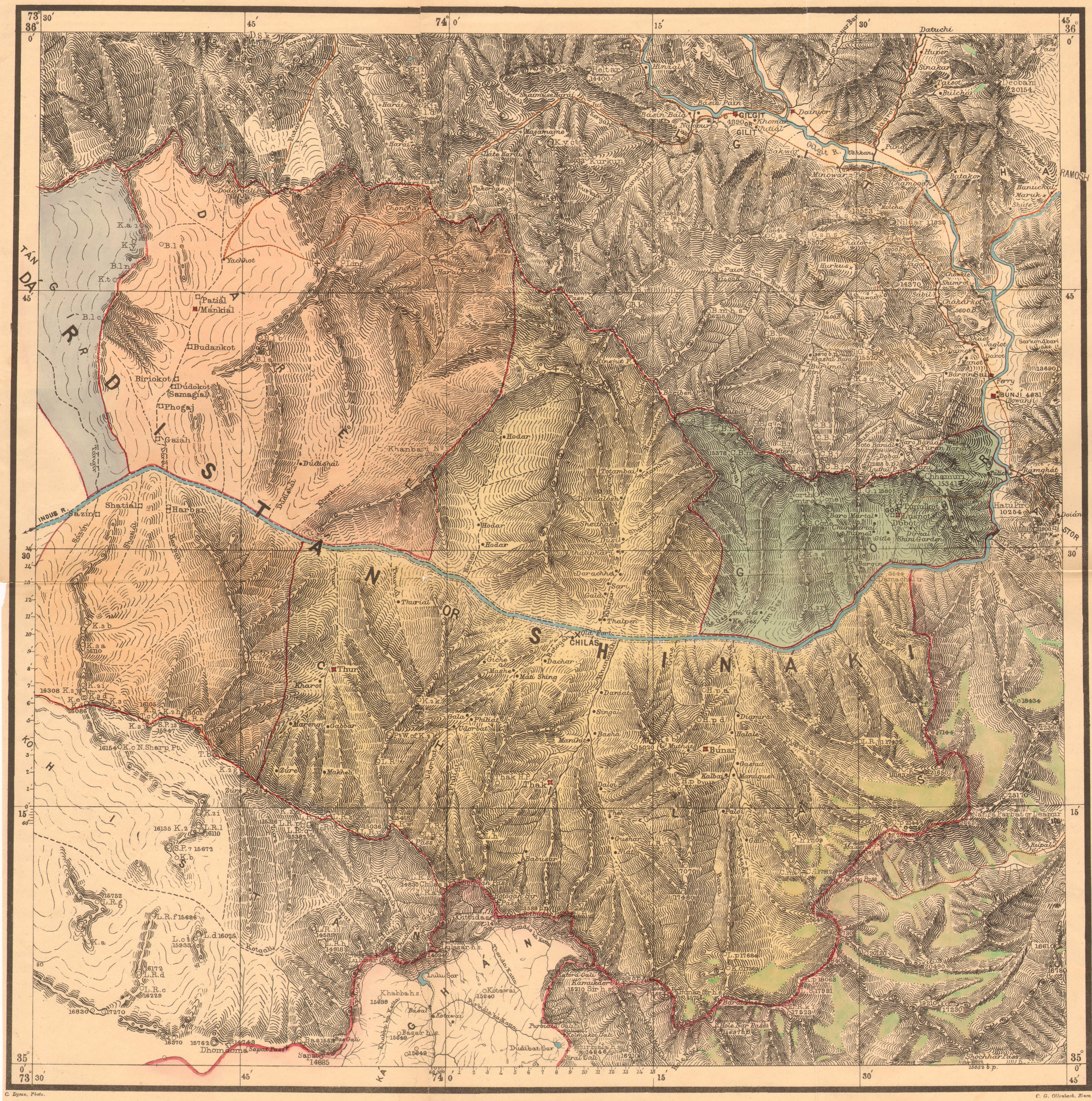
It is not customary to milk the cows. The milk of the goat, which is in general use, is thicker, and tastes better than that of the cow, and comparatively a greater quantity of butter is produced from it. Butter is made from milk which has been kept for 24 hours

MAP OF

DÁRDISTÁN OR SHINÁKI

INCLUDING

CHILÁS



C. Dyson, Photo.

C. G. Ollenbach, Zinco.

Published under the direction of Colonel G. C. DePrée, S.C., *Surveyor General of India.*

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, August 1884.

Surveyed by Ahmad Ali, Sub-Surveyor in 1882-83.

Outlined and hill-shaded by Ahmad Ali, Sub-Surveyor.

Surveyed and mapped under the Superintendence of J. B. N. Hennessey, Esq., M.A., F.R.S., Deputy Surveyor General in charge of Trigonometrical Surveys.

Scale 1 Inch = 4 Miles

Miles 4 3 2 1 0 4 8 12 16 Miles

REFERENCES.

Points fixed with the theodolite ○

Forts ■

Villages •

Routes in general use

Glaciers are colored green

in a goat or sheep skin, by shaking it for about 3 hours and putting in some water at intervals. The milk thus agitated is afterwards put into a wooden vessel and the butter is separated, the milk being used either alone or taken with bread. The butter is collected into a lump of about 25 seers, wrapped round tightly with the bark of the birch tree, and then deposited in the earth, to be taken out on occasions of feasts. It becomes black shortly after being buried, and smells very offensively, but the people of the country eat it with much relish. The older the butter the more it is liked, and the man who possesses it is considered a great personage.

The price of a bullock, or of a cow with a calf, or big with calf is one *tola* of gold; other cows can be had for half that price. The goats are of every colour, and of small size; their coat is short. The price of a common she-goat is one *sone* rupee, and that of a he-goat three *sone* rupees. The sheep too are small in size, and have small tails; they are not so numerous as the goats: their wool is made into cloth. The price of an ewe is a *másha* of gold, and that of a ram two *máshas*.

Religion, Customs, Dress, Arms, Dwelling-places and Commerce.

The people of the country are Mahomedans of the *Sunni* sect. Seven generations previously they were all Buddhists. They were persuaded to embrace *Islám* by the *Mullas* of Kághán and Kashmir. They divide themselves into four castes: *Shín*, the most respected of all; *Yashkun*, the second; *Kamin*, the third; and *Dom*, the fourth in order.

The men as well as the women are of a moderate height, healthy, and of fair, florid complexion; have short fat necks, broad chests, and muscular legs. The men fight well from behind rocks, but will not stand for a moment in the open. They are strong enough, but cannot stand hard labour or anything which they are not used to. They are not wont to travel, and are especially very backward in carrying loads. One man can with much difficulty carry 20 seers for one march.

They never willingly travel under a hot sun; when they go out, they do not take any cooking utensils or anything that might be useful or make them comfortable; even salt is neglected, and they are content with some clothing and flour as their sole provision against necessity during the journey. They make use of large stones in place of vessels, and bake their heavy loaves (sometimes a seer in weight) in hot ashes.

As to arms, each man as a rule possesses a sword and a matchlock. Some have daggers, but not as a rule; bows and arrows are also used in some of the valleys. In general their arms are old, but whoever purchases new ones chooses those made in the Punjab or Kashmir. Repairs to them are done by the blacksmiths of Dárel, Tángír, and Koli, who visit the country round about once a year for that purpose.

The implements of husbandry are made by the people themselves as far as the woodwork is concerned, but the ironwork is made by a blacksmith. They can all make cups, dishes, and the like from the wood of the walnut tree, and spoons from that of the birch, by turning them on the lathe; but on the whole they are not beautiful. Copper vessels are also in use, but they are never tinned again after the day of their purchase. In fact, the people do not observe any sort of nicety in preparing their meals; they possess no taste for the table, and merely care to fill their stomachs in obedience to the call of nature.

They make their dress from woollen and cotton cloth: the former is spun at home and the latter purchased. The women in general, and some of the men, make clothes for themselves. A man's cap consists of a bag, about 10 or 12 yards long, with the mouth rolled up: the folds serve as a place of deposit for tobacco, needle and thread, and money. On the body is worn a loose sack reaching down to a little below the knees, and under the sack a pair of trousers, loose at the ankles. Besides this a *choga* (over-coat), hanging down to the ankles, with sleeves moderately loose and about a yard long, is worn when needed. It is invariably made from *pattu*. The caps of the women are made of black *pattu*. They are of a roundish shape, very loose, decorated with shell buttons and red gems, and in fact of quite a different fashion from those of the men. The sack reaches down to a little below the knees with loose sleeves about ¾ yards long. In lieu of a pair of trousers, the women wear *ghutanna* (half trousers) from knees to ankles, and tight at the latter. Now and then a sheet of cotton cloth or of sheep or goat skin is worn over all. On a journey the men wear sheep or goat's skin fastened round their legs from knee to ankle, and also on their feet. Women always go barefooted. They have no ornaments of gold and hardly any of silver. In the *binagosh* (cavity at the lower part of the ear) they wear brass or silver rings with three or four artificial pearls or coral. Their necklaces consist of artificial coral, or beads of agate, and such like tones. Their finger rings and bracelets are chiefly made of brass or bell-metal; the forme are sometimes made of silver also.

The women wear their hair either all plaited in a single tail at the back, or let it hang over their shoulders in two plaited masses. They never decorate themselves; on the contrary they always wear dirty and patched up clothes. Bathing is very seldom resorted to; even washing of the face is looked upon as an unpleasant task. The men, however, are not quite so dirty: they wash their clothes now and then. They generally shave their heads and wear long beards with moustaches cut to a moderate size.

The walls and towers of their forts are built of rough stone and mud, as are also the dwellings within. The walls of the houses, or rather enclosures, are not higher than 7 or 8 feet. The roofs are covered with *chír* or some other wood of that kind. The houses have either a very small courtyard or none at all; are very small and built close

to each other for protection against cold; they are sometimes two-storied. Two or three families, closely related, live in the same enclosure. The forts will stand musketry fire, but not that of guns.

Disputes of all sorts are generally settled by the headmen of the different places, who receive no allowance for their labour, nor are exempted, even in part, from paying their share of presents made annually to the Máháraja of Kashmir, but are held in higher respect than others. An appeal from their decision is made to the headmen of Chilas, but cases of importance are sent to Gilgit for final decision. The common mode of punishment in this country for quarrels of an ordinary nature is, to make both the parties give a feast to the whole village, that is, each provides food for half the inhabitants, women and children included.

English and Kashmir coins are very little used. In transactions among themselves the people use their own *sone* rupee (equal to one *másha* of gold and valued at 1½ rupees of the English coin). They much prefer gold to coined money, and never give it to a foreigner except in exchange for articles (cloth, vessels, tools, &c.) of English or Punjab manufacture, or salt; when they calculate the value of their one *tola** of gold at Rs. 12 of Indian money. Copper coin and shells (*kori*) are nowhere used in the country. There are very few tradesmen indeed, all live by cultivation. The people of Koli, in Kohistan, come here for the purpose of trade, and have even settled in some places.

Oil is not used at all, either in the kitchen or for lighting purpose. A burning piece of firewood serves for a lamp. Its smoke, however, blackens not only their clothing, but also their faces. When asked if the black spots on the faces of the women and children could not be washed off, the people said that they could be, but it was against the custom and practice of the country.

Wheat and *maki* are sold at 20 *topas* for a *sone* rupee; barley, *chína*, *turumba*, and other coarser grains at 23 *topas*; and *ghi* at one *doru*. A *topa* is a wooden measure which contains 1½ seers of grain. A *doru* contains about 2 seers of *ghi*. Besides *topa*, a *sin* and a *kút* are used in measuring the grain. A *kút* is equal to 6 *topas*, and a *sín* to 20.

Peshawar salt is used throughout the country, and is brought from the Swat side. *Gur* and sugar are unknown, and grape juice supplies their place. The use of wine or any intoxicating substance is considered a sin, alike with theft and gambling. Adultery is very rare, and people found guilty of this crime are invariably punished with death.

Marriage ceremonies are performed in the beginning of winter. Boys of 15 or 16 years of age marry girls of 12 or 13; as a rule, each man has one wife, but a second wife is not very uncommon. The people of the *shin*, highest caste, contract marriages in general among their own caste, but the practice of marrying boys of the *shín* caste with girls of the *yashkun*, the next lower caste, is not entirely prohibited: their offspring, however, is not held in the same consideration as that of pure *shins*. The *yashkuns* marry among themselves. In the two lower classes, *kamin* and *dom*, marriages are contracted between the two castes, as well as in the same caste. The people in general do not care about saying daily prayers, but they observe the *Ramazan*, and the women do not practice *pardah* as they do in other Mahomedan countries.

In the beginning of winter a sort of fever breaks out in the country, which often causes great mortality. The treatment resorted to is bleeding in the arm. When the head aches severely a little blood is taken from the forehead between the two eyebrows. In addition, some medicines are made use of, but their names and description could not be obtained.

Narrative Report, dated 18th November 1884, *by* W. H. Cole, Esq., m.a., *Officiating Deputy Superintendent, 3rd grade, on the operations of the detachment in Kashmir and on surveys in the Kishanganga valley for the six months ending 30th September* 1884.

This small detachment, which was last year employed chiefly in making a survey of Chilás from the surrounding mountains, was this year directed to continue the revision of the survey of the Kishanganga valley in Kashmir.

The original survey of this valley was made in 1860 under somewhat unfavourable circumstances, and a revision had for some time been thought necessary. A tract about 600 square miles in area in this valley was revised by Ahmad Ali in 1882, and a small portion in 1883. He has now completed the revision of the whole basin nearly down to latitude 34° 30′, with the exception of the small Jagrán Dara. This he was obliged to leave owing to the setting in of snow.

Ahmad Ali left Dehra Dún on the 2nd May for Srinagar, where some days were spent in laying in supplies and making necessary arrangements: he then proceeded to Gures, where he arrived on the 29th. The snow still lay thick on the hills, and he was unable to commence work until the 10th June. Between the 10th of June and the 15th August he surveyed from Gures up the Burzil valley to the Burzil pass on the north, to the Gugai pass on the west, and the Parashtkhar and Buroh passes on the east, as well as a portion of the Tilel pargana. By the end of September he had finished the valley in which the Kishanganga takes its rise, and had surveyed to the west of Gures as far as the Machhil Dara. From here

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* A *tola* is equal to 8 *máshas*, and one *másha* to 9 *rattis*.

he continued his work westwards. Towards the end of October snow began to fall, and by the 12th November he was obliged to close work, having, however, very nearly completed the whole of the work assigned him and topographically surveyed 2,100 square miles on the ¼ inch scale.

Besides the revision of the topography, he has taken many angular observations for fixing additional points to those previously determined trigonometrically, and he has also observed a number of heights.

The stations visited varied from 13,000 to 16,500 feet above sea level, at most of which the observations necessitated a stay of two to three days, the observing being much delayed by cloudy weather. To the end of August the mountains all round remained covered with snow, and, as nothing but a white expanse was visible on all sides, it affected his eyes and brought on ophthalmia. This continued to trouble the Sub-Surveyor for a long time, and he has not yet quite got over the effects. Most of the stations being far from the habitations of men, supplies had to be carried with the party, and fuel had to be brought up from the valleys. In one case, misled by the old map, which showed a path where none was found to exist, much time was lost in trying to cross over the range between Nagai and Tilel, and finally the circuitous route by Shingo valley had to be adopted; provisions ran short, and for three days the party had to eke out their small stock of flour with wild vegetables. After August the snow melted, but the air became colder, and then also water, which the snow had before supplied, had to be brought up from the valley.

The Sub-Surveyor having only just returned from the field, there has been no time to make any close examination of his work. His topography appears to differ in several minor features from that hitherto shown on our maps, but there are no serious discrepancies. He shows a large increase of villages, which is an important addition to the old work.

He appears to have worked hard and well, notwithstanding having to submit to several hardships, and he deserves a good deal of credit for his work.

The country surveyed is, roughly speaking, comprised within the parallels of 34½° and 35° and the meridians of 74° and 75⅓°. It is bounded on the north and south by the water-shed of the Kishanganga river and towards the eastern extremity, where the river has its source, is very elevated, the ranges on either side being covered with perpetual snow. In the south-eastern corner of this region are several glaciers, none of which, however, are more than about a mile in length by half a mile in breadth. The valley of the Kishanganga, within the limits so defined, consists of the parganas of Tilel, Gures, and Shárdi; of these, the first two form a part of the Iskardo district, the last that of Muzaffarábád. The transverse valleys are in general open, the hill sides, with the exception of the high ranges, which are covered with snow, are clothed with grass and forest trees, and are used as pasture grounds. Only one crop, consisting, in the case of Tilel and Gures, of either barley, peas, "*turumba*," "*china*," or "*kangni*," and in that of Shárdi of peas, Indian corn, or some paddy is raised in the year. The yield in the first two parganas is insufficient for the wants of the people and food-grain has to be imported. Sheep, goats, cows and horses, and in Shárdi buffaloes also, are reared. Honey is largely produced in Shárdi; the bees are here domesticated, and a portion of their produce sent as tribute to the State. Only a few fruit trees are met with, and those below Shárdi.

In Tilel and Gures the inhabitants live in villages, while in Shárdi detached houses in fields here and there are common. In the former parganas a single family lives in a house and the custom of polyandry prevails: in the latter, two or three families live together in one house. The number of villages with the total number of houses in each pargana and the revenue paid to the State is as follows:—

	Villages.	Houses.	Revenue in chilka Rupees.*
Tilel	25	175	1,800
Gures	25	225	2,250
Shárdi	93	350	8,000

The inhabitants are well-built and middle-sized; they are Muhammadans of the Sunni sect. The language spoken in Tilel and Gures is Shina; that in Shárdi is the same as that spoken in the hilly tracts of the Punjab. In the first two parganas a cap, a long loose coat and *paijámas* (pantaloons) form the dress of the males as well as females, the only difference being in the cut of the *paijámas*, which are loose for the males and tight fitting for the females. In Shárdi, a turban instead of a cap, and a shorter coat are worn. The people are not traders. They manufacture their own cloth, from the wool of their herds, their agricultural implements, and utensils for domestic use. Salt only is imported from Kashmir, and that of an inferior kind for cattle is brought from Iskardo. The people are unarmed.

On the south several passes; of these, that of Satasar from the pargana of Tilel, those of Rájdaiángan and Gusai for Gures fort, of Naunár and Soidúr from Machil, and of Sonápind and Pathre from Shárdi leading into the Kámráj Iláka of Kashmir, are well known and much used. They are all practicable for beasts of burden, the road over the Rájdaiángan in particular being kept in good repair. On the east the passes of Káubal or Káukhon, Buroh, Parasht Khar, and another one near the Burzil pass lead to Iskardo; of these only Parasht Khar, on account of a dense forest on its western side, is impracticable for beasts. On the north the passes of Burzil, Kamri, Shochhar, Kamukdori, Duarian

* One chilka rupee = 10 annas of Anglo-Indian money.

and Luiát lead to Astor, Chilás and Kághán; the first four of them are practicable for laden animals, while the others are not difficult; but as no traffic is carried across them, they are not cared for. The path along the Kishanganga river, with the exception of the portion between Gures and Shárdi, is good. In Tilel and Gures, wooden bridges, where necessary, are constructed over the main and tributary streams, but in Shárdi rope bridges are common.

The Rájdaiángan pass, by which the Kishanganga valley was entered, was reached about the middle of May. The pass was then found covered with some 30 to 40 feet of snow, the upper layer (of 2 to 3 feet) of which was soft and made the passage difficult. It took two days to get over an ordinary day's march, and even then some of the baggage had to be left behind.

Extract from the Narrative Report of LIEUT.-COL. H. C. B. TANNER, S.C., *Deputy Superintendent, Survey of India, in charge Darjeeling and Nepal Boundary Surveys;—season* 1883-84.

Sikkim Survey.

MR. ROBERT started for North Sikkim last October, accompanied by Rinzin Nimgyl, a Sikkim guide and surveyor, and returned to Darjeeling in the December following, after having completed in a most satisfactory manner the remaining unfinished portions of Independent Sikkim. He also revised and amplified Captain Harman's work, which was surveyed on a smaller scale than the rest of the country. The survey of this interesting section of the Himalayas has been going on in a desultory way for the past 20 years, and I have much satisfaction in reporting that it has now been completed, and that the maps, most skilfully and artistically drawn by Mr. Peyton, are nearly ready for publication. These maps, three in number, embrace a tract on which several surveyors and others from time to time have been engaged. First and foremost came Dr. (now Sir Joseph) Hooker, who about the year 1842 made a reconnaissance survey of Sikkim and a portion of Eastern Nepal. His sketch extends from the Donkia and Chola passes on the north-east to Khambachen and the Wallanchoon passes on the north-west. Hooker's sketch remained untouched until Lieutenant (now Major) Carter, R.E., added to it by his reconnaissance survey of the country between Darjeeling and Tumlong, which was executed during the march of Colonel Gawler's force in 1861. The survey of Independent Sikkim was again resumed by Captain Harman, R.E., in 1878, and, as now reported, was completed by Mr. Robert, Assistant Surveyor, in the winter of 1883.

At the Donkia (Donkhya) pass Mr. Robert was met by a large party of Tibetan officials and soldiers from Khamba Jong, who treated him with more respect and civility than hitherto it has been their custom to accord to European travellers who have happened to visit the frontier.

It is unfortunate that, although both Sir Joseph Hooker and Captain Harman had visited the Donkia pass previous to Mr. Robert's expedition, yet neither of them were so fortunate as to fix any of the great snow peaks in Tibet. Mr. Robert was equally unsuccessful, for, though with his theodolite he intersected a number of lofty mountains, he saw none of them again from any other point of view. Captain Harman described to me the snow panorama he saw in Tibet as "immense," and Hooker's little sketch quite confirms this. Countless ranges rise one behind another until they are lost in an unknown and remote distance. Some five or six fortunate Europeans from time to time have made their way to the now well-known Donkia pass, but except Hooker, none of them, so far as I am aware, have brought back even an outline sketch of the grand panorama of the Tibetan snowy ranges visible from that place.

Mr. Robert visited the Giagong-Donkia boundary on the Lachung river, which is the most northerly position he reached. It is here that the boundary claimed by Tibet crosses the Lachung from east to west, and beyond this no European is allowed to travel. Hooker escaped over the so-called boundary by a ruse, and got round the Cho-la-mu lakes to the Donkia pass by riding faster than the Tibetan guard could follow him on foot. Mr. Robert saw the lake, the limits of which he fixed by rays. Both Hooker and the Lama have also laid down these lakes; but all these authorities differ as to the size of the sheet of water, and this is because the banks shelve so imperceptibly that a very slight addition to the quantity of water makes a very considerable difference in the area which it covers. The same remark explains the reason of the very considerable discrepancy in the size of the Kalo-cho and Kham (or Bam) Cho on the maps of Captain Turner (1784), explorer "L" and the Lama. In the Tibetan winter there is very little flowing water, except in the large rivers, for all nature is frozen up; but in summer the melting snows and a moderate rainfall are quite sufficient to account for the variable size of the Tibetan lakes at different seasons of the year. Mr. Robert has brought back the unlooked for intelligence that to the north-east of Kinchinjinga, that is, on the shady side of peaks and ridges which vary from 23,000 to 28,000 feet, and which are nowhere under about 20,000 feet, there is not a single glacier. Masses of glacier ice and *névé* skirt the lower slopes, but in none of the valleys does the ice flow away to any distance from the immediate foot of the mountains. Hooker's picture of Kinchinjinga shows an insignificant glacier which extends for a short distance from that peak, but as a rule the whole of the enormous mass of snow which is depicted on the slopes of the Kinchinjinga group is either evaporated where it falls, or else

is melted and carried off by the Lachen and other feeders of the Teesta without having first passed into the state of glacier ice. In clear weather small glaciers may be seen from Darjeeling at the foot of Kubroo, and I have noticed a great extent of glacier ice between Kubroo and Junnoo, but it hardly reaches the valleys. In fact, Kinchinjinga may be said to have no glaciers worthy of the name, and certainly none half the size of those given off by a Gilgit mountain of the comparatively low altitude of 18,000 feet. A very few days ago I was looking straight up a valley to the very base of Mount Everest, and there also I could not detect glaciers of any noteworthy size. Along the Nepal snowy ranges for a hundred and fifty miles west of Everest, I have closely examined the valleys with rather high telescopic power, and, except on the lower slopes, I can discover no glaciers.

Mr. Robert made his way for a considerable distance up the streams which drain the eastern face of the Kinchinjinga group, experiencing the same difficulties and hardships described as being met with by Hooker in that locality. The dense growth of stunted rhododendron in the Zemu valley was found to be a very serious obstacle. The source of the Zemu was found to be in the range which runs north, and a little east from the summit of the Kinchinjinga, thus necessitating a large correction in the last published map of this region, which depicts it as rising many miles north-west of Kinchinjinga.

The valley of Talung, which is the only one in all Sikkim that has not been visited by a European, was explored by Rinzin Nimgyl, who surveyed the habitable part of the valley by plane-tabling and sketched in the remainder approximately. He fixed the position of the Talung monastery, which contains, I understand, certain relics of the family of the Sikkim Raja, in whose eyes it appears to be especially holy, and a certain mystery attaches to the place. Hooker tried, but was unable to visit it. Captain Harman made an attempt to reach it, but the people fearing his intrusion cast stones down the mountain sides and forced him to turn back, which he did at a point where the road is confined between rugged cliffs. Should any one propose to visit Talung, he is generally put off by the exaggerated accounts given by the people and Sikkim officials of the dangerous passage along the scarps which wall in the defile from which Captain Harman was driven back.

Near the two heads of the Talung valley are two roads; one leads over the Eincha-La pass to Alathang (or Alak Thong), and thence to Jongri, and the other by a pass without name to the Zemu country. The former of these has been visited by Dr. Simpson, and is said to be almost 17,000 feet in altitude, but Talung has not been reached by this pass for many years, and never by an European. The road when in use was difficult, but now it has become almost impassable, and is choked up with glacier ice and *névé*, and the slight track which once existed has been lost. The nameless pass above noted is situated immediately to the west of the well-known and picturesque peak D^2 or Simolchum, and is about 17,300 feet in altitude, appears open and easy, and the south side only partially covered with snow fields, but it is said not to be used. There is a third pass leading over the range north of Talung which is much frequented and is a good road for yaks. Its height has not been ascertained. There is no pass whatever out of the Talung valley towards Pamionchi and Tassiding, the cliffs on the Pandim Narsing range, and its southern continuation being quite inaccessible. Viewed from Darjeeling, the range is seen to consist of a series of immense pointed splinters of rock, streaked here and there with fine lines of snow. In company with Dr. Joubert I made the attempt to scale this range so as to get a view down into the Talung valley beyond; but after cutting our way for several days through the densest network of rhododendron branches and roots, we were stopped at the edge of the snow by huge cliffs which closed the valley head on every side. The water from the small glacier and from the snow fields above us finds its way through a narrow cleft or gorge down which the torrent thunders in a series of cascades. Except that we enjoyed some remarkably fine scenery up this valley, our journey was a fruitless one. The famous caves of Lhárhienphúk, which we visited, were really not worth going out of our way to look at. We found pilgrims there who had come from Western Tibet to pay their respects to the presiding spirit, but there was no idol of any kind, and the so-called cave was merely a cavity between great masses of rock which had fallen from the mountains above. From all the information I can gather respecting the routes to Talung, it appears that the only one which is at all practicable is that which was attempted by Captain Harman, and it is a thousand pities that his exploration of the mysterious valley was not successful; for had he reached the place, we should now be fully informed of the whole of the topography of Independent Sikkim. Mr. Robert's sketch map of North Sikkim, now being published, is the outcome of a most creditable survey operation performed partly by himself and partly by the late Captain Harman. The notes of the latter lamented officer and of Mr. Robert, which are in my possession, need a more extended notice than they can receive here, and it is my intention to submit them hereafter, when the surveys on the Sikkim frontier now being conducted by Rinzin Nimgyl have been concluded. Rinzin's last report was sent from the Kanglá pass, and I am informed therein that the explorer had already, at the end of October, visited a high peak to the north of it, after having reached Hooker's "Yaloong."

With the exception of a tract to the north-west of the summit of Kinchinjinga, we now have a map of the whole of that great mass of mountain peaks and ridges which collectively go by that name. Many of the different features comprised in the group have names of their own. Of these the principal are Kubroo, Junnoo, Pandim, D^2, and Narsing. It may be said that Kinchinjinga is a better known mountain than any in the Himalayas, and taken altogether it is perhaps, with one exception, the grandest in the whole range. It is regarded by the permanent residents of Darjeeling with admiration that never

palls, and although it is constantly, in clear weather, a prominent object in their front, the beholder is never wearied of studying the great snow slopes and ice fields which cover its sides. The aspect of the mountain has many phases which constantly alter its appearance from day to day. It is seen to best advantage when its base is veiled in a delicate curtain of clouds, so that the imagination is allowed to magnify the part which is hidden from view.

From Darjeeling and from the Sandukphu range, Kubroo appears as a straight-topped and uninteresting ridge of snow, standing slightly away from the central peaks of Kinchinjinga proper; but at a distance of 100 miles from points in the Purnea district towards the south-west, a telescope reveals the fact that the face of Kubroo presented towards Darjeeling is only one side of a huge snow-clad table-land (24,000 feet), quite smooth at the top with a very slight slope down to the westward. Near the summit Kubroo is very steep, and a considerable scarp bounds the western edge of the plateau, below which extends a long declivity of snow.

To the west, and between that plateau and Junnoo, from the same point of view in the plains of Purnea, with a high power telescope I made out extensive masses of glaciers, and although 100 miles distant, I could still detect the broken character of the ice blocks composing it. Kubroo is connected with the second highest peak of Kinchinjinga (27,815 feet) by a ridge, the very lowest depression in which has an altitude of 22,100 feet. This depression has been accurately determined from several points of view by a trigonometrical observation, and the height I mention is not open to any kind of doubt, notwithstanding that Mr. Graham, the celebrated mountaineer, informed me that it was between Kubroo and Kinchinjinga, over a depression of 16,000 feet altitude, that he took his Sikkim coolies when making the circuit of Kinchinjinga. Junnoo is only partially visible from Darjeeling, but from the Sikkim-Nepal watershed, anywhere beyond Singale La, it stands apart, and forms a most striking object, rising out of snow fields through which sharp needles of rock protrude. The slope of the western face of Junnoo is sufficiently gentle to allow snow to remain on it. Its peculiar outline never seems to vary whether viewed from the Darjeeling, Purneah, or Bhagalpur districts. From the Durbhunga district, after receding 120 miles from Junnoo, I could at last observe to the great chain of peaks and snow-clad ridges which run almost due north from the highest point in Kinchinjinga, and from the great distance mentioned I was still able to fix heights of knolls and depressions. A depression which I observed to the north of a long hog-backed mass of snow may perhaps be the Jinsong La pass, by which the Lama and Babu S. C. D. passed from the drainage of the Arun river system into that of the Teesta, where they experienced great hardships, and suffered much from the effects of rarified air and cold. The Lama informs me that the Jinsong La is the highest point he has ever visited, and that when Mr. Graham made his circuit of Kinchinjinga he must have crossed by the Jinsong La, for it is the lowest depression in the whole range. How Mr. Graham reached his starting point, Jongri, to the west of Kinchinjinga, after making his way round to the east, I have been unable to discover. Mr. Robert has, he thinks, fixed the Jinsong La pass, but he is not certain. It is hardly ever used, either by the people of Khambachen to the south-west or by the Tibetans to the north, its height (about 19,000 or 20,000 feet) being too great for laden coolies of ordinary physique, and firewood or other fuel is far away from it on both sides. It is owing to an error made in the position of this pass by the rough exploration of the Lama and Babu S. C. D. some years ago that the whole of the topography or rather geography of the north of Kinchinjinga has been so much distorted on the last published map. West of Junnoo the range consists of a series of fully clad snow peaks of bold outline, but the passes over the lower and more western extremity of this ridge will probably remain undetermined, unless Rinzin has been able to fix them from the Kangla peak. It is most unfortunate that the position of Junnoo was so much out on Sir Joseph Hooker's sketch map, for it has caused a corresponding error in his topography about Waloon and to the westward. Hooker's Mount Nungoo has been identified and fixed, and I believe that we have also secured the position of the Wallanchoon pass, the base of which was visited by Hooker.

Away to the left (or north) of the third highest peak of Kinchinjinga the mountain falls abruptly, after which there succeeds a portion of the ridge (which is quite flat with a snow cliff at its edge) on which rises a slight rocky knoll, which may be identified from Observatory Hill in Darjeeling, and again with precisely the same outline from the Bhagulpur district. It is immediately to the north of this knoll that a blank exists on the maps, for the details of the range which lies between the great northern spur of Kinchinjinga and the Junnoo chain can be seen neither from the plains of Bengal nor from the Donkia or the Zemu country. It is probable that this unknown tract drains into the Khambachen river. Shortly to the north of the knoll in section 13, which stands on the smooth, flat portions of the Kinchinjinga chain above noticed, the range dips down to a sharp and deep gorge, and immediately rises again almost precipitously to the eastern peak of Junnoo. The gap or depression is 22,500 feet in altitude, and has been trigonometrically fixed.

The well-known Pandim and Narsing peaks are the two nearest to Darjeeling. The former is separated from the main body of Kinchinjinga by the Guicha La pass alluded to before. This subsidiary range has many interesting features which might be dilated on. It has small glaciers which descend to some 14,000 feet. I believe Narsing and Pandim to be inaccessible owing to the great mass of cliffs by which they are surrounded. D^{o} or Simolchum of Mr. Robert is perhaps the most picturesque of all the peaks of Kinchinjinga; it has an exceedingly sharp summit which is just visible from Darjeeling, peering over the Pandim-Narsing ridge. The black rock needles of its base are on the largest scale, and from the Bhutan frontier and that neighbourhood, stand out in bold relief against the very

considerable snow fields on the slopes behind them. Its eastern spur dwindles away gradually until it dips into the Lachen valley, but though the ridge has considerable peaks, they are in no way remarkable either in respect to their height or form. On the slopes of Kinchinjinga, below 16,000 feet, there is a fair amount of game, but so few sportsmen have explored this part of the Himalayas that we are almost in ignorance respecting the beasts which are met with. The Serrow is the commonest animal on the southern slopes. Associated with him are found in no great numbers the Gural, and higher up the Musk deer In the upper feeders of the Lachen and Lachoon, the Ovis Ammon or Barral is not uncommon, but there are no wild yaks. The brown bear, if found at all, is exceedingly rare, and I should say that it only occasionally strays across from Nepal, and does not make Sikkim its home.* Hooker relates that he saw game in plenty north of the Donkia on the flat ground which surrounds the Cholamu lakes, and among the animals he met with were the Tibetan antelope and the small Tibetan gazelle. For a long while I laboured under the impression that the so-called Sikkim stag, or as the Tibetans call it, the Shao, was to be found in the country under notice, but after a careful and searching enquiry I have come to the conclusion that this stag is not to be classed as a frequenter of Sikkim at all. In the Calcutta museum there is a stuffed specimen of this noble beast, and its habitation is put down as being along the Singale La range. I am convinced that he has never been seen in that part of Sikkim, and if he ever enters the country at all it is by one of the eastern passes. The habits of this magnificent stag are described to me to be exactly those of the Bara Sing of Kashmir. In October he gives forth the same plaintive cry which falls so pleasantly on the sportsman's ear in the lovely Kashmir valleys. In appearance he is precisely like his Kashmir brother; only he is on a larger scale. Mr. Robert, I believe, is the only European who has seen the undulating grassy slopes above Chumbi in Tibet where the Shao has his home, and it is from these high lands that in winter he makes his way down to the warmer pine-clad tracts, just as in Kashmir he migrates from the upper into the lower valleys, where he is able to graze on pastures free of snow. The horns of the Shao are difficult to obtain, because there is a great demand for them in China, where they are exported after having been sawn up into convenient lengths. The Abbé Des Godins informs me that the Shao is found in the Alpine regions far past Bathang and Taisain Do (Darchando) and beyond; and the Lama states that in the Upper Lhobrak in Bhutan they are plentiful, but I feel quite certain that between the Chumbi uplands on the east and Kashmir on the west the beast is absolutely unknown. Any one who has visited the Singale La range and the southern spurs of Kinchinjinga between 10,000 and 13,000 feet will perceive at once the improbability of the Shao finding a suitable home in Sikkim. Between the altitudes named, the rhododendron jungle is so dense and impenetrable that no animal could pass through it. The roots cover the ground with a sufficiently intricate network, and the branches of the bushes are so closely entwined with each other that one has literally to hew one's way through the forest with axes. Nowhere have I seen vegetation so dense as that met with just below the Alpine zone. The ranges present a remarkably smooth and shorn appearance, and this is due to the dense compact mass of rhododendron jungle, every bush of which attains exactly the same height. No branch dares protude above his fellows for fear of being out off by the icy winds. One great drawback to the Sikkim range is the almost entire absence of the smooth, turfy downs met with in the western Himalayas, rhododendron of one kind or other occupying the entire zone in which vegetation is met with. The commonest bird Mr. Robert met with around Kinchinjinga was the Blood pheasant, which he found in the winter at about 13,000 feet in great packs. Munal are plentiful in parts at altitudes between 10,000 and 12,000 feet and the Snow pheasant also at higher elevations. These birds occupy the same zone in Sikkim that they do in other parts of the Himalayas.

In saying a few last words regarding the lofty Kinchinjinga it is necessary to state that the slope presents more naked spots than in the case of mountains in the western Himalayas of far less altitude. The snow fields are less continuous, and this to a certain extent detracts from the grandeur of its appearance. Its outline too is tame and almost ugly, but taken as a whole the vast pile is, with one exception, more worth seeing than any of the great peaks of the Himalayas. I would make Nanga Parbat, as seen from the north-west, that one exception, but unfortunately, besides Major Biddulph and myself, no one, as far as I am aware, has ever had the good luck to climb to the lofty crag whence the finest snow view on the globe may be obtained; hence the comparison I draw to the disadvantage of Kinchinjinga has little significance.

It is remarkable and perhaps to be wondered at that only one Englishman besides survey officers has had the curiosity to examine the topography of Kinchinjinga closely, and the praiseworthy efforts made by Mr. W. W. Graham to ascend to its highest peaks deserve to be rewarded with success. The Anglo-Indian sportsmen who have visited northern Sikkim are at the most only two or three in number, and this notwithstanding that the country is quite as accessible as any other part of the Himalayas. During the past six weeks I have been engaged on fixing Himalayan peaks and ranges from the tower stations of the Trigonometrical Survey in the plains of Bengal, and a few words regarding the results of my examination of the Everest group may not be out of place, though until further information is forthcoming a full report on the greatest of all mountains cannot be rendered. In the first place it should be understood that Mount Everest cannot be approached by an European

* I am informed by Dr. Scully that a very rare bear is found sometimes in North Sikkim.

within 80 miles, owing to the persistency with which the Nepalese Government keep Englishmen out of their country. The survey which is now being made of the Everest group is therefore conducted under the greatest disadvantages. Sir Joseph Hooker, when he was at Walloon and in that neighbourhood, was within 65 miles of the peak, but he was deep down in the valleys, and the view of Everest was blocked by the great peak No. XIII or Makalu. Probably Hooker never saw Everest. Sandakphu, 38 miles from Darjeeling on the Darjeeling and Nepal boundary, commands the finest view of Everest that is anywhere obtainable from British territory. The mountain from that place is 90 miles distant, and though so remote is a fairly striking object, and would appear to better advantage were it not that Makalu, which is 12 miles nearer, to some extent shuts out the view; and as the latter peak is exceedingly bold and picturesque in appearance, it generally comes in for more attention than its higher neighbour.

The outline of Everest is rather tame than otherwise; it is fairly sharp, and has a long snowy slope on its north-east flank, the south-east being precipitous. Peaks of 22,000 and thereabouts encircle its southern base, and below them are seen many outlines of dark mountain masses which are without snow. These middle distant ranges of the Eastern Himalayas are almost bold in appearance, but those within 20 miles of Sandakphu are tame and scarcely picturesque, and like all the Sub-Himalayas of Eastern Nepal, Sikkim, and Western Bhutan do not rise in artistic lines. As one proceeds north along the Sandakphu ridge, Everest gradually becomes hidden behind Makalu, and does not reappear until the foot of Kubroo is approached.

From due south, near the Koosee river in the Bhagulpur district, Everest is by no means a marked feature in the landscape; its southern face has but 190 feet of snow, below which the mountain falls for 4,000 to 5,000 feet in a series of crags of very dark-coloured rock, only here and there dashed and streaked with snow, below which are snow fields and broken masses of rock intermingled with snow and *néré*. When the atmosphere is not very transparent the sharp tip is seen as a mere floating white speck, the rock below it being almost exactly the colour of the sky and therefore invisible. The southern face of Everest from a near point of view is doubtless wild, and the cliff must be very lofty; but the great distance from which it is viewed renders this aspect of the mountain uninteresting. The crags, as also the summit, are strongly marked with lines of stratification which dip towards the west at an angle of between 20′ and 30′. In fact, from the south, Everest has all the appearance of a very moderate hill, not in the least imposing and hardly picturesque. It is interesting only because by a trigonometrical operation its summit has been found to rise up further from the general level of the earth's surface than that of any other point. The finest mountains are those which expose the greatest extent of their slopes to view, and Everest, though 29,002 feet in altitude, only rises about 12,000 feet above its fellows. It is absolutely lofty, but relatively only commonplace. Babu S. C. D., who has an extensive knowledge of Tibet, gained in several visits to that country, describes the mountain which the Tibetans suppose to be Everest as having "a rounded top." Now Everest is distinctly sharp at the top, and I therefore can only suppose that there is some other lofty mountain to the north or north-west of Everest which to the Tibetans does duty as the highest in their country. A new peak, T 45, fixed last month, has a rounded top: it is 27,000 feet high and situated to the north-west of Everest, and perhaps is the one alluded to by the Babu. The northern spur of the mountain was determined last year for a distance of 10 or 12 miles; it has peaks 23,500 feet or more, which rise but slightly above the general level of the spur on which they stand.

Where nearly everything is absolutely unknown, it is futile to discuss the probabilities of there being higher mountains than Everest or not. Native information on the subject of heights is quite untrustworthy, and as no European has been in a position to obtain any direct knowledge of the immense mass of snow mountains that exist between Everest and a point 80 miles to the westward, and again for 50 miles to the north, what man will be bold enough to hazard an opinion on the subject? It is true that Mr. Graham and his guide are reported to have seen two peaks to the north-west, higher than Everest, but how is it possible that they could have ascertained the fact? They did not know their own position, nor its height above the sea, nor, as far as I can see, did they know Everest by sight. Mr. Graham never arrived at any position whence Everest was visible until he found himself in the midst of lofty mountains at the base of Kinchinjinga. He did not go to Sandakphu to learn Everest and Makalu by heart, but he made his first acquaintance with the extensive panorama of the snows, which for convenience I call the Everest group, from a spot whence, Everest being unknown to him, he might well take, say, No. XIV for it, and mistake the real Everest and Makalu for the two peaks pointed out by the guide as being higher than it. From an extensive experience in Himalayan surveying, I can safely state that even when carrying on our work with the aid of the best maps, instruments, and requisite knowledge of surveying, we are liable, until we compute out the positions of our points, to mistake one mountain for another, even though we may have learnt their appearance by heart from other stations. But when without having the least acquaintance with the outline of Everest, or without knowing his position on the earth's surface, Mr. Graham suddenly emerges from a deep valley, and without further ado lays his finger on it, then I must say that I doubt the possibility of his being able to identify that particular peak. Two of my assistants last year mistook other mountains for Everest, and I myself recorded "Everest" against a mountain 5,000 feet lower than it. This was because I had not gradually worked my way up to the station of observation after having previously made the acquaintance of Everest, but I commenced work in a new part of the country

quite remote from the place whence I had seen it. I have the greatest respect for Mr. Graham's prowess as a mountaineer, and admiration for his most praiseworthy attempts to scale the highest peaks yet attained by man, but I wish most emphatically to deny his power to recognize peaks, the appearance of which was not known to him. The two peaks stated to have been seen by Mr. Graham and his guide must have been visible to them over the northern spur of Everest, which I elsewhere state to be 23,500 feet in altitude, and they must have been very far beyond this ridge, otherwise they would have been fixed by me during the operation which I am now conducting; and taking into consideration the curvature of the earth at very great distances, these peaks, if they exist, must be enormous indeed. Sir Joseph Hooker, whose scientific attainments and whose reputation as an exact observer of nature are beyond dispute, has given an opinion on the subject of estimating the height of snowy speaks by the eye alone which should be considered conclusive. So little did Sir Joseph trust to his own estimates of the height of the great peaks he saw far away in Tibet from the Donkia pass, that having observed the altitudes with a theodolite, he assumed different distances, and computed the different heights that those distances would give, but he never pretended to fix the peaks absolutely.

With the exception of the Kinchinjinga peak, No. XIII or Makalu (27,990 feet) is the finest yet fixed in the Eastern Himalayas. It stands apart from the Everest group, and exposes a great mass of snow towards the Sandakphu ridge. From the south, in the plains of Bhagulpur and Purnean it is the most striking object in the panorama of snow. It has a remarkable cup or hollow which extends for about one-third down its slope, by which it may be recognized. When examined with a high power telescope great masses of glacier ice may be seen finding their way over the edge of the cup. This ice has been collected round the sides of the amphitheatre-like hollow and deposited in the shape of avalanches to the bottom: thus it becomes what is called névé and afterwards is formed into glacier ice. The upper half of the mountain is composed of a very light-coloured rock, but the southern spur is dark like the cliffs which are seen on the southern face of Everest. The white colour of the rock lends it a softness, which is absent in the appearance of its higher neighbour. The southern and eastern faces are fully snow-clad, but on the west are much bare rock and extensive streaks and patches which are too steep to retain snow on their slopes. No northern spur of this mountain has been seen, but I have traced one of about 19,000 feet elevation towards the east, until it dips into the Arun valley. To the south two picturesque branches fully clad with snow are thrown off, but I cannot say that I have detected any saddle or ridge connecting Makalu with Everest.

From Sandakphu about 9,000 feet of this striking mountain are exposed to view, but except in the cup above noticed, there is no sign of a glacier. Makalu is remarkable for the very striking sharp-edged buttresses which are reared up against its huge sides, and which lower down become the starting points from which ranges are thrown off towards the east and south.

Now that our knowledge of the topography of the Himalayas is being extended, it is thought desirable to make a table showing a comparison of the absolute height of some peaks above sea-level, with the actual amount of their slopes exposed to view. Such a table for a few well-known mountains I here give, and a glance at it will show that the absolute height of the top above the sea is no criterion of the size of the mountain: I draw up this table partly with a view of bringing again more prominently into notice than I have hitherto done the vast superiority of Nanga Parbat in Kashmir over all other mountains at present known to us.

It is a veritable Deo Mir* or, as the Dard name signifies, "King of Mountains," and it cannot be too often or too highly extolled.

The top of Everest is 29,000 feet above sea-level, and at a distance of 90 miles presents approximately about 12,000 feet of its side to view. This, or a little more or less, is the actual height of Everest as a mountain, for practically we have no concern with the 17,000 feet which in reality form but a portion of the earth's crust. In other words, the general level of the earth's surface on which Mount Everest stands is at that particular place 17,000 feet above the average level, and the summit of the mountain above its base is but 12,000 feet.

Similarly, though the peak Makalu is elevated 27,990 feet above the sea-level, the actual mountain available for man to gaze at and admire embraces from top to base only 9,000 feet of vertical height, and is seen from Sandakphu, a distance of 78 miles. Kinchinjinga is situated 46 miles from Darjeeling, and though the top is 28,125 feet above sea-level, only 16,000 feet of its height is exposed. (The lower extremity of the slope in this case I take to be the valley below Jongri.)

Of Tirach Mir† in the Hindu Kush, near Chitral,‡ the base was only partially seen by myself, but Major Biddulph, who passed just below its south-eastern face, describes it as "occupying the entire view" at a distance of 40 miles. The peak is 25,400 feet above sea-level, and the base stands on ground which is 7,000 or 8,000 feet in altitude, thus leaving 17,000 or 18,000 feet exposed to view; and this portion which stands outside the earth is the real mountain, and it may be described as 17,000 or 18,000 feet high. In the latitude of Chitral the snow extends down thousands of feet lower than it does in

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* Wrongly spelt on the engraved atlas sheet "Diar Mur."

† The name is derived from Tirak, a poplar. These trees occur in great profusion on the lower slopes. Mir, mountain is pronounced Mîr or Mēr, and occurs in Pá-Mir, Deo-Mir, &c.

‡ Derived from Chitr, cotton, and Al-Alia, country. Chitral is the last place on the Kunar river where cotton is grown.

Nepal and Sikkim, and besides forms a thick unbroken covering without those blemishes and faults which so mar the appearance of the snow mountains in the Eastern Himalayas.

The mighty Rakaposhi or devil's tail of Gilgit, 25,550 feet, on ground which is seven or eight thousand feet above the sea, may be viewed from a distance of less than 40 miles by any one bold enough to make the journey over the dreadful Sai Char* pass to Chaprot, and thence up to the grass downs above that place, and the splendid appearance of Rakaposhi will be a sufficient reward for his trouble. It is a vast clean cut brilliant snow needle, absolutely sharp, rising thousands of feet above a mass of broken snows, below which are the wild precipices and serrated ridges peculiar to the Gilgit mountains. In the fore-ground are rolling grass downs, embellished with clumps of juniper; a deep valley lies at the foot, and on the west side rise black cliffs. Mount Blanc, though but 15,781 feet, rises from a valley of about 3,000 feet altitude, and therefore exposes 12,000 feet of its sides; but it must be mentioned that owing to the short distance from which the summit is viewed, the slope to a great extent is foreshortened, and much of the imposing effect of height is thereby lost.

Nanga Parbat's summit is 26,600 feet above the sea, and its base stands on the left side of the Indus valley, which at that point is but 3,500 feet; it therefore exposes 23,100 feet of its side to an observer, who, standing as near as he may dare to the edge of perhaps the most lofty cliff in the world with the Indus valley 12,000 feet below him, may regard at the distance of less than 40 miles the unparalleled view presented by the vast snow fields, glaciers, and crags of this king of mountains. It is a scene that is not grasped or taken in at once, but after a while the stupendous grandeur of the view is appreciated. It is quite overwhelming in its magnitude; it is in fact one of the grandest spectacles that nature offers to the gaze of man. Great height, vast breadth, and appalling depth are combined, and like the panorama of the Tibet snows, as described to me by Captain Harman, it is "immense." There is nothing small or mean about it; it is on a scale which is gigantic. Without considering the great slope from the level on which you are standing down to the Indus valley—a slope of about 12,000 feet—there still remains above the level of the spectator a mountain as big as the whole of Everest, and that, too, seen at less than half the distance.

Table showing the height of some mountains compared with the amount of their slopes which is exposed to view.

Rank. Now claimed.	Rank. Accepted.	Name of mountain.	Name and height of place of observation.	Distance from which observed.	Height above sea level.	Amount of slope exposed.	Angle contained in vertical view—degrees and quarter degrees.	Remarks.
				Miles.	Feet.	Feet.	Deg.	
	1	Mount Everest between Nepal and Tibet.	Dewanganj, Purnea district, Bengal, 200 feet.	118	29,000	8,000 Approximate.	¾	A mass of dark crags and cliffs slightly streaked and dashed with snow. Capped with snow point from 100 feet. Seldom visible to base on account of cloud and haze. Point of observation reached in a buggy or otherwise. Extensive panorama of surrounding snow peaks.
5	...	Ditto ...	Sandakphu, Darjeeling, 12,000 feet.	90	.....	12,000 Approximate.	1¼	A fine view. N. E. flank along slope, well snow clad. South face broken and bold. Seen often in early morning; seldom in evening. Point of observation reached on hired pony. Great comfort, but cold.
6	2	K2 North or right bank of Indus on mountain boundary of Kashmir.	Range between Gilgit and Gor, 16,000 feet.	.....	28,278	.....	....	For description and sketch see Drew's Kashmir. K2 is surrounded by a great mass of peaks which prevent much of it being seen. View not very impressive, but extremely wild.
7	4	No. XIII or Makalu, between Nepal and Tibet.	Purnea district, Bengal, 200 feet.	120	27,800	8,000	½	A fine bold mountain, well worth seeing; well snow clad. Outline very picturesque. Peculiar cup or amphitheatre at top, partly seen from Purnea district. Point of observation from comfortable tent. Requires clear weather, otherwise only tip is seen.
		XIII or Makalu ...	Sandakphu, Darjeeling, 12,000 feet.	78	.....	9,000	1	A magnificent mountain backed by Everest. Outline very bold. Fine view. Ride or walk to bungalow at Sandakphu. Made road.
1	5	Nanga Parbat or Deo Mir. Left bank of Indus, Kashmir.	Cliff above Gor overlooking right bank of Indus, Gilgit, 16,000 or 15,000 feet.	40	26,600	23,000	6 and more view with Biddulph.	The view—tremendous exposure of snow, cliff, and glacier—baffles description. Frightful journey over cliffs, rocks, torrents—cross the Indus, a turbulent rushing river, on raft. Cross snow passes. Tribes independent; not safe. Game. Flood. Landslip. Always snows, except for a short time in August.

* Sai, white; char, cliff.

Rank. Now claimed.	Rank. Accepted.	Name of mountain.	Name and height of place of observation.	Distance from which observed.	Height above sea level.	Amount of slope exposed.	Angle contained in vertical view—degrees and quarter degrees.	Remarks.
				Miles.	Feet.	Feet.	Deg.	
3	7	Tirach Mir, Hindu Kush, north of Chitral.	On road from Gilgit to Chitral, 8,000 feet.	40?	25,400	17,000 to 18,000	4¼	A splendid mountain (see Biddulph's Tribes of the Hindu Kush). "Fills entire view." Dangerous journey. Passes rivers, cliffs, treacherous chiefs, uncertain tribes.
2	6	Rakaposhi, most westerly peak of the Himalayas, Gilgit.	Downs above Chaprot, Gilgit, 13,000 feet.	40 or less	25,560	18,000	4¼ and more.	A superb snow needle which cleaves the sky. Most symmetrical shape; base wild and bold. Journey to Chaprot over awful pass of Shai Chár crossed by Biddulph and self. Tribes rather surly. Point of view just off Biddulph's road to north of Chaprot.
4	3	Kinchinjinga, Sikkim.	Darjeeling. 7,000 feet.	46	23,160	16,000	3¾ and more.	Magnificent view. Finest snow view accessible to ordinary traveller. Snow on slopes not quite sufficient. Much bare rock often visible; requires cloud at base to render view effective. Intermediate hills tame. Seen from "hotel door." From Sandakphu view very grand and imposing.
6	8	Mount Blanc, Europe.	Range above Chamumi, 7,000 feet.	Short distance.	15,781	11,500	.....	Tourist either rides, walks, or drives. A very fine view.

Survey of the Himalayan ranges.

While the triangulation of the higher snowy ranges has been going on, the importance of obtaining the topography of the lower hills has not been lost sight of, but it is to be regretted that the haze stratum which nearly always hangs about Bengal seldom sinks low enough to permit the sub-Himalayas to be seen. During the working season there have been but few days when the faintest outline even of the lower ranges could be detected. Nevertheless I have secured the Máhábárát range for 60 miles west of the point where Mr. Robert's sketch terminates. Mr. Barckley has also secured some topography, but not much. I think that there is little doubt that before the end of the hot weather we shall have mapped the whole of the ranges between the North-Western Provinces and Darjeeling. Máhábárát, I am told by a Nepalese officer, is the name of the whole sub-Himalayan range that extends from the Kosee on the east to the Gunduk on the west; it has the character of the Senchal and Kurseong hills, and varies from 8,000 to 6,000 feet. Near the left bank of the Kosee it dwindles down to 5,000 feet, but, as far as I have been able to ascertain from observations, never lower, except where there exist occasional gaps. This topography having been secured, I now have to dispose of the various branches of the Kosee river which wind about out of view behind the Máhábárát range, and this, I confess, I am at present unable to do.

Between us, Mr. Robert and I have dotted the country south of the snows with trigonometrical points, and I can find no room between any of them for a valley wide enough to contain the western Koosee in its course from west to east, that is from near Khatmandu hills on the west to Chatria thana. This is now the third season that operations have been going on facing the sub-Himalayas, but though Mr. Senior, in conjunction with myself in 1882-83, did a good deal in the Gunduck basin, and Mr. Robert in 1881-82 sketched a section of the Eastern Nepal hills, last year no topography whatever was obtained. It is work that requires an intelligent use of sharp eyesight combined with a fair knowledge of the simple rules of surveying. There is one way, and I think one way only, to secure distant topography. A plane-table survey, however rough, must be carried on *pari passu* with the theodolite survey, and after the computations have been concluded, the crude plane table survey must be adjusted to the trigonometrical points.

Demarcation and surveys on the Nepal-Bengal boundary.

This is an irksome piece of work which demanded close attention from Messrs. O'Sullivan and Barckley, who repaired the demarcations, and from Mr. Ryall, who carried out the surveys connected with those portions of the boundary which, owing to fluvial action, required rectification.

The ditch which runs along the greater part of the boundary between the Kosee and Biknatori has been cleared, and all the boundary pillars, with one exception, have been repaired. For the past season these operations cost Rs. 13,691.

We are now setting up iron posts on those sections of the boundary which have been rectified, and also the stone prisms which are to be laid down at the trijunctions of village boundaries that occur on the line.

All the pillars, prisms, and posts on the entire line have to be numbered afresh. This may appear to be a small and light operation, but to be done thoroughly and to avoid mistakes it will take two assistants several months to complete.

The survey of that portion of the Mechi river which forms the boundary between Nepal and British territory is in progress.

Extract from the Narrative Report of LIEUTENANT THE HON'BLE M. G. TALBOT, R.E, *Deputy Superintendent, Survey of India, in charge Baluchistan Topographical Survey, on Surveys in South-West Baluchistan;—season* 1883-84.

IT having been arranged by the Surveyor-General that Lieutenant Wahab and I should accompany Sir R. Sandeman for survey purposes during his march through Western Baluchistan, we left Mussooree for Jacobabad early in October; a few days were spent there in preparations, and eventually we arrived at Quetta on October 17th. The party consisted of Lieutenant Wahab and myself, sub-surveyors Ikbaludin and Ata Mohamed, and 28 Punjabi klassies.

In concert with the Agent, Governor-General, Baluchistan, the following plan of operations was decided upon:—

Lieutenant Wahab and I were to march together to Kalat, and then separating, each of us was to carry on an independent series of triangulation in continuation of the Kalat series; Lieutenant Wahab working at first in a westerly, and then in a southerly direction, and I in a southerly, and then south-westerly direction; eventually we were to meet the Governor-General's Agent and his escort wherever he might appoint. To further this plan, Sir R. Sandeman kindly arranged with the General Commanding for an escort of 15 rank and file of the 2nd P. W. O. Grenadiers to accompany us.

We arrived at Kalat on the 30th of October, and were detained there some days taking in supplies, collecting camels, &c., and also on account of the weak state of the klassies, who were nearly all attacked with fever, brought on by the hot sun by day and the severe cold at night. Lieutenant Wahab also had a severe attack. The Assistant Surgeon at Kalat was very attentive, and did everything he could for us. On the 6th of November I started work, and by the 19th December, when the mission caught me up at Gidar, I had carried my triangulation and plane-table reconnaissance up the border of Azad Khan's territory, and intersected a considerable number of points to the south and west. From Gidar I had to keep pace with the mission on its road to Kharan, and further triangulation became impossible, so I had to leave it there to be eventually picked up on our return journey from Panjgur.

On the 23rd of December we debouched into the great Kharan plain, and were met by Lieutenant Wahab at Garok, one march from Kharan, where we arrived on the 24th. Lieutenant Wahab had brought down his triangulation close to Kharan in spite of great difficulties; he had also attempted and proved the impossibility of ascending the highest point of Raskoh. It was very fortunate he had done so, as otherwise we should have been tempted to have wasted our precious time at Kharan in the fruitless attempt. After consultation together we agreed that I should undertake the task of fixing points from an extension of Lieutenant Wahab's triangulation across the Kharan plain in the direction of Washuk, while Lieutenant Wahab should make his way across the Raskoh range, as far as time would allow, in the direction of Chagha.

After spending three days at Kharan, during which we twice observed at a station in the vicinity, and made a station in the camp, at which we observed a check azimuth, we obtained our camels, and leaving our escort of native infantry, started with some of Azad Khan's men as guides. I had also an influential jálawán named Abdul Karim, who was useful as interpreter, and in making arrangements with the natives. Alayar Khan, a brother of the Sárawán Sirdar, a most useful man, who had been attached to Lieutenant Wahab for his journey to Kharan, was allowed to remain with him by Sir R. Sandeman, and proved of great assistance throughout the expedition. At the first camp at Erikalag, just inside the Raskoh hills, we separated. Lieutenant Wahab continued his march to the north, while I, after observing at a hill in the vicinity of Erikalag, proceeded west along the foot of the wall-like southern ridge of the Raskoh range as far as Azad Khan's fortress of Jalawar. This place has been fully described by Lieutenant O'Donnell, who was my companion on this trip.

By means of stations near Kharan, Erikalag, and Jalawar, I was able to fix high points on the south of the Kharan desert, though by very long shots, some of the rays being as much as 80 or 90 miles; having thus made sure of having points with known latitudes and longitudes on which to tie my future work, I started south across the desert, and catching up Sir R. Sandeman at Mam, accompanied him to Washuk. On my arrival there, a day spent in reconnoitring showed me that I could fix three stations within easy reach of the camp, from which were visible the points that I had fixed from the Raskoh range. I at once commenced the triangulation, and on the arrival of Ikbaludin, who had been left behind to traverse the road from Kharan to Washuk, I measured a base of about a mile and-a-half, with a steel tape, observed an azimuth, and computed the positions of my stations. Lieutenant Wahab joined me in time to share in the azimuth observation and consequent computations. At Washuk I lost one or two days from the dusty haze which so frequently rises in Southern and Western Baluchistan, generally accompanying a southerly wind. While a few days previously I had been observing points 50 to 80 miles distant without any difficulty, at Washuk for two days I was unable to observe points five miles distant. After this the haze never really left us, sometimes for a day or two it was fairly clear, but we never had again such grand weather for observing as we had in November, December, and part of January, though even during that period the haze occasionally gave trouble for a day or two.

Sir R. Sandeman and escort marched from Washuk on the 10th of January, and having secured a satisfactory basis for the triangulation, the whole survey party started on the

14th. Lieutenant Wahab pushed on to catch Sir Robert at Panjgur before he left for Gwadur, plane-tabling the road as he went, and sending back traces to me to assist the triangulation. Ikbaludin continued his traverse to Panjgur, and I endeavoured to do the same with the triangulation.

On the 23rd I was joined by a party of the Sind Horse, which Sir Robert had sent out for my protection, he having heard of a party of marauding Damanis being in my neighbourhood. Fortunately they did not molest my camp, though traces of them were afterwards found close by.

On the 24th I arrived within one march of Panjgur, but such cold, violent, dust laden winds set in that observation was impossible, and I was glad to get a letter from Sir R. Sandeman on the 25th telling me that he would march on the 27th, and that he wished to see me before he started. Accordingly on the 26th I marched into Panjgur in a howling dust-storm.

Sir R. Sandeman arranged that a party of 15 rank and file of the 2nd P. W. O. Grenadiers should remain with us, that we should retain Alayar Khan and Abdul Karim, and further attached to us Mir Pasand Khan, son of Mir Murad Khan, the former owner of Kuhak, with two of Azad Khan's sowars, who were to remain with us as long as they were required. The only restrictions he imposed upon our movements were that we should not separate our camps, nor enter any territory whose ownership was under dispute.

Accordingly we abandoned all idea of carrying on two separate triangulations, and agreed that as I had begun the work, I should continue it, and that Lieutenant Wahab should undertake the plane-tabling. Ata Mahomed continued to record and compute, and Ikbaludin was employed in plane-tabling easy portions of the country. Four days were spent at Panjgur waiting for camels, during which time the weather changed and became provokingly clear. We utilized the time to a certain extent by taking some circummeridian observations for latitude, which was all we could do, as we had not been able to fix our position satisfactorily. On the 1st of February, after much wrangling with the camelmen, we started, carrying 20 days' rations, and retraced our steps towards Washuk to pick up the triangulation where I had left it. This was a work of some difficulty owing to the nature of the hills, which consist of numerous steep parallel ridges on which I found it very difficult to select points which commanded a view on both sides, and which I could make sure of recognizing from a distance. I had to make four stations without moving my camp more than three or four miles before I got the observations I required. Two of these stations have since been found unnecessary, and have not been included in the revised computations. We now left the Washuk road and turned north and west towards the Koh-i-Sabz, on which I made three more stations. While at one of these, the haze to the north partially lifted and gave me a glimpse of the western end of the Raskoh range, which enabled me, in conjunction with observations from other stations, to satisfactorily fix several points on it. As our orders prohibited us from crossing the Mashkel, and our rations were nearly expended, we turned south from the end of Koh-i-Sabz and returned to Panjgur along the Mashkel and Rakshan rivers, just in time to escape a downpour of rain. On arriving at Panjgur I found that Alayar Khan, who had been left there to make arrangements for food, had been so successful that I determined to make another circuit, this time to the south, and on the 20th of February we started again. At first I directed my attention to fixing as many points as possible up the Rakshan valley in the direction of my return route, so as to leave as little to be done there as possible, and for this purpose made two more stations on the north of the valley before commencing on the south. Eventually we crossed the Lagar Koh by a little used pass into the head of the Gwargu valley, and ascended two points south of that valley from which we had hoped to have done much. Unluckily the haze had thickened so, that, though I was able to fix some points on the range north of Kolwah Kej or Kech, the topographical detail was so blurred as to be almost impossible to sketch. I wished to make a third and, if possible, a fourth station on this range as far as time would allow me to go, and after three days' march, reached one of my intersected points which seemed promising. Unfortunately the day I visited it was even more hazy than usual, which again interfered with the plane-tabling, and to a less extent with the triangulation also. The weather looked so unpromising that we decided it was useless to wait to observe again from this station, or to make another further on, and returned to Panjgur again just in time to escape rain. Circumstances combined to delay our start, fresh camels had to be engaged, 30 days' rations had to be taken in, as we could expect none for the next 150 miles; and as I wished to observe an azimuth, I had to wait till the weather allowed me to do so. On the 14th of March the sky at last cleared, we got observations for azimuth from a station close to our camp, and the next day we started on our return journey. Our road lay up the Rakshan valley, on either side was a range of broken hills, so far apart that it was impossible to get from a station on one range to a station on the other, under two days. The total distance of the gap between the Panjgur triangulation and my Gidar triangulation was 130 miles, which had to be bridged before the rations we took in Panjgur were expended.

Though the actual series was not very much impeded by it, the haze continued to give trouble, particularly to the south and east, where we obtained far less, both of triangulation and topographical detail than we had expected. On the 26th of March from Dranjak H. S. I sighted some of the stations I had visited in December, and found from my plane table that there could be no very large discrepancy. A few days later, after visiting one of the

points that had been intersected both from Kharan and Gidar, I found that this discrepancy amounted to 7″ and 5″ in latitude and longitude respectively, much of which I am glad to say has disappeared on recomputation. After effecting a good junction between the Panjgur and Gidar triangulations, we reached the tract previously reconnoitred by me, and closing work set out for Quetta as fast as we could.

On the 29th of April we reached Jacobabad, where I found the office of the party, and assumed charge. After a few days spent in final arrangements, we started for recess quarters at Mussooree, where we arrived on the 6th of May.

The country visited presents many advantages for rapid work. The hills run in straight or gently curving ridges, the tops of which present numerous well marked points, so sharp that the difficulty sometimes was to put the theodolite upon them. The country is, as a rule, easily traversable by camels, so that the surveyor can generally get his camp within three or four miles of the point from which he wishes to observe, and the absence of any marked features over much of the plain country enables a large area to be rapidly surveyed. Great clearness of atmosphere occurs at uncertain times; but this which is so favourable for observation is always liable to be replaced by a dense haze which may last for several days; and at this season there is almost always a strong wind blowing, sometimes rendering it impossible to observe, and on at least half the days I had to dispense with an umbrella. Though one can generally get one's camp within a reasonable distance of the point one wishes to observe from, it is quite uncertain whether water will be found there, and in some parts, notably the Koh-i-Sabz, water, where found, will very probably be so salt as not to be drinkable.

The hills are made up of masses of minute features, in many cases so small as to be incapable of delineation on the ½-inch scale, and yet so tangled and mixed that it is difficult to grasp their shape sufficiently to generalize them. Though we met with much bad weather, it fortunately did not come at the times at which it would have been most inconvenient, and the rain which fell while we were at Panjgur relieved us from much anxiety about water in that neighbourhood.

The success of the survey is in a great measure due to the excellence of the arrangements made for the party by Sir. R. Sandeman, who with unvarying kindness rendered it every assistance throughout the expedition.

Extract from a report by MAJOR T. H. HOLDICH, R.E., *Deputy Superintendent, Survey of India, on an expedition to the Takht-i-Suliman in December* 1883.

THE object of this survey expedition was to explore the Takht-i-Suliman mountain and complete as much of the topography as possible of the Sherani country, keeping up a continuous border survey with that already completed to the north, which terminated about the line of the Gomul valley; and to fix, if possible, a certain number of points in the country west of the Takht-i-Suliman from trigonometrical stations on the mountain itself.

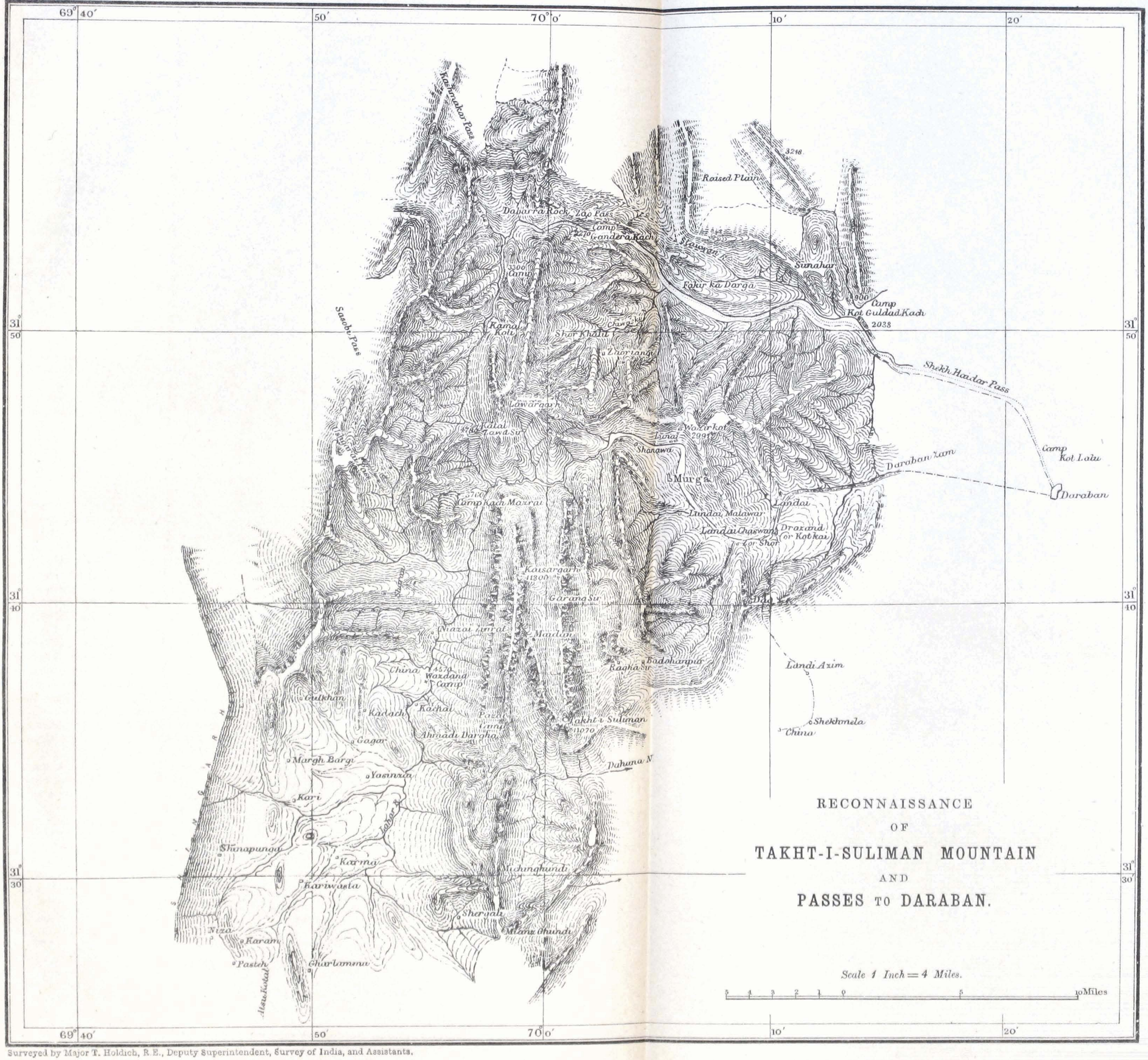
For the completion of the topography, Mr. Coxen and sub-surveyors Imam Bux and Hera Singh were provided with projected sheets on ½-inch and ¼-inch scales for plane-tabling; Hera Sing's duties in the first instance being confined to traversing.

Triangulation.

For the triangulation, I and sub-surveyor Esuf Sharif were each equipped with a 6-inch subtense theodolite, a 12-inch heliotrope, and one or two smaller heliotropes, which proved useless in the peculiar state of the atmosphere.

Only one Great Trigonometrical hill station was available for possible reference from any position so far west of the frontier as the Takht mountain. It was obvious from the very commencement of survey operations that no station of the Indus Series, in the plains, would ever be visible from the Takht on account of the dense atmosphere overlying the banks of the Indus. It was possible that the one hill station referred to, Shekh Budin, might be visible, as its height was considerable; it was an unmistakeable and conspicuous hill, and one of the 12-inch heliotropes could be placed on it. On examination it was found that neither of the original sites of the Great Trigonometrical stations on that hill could be identified, but this was of no great consequence, as an excellent site was afforded by the roof of the highest building in the place, and the principal stations of the Indus Valley Series, from which the Shekh Budin points were originally fixed, were all found to be in perfect order, so that the new hill station was easily fixed by subsequent triangulation. There was no possible means of carrying any connected series of triangles from the frontier up to the mountain, and at best it was exceedingly doubtful whether such a series would result in fixing any points on the main ridge better than the two already fixed by means of first class instruments from the Indus Series, called respectively the northern and the southern summits. The great trigonometrical computations showed discrepancies on the common sides to these two points of a few feet only: they were the two obvious points (so far as could be seen from the eastern side) to be selected, as giving the best base for triangulating to the west of the Takht; and any third point would have been quite out of place and useless on account of the excessive shortness of the base. These two points included apparently the full length of the mountain, which was, however, something less than eight miles. But as it was hoped that in the course of the circuitous march to the Takht mountain some third point to the north might be

To accompany Surveyor General's Report for 1883-84.



Surveyed by Major T. Holdich, R.E., Deputy Superintendent, Survey of India, and Assistants.

Lithographed at the Survey of India Offices, Calcutta. February 1885.

reached which would give a check value on the observations from the other two, the following arrangement was made for fixing any such position :—

Esuf Sharif was placed in the Shekh Budin station with orders to reply instantly to any signal made from the hills, and to show a steady light in reply. He was then to observe the angle between the signal given him and one of the principal Great Trigonometrical stations in the plains, carefully noting the position of the point observed, and subsequently observing that same point from the principal Great Trigonometrical station below: thus two angles would be secured from an assured base; the third angle, viz. that between Shekh Budin and the Indus valley station, it was known would be impossible for observation, owing to the haze already referred to. It must be understood that while it is possible to observe from the plains to the hills under such conditions, it may be totally impossible to observe from the hills to the plains. It may be as well to state at once what measure of success attended these arrangements.

Under considerable difficulties, as will be hereafter detailed, the third point north of the mountain was reached sufficiently early in the day for Shekh Budin to be visible. After some delay an answering light was obtained from Esuf Sharif on that station; but this would have been impossible with any glass of a less dimension than 12-inch. There was no difficulty in observing to Shekh Budin, but there appears to have been great difficulty in observing from it. Anyhow, Esuf Sharif reports that he was quite unable to discern the signal after the first flash, nor was it of any consequence, for he could not again have identified the position of the point reached, owing to its not appearing to him on the sky line. Another and slightly higher range was at the back of it, the effect of which was to obscure the position of our point more effectually. This higher range was beyond our reach. Consequently the position of this station, Kārajbina, depends entirely on an interpolated value from the Great Trigonometrical intersected points surrounding it. These are of very unequal value, but still should give fairly trustworthy results.

The second point reached, viz. the northern summit or "Kaisargarh," proved to be a well fixed and thoroughly good position, but the difficulty of reaching it, owing to its altitude reduced the time for observing to very narrow limits.

The southern summit, which it was intended to visit, proved a complete failure. From below, eastward, it appeared a sufficiently well defined point, but it proved to be a square-headed block of sandstone, level at top, apparently inaccessible on all sides, and covering so many acres in extent that the coincidence of common sides was evidently a happy accident. Moreover, it was on the eastern ridge of the mountain, overlooking the plains of India and much shut out from the plains of Afghanistan by the western ridge. The choice of a second station on the mountain was thus rendered exceedingly difficult. The western ridge afforded the only site for a station from which the Afghan plains were sufficiently visible, but from no point on the western ridge was the northern summit, being on the continuation of the same ridge, visible, nor from it, again, could the plains of India, or Shekh Budin, be seen. There was nothing for it but to fix another station by interpolation, but in this case the surrounding points proved exceedingly weak, the nearest being the vague and uncertain "southern summit" referred to. But for the future chance of fixing that station from the Zhob valley, it would have hardly been worth the day's observations. That chance has come more speedily than could have been anticipated, and if the position of it can now be but approximately defined, there should be little difficulty in identifying and fixing it permanently.

On the 17th of November the force was camped near Daraban, facing the Takht-i-Suliman, and not more than 20 miles from it in a direct line. The summit of the mountain was then covered with recently fallen snow, which threatened to retard the progress of the party. Early on the morning of the 18th, the first camp over the border in the Shekh Haidar pass was reached, and during that day plane-tabling was commenced by Mr. Coxen and the Bozdar, from the neighbouring heights. The character of the ground bordering the pass was distinctly visible all the way to the northern foot of the mountain. This strip of country, 20 miles wide, between the foot of the eastern slopes and the frontier, was made up of low sandstone ranges of most irregular formation and intricate topography. Immediately on the frontier line were fairly well marked, definite ridges, but from the frontier to the first line of the sharp edged knife-like limestone ridges, offshoots of the great mountain itself, and parallel to its formation, were nothing but barren, broken, sandstone hills of no great altitude, bare of cultivation. So far as could be seen, though here and there hidden in the recesses of the watercourses, were small insignificant villages, each with its little patch of unhealthy-looking fields. The line of march followed the Zao stream, usually called the Shekh Haidar pass, to a point called Gander Kach, where the real defile of the Zao, about four miles in length, commences at the end of the second day's journey. So far the Great Trigonometrical points fixed on the line of the Suliman ridge, supplemented by fixings obtained from points visited on the frontier line previous to the first day's march, were sufficient for the plane-tablers to carry on the topography of a strip of country of varying width, adjoining the route itself. The route was traversed at the same time, chain measurements being taken and bearings recorded with a prismatic compass. From Gander Kach through this four-mile defile, the traverse alone could be depended on. It was not till the party emerged on the far side that plane-tabling points were again visible. Each day a small guard, usually not more than a havildar's party, was detailed for duty with the signallers and surveyors, who ascended the highest available points on either side of the route, whilst the main force of about 2,500 men was retained in as compact a formation as possible on the bed of the pass. The defile was not found easily passable. In addition to waterfalls and other obstructions, there was the well-known Dobarra rock, which

blocked the way so as to narrow the pass to a few feet, through which only unladen baggage animals could make their way. In the absence of pioneers or sappers, or any scientific road-making equipment, this was a serious obstacle, and it was only finally surmounted after two days delay by passing the 1,000 Povindah camels (of which 500 were laden with "bhoosa" for the use of the 800 mules) through first, while the force remained encamped at Gander Kach, in rear of the Dobarra stone. During this process but little could be done in the way of surveying, but the Bozdar made a useful reconnaissance towards Drazand, and the traverse was kept up continuously. From a little ahead of the Dobarra rock a long march was made to a place called the "Ghât," passing over the kotal or watershed at the head of the Zao, and down into the drainage of the Daraban Zam, which at the Ghât rushes through a wild narrow gorge, cutting across the massive limestone ridges of the northern spurs of the Takht-i-Suliman and streams out into the sandstone country beyond. This forms the Daraban pass. It is possible for men on foot to get through it, as later on Hera Sing carried a traverse from the site of this camp through the pass, fixing the position of Drazand, and finally joining on to the line of original route. On the day on which this march was accomplished, an effort was made to reach the high range which is the natural continuation of the Takht ridge, northwards, and there to establish a trigonometrical station which might serve as a third point of observation to the two on the Takht mountain itself. Starting at day-break with a small escort of 25 men, the party struck into a line of drainage which obviously would finally carry it to the summit of that ridge if persistently followed out. No guides were procurable, and it consequently devolved on the survey officers to find their own way about. The ascent lasted many hours, and was very severe. In the short November days it was soon apparent that the real backbone of this great range was beyond reach, and that some minor point must be selected in order to secure time for even a rapid round of observations, in addition to the plane-tabling. The point called "Karajbina" was finally selected, and from it communication by signalling was opened with Shekh Budin. Late in the afternoon the observations were concluded, and it was dark before the party had reached the Zao nullah, on the line passed over by the force. The greater part of that long march to the Ghât had to be made at night by the survey party and the small escort with it, but no attack was made and camp was safely reached. I was, however, warned by General Kennedy, commanding the force, that no further attempt to reach points so far from the line of route would be permitted. From the Ghât to Wazdana and Wazdana to Pazai the topography was carried on as before with the aid of the Takht points, and one or two north and south of the mountain. At Pazai the force faced the western side of the mountain, nearly opposite the Southern Takht peak, and a small narrow path up a steep spur leading to a defile through the stupendous cliffs which surrounded its summit showed the way to the top of the mountain. Such a pathway would have been difficult enough at any time, but it was now held by the Kedarzai section of the Sherani tribe, who had built formidable "sangas" and other barriers across the defile, and were prepared to defend it to the last extremity. A survey reconnaissance, however, assisted by the local knowledge of the Bozdar, led to the suggestion that another way up might be found by making a long flanking movement to the southern end of the mountain, following the course of a nullah, the head of which must clearly be found under the edge of some rather more accessible looking, but still precipitous, cliffs that could be seen through the telescope in that direction. But as such a movement would have no chance of success unless by way of a surprise, and as Sherani guides were certainly not to be depended on, it devolved on the survey officers to show the way in the dark. Accordingly, with the help of the trusty old Bozdar, I offered to guide a flanking party to the summit of the mountain by night, and to turn out the Kedarzais, if possible, by daybreak. It was a long and anxious night's work, stumbling almost blindly along the bed of a nullah full of boulders and fallen trees, and as day dawned we just found ourselves on the summit without having fired a shot, but still a long distance away from the head of the Pazai Kotal. It was then difficult to determine what course to pursue. There were two ways leading to the Kedarzai position: one along the edge of the cliffs, which might easily prove impracticable, and another which was an obvious hill track, and which the Bozdar rightly surmised led from their position to the Kedarzai village in the plains below. We followed both, the main body of the force took the road, and a smaller party of the 1st Sikhs, which I accompanied, pushed their way along the cliffs. The latter were the first to reach the Kedarzai position, coming suddenly to a point commanding it, just as the front attack from below was beginning to develop. It needed but one volley from the advanced guard of the Sikhs (about fifty men) to scatter the whole Kedarzai force. They were so completely surprised, and so utterly routed, that I believe that in the course of an hour or two not one was left on the summit of the mountain. Their loss was about 30 killed and ours was *nil*.

The summit of the Takht mountain was found to consist of a long, narrow valley, about eight miles long, and of width varying from one to two miles, enclosed between parallel ridges of rugged and precipitous limestone rock, seamed and scarred with deep indentations where the drainage had worked its way during the course of ages to the plains below. About two miles from the highest peak, the northern summit, called locally the "Abashta chuka," or juniper point, or sometimes the "Kaisarghar," was a level space, covering about half a square mile, called Maidan; this was the water parting. From here the drainage found its way through precipitous gorges both to north and south along the line of the enclosed valley. The whole mountain was thickly covered with two classes of pine; the "chilgosa" (or edible pine) and the *pinus excelsa*. During the first day, after securing the road up the

mountain, a reconnaissance was made northwards along the valley in search of water. No water was found, although it probably existed far down in the deep ravines which drain this central valley. At Maidan there were two dry tanks, said to be full of water immediately after the rainy season, and generally to hold a sufficient supply all through the subsequent winter. The want of water seriously retarded the progress of the work. Not less than 450 men were considered sufficient as a guard and escort to the survey party, and 150 more were added to assist in transport arrangements. Water was brought up from Pazai in pukhals, on mules. On the 29th November the advanced force pushed on over most trying ground to Maidan, and the night was passed there round log fires, which were freely kindled in order to temper the cold of 18 degrees of frost. On the 30th the great "Kaisarghar," the highest peak of the Takht, was ascended. The air was clear, and a most comprehensive view northward and westward was obtained. Unfortunately the delay caused by taking 450 men up a steep and rugged mountain peak was fatal to the chance of a long day's work. Two or three hours were all that were obtainable, and, unfortunately, also at this juncture the Bozdar collapsed with pleurisy. Mr. Coxen never attempted the ascent, so that triangulation and topography had thus to be carried out together by one unassisted officer. The extent of view was very remarkable towards the north-west and south, but eastward the eastern ridge of the mountain blocked out the view of the plains. The height of the "Kaisarghar" (11,300 feet above sea) was such that the innumerable lines of hills traversing the central Afghan plateau were very much dwarfed to the observer, there being absolutely no peaks or points in that direction which appeared to have any special prominence. A reference to the plane-table chart very soon showed that every commanding peak that in any way stood out in the perspective of this vast landscape had already been fixed in the course of the Afghan surveys. This was satisfactory to a certain extent, but it still left a large central area unprovided with trigonometrical points. Observations were accordingly taken to these low lines of hills, and a record kept of the approximate distance and appearance of each point observed; but it was exceedingly difficult to pick out any point certain of identification in future, and the intense cold rendered the process of observing a most trying operation. It was almost more important to examine the topography of the map compiled from recent explorations than to take observations with the theodolite, and this part of the work proved entirely satisfactory. The distance was too great generally to make certain of details, but many important geographical features in the Birmal hills, the Gomul and Zhob valleys, and the Musakhel country of the Upper Vihowa, recently explored by the Hakim and the Bozdar, were easily identified, and the general correctness of their geography certified. It may be stated broadly that the trigonometrical fixings required as a basis for topography in that central area, which is bounded on all sides by completed surveys, are very few. The summit of nearly every hill in that area would have sufficient command to bring well fixed points into view along three-fourths of the horizon; but, as matters now stand, the scale would be small to admit of their introduction into the map. It is certainly advisable to obtain more points if possible, and the triangulation from the Takht will secure this result. On the night of the 30th, another bivouac was made on the Maidan, and the following day the party returned to the Pazai pass. No attempt was made to ascend the southern peak of the Takht for reasons already given, but an exploring party would doubtless have visited that corner of the mountain, to ascertain the accessibility of the peak, and to visit the great shrine which exists below it (and not, as is generally supposed on the summit), but for the impossibility of providing for such an unwieldy force as was considered necessary for escort duty. Another and more suitable peak to the south-west of the Southern Takht was selected for a station, and observations, combined with topography, were taken on the 31st. Here the luck which had so far attended the operations in the matter of fairly clear weather suddenly failed. The day was cloudy and hazy, but so far as it was possible to tell, no point previously observed was missed from the round of observations. The return journey to Dera Ismail Khan was unmarked by any special incident. Fresh points of vantage were reached by the topographers, Mr. Coxen having penetrated some distance into the hills west of the Takht during the course of the operations on the summit of the mountain. The topography was increased and improved, especially by the plucky traverse run by Hera Sing, who took a native escort only, and traversed the "Ghât" defile to Drazand. This left very little of the district between the Takht and the frontier unmapped. Subsequent to the return to Dera Ismail Khan, the Bozdar continued the topography of this trans-frontier strip southwards, but was unable to map the Dabua pass, which still remains a blank. Esuf Sharif's survey of the Gomul pass connects the work with Waziristan on the north, and a subsequent exploration on his part up the Reminuk pass to the foot of the great Misri Rob mountain has filled in still further details in continuation of the Bozdar's topography. Thus, with the exception of the head of the Dabua pass, the topography of the frontier is continuous and complete from Kohat to the Reminuk.

Memorandum on the tribal divisions of the Kakar tribes by Mr. G. B. Scott, *Surveyor, Survey of India, dated 28th November* 1884.

Tribal Divisions and Locations.

The *Kakars* are divided into two main branches, known respectively as the *Sanatia* and *Sanzár*. The latter appears to be that hitherto styled the *Suran Kakars*. To the name

Saran I could find no other clue than one given by the chiefs assembled at Mena, that it was applied to the Sanzar by those unacquainted with the true appellation.

The *Sanatia* occupy the country between the Harnai and Bori valleys, portions of the *Pishin* and some villages at the extreme head of the Bori.

The sections and sub-sections of the *Sanzár* are given below :—

The Sanzár are divided into six main sections: 1, Alikhel; 2, Arabikhel; 3, Utmankhel; 4, Barátkhel; 5, Abdullazai; 6, Kibzai.

1. The *Alikhel* occupy large portions of the main Zhob valley and Khaisor.
2. „ *Arabikhel* occupy the eastern portion of the Bori (or Arabori) valley.
3. „ *Utmankhel*, most of the western portion of Bori.
4. „ *Barátkhel*, the country in the neighbourhood of *Chena* between Marra and Zhob.
5. „ *Abdullazai*, Mena Bazar, and country to the north and east of it.
6. „ *Kibzai*, or *Kiwaizai*, Morga, Kakhoo, and neighbourhood, up to the Musakhel country.

These are sub-divided as follows:—

The Alikhel.

1.	Shadozai ...	*a.*	Shamozai ...	Mardanzai ...		Watral and Khaisor
				Ialalzai ...		Zhob and Khaisor.
				Massazai ...		Zhob and Arat-i-khula.
				Aladadzai ...		Zhob and Khaisor.
		b.	Ibrahinozai	Khoidadzai ...		Hindu Bagh and north of it.
				Daulatzai ...		Sur Tangi, Tirakhula, and Zhob.
				Akhtarzai ...		Zhob (Shinkai Bagh, &c.)
				Shahzai ...	}	Among the others in Zhob.
				Marozai ...		
				Ahzai ...		
2.	Mirzai ...		.....	Patozai ...		Kazhe and Sharan.
				Fakirzai ...		Ditto.
				Washinzai ...		Gwandamarra.
				Ahmakzai ...		Kats (in Bori).
3.	Badsuzai ...	*a.*	Yahyezai ...	Ismailzai ...	}	Zhob, Wakhlin, and Eastern Khaisor.
	Also known as			Manakzai ...		
	Dreplarai or 3 fathers.	*b.*	Alizai ...	Adinzai ...		
				Baizai ...		
				Anezai ...		
				Ibrahimzai ...		
4.	Gorizai ...		.....	.....		Thahigalu.
5.	Ismailzai ...		.....	.....	}	Gwal and neighbourhood.
6.	Hedarzai ...		.....	.....		

The Arabikhel in Bori.

LOCATIONS.

1.	Hamyazai	...	Mekhtar, Nalai, Nushpa, Wahar, Eastern Sharan, Nai Wiala, Sabara.
2.	Alizai ...	...	Western Sharan, Chena, Sagrai, Barnamai, Sharan.
3.	Shabozai	...	Dargai (Eastern).
4.	Khudizai	...	Dilhi, Lahor, Marra, Wariagai, Dargai, Zangiwal.
	Khanan or ruling section.		Eastern Karez, Eastern Shah Karez, Pinkai (on Toralar). All four sections graze their flocks on Torkheza, Churma, and Uzhda.

The Utmankhel.

a.	Shahbazai	...	Pathan, Sirki Zangal, Kohar.
b.	Mahmudzai	...	Kot and neighbourhood.
c.	Nakozai	...	Rodlin, Arboshin, Nigange (Nimgan of old maps).
d.	Turkzai	...	Zgarluna, Western Karez, Western Shah Karez, Jarkarez, Kohar, Sirki Zangal.
e.	Khadarzai	...	Minara, Agberga,

A family of Syuds known as *Baidar* live in Jarkarez.

The Barátkhel.

This class is not divided into any well-known sections; is not so considerable as the others; lives in Chena and neighbouring hills between Bori and Zhob.

The Abdullazai.

a.	Pakhezai	...	... Mena Bazar.
b.	Mallizai	...	... In hills north and east of Mena, as far as
c.	Badenzai	...	... Marani and Mandokhel country.
d.	Khajalkhel	...	... Pagaosheks, a valley near Sawara, south of Mena.

The Kibzai.

a.	Kabalzai	...	... Morga Kakshai.
b.	Shamamzai	...	... Kakhas, Barakwal.
c.	Khudizai	...	... Taoda and neighbourhood.

The hamlets of Chimjan, Chinalai, and Dargai on the west end of Bori, and certain hamlets among the other Bori villages are inhabited by *Dumers*, a tribe apparently descended from the retainers of the first Kakar invaders, and known as "Hamsayas." They also occupy villages in the *Sanatia* country, among others, *Baghao*, *Sinjawi*, and *Smallen* on the Quettah-Duki road. They appear to be more skilled and careful in agriculture than the Kakars.

The Musakhel Tribe.

The Musakhel, which is quite distinct from the Kakar tribe, inhabits the country along the upper portion of the Suni and Vihowa rivers, between the eastern watershed of the Bori, the Bozdar and the Sharani countries. The people are nomadic in their habits and possess large flocks and herds; but their chief wealth consists of camels, and they are largely engaged in the carrying trade between Zhob, the Bori and India, especially the Lehrzai section, which does not appear to have any settled habitation. They probably would find it difficult to muster 1,000 *talwars*, all told, or 100 matchlocks.

The Musakhel.

1.	Lehrzai	...	Mangazai ...	Bazar, Kot, and scattered over the hills in blanket tents.
			Kabalzai ...	
			Nohzai ...	
2.	Hassankhel	...	Senzai ...	Toi.
			Umarzai ...	Premzai.
3.	Belkhel	...	Hamzazai ...	Baha.
			Mugdzai ...	
			Malizai ...	Choha.
			Shadizai ...	North of Nari.

Estimate of the fighting strength of Sanzár.

The care and persistency with which the Zhobwals and others hid themselves and their families, the peculiarly low hovels in which all but the chiefs live, only showing as low mounds of earth, and the numbers who live a purely nomad life in blanket encampments, render it difficult to form a correct estimate of the inhabitants. But the following process may give a fair approximation.

The Boriwal, consisting of two main sections of Sanzár,' viz. the *Arabikhel* and *Utmankhel*, live in fairly well-built huts in villages that form a marked and pleasing feature in Bori, in contrast to Zhob. At first sight these villages appear very large, but on closer inspection it is found that large portions of what appear to be habitations are enclosed fruit or vegetable gardens.

They engage more largely in agriculture, possess a far larger area of cultivation, are evidently much wealthier, except in sheep and cattle, than the Zhobwal, and clan for clan should certainly be more numerous.

They occupy about 35 villages from Mekhtar to Kats; allowing 30 families for each village, or rather cluster of enclosures, and two able-bodied men for each family, we get a total of 2,100 *talwars*; add ½ more for the nomads, and we get a sum total of 2,800 fighting men, or 1,400 for each section.

Taking, next, the most powerful of the Zhobwal, the *Alikhel* section, we find them divided into six sub-sections, three important, three unimportant. Of the three first, taking the most powerful, the *Shadozai*, we have the occupants of Hindu Bagh of some 200 to 300 hovels in the neighbourhood of Shah Ishan Killa, and the Daulatzai hamlet perhaps capable of sheltering 200 families, thus we get a total of about 700 families: again, allowing two able-bodied men for each family, we get 1,400 men; add about a third for pure nomads, and we attain a total of 1,800.

Taking, next, the *Badsuzai* section, the group of huts they occupy in Zhob might shelter 300 families at the utmost; add 100 more for nomads in Khaisor and Wakhlin, and two able men for each family gives 800 men. Allowing an equal number, that is 800 men for the *Mirzai* and half that number for each of the three less powerful sections, viz. the *Ismailzai*, *Hidarzai*, and *Gorizai*, we get a total strength for the *Alikhel* of 4,600 men, which is evidently rather over than under the mark as compared with Bori.

Next, allowing something less than to the two Boriwal sections for the *Abdullazai* and Kibzai, or say 1,200 men each, and say 1,000 for the smallest section, the *Barátkel*, we then have the following numbers:—

1.	Alikhel	4,600	*talwars.*
2.	Arabikhel	1,400	,,
3.	Utmankhel	1,400	,,
4.	Barátkhel	1,000	,,
5.	Abdullazai	1,200	,,
6.	Kibzai	1,200	,,
	Total ...	10,800	able men.

Of these, at least one-third would be compelled to guard the flocks, herds, and families in a tribal gathering.

I find the total number of *men* has lately been estimated at about 144,500. Even allowing men here to mean *souls*, it would still mean a fighting strength of 29,000 men. But the *Sanatia* are only estimated at 7,000 men. As these are descended from the same stock, occupy an equal, if not larger, extent of country, are more settled, and possess more villages, and have always held their own against the Sanzár, the total strength should be quite equal to, or very near, that of the Sanzár: I consider 10,000 *talwars* a very liberal allowance for the Sanzár Kakars. Certainly this number only allows about 10 souls per square mile. But a large portion of the country is uninhabitable, and a larger still, only suitable for grazing purposes.

The principal articles of import are—

English and Indian cotton goods, indigo, salt, iron, copper and brass utensils, wooden platters, sugar, molasses, tea, alum, leather, shoes, China-ware, and cattle.

Exchange is generally by barter, but British Indian coinage is coming into general use. The terms pisa, anna, and rupee are adhered to: a 4-anna piece is called a "pao," and and an eight-anna piece a "habasi."

The following local names of trees found in the Zhob hills may be useful:—

Tamarisk	*Shinezgai.*
Wild olive	*Sharawan.*
Juniper	*Obushta.*
Poplar	*Spinawani.*
Willow	*Willi.*
Pistachio, a small wild variety	*Uzhgai and Shna.*
Bhan (Punjabi)	*Palawan.*

I have here only taken up topics unlikely to be taken up by those unacquainted with the language, and only that portion of Zhob, &c., that I was more particularly employed in.

Notes by Col. H. C. B. Tanner, s.c., *Deputy Superintendent, Survey of India, on the journey of the Lama through Central and Southern Tibet.*

Amongst other information of great interest brought back from Tibet by the Lama is his account of the famous lake of Yámdok-tso or Lake Pálti. The notes are accompanied by an excellent map obtained by pacing and angular measurements made with a prismatic compass. The Lama made a circuit of the whole lake, and then a circuit of the tract which is almost enclosed by arms or broad creeks in which the western extremity of the lake terminates.

Yám or Yeum of some. Nagarchi.

All previous travellers and explorers have confined their examination of the Yámdok-tso to a small section of its north-western shore between Nágartsi and the Khámba La pass, because that section lies on the high road between Shigatsi and Lhása. Mr. Thomas Manning in 1811 followed this route when he visited Lhása; and the beautiful view he obtained as he approached the lake from the west is one of the few in all Tibet that called forth remarks of admiration from him. Beautiful as the view of the long reach of the northern creek appeared to Manning, it cannot be compared with others that may be obtained from the southern or eastern shores. Manning's view was restricted to one arm of the lake, only about 1½ miles broad, and extending for about 16 miles, and the snow-capped mountains which were visible on the opposite shore were too close to allow of an effective view; but from the points towards the eastern shore the snow-clad mountains, distant from 16 to 25 miles, are likely to appear to great advantage, reflected in the lake. From the south the view across the water is varied by an additional point of interest in the shape of an island and monastery, about a mile or less from the shore. The whole lake is embosomed by mountains, except at the eastern extremity, where they fall away and admit the respectable stream which drains the Yámdok kár má sing or the "starry plains" or "plains of heaven," a delightful and far-reaching extent of rich sward

Sheet No. 6 of NORTH EASTERN FRONTIER

TRIGONOMETRICAL BRANCH, SURVEY OF INDIA.

Parts of TIBET, SIKHIM and BHUTÁN

NOTE.—The positions of Lhása and Shigatse as shown on this map are not consistent with the latest adopted values which are

Lhasa { λ 29° 39' 12" / L 91 5 30 } Shigatse { λ 29° 16' 32" / L 88 54 0 }

REFERENCES.

Monasteries (Gompa) and Temples (Lhákáng) are shown thus
Graziers huts or Encampments (Dok) ... Do.
Passes (La) ... ... Do.
Lakes (Tso) or (Tsho) or (Cho) in old maps ... Do.
Rivers (Chhu) ... ... Do.
Forts and Head Quarters of Officials (Jong) or (Dzong) Do.

Scale 8 Miles = 1 Inch

Published under the direction of Colonel G. C. DePrée, S.C., *Surveyor General of India.*

Compiled under the direction of Colonel G. C. DePrée, S.C., Surveyor General of India and under the Superintendence of J. B. N. Hennessey, Esq., M.A., F.R.S., Deputy Surveyor General in charge Trigonometrical Branch, by Colonel H. C. B. Tanner, Bo. S.C., Deputy Superintendent.

Hill shading by Mr. J. Peyton.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, February 1885.

Note.—A route leads from Tong-tsho Pámá-ling over the Rong Pá La and Mon Lá Ká Chung La passes to Tongsah—a journey of 5 days—passing Kurtong, Dongchun, Tsumpa (Tsumba), Ngawang-Lhákáng Monastery and the important village of Punthang; and thence over the Kika La Pass. The boundary of Tibet is met at the Mon Lá Ká Chung La Pass. At Lungdom in the summer, and at Tsumpa in the winter, the Tibetan and Bhután merchants exchange goods. Tongsah is probably Tongsa of Pemberton.

A trade route leads from Lhá-kháng Jong to Dungsáng in Bhután as follows:—*viâ* Náling, Labo, Kurti, Tincho Pet, Tunkar, Tápé, Tákéchi, and Chákoum; thence crossing the Chatsi Pekla Pass *viâ* the Shu thung Monastery, Leling Jong (Tinchi Jong), Khama-Yalamdung, Shinká Takleng, Pujur, Tangdong, to Dungsáng,—an important place where arms are manufactured.

Two days from Lhá-kháng Jong the boundary of Tibet is met at Náling where duty is taken. Leling Jong is probably Lingtsi Zong of Pemberton.

on which graze thousands of cattle, horses, and beasts of the chase. The mountains surrounding the Yámdok in some places recede to a distance of several miles, and the space between the foot of the hills and the water is either cultivated or left for grazing. Villages and monasteries surround the lake, and are dotted all along the small bays which so frequently indent its shores.

The Tibetans have bestowed upon the lake the very prosaic name, Yámdok, or scorpion lake, in allusion to its shape, Nágartsi being at the extremity of the right, and Tag-lung of the left claw; the tail is at Loh-bu Jong. It is difficult to understand how, without a map, the Tibetans could have been aware of the resemblance the shape of the lake has to that of a scorpion; and as the delineation of the lake in the Lama's maps bears out this resemblance, they presumably have maps which give a fairly correct idea of the shape of the lake. As a matter of fact, the lake, which was first visited by D'Anville in 1735, has been shown in all the old Himalayan maps, but inaccurately as regards both its geographical position and its size. The Pandit connected with the Survey Department, who visited it in 1866, made a round guess as to its circumference, which he believed to be about 45 miles; but as neither the Pandit nor any previous explorer had examined any but its western section, they could not have had any complete idea as to its actual dimensions. It is a singular merit on the part of the Lama that he cleared the map of this lake district of everything which was not the result of positive information. Many high hills or mountains dip their spurs precipitously into the waters, and cause an endless variety in the scenery.

On the mountain tract, which is nearly encircled by the two scorpion claws, or the western arms of Yámdok, is an inner lake, Dumu-tso, with a circumference of some 24 miles, and elevated above Yámdok as much as 500 feet. This sheet of water is regarded by the Tibetans with great awe, fear, and superstition. There is an idea that some day Tibet is doomed to be flooded, and all animal life destroyed by the overflow of this lake; and prayers are constantly being offered up in the surrounding monasteries to avert the catastrophe. Earthquakes, landslips, and convulsions, accompanied by subterraneous noises, are said to be of constant occurrence, and the waters are reputed to be steadily rising, notwithstanding the precautions taken by the monks, who continually offer up their prayers to turn away the wrath of the demon of Dumu-tso, said to be confined below the waters.

Yámdok-tso has been called indifferently Piahté or Pálti or Pedé, simply because one of the best known and most frequented towns on the northern shore is a resting-place on the high road between Shigatsi and Lhása. Yámdok, however, is the true name. Its altitude above the sea is determined at 13,800 feet by the Lama, and previously at 13,700 by other explorers. The circumference, including the bends of the shore, is about 170 to 180 miles, and by the regular road which crosses many spurs of the encircling mountains, 120 miles. There is a large population on the banks, and much cultivation. An old account states that there was a great export of salted fish from the neighbourhood of Yámdok, and that boats were much used; but the Lama reports that the traffic in fish has been stopped. The mountains which rise up near the centre of the lake are assumed by the Lama to attain about 18,000 or 19,000 feet, which would place the summit of the highest one 4,000 feet above the waters. On the whole, lake Yámdok must be about as charming a spot as one could well find anywhere; and I cannot conceive a more exhilarating trip than a gallop across the soft turf of the "starry plains," followed by a row over the lake, and finally an ascent up the central mountains, whence the beautiful scenery of the neighbourhood might be enjoyed.

A number of much used, but little known, routes lead away from Lake Yámdok. One over the Thib La pass *viâ* Kodesho Jong (Kidishor) and Tungo La (16,330 feet high) to Lhása was followed some years back by D. C. S., who has kindly supplied me with names of places on the road. The Thib La is very high indeed, and a very difficult pass. From the summit D. C. S. saw some very high snow-clad mountains towards the north-east, situated somewhere on the watershed of the Ki chhu and Brahmaputra, and he supposes them to be more lofty than any he has seen in any part of Tibet, except amongst the Everest group. A third well-frequented road leads from Tag-lung (pronounced Tálung) on the south-western corner of Yámdok to the Lhobrak* (pronounced Lhobra) country. It was followed by the Lama, and will receive a few words of notice presently. These routes, and the interesting countries they pass over, have never until now been made known. The map of the Himalayas showed pure white paper, or at most dark lines of imaginary hills, which were inserted to give continuity to the Himalayan chain, and existing maps do not even hint at any of the Lama's geography.

Thib La. Tungo La.

It may not seem a difficult matter to decide whether a lake such as Yámdok has an outlet or not; yet, though a circuit of it has now been made, this question is still to a certain extent an open one. The Lama's exploration embraced a re-survey of the Rong valley, and he distinctly affirms that he saw the waters of the Yámdok flowing westward through the Rong valley into the Brahmaputra. We know that the height of the water in the Yámdok is very variable; and the Lama states that when the water of the Brahmaputra is higher than that of the Yámdok, the latter receives a supply from the river; but when the water in the lake is the higher of the two, the flow is the other way. Though D. C. S., however, does not confirm this, I conclude that the Lama is right. He is a careful and intelligent observer, who is not

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Lho=south.

likely to have mistaken the direction of the flow of water down the Rong valley when he marched its whole length from the Brahmaputra to the lake.

The Lama left Yámdok at Tag-lung (Tálung), and crossing the Yeh La pass (17,000 feet), descended into the basin of the Pho Mo Chang Thang* lake (16,050 feet), one of the highest in all Tibet. This newly-discovered lake is surrounded by high mountains which leave a fairly broad margin of grass land along the shores. It has no outlet for its waters. A nomadic tribe of pure Tibetans inhabits the margins of Pho Mo Chang Thang; they speak Tibetan, and are not to be confounded with the Gálokh who occupy the Tibetan highlands to the west and north. The height of the lake is over 16,000 feet, at which altitude there is no cultivation whatever; the circumference is about 46 miles.

The basin of Pho Mo Chang Thang was left by a depression in the surrounding mountains in the south-east corner, and the Menda La (written Manda La) pass, which leads into the Indian drainage, was crossed. At the foot of the Menda La, the Lhobra river was met with, flowing from some high mountains to the westward. At or near the foot of the pass the mountain sides were sparsely covered with juniper; lower down with the Dun-san pine of Sundakphu; and at Lha-khang Jong,† where the Lhobra was a large river, with pines and the forest common to Upper Sikkim.

The Lama did not travel along the Lhobra valley, but turned off south by the Tum La pass to visit a monastery situated at the foot of Ku Lha Kangri, one of the four holy mountains of Tibet proper. From the Lama's description I should suppose the altitude of Ku Lha Kangri to be from 23,000 to 24,000 feet. I think it has no glaciers, for there is a monastery in the bottom of this valley at the very foot of the mountain. There are some lakes formed by glacial action close at hand, but I cannot make the Lama understand the difference between perpetual snow, *névé*, and glacier.

The Bhutan frontier is two days' journey southward from Lhá-kháng Jong, at an important place called Dumt-sang, where there is a frontier post, where those beautiful *repoussé* silver dagger sheaths which are sometimes offered for sale in the Darjeeling Bazar are made, and it is a wonder how people living almost as barbarians can produce articles so artistic as the sheaths noticed. Dumt-sang I have been unable to find on any map.

Some uncertainty appears to prevail regarding the vegetation of Tibet, and especially so with the trees: very large pines clothe the slopes of the Lhobra valley at a certain altitude, and the same fact was noticed by explorer No. 9, who crossed from Tibet to Towang, and who styled them "enormous." The Lama describes the Lhobra pines as being identical with the common pine of Sandakphu, the Dúng shing of Sikkim, and the Gobari sala of the Nepalese. A high authority on such matters has informed me that the Sandakphu pine is the *Abies Webbiana*. But as Webb, after whom the *Webbiana* is named, never, I believe, visited Sikkim, and travelled much in the Western Himalayas, the identity of the *Webbiana* of the Western Himalayas with the common pine of Sandakphu cannot be established. No two kinds of pine can be more unlike; the Webbianna of the Western Himalayas is tall, gradually tapering from its root to a pointed summit; its trunk is evenly and fully clothed from top to bottom with a regular succession of short branches, but the pine of Sandakphu spreads out cedar-like at the top, or has an umbrella head, whilst its trunk is almost destitute of branches Very often it is scarcely to be distinguished from the Deodar. There is also a remarkable and peculiar curve or sweep of the branches, which I have not seen common to any other tree.

Now that the Lama's work has been combined with that of other explorers who have preceded him in the region between Sikkim and Lhása, the map reveals a very curious system of drainage that prevails in the part of Tibet under notice, namely, that the chief feeders of the Brahmaputra run for the greater length of their course in a contrary direction to that of the chief river of Tibet, or in other words, the sources of the affluents of the Brahmaputra are situated towards the direction in which that river flows. This is the case with the Ki Chhu, the Rong Chhu, the Shang Chhu, the Tong Chhu which flows past Thab-den monastery, the Nyang or Paina Chhu, and lastly, the Rhe Chhu which rises between the Lá-Mo La and La-Ngoi La passes.

The high lands near the head of the Lhobra are said to be the home of the Shao, the magnificent stag of Tibet. The other animals in the valleys are identical with those found in Sikkim.

From Lhá-kháng Jong, the most southerly place reached by the Lama, the Lhobra river was seen flowing away to the south towards Bhutan through a deep gorge. This river must be one of the largest, if not the very largest, feeder of the Monas, but we know so little of Bhutan that it is hard to say which of the streams crossed lower down by Pemberton is the one explored by the Lama.

A trade route leads from Lhá-kháng Jong to Dumt-sang in Bhutan *viâ* Náling, Libo, Kurti, Tincho Pet, Tunkar, Tápé, Takachi, and Chákosum, thence crossing the Chatsi Pikla pass *viâ* the Shuchung monastery, Leling Jong (Tindu Jong), Khomá Yalamdung, Shinká Takteng, Pujur Tsing dong, to Dumt-sang, an important place where arms are manufactured.

The boundary of Tibet is met at Náling, where duty is levied, two days from Lhá-kháng Jong.

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* Pho Mo=man and wife.

† Lha-khang=God's house, *i.e.*, temple.

Leling Jong is probably "Ling-Tsi-Zong" of Pemberton.

From Lhá-kháng Jong the Lama ascended the north-eastern branch of the Lhobra, and crossed out of the Indian drainage into the region of neutral drainage by the Shar-kha-leb La pass. The ascent was fairly easy, but the descent on the other side quite imperceptible, the pass leading up to a regular plateau called Tigu,* a desert on which is situated the extensive lake Tigú-tso (15,500 feet high). This was skirted by the Lama for some five or six miles, and then the Che La pass (17,000 feet high) was crossed, and the head of the fruitful and populous valley of Yarlung was entered.

Tigú-tso is a fine body of water, with a circumference of 38 miles. It may have an outlet towards the south-east, but though the Lama saw a depression in the mountains in that direction, through which there might be an exit for the waters, he was unable to obtain certain information on this point.

From the Che La, a splendid view was obtained of the group of peaks composing the Yar-Lha-Shang-Pu, one of the four holy mountains of Tibet. The mountain cannot be very high as supposed by the Lama, for the monastery of Kang-gyi-oo (15,500 feet high) situated in the bottom of a valley is within 2½ miles of the summit of Yar-Lha-Shang-Pu.

The Yarlung valley is the pleasantest and the most populous in all Tibet. At its lower and northern extremity fruits grow in profusion, and unlike the slopes of Western Tibet, the hills are forest-clad. Monasteries of note are numerous, and shelter thousands of monks.

The journeys made in Tibet by the Lama in years previous to 1883 will only receive a passing notice from me, although the geography collected in these journeys has been shown on the Lhása map. The most important of these journeys are two: one which traversed from Shigatse along the left or north bank of the Brahmaputra to Thán-den monastery, and thence on to Pon Shendarding; and the other from Janglatsi Jong through Sákya to Khámba Jong. Pon is the name of the ancient religion of Tibet which was almost extinguished by Bhuddhism. The map shows by the prefix "Pon" those places where the religion, of which we shall know more when the reports of D. C. S. are made public, still has votaries.

From Pon Shendarding the Lama travelled by a new route to the great monastery of Sákya, which is for many reasons only second in importance to Lhása. From this place he went by a road not marked previously in any map to Tashi Tso (Tashi Chuïding of explorer No. 9), at the south-west corner of Lake Tso Mo Tel Thung, a fine sheet of water, 44 miles in circumference. Explorer No. 9 in 1871-72 skirted the western, while the Lama in 1882 followed the southern shore. Pho Mo Tel Thung may or may not have an outlet for its waters, for although the Lama, at a short distance from the lake, crossed a stream flowing in a direction away from it, he could not make up his mind on this point.

On the western bank of the lake the Sikkim Raja has a *jagir* which was presented by the Tibetans some time back to his father or grandfather.

Besides the journeys here noticed, the Lama has made others, but owing to his want of a thorough knowledge of route surveying, the geographical information he might have brought back with him has been lost to us. Thus the route from the Kang La on the north-west frontier of Sikkim to Khamba Jong cannot be mapped. The journey was a very arduous and trying one owing to the height of the passes met with. It was in that journey when in company with D. C. S. that the two together crossed the high Nai Jin Sáng Ra, and then after traversing the elevated region at the head waters of the Zemu river, found their way by the Chorten Nyiama to Khámba Jong.

One very plain fact may be gathered from the notes furnished by the Lama, namely that Tibet in summer is as delightful as in winter it is wretched. In summer the land is covered either with crops, with luxuriant waving grass, or with soft velvety turf; streams flow in every valley, and all nature is bright, sparkling, and fresh, but in winter king frost reigns supreme; all vegetation is dried up, the trees are leafless, and a cold, cutting wind tears over the face of the land, raising clouds of dust, and forcing its way through the ill-made doors and windows of the houses.

Game is abundant in Tibet, but one cannot learn much about it. There appears to be a great objection to taking animal life, and those of our countrymen who in the last century visited Tibet complained of the obstructions put in their way when they wanted to shoot.

There is a great difficulty in arriving at a suitable method of spelling Tibetan proper names. I have attempted to render them on the map so that they may be recognized by travellers, but the system employed may be objected to by those who know Tibetan. One of my difficulties has been this, that the Lama differs sometimes with D. C. S. The latter is no doubt a high authority, but the Lama, I should suppose, would be more likely to give the names as he has heard them pronounced by the common people of the country. Some of our explorers, not knowing Tibetan thoroughly, have occasionally made a great mess of Tibetan names, a number of which, as they appear on the maps, cannot be recognized either by D. C. S. or by the Lama.

In most cases I have adopted the spelling of D. C. S., and I am indebted to him for having taken the trouble to revise most of the names which appear on the map.

Another lake it was my duty to report on was the Sar-i-Chashma-i-Aba Sind, otherwise Gház Kul, at the head of the Kunar branch of the Indus, situated in Lat. 36°·54′ Long. 74°, and accepted by the inhabitants of Gilgit,

Lake Gház Kul.

* Tigu=fish.

Yasin, and the Baroghil country as *par excellance* the source of the Indus. The name is by no means uncommon, another lake of the same name being at the head of the most southerly feeder of the Oxus and separated from that under discussion by the undulating spurs of the Barojhil range, *i.e.*, the Hindu Kush. That at the head of the Kunar branch was known by hearsay to Asiatic geographers before the exploration of M.—S., the Kashmir Syud, fixed its position, and in my opinion is identical with Hayward's Karambar Sar or Tshkarmam Sar, whose waters flowing under a glacier pour into the valley of that name.

The people of Yasin and the adjacent tracts are aware of the peculiar way in which the glacier nearly closes up the outlet into the Karambar valley, and Hayward received his information from them. He, however, was murdered in the Yasin valley, at a spot only two or three days' journey from the lake, just when about to cross over into the Karambar valley with the object of exploring the lake of that name.

The explorer travelled from the Barojhil highlands along the right bank of the Kunar river until he reached the lake Ghâz Kul or Sar-i-Chashma-i-Aba Sind at its head, and from a spot on the northern shore was pointed out the gap through which the Baroghil people stated the waters were discharged into the Karambar valley. The people described how the glacier, sometimes advancing and sometimes stationary, either blocked up this outlet or allowed the water to pass beneath the ice, and how great noises "like the firing of guns" were made by the water in its sub-glacial passage.

General Walker was inclined to suppose that the Syud's Sar-i-Chashma-i-Aba Sind and Hayward's Karambar Sar were two different lakes, but against this supposition I urged that the region embraced between peaks trigonometrically fixed by myself was not extensive enough to contain two large lakes. In making the map I had barely room for the insertion of one.

The region about lake Ghâz Kul has rather the aspect of a tract in the Arctic zone than one pertaining to an Indian system of drainage, and the constant movement of great masses of ice gives rise to peculiar and strange topography not found in ordinary mountain regions. The freaks and vagaries of glaciers moving on steep gradients produce sometimes unexpected and startling phenomena, of which we know very little; and considering that the evidence regarding the two outlets of the lake obtained by "The Syud" from the people of Barojhil was quite independent of that furnished to Hayward by the people of Yasin, I think the chances are greatly in favour of my theory, that there are two outlets to the lake under notice, and that there is only one lake called indifferently Sar-i Chasma-i-Aba Sind and Karambar Sar, and not two lakes as supposed by General Walker.

Major Biddulph penetrated a considerable distance up the Karambar valley till confronted by glaciers barring further progress; had he reached the head of the valley, this interesting lake question would have been cleared up.

It was from the Karambar valley that the water, long pent up by a glacier which had broken away from a side ravine, and had been precipitated into the main valley, suddenly bursting the ice dam, swept down the Gilgit and Indus valleys, and devastated a vast region as far as Attock, and causing the Kabul river to flow backward on its course, inundated the cantonment of Nowshera.* Could the identity between the Syud's Sar-i-Chasma-i-Aba Sind and Hayward's Karambar Sar be established, the lake might with great propriety be named after Hayward, who lost his life in so courageously endeavouring to explore it.

Extract from the Narrative Report of MAJOR A. W. BAIRD, R.E., *Deputy Superintendent in charge Tidal and Levelling Operations;—season* 1883-84.

THE levelling operations under Mr. Belcham extended from Chikhalvohol (the closing point of the levelling done in 1877-78) near Dhulia in Khándesh, to the Sironj base line, having been carried *viâ* Mhow and Bhopal.

Thus the line of levels from Kurrachee, through Sind and the Punjab, to Dehra Dún and thence *viâ* Delhi along the great arc series has been joined to the line of levels from Bombay, which was carried to Kalyān, Igatpuri, Dhulia, Mhow, Bhopal, and Sironj. The termini of this very long chain of levels are the tidal stations at Kurrachee and Bombay; and the determination of the mean level of the sea has been obtained at both places with great accuracy.

We are thus enabled to apply a very rigid test to the levelling operations, and the result is a highly satisfactory one, viz. that the error in levelling over this immense distance is only 0·624 foot, or 7½ inches.

The volume of tide tables for 1885 will contain the predictions of high water and low water for the same number of ports (20) as the tables for 1884, and the actual values of the co-efficients to be employed in setting the tide-predicting machine have this year (for

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* *See* Drew's work on Kashmir.

It is strange that Kailas mountain in Western Tibet is not considered one of the four holy mountains, but the Lama never seemed to include this region in Tibet proper.

The four holy mountains are Ku La Kangri, Yár Lhá Shángpu, Nuijin Káng Sáng or Há-o-Káng Sáng, and Nuijin Tháng La, near Tengri Nur lake. With the exception of the last, they are shown on the Lhasa sheet.

Ghâz Kul = Goose lake.

Sar, Kul or Kol = lake.

Bar = stream or valley.

the first time) been sent to Mr. Roberts. The form in which the various co-efficients are now determined, according to Professor Darwin's suggestion, enabled me to make *one* determination of the *mean value* of the amplitudes of each tidal co-efficient from each year of observation; and by taking the average value of all these means we obtained a very near approximation to the true value of the mean amplitude in each case. Then, by applying the proper factor we determined (R) the throw of the crank and (ζ) the angle at which the crank had to be set in each case for 0 hours, 1st January 1885, at every port. Thus, Mr. Roberts will not only have been saved a great deal of trouble in calculating, but the values sent him are more rigorously determined than those formerly computed by him, and the predictions ought to be all the more exact.

It is most satisfactory to learn that the predictions given in the tide tables are improving as we obtain more data from new observations. A regular return is submitted monthly from each observatory showing the comparison between actual and predicted heights.

Another pamphlet (No. 2) of auxiliary tables has been prepared and printed for use in the office, to enable the computers to reduce the observations and obtain the results according to the lines laid down by Professor Darwin. The calculations made for this table occupied the office for a considerable time in the early part of the year.

It was necessary to extend the results obtained by former years' work in order to determine values (H and κ) of the various co-efficients of each tide according to the method which Professor Darwin proposed, and this was a piece of work of considerable magnitude in the shape of computations; and much credit is due to Mr. Connor for the way in which he and his computers worked to turn it out quickly.

The Marine Survey Department has from time to time been supplied with information as required. The military authorities in British Burma have been supplied with a complete copy of the meteorological statistics for Amherst from August 1880 to 31st July 1884 in compliance with their request. The information was required, so that Government may consider the advisability of establishing a sanitarium there.

The working of each observatory will now be briefly reported on, commencing with Aden, then Kurrachee, and so on, taking each station in order round the coast.

Aden.—At Aden, the tidal registrations were excellent during the past year. There was only one stoppage of the clock, and that was only for four hours; and on one occasion the wire connecting the pencil traveller and the float-wheel broke: it was at once replaced by a new wire, and hardly any loss of work occurred. With these two exceptions, the tidal observations have been continuous and uninterrupted.

A new anemometer, somewhat larger than the old one, was set up at Aden in November 1883. It continued to work very well until the 17th September 1884, when the clock ceased to go. I was passing Aden about that time on my way out from England, and of course landed to see the state of the observatory. So I arranged with the Port Officer to have the anemometer clock cleaned. This has been done, and the wind observations were resumed on the 1st October. The self-registering aneroid has worked without a single break during the past 12 months.

The observatory was inspected, and the whole of the instruments were thoroughly cleaned by Mr. Rendell in October 1883. Much of the success of the observations at Aden is due to the excellent supervision which Captain Thyne, the Port Officer, exercises, and I am greatly indebted to him for the interest he takes in our work.

Kurrachee.—Soon after the date of my last annual report this observatory was inspected by Mr. Rendell, and he had the instruments overhauled and cleaned by the native mechanic who accompanies him. Since then there have been eight stoppages of the tide gauge work at various times, but only for an hour or two at a time.

The anemometer here is a large one, belonging to the Port authorities. On two occasions it failed to register properly, and it had to be repaired. The self-registering aneroid has been working satisfactorily throughout. My acknowledgments are due to Mr. Price, the Port Engineer, for his hearty co-operation in the work, and I attribute the successful working of the Kurrachee observatory to his supervision.

Bombay.—At Bombay there has been absolutely no interruption in the continuous registration of the tidal observations. This observatory has always given extreme satisfaction; but such a perfectly continuous record, viz. since December 1882 (when the instrument was cleaned in the usual course) up to the present date, is unprecedented at any station. The clerk deserves much praise for the careful performance of his duties. On two occasions the wire attached to the pencil traveller and the counterpoise weight broke, and he at once repaired the damage, so that no work was lost.

Marmagão.—At the beginning of March last I proceeded to Marmagão to start the operations at that station. The small observatory, which was formerly at Kárwár, was removed during the preceding year, and erected on the pile pier recently constructed by the Railway authorities. The instruments which were in use at Kárwár were sent to England in the autumn of 1883, and were thoroughly repaired and considerably modified and improved in accordance with my suggestions by Messrs. Légé & Co. of London. The new instruments having arrived, were sent down to Marmagão in February last, and were stored there till I arrived. I must here observe that it is entirely due to the interest taken by Mr. E. Sawyer, the Engineer-in-Chief of the West India Portuguese Railway, that the tidal operations at Marmagão have been started. During my stay at Marmagão, Mr. Sawyer gave me great assistance and met my wishes in every way.

The apparatus was completed, and the observations were started on the 14th March 1884. Since March last the tide gauge clock has only stopped once, and then only for three hours;

but on the 23rd June the German silver chain which connected the sheave attached to the float-wheel with the pencil traveller (and which had been substituted by Légé & Co. for the silver wire formerly used) broke. Although a piece of silver wire was put on in its place by Mr. Good, the gauge would not work well, and the chain was repaired and replaced on the 25th June. All went well till the 7th September, when the chain again broke, and the wire was once more substituted. This portion of the apparatus will be attended to at the next inspection; meanwhile everything is progressing very well with the tidal registration.

The self-registering aneroid barometer gave much trouble at first by the clock continually stopping, and it was not till the 5th of May, after it had been overhauled by the native mechanic, that it worked satisfactorily. Since then it has only stopped once. The anemometer did not work properly until the 23rd May, when it was re-started by the sub-surveyor, Dhondu Vinayek, after being cleaned by the mechanic. On the 17th June it had to be again repaired. Thus the meteorological observations have been anything but satisfactory hitherto, and it is to be hoped they will improve in future.

Major Hill, R.E., visited the observatory in May, and Dhondu Vinayek, sub-surveyor, was told off to stay for some time at Marmagão to teach the clerk his duties.

Beypore.—At Beypore the self-registering tide gauge has continued to work most satisfactorily. Only once during the past 12 months has its clock stopped, and then it was re-started after 9 hours' break in the registration.

In December 1883. the float-cylinder was flushed out, and the old pipe which connected it with deep water was removed and a new one laid down. In August last, and again on the 7th of the present month, the cylinder was flushed out, as there was a certain amount of retardation noticed in the flow of the water through the pipe on account of the gradual settlement of fine mud causing a partial choking of the pipe.

The self-registering aneroid has worked without a single break since last year.

The anemometer gave much trouble for the first three months of the present year: the instrument has been in constant use so long that it wants a thorough repair. Another anemometer, which had formerly been at Pámban and which was put in order by Messrs. Légé & Co. of London, was set up at Beypore on the 8th April, and the instrument has worked capitally ever since.

I inspected the Beypore observatory in December; again in May last Mr. Rendell inspected this station, and during his visit the whole of the instruments were cleaned by the native mechanic.

A new mercurial barometer was put up in May at Beypore, and the old one sent to the Mathematical Instrument office for repair. The clerk in charge of the observatory at Beypore performs his duties most creditably.

Colombo.—In December the Government of India sanctioned the sum of Rs. 1,700 for the construction of the tidal observatories at Galle and Colombo. Correspondence on this subject had been going on for some time, and it was hoped that the Government of Ceylon would so far assist in the operations as to defray the cost of the erection of the observatories, on the understanding that the instruments would be supplied, and the salaries of the clerks for each observatory be borne by the Government of India; but the Ceylon Government were unable to sanction the expenditure of the amount.

Meanwhile I had made every preparation for the immediate commencement of the observations pending the allotment for the construction of the observatories: the instruments which were in use formerly at Pámban had been remodelled and put in excellent order by Messrs. Légé & Co.; and these instruments as well as the self-registering tide gauge which was exhibited at the Venice Geographical Congress (and which was kindly lent for the Ceylon operations by the Master Attendant at Madras) were despatched to Colombo, and were lying ready to be set up. The observatory formerly in use at Pámban was ordered to be sent round to Colombo in a native boat, and I had placed myself in communication with the Public Works authorities and with the Masters Attendant at Galle and Colombo, so that all preliminary arrangements were completed before January.

I received a te egram from the Surveyor-General when I was at Beypore informing me that the Rs. 1,700 was sanctioned; and I proceeded to Colombo as soon as possible.

On arrival at Colombo the site for the observatory was selected, viz. at the end of the Government pier and between the pier and the stone-work pedestal of a huge crane. Within a fortnight the observatory was erected,—a result due to the help I received from Mr. Churchill, the Director of Public Works, who took considerable pains to get the work pushed on, and who assisted me most kindly in every way, both at Colombo and Galle.

I arranged with the Surveyor-General of Ceylon to obtain copies of the meteorological observations taken at his office, and as these were made with great care and exactness, there was no necessity for our setting up a self-registering anemometer and self-registering aneroid.

The tide gauge was started at Colombo on the 24th January, so that within one month of the time of sanction by telegram the observatory at Colombo was fitted up, placed in position on the supports which were constructed for it, and the instruments set up: this is the quickest piece of work of the kind we have ever done.

Captain Donnan, the Master Attendant, has a very neat electric apparatus for determining the time from Madras. He arranged matters so that the semaphore signal in connection with this apparatus should be observed by the clerk at the tidal observatory, and then the clock could be properly rated. The clock being a pendulum one, there have been

several stoppages on account of the bumping of boats against the side of the pile pier, but, these stoppages were only for an hour or two on each occasion. The end of the pier Mr. Rendell informs me, has been isolated from the remainder, and the stoppages of the clock have been fewer of late, but I intend to substitute one of the new spring-escapement clocks which we have just received from England, and then it does not matter whether there is any shaking in the observatory or not. There have been a few mishaps in the shape of the float-band coming off the stud-wheel, and the pencil tearing the diagram on two occasions; but the interruptions in these cases were unmportant. There is a continuous small oscillation of the water at the end of the harbour at Colombo, which goes on both during a rise and during a fall of the tide; even when the surface water is perfectly calm, the inlet hole near the bottom of the float-cylinder was large enough to admit of the water inside the cylinder being subjected to this oscillation, and this caused the tidal curves to be recorded in a series of zig-zig lines across the true tidal curve: consequently when the diagrams were received it was impossible to follow the work on account of the mass of wavy lines, even though each day's record had been inked in with different coloured ink.

In June last a small 2-inch pipe, with a block of wood inside it, and having a tube of $\frac{1}{8}$th-inch diameter running through its centre, and also having on the top a cone of copper which had a $\frac{1}{8}$th-inch hole at its appex, was fixed on to the inlet hole near the bottom of the cylinder: a "rose" or perforated nozzle covered the mouth of this small 2-inch pipe. The result of this modification in the apparatus has been to give us clear curves which are easily followed: the oscillations referred to are not obliterated from the tidal curves, but are so far lessened that the work of one day is seen quite distinct from that of another.

I am much indebted to Captain Donnan, the Master Attendant, for the supervision he exercises over the clerk in charge.

Galle.—While the erection of the observatory was progressing at Colombo I went down to Galle to make a start in the work there.

The site of the observatory is at the end of a pile pier close to the Master Attendant's office: the float-cylinder stands in 7 feet of water at low-tide, and the two inlet holes of about $\frac{1}{2}$ an inch diameter are close to the bottom, so that any roughness on the surface of the water outside is not felt inside.

After the clerk at Colombo had been taught his work, the sub-surveyor proceeded to Galle, and was engaged there from the 15th February until the beginning of April.

Captain Blyth rendered much assistance in getting the work pushed forward, and the instruments which had been sent round in the Government steamer from Colombo were set up and tested by the middle of March.

On the 23rd March the observations were commenced, and the sub-surveyor remained till the beginning of April teaching the clerk, who is one of the Port Officer's clerks, his duties; a second clerk was also taught so as to be available in case of accident.

Thus the two new observatories in Ceylon were established, and the registrations were well begun in less than three months from the time the work was commenced. The tide-gauge at Galle is the one formerly used at Pámban, considerably modified and improved in accordance with my suggestions by Messrs. Légé and Co. It has a spring-escapement clock, and is similar to the instrument set up at Marmagão. The anemometer is a large new one by Messrs. Légé and Co., and the self-registering aneroid, formerly at Pámban, had also been put in good order by that firm.

The clock of the self-registering tide-gauge has only stopped once (for two hours) since the observations were commenced.

On the 6th September the float cylinder was slightly shifted by a heavy sea, so it was got up, and it was not till 18th that it was refixed in position and properly secured. Thus an interruption of 11 days occurred.

The anemometer was set up on the top of the observatory and not on a separate small house, to be erected near the Master Attendant's house as I wished it to be, but on account of the inconvenience it would have been to the clerk, unless a special man had been appointed, Captain Blyth decided to set it up on the observatory. The site is undoubtedly bad, and I hope yet to have it placed in a more favourable position. The anemometer clock has stopped three times since it was started, but was re-started within a few hours on each occasion.

The aneroid clock stopped 10 times between 23rd May and the 23rd June. On the 24th June this instrument was given to a watch-maker to look at; it was set up again on the 27th June, and since then there have been four short stoppages.

The clock will require thorough overhauling by our native mechanic at the next inspection.

The observatory was inspected in the middle of April by Mr. Rendell.

Negapatam.—The observations here are most satisfactory. Except when the instruments were taken to pieces and cleaned in May, the tide-gauge has worked without a single break during the past year.

The self-registering aneroid has given a perfectly continuous registration also, and the anemometer clock only stopped twice.

This observatory was inspected by myself in December and again by Mr. Rendell in May: during the latter inspection the instruments were taken to pieces and cleaned by the mechanic.

Madras.—The observations continued without interruption till June, and on the 28th of that month they were suspended for a time pending alterations in the roof of the observatory to admit of some lighting apparatus being placed on it.

On the 22nd July the tide gauge was again started: since then the self-registering tide gauge clock stopped five times, and was re-started within two hours on each occasion: then on the 29th August the clock had to be again sent to the watch-maker, and it apparently took more than a month to repair.

Thus the Madras tidal registrations for the past year are by no means good, as more than two months have been lost.

A self-registering aneroid, which had been lying unused at Madras for some considerable time, was repaired by the mechanic during Mr. Rendell's inspection in April, and was set up in the Master Attendant's office and started. In July it was necessary to hand this instrument to the watch-maker for repair, and it worked then all right till the 29th August, when it was reported as needing repairs again. As in the case of the tide gauge clock, a month was lost in effecting the repairs, and the observations were resumed on the 1st of October.

I inspected this observatory in December, and Mr. Rendell inspected it in April last.

Vizagapatam.—There were a series of interruptions in the tidal observations during the first six months of the year under review.

The observatory was inspected by Mr. Rendell in February, during which time the instruments were taken to pieces and cleaned by the native mechanic. Since then the tide gauge has stopped 10 times, and from 5 to 12 hours' work has been lost on each of these occasions.

Mr. Rendell again visited this observatory in April, and since then there have been five stoppages of the self-registering tide gauge clock of from 1 to 3 hours each.

Regarding the anemometer, there were only two stoppages of the clock during the year: thus we may consider that this instrument has worked very well throughout.

The self-registering aneroid has given an almost continuous registration for the whole year Mr. Rendell reported when he inspected the observatory in February that there was a good deal of friction in the action of this instrument.

On the 4th August it was reported that the aneroid was out of order. The Port Officer re-adjusted the instrument himself, and had it promptly replaced in the observatory.

The Port Officer at Vizagapatam heartily co-operates with me in taking the observations, and I am much indebted to him for his interest in the work.

False Point.—The observations here have not been at all satisfactory. The continual stoppage of the clock of the self-registering tide gauge is much to be regretted, and one of the new spring-escapement clocks will be substituted for the present one as soon as possible. From the beginning of September 1883 up to 9th December there were no less than 27 stoppages of from three to nine hours each. There were two short stoppages in March, six in April, two in May, and one stoppage in each of the months June, July, and August, and three in September.

With regard to the self-registering aneroid, it had worked very well up to December 1883, and the stoppages which have been few and of short duration were caused by the vibration of the observatory. The instrument was cleaned during Mr. Rendell's inspection in December 1883. After this there were about 15 short stoppages before the 28th February, when Mr. Rendell again visited the observatory. On examining the instrument he found it necessary to alter the position of the steel rod which gives motion to the pendulum, and also to raise the endless screw which gears with the cog-wheel on the diagram barrel Since then the instrument has worked most satisfactorily.

Regarding the anemometer, the velocity gear had ceased to work for several months previous to Mr. Rendell's inspection in December 1883, and one of the four large new anemometers recently received from England was set up at False Point. The other three large anemometers were set up at Aden, Moulmein, and Galle. I may here make a few remarks about these new instruments.

Messrs. Légé & Co. had made two mistakes in the instrument, one of which was in the construction of the clock and the other in the printing of the diagrams. The effect of the clock error was that in 24 hours of time, as shown by the dial, rather more than 25 hours of the diagram had been registered. The error in the diagram was made by having the direction lines printed as N., N.-W., W., S.-W., S., S.-E., &c., instead of N., N.-E., E., S.-E., S., S.-W., and so on. With regard to the latter error, a correction in red ink could be applied to the heads of the diagram. This was done. Messrs. Légé & Co. were promptly informed of the circumstances, and a supply of new diagrams with proper headings ordered.

As regards the clock error, I went to see Messrs. Légé & Co. while I was in England, and the fault in construction of the clock was acknowledged by them. They are supplying me with new clocks properly constructed to replace the others, and these I expect to receive in a few days: the old clocks will be returned to Messrs. Légé and Co., and of course no charge against Government is to be made. The diagrams which have been used hitherto will have their time-lines altered, as required, in due course. Since the new anemometer was set up at False Point it has worked most satisfactorily.

I have already alluded to Mr. Rendell's inspections, viz. in December 1883 and at the end of February 1884. A new clerk for the observatory was appointed in September last, as the former clerk got another situation at False Point which carried better pay; the change was permitted on the distinct understanding that the new clerk should in the first instance be thoroughly taught the work, and then if anything went wrong that the former clerk should give any assistance from time to time as required. I regret to say that the new clerk seems to suffer as much from fever as the old clerk did, and he frequently has to miss some of the times for visiting the observatory; but fortunately up to the present time he has always gone at least once a day to his work.

Dublat.—There have been a great number of stoppages of the tide gauge clock, viz. about four or five times per mensem, from 4 to 12 hours on each occasion. These stoppages are solely due to the vibration in the observatory. The same remark applies to the aneroid clock. The anemometer has only stopped working once, for 10 hours, during the whole year; its clock having a spring escapement is not stopped by the vibration in the observatory.

I am endeavouring to have this observatory strengthened so as to lessen the vibration, and I hope to see the Port Officer at Calcutta soon and arrange matters with him. In any case, a new spring escapement clock will be fitted to the tide-gauge and a new self-registering aneroid with a spring escapement clock will be set up at Dublat during the next field season. Mr. Rendell inspected this observatory in March, and he reported that the instruments were working most satisfactorily, and that the stoppages were, as above stated, due to the vibration of the observatory staging.

Mr. Rendell reported very favourably on the clerk, that he took an interest in his work, and kept the instruments in good order; also that the observatory was neat and clean.

Diamond Harbour.—There were a few stoppages of the tide gauge clock in October and November 1883 and in January 1884, but they were only for a few hours on each occasion. In March 1883 it was cleaned during Mr. Rendell's inspection; since then there were six stoppages, of from 7 to 12 hours each, prior to the 3rd July, when the steel rod giving motion to the pendulum was found to be broken; this was put all right immediately, and work was resumed on the 4th July. After this there were eight stoppages in July, and the clock was then sent to Calcutta for repair; it was returned on the 3rd August, and since then has only once stopped. The aneriod has worked most satisfactorily and not a single stoppage has occurred. The anemometer too has been working capitally: there had been one or two stoppages previous to Mr. Rendell's inspection in March. These he found to be due to the diagram barrel not moving freely in its supports, and since he had this rectified only one stoppage has occurred.

Kidderpore.—The work at this observatory has been most satisfactory.

The tide-gauge clock has stopped four times during the past year. Mr. Rendell inspected the observatory in March, and had all the instruments and their clocks taken to pieces and thoroughly cleaned. Previous to his inspection the anemometer clock had stopped eight times, for a few hours each time, in the month of January; since then it has only stopped three times.

The aneriod has worked without a break during the past 12 months.

Thus the observations in the Hooghly have been progressing most satisfactorily, and I would here beg to express my acknowledgments to Lieutenant Petley, R.N., Conservator of the Port, for the interest he takes in our work and for his hearty co-operation in conducting the operations.

Rangoon.—In September 1883 the working of the float-band on the stud-wheel was found to be faulty; and on three occasions the registration was impeded. It was found that the end of the band had got entangled at the bottom of the float-box, which was damaged: a new float-box was fitted up in November. The observatory was inspected in January by Mr. Rendell, who reported that the self-registering tide-gauge was working most satisfactorily.

Since that time there have only been five stoppages, each of a few hours.

The anemometer has worked without stoppage during the past 12 months.

The clerk at Rangoon performs his duties to my entire satisfaction. He is a very smart man, and it is of great importance having such a good man here, because if any interruption occurred at Rangoon or at Elephant Point, he would most probably be able to set matters right and keep the observations going.

Elephant Point.—In my report for last year I explained the cause of the delay in resuming the observations at this station. Mr. Darlington, Vice-Chairman of the Port Commissioners, took much interest in the matter, and the new observatory was removed from the wrong site and placed in the Pulekah creek, at the place which Major Rogers had selected. The observatory was ready for the reception of the instruments by the 1st of September 1883, and Mr. Darlington telegraphed to me to send some one to start the observations. Mr. Rendell went to Elephant Point as soon as it was possible, and the first tidal diagram at this station was placed on the self-registering tide-gauge on the 30th December, so that the observations were well started by the 1st January 1884.

The clerk in charge was placed under the immediate supervision of the Telegraph Master, and the Superintendent of Telegraphs at Rangoon arranged that the Telegraph Master at Elephant Point should visit the tidal observatory once a week.

The anemometer was erected on the "Look-out House" near the Telegraph office, and the aneroid and mercurial barometers are in the Telegraph office. The duplicate tidal heights are registered by the Telegraph Master. Excellent arrangements were made by Mr. Rendell for the clerk in charge being periodically changed with the clerk in Rangoon.

The float and band have occasionally to be removed to clear out the mud which settles in the float-box.

The clock of the tide-gauge had only stopped twice, for a few hours each time, between January and September, but latterly there have been six stoppages of from one to three hours each time.

The aneroid and anemometer have been working most satisfactorily, not a single stoppage of the former instrument being reported.

I am much indebted to Mr. Jennings, the Port Engineer at Rangoon, for the trouble he took in getting the observatory properly erected.

The success of the tidal operations at Rangoon and Elephant Point is due in a great measure to the hearty co-operation of Mr. Darlington, and but for his assistance I should have been at a standstill on many occasions.

Amherst.—In the month of September 1883 the clerk discovered that the gauge was not working satisfactorily, and on examining the stop-cock, by means of which the accumulation of air is exhausted from the pipe which connects the float-cylinder with deep water, he found a washer missing; he tightened the screw, after which the gauge worked properly. Another similar occurrence took place in April last. It is usual to have the float-cylinder and connecting pipe flushed out once a fortnight. This necessitates the removal of the float and band. In June a hole was discovered in the cylinder, about eight feet from the bottom, so that the flushing could not be carried out. On the 6th July the hole was stopped, and thus the work was only suspended for a few hours.

The tide-gauge clock has worked remarkably well, and there have been no stoppages since October 1883. The wire connecting the pencil-traveller with the float broke on the 27th May; thus the instrument ceased to record the curve, and the band had come off the stud-wheel. The clerk put matters right immediately he visited the observatory, and inserted a new wire. On the whole, we may consider the past year's observations satisfactory.

Twice during the month of September the observatory was broken into, and the tide-gauge put out of order: entrance had been effected by smashing the window panes. The Port Officer, Moulmein, has ordered a wooden shutter to be made for the window; but as the observatory has been broken into on former occasions, I have addressed the Secretary to the Chief Commissioner and solicited his assistance to prevent such wanton mischief.

The aneroid has been working without interruption, and there have been but one or two stoppages of the anemometer clock.

Mr. Rendell during his inspection in January reported the anemometer as being very dirty, and that it had not been attended to properly. The direction gear was out of order, and altogether this instrument was in a most unsatisfactory state. The clerk was reprimanded.

Moulmein.—There have been a good many stoppages of the tide-gauge clock, about three or four per mensem, between January and September, but these were only for an hour or so on each occasion.

On the 7th September the greater part of the float-box was carried away by, it was supposed, some heavy piece of half-submerged timber coming down against it. While a new box was being prepared the clock was given to the watch-maker to be cleaned. I have just heard by telegram that the observations have been resumed, but over a month's registration has been lost.

A new anemometer, one of the large ones, was set up by Mr. Rendell during his inspection in January last.

The aneroid and anemometer have worked without stoppage during the past year.

I am greatly indebted to Captain Dodd, the Port Officer, for the assistance he gives me. It is mainly due to his supervision of the Amherst and Moulmein observatories that we are securing good observations.

Port Blair.—The observations at this station were most excellent; in fact, all the instruments have worked uninterruptedly since the date of last report till the 10th September 1884, when the Port Officer wrote to say he had stopped the work for a few days until he had the float-cylinder repaired, as there were some holes in it. The post from Port Blair is unfrequent, and I heard nothing more till the beginning of October, when I was thunderstruck to find that the Port Officer actually proposed stopping the observations, as he supposed now that good tide tables had been secured, it was not worth while repairing the cylinder and pipe. I telegraphed to the Chief Commissioner, and begged him to have a wooden box at once set up for the float to work in, pending the repairs of the cylinder, that the work must on no account be stopped, and that the Port Officer was quite under a misapprehension as to the scope of the operations.

I am afraid some six weeks' work at least will be lost, and this is most annoying, for it was quite unnecessary, as the holes in the cylinder must have been gradually formed, and it should not have been removed without my permission, unless to have it very quickly repaired and set up again.

Port Blair, from a scientific point of view, is one of our best stations: the observations are first-rate, and the results are most valuable; we were getting a continuous record of the tidal curves, and this stoppage is a great blot.

Spirit levelling operations.—These operations have been again carried out by Mr. Belcham during last field season, and sub-surveyor Narsing Dass worked the second level.

After examining the instruments, comparing the staves, and testing the stability of the Chikhalvohol bench mark, Mr. Belcham commenced operations on the 14th of November. Continuing along the Bombay-Agra Road through Dhulia, the party reached Mhow on the 22nd January. This section of the work was 170 miles in length, and passed over the Tápti and Nerbudda rivers and through the Sátpura and Vindhya ranges at Mhow. Mr. Belcham laid down a bench mark in the railway station compound, and having obtained permission of the Executive Engineer of the Indore State Railway, he worked along the railway as far as Indore (13 miles), and placed a number of bench marks on the principal bridges and level crossings.

Reporting on the remainder of the work, Mr. Belcham writes:—"At Indore I again got on to the high road, and worked along it as far as Dewás, at which place I took the more

direct route through Sehore, Bhopal, and Bhílsa to Sironj, and reached the south-west end station of the base on the 4th April. This section was 200 miles in length; between Dewás and Bhopal (120 miles) we had a very fair road to work on, but beyond Bhopal there was a very bad cart track which we had to make the best of.

"From the south-west end station of the Sironj base, I went on to the north-east station. The upper and lower mark-stones of both were connected, as directed. To effect this, I had first to remove the closing pillars and then the upper mark-stones, and after the observations I built up both the stations again, taking care to place the mark-stones as I found them.

"I must here mention that though the outward appearance of the south-west end station was good, yet on removing the closing pillar I found it to be merely a shell of brickwork, plastered over and filled in with loose earth and stones. The surface of the upper mark-stone was about 2 inches lower than the annular wall, and instead of the 4-feet pillar surrounding the mark-stone there was only loose earth, stones, and broken bricks mixed up with the roots of a large "babul" tree that had been allowed to grow alongside the station. I also observed that the surface of the lower mark-stone was considerably tilted towards the side the tree was growing, but the masonry surrounding it was firm and solid. From enquiries made on the spot I gathered that many years ago the station had been tampered with by thieves in quest of treasure, but I could not get any authentic information from the officials at Sironj regarding it. A full description of the state in which the station was found has been entered in the records of the levelling operations.

"My next duty was to continue the levels to Surentál H. S. and Mohasa bench mark, both of which had been connected with the line of levels from Kurrachee. This entailed an additional 26 miles of levelling, but the results obtained proved most conclusively that the south-west end station of the Sironj base had been tampered with, and besides it established a more rigorous check on the two lines of levelling."

The levelling throughout was carried on in the rigorous method which General Walker laid down. The "rectangular" level was used by Mr. Belcham for the whole time. Cylindrical level No. 1 was used by sub-surveyor Narsing Dass for the first 170 miles, when it broke down, the focussing screw having worn away so much that it became useless; he then used "Cushing's reversible level" for 42 miles, but as this was not found very well adapted for long lines of levels, Mr. Belcham reported the matter to me, and cylindrical level No. 4, which had just been repaired at Calcutta, was sent direct to Mr. Belcham.

Regarding the connection of the trigonometrical stations Mr. Belcham writes: "Three stations of the Khánpisura Series were connected, Anakwári H. S. (2,244 feet), Singárchori H. S. (2,891 feet), and Thíkri H. S. (855 feet). The two former were very precipitous near the summit, and were connected with great trouble and danger to the instruments and the party. These were the only stations lying anywhere near the line of levels, and I was determined not to pass them without connecting them. I also connected Gidgarh H. S. and Kámkhera H. S. of the great arc series, the two ends of the Sironj base and Surentál H. S., making in all eight trigonometrical stations."

The total amount of levelling executed during the season was over 425 miles, and the total rises and falls nearly 22,000 feet. To accomplish this outturn, Mr. Belcham says they had to work longer than usual, and such a large outturn is certainly very creditable to him and his party.

Tabular Statement of outturn of work for the Field Season 1883-84 *by the Levelling Party under Mr. G. Belcham.*

During the month of—	No. of Miles. Double Levelling.		Total No. of Feet.		No. of Bench Marks, embedded, inscribed, and connected.					
	Main line.	Branch line.	Rises.	Falls.	Embedded.	Inscribed.	Public Works Department.	Railway.	G. T. Survey Stations.	Kurrachee line bench marks.
	Ms. Chs. Lks.	Ms. Chs. Lks.	Feet.	Feet.	No.	No.	No.	No.	No.	No.
November 1883	40 11 84	3 76 06	1,678·0	1,396·5	3	41	.....	.....	1	.....
December ,, ...	83 52 74	.....	2,566·9	2,689·6	7	60	.....	.....	.....	.....
January 1884	71 12 0	10 11 96	3,095·2	1,519·4	5	60	1	4	2	.....
February ,, ...	87 70 78	.....	1,406·6	1,403·7	7	33	.....	.....	.....	.....
March ,, ...	80 41 58	3 14 14	1,624·0	1,556·3	5	15	.....	.....	1	.....
April ,, ...	18 22 14	20 34 4	1,332·2	766·7	3	7	.....	.....	4	1
Total ...	381 51 8	43 57 10	12,502·9	9,332·2	30	225	1	4*	8†	1‡
Total No. of miles, double levelling ...	425 28 18		Total of rises and falls ... 21,835·1							

* Level of rails at Mhow, Rao, and Indore Railway Stations (Indore State Railway).

† { Anakwári H. S., Thíkri H. S., and Singárchori H. S. (Khánpisura Series). Gidgarh H. S., Kámkhera H. S., and Surentál H. S. (Great Arc Series). North-east and south-west stations, Sironj base.

‡ Mohasa B. M. of the line of levels from Kurrachee *viâ* Agra to Sironj.

Mr. Belcham says that the officials of the Khándesh and of the several Native States through which he passed afforded him great assistance, and that the arrangements for carriage and supplies, even in the wild parts of the Sátpuras and Vindhyas, were so perfect that he was not delayed for a single day.

The levels taken during the field season 1883-84 have just filled up the gap in the great chain of levels from Kurrachee *viâ* Mithankote to Dehra Dún, thence along the Great Arc Series to the Sironj base line, and on to Bombay. We have thus the means of testing the work along this enormous chain in a most rigorous way, viz. by comparing the mean level of the sea at Kurrachee and Bombay where accurate determinations of the sea level have been made by tidal observations.

If we take the bench mark, Surentál H. S., and the Mohasa bench mark, near the Sironj base, as the points for comparison, and we know that these stations have not been disturbed, we find that they are 0·607 and 0·640 of a foot respectively higher above the mean level of the sea at Bombay than they are above the Kurrachee mean sea level, or that the mean sea level at Bombay was 0·624 of a foot lower than at Kurrachee.

Now, in the Bombay-Madras levelling operations the discrepancy at Madras has been apportioned to the various bench marks along that line, and there was a correction of 0·360 of a foot at Kalyán; and as the line of levels to Sironj from Bombay may be said to emanate from Kalyán, we may apply this correction to all the heights up to Sironj, and the effect would be to make the mean sea level at Bombay *lower* than Kurrachee by 0·264 feet.

As a piece of levelling, I apprehend it will be acknowledged very good work to have such a small discrepancy as 0·624 of a foot between Bombay and Kurrachee. But the most important part of the result is, that it does not bear out the idea hitherto entertained, that the southern are apparently raised above the northern stations in great lines of levelling as was found to obtain between Bombay-Madras and Kurrachee-Calcutta, and which was considered probably due to oblique illumination of the bubble.

Connection of Kurrachee Tidal Observatory with bench mark at Trinity Church.

The values of the spirit level heights in Sind and on to Dehra Dún *viâ* Mithankote, and on to Calcutta are given in terms of mean level of sea at Kurrachee, the value of which had been determined many years ago by tidal observations extending over only two semi-lunations. In order to determine the accuracy or otherwise of this value of the mean sea level it was necessary to connect the tidal observatory with one of the bench marks of the line of levels. Mr. Rendell, assisted by Mr. Connor, carried this out last October and reports as follows:—

"The bench mark on Trinity Church, Kurrachee, was selected as a favourable point for connection. In order to carry the line of levels to this point it was necessary to level across Kurrachee harbour, which at its narrowest part is about half a mile broad. This was done by taking the mean of a series of observations with both the rectangular and cylindrical levels: the results, one instrument compared with another, agreed within one-thousandth of a foot. The bench mark on Trinity Church was thus connected with the mean level of the sea at Manora, and the value, when compared with that obtained in the first instance in 1855, agreed within 0·010 feet."

Revision of the Heights of the Khánpisura Series.

Last year Mr. Christie had brought this work southward from the Kurrachee Longitudinal Series to the side Jalalabad H. S.-Bábákuwar H. S. in latitude 21°-40′. Mr. Keelan was instructed to commence this season on the initial base of the series, viz. the side Agargaon H. S.-Chincholi H. S., and work northwards so as to close on the side where Mr. Christie had finished the previous season, and so complete the revision of the whole series. Mr. Keelan marched to Agargaon H. S. on the 15th November. The platform at this station was found to be out of repair, so the observations were not completed till the 17th November.

While at Agargaon Mr. Keelan was unfortunately attacked by severe inflammation of the right eye, and had to return to Ahmednagar for medical aid, and take privilege leave from the 1st December 1883 to the 15th January 1884. The loss of nearly two months of the best part of the season for observing was fatal to the attempt to complete the revision of the series, and so four stations of the Khánpisura Series still remain to be visited and observed at in order to complete the revision of the whole series.

Mr. Keelan says: "most of the pillars or platforms at the principal stations visited were found in a state of disrepair, or entirely destroyed. Thus only two stations, Dhaigaon and Walwari, were found with protecting masonry pillars built over the upper mark. The stations of Chincholi, Jámkhed, Ahirmat, and Rájur had masonry circular pillars, but no protecting structure built over them. All the remaining stations had only rough stone and mud structures, without any pillars, defining their positions, some in ruins and some with all mark-stones removed and platforms destroyed. Stations observed at were invariably repaired, and after observations protected by large cairns of boulders."

Mr. Keelan reports favourably regarding the native establishment, and that, with the exception of a few cases of fever and dysentery towards the end of the season, the health of the party was good. It is a matter of regret that the observations for the whole series were not completed; but considering the long break in his work, which was absolutely necessary,

and the delays he experienced, I think he did very well to visit and observe at 14 principal stations, besides the three subsidiary stations which he found necessary to establish.

Computations in the Poona Office.

At the head-quarters of the party at Poona, the computations for the reduction of the tidal observations have progressed most satisfactorily, and a vast amount of work has been completed. In my report last year under the heading "Evaluation of tidal constants" I pointed out that in accordance with Professor Darwin's proposals, the co-efficients would in future be presented as follows, viz:—(1) To tabulate the R's as formerly, and also to give the values of "ζ" in each case ("ζ" being the old uncorrected "e"), so as to give the results of the analysis in the form R cos. (nt—ζ); (2) also to tabulate the H's and κ's so as to give the results in the form f H cos. (V + u—κ), and the H's and κ's would be strictly comparable year by year.

Under the same heading I gave the definition of the various symbols H, κ, V, and u, and I have repeated the definition this year at the same place in this report.

To carry out this plan the first thing to be done was to have the computation forms modified so as to extend the analysis for the calculation of the H's and κ's. New computation forms were made up in England by Mr. Roberts under Professor Darwin's supervision, and I received 100 sets for the portion of the work which relates to short-period tides.

But these forms were only to be used in reducing *observations not yet analysed*; accordingly I had forms prepared in India suitable for determining the H's and κ's for all *observations already analysed as far as the evaluation of R's and ϵ's.*

I also prepared and had printed a set of auxiliary tables (No. 2) to facilitato the computations which were now necessary. The calculations for obtaining the data given in these tables were very considerable, and the tables themselves were necessary before we could take up the further analysis of the observations.

After this the determination of the H's and κ's was proceeded with. I am glad to say that we have been able to treat the whole of the observations taken in India as well as those referred to in the British Association reports for which we had data, so that by the end of June the values of the H's and κ's were obtained and thus made available for calculating the "constants" for the 1885 tide-tables.

It is difficult without going into detail to explain how great a piece of work this has been, and I must here record that Mr. Connor and his staff of computers worked splendidly to accomplish it. Besides the above, the regular analysis of the current work has progressed steadily, but of course it is somewhat in arrears. Regarding the analysis of the observations I should also mention that four new tides, three of which are compound tides, are now recognized, and have to be computed. This has thrown a very considerable addition of work on the office. Fortunately the computers are becoming more expert, and we are able to keep up the reductions fairly well, but from what I have stated it will be easily understood that the analysis of last year's observations is somewhat in arrears, and I can only report on the results for six out of 19 stations.

The Tide-tables.—The tide-tables for 1885 will contain precisely the same number of stations (20 ports) as the 1884 tables. The values of the constants were, as usual, sent to Mr. Roberts, but for this year these values have been prepared somewhat differently. I have alluded in the remarks under "Computations in the Poona office" to the determination of the *mean amplitudes* (H) and the *mean epochs* (κ) of each particular tide: when these were calculated for each year of all the observations at the various ports, we had a *series of values of the mean amplitudes* of each tidal co-efficient for each tidal station. These values were comparable *inter se*, and by taking the average of all the values we obtained a *final value as far as it could be determined* of the mean amplitude or semi-range for the particular tide.

By applying the proper factors, we calculated the *actual value of the amplitude and epoch of each particular tide which would be in force at the port in* 1885: these were the "constants" sent to Mr. Roberts, and they represented the *throw of the crank* and the *angle to which it had to be set for* 0 *hours*, 1*st January* 1885, for each of the constituents included in the predicting machine.

This is the first time we have been able to send Mr. Roberts the data in such a complete shape, and it now makes the arrangements for the tide-tables very satisfactory.

I might mention that Professor Darwin found a slight mistake in two of the formulæ given in the "Report to the British Association Tidal Committee (Southport, 1883)."

Two of the auxiliary tables which we had prepared were dependent on these formulæ; happily the error was detected in time, as Professor Darwin telegraphed to the India Office in London (he was in Italy at the time), and a telegram from the India Office on the subject was despatched to me. The auxiliary tables were at once corrected, and the values of the constituents affected by the error were promptly re-computed, so that the tide tables for 1885 were saved being burdened with the error. All this threw a great deal of extra work on the office.

While in England I discussed with Mr. Roberts a plan for improving the predictions at riverain stations, which I hope to carry out for the 1886 tables; for the 1885 tables we had to follow the method employed in the two previous years.

Up to the present time the Port Commissioners of Calcutta have printed tide-tables of their own. In the issue for last year a vast amount of information was given regarding

port rules, signals, &c. Lieutenant Petley, R.N., Conservator of the Port, wrote to me in the early part of the year suggesting that our tide-tables *only* should be published, and that all the extra information about port rules, &c., should be incorporated.

I of course concurred, and as he asked me to arrange for carrying it out at once, the tide-tables for the Hooghly for 1885 will be very complete, and will contain the extra matter referred to in *French* as well as in English. The Port Commissioners have agreed to bear the cost of the entire pamphlet. The extra matter, however, will not be given in the large volume for all Indian ports. The following statements have been drawn up giving the percentage and the amount of the errors in the predictions for the whole of 1883.

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* 1883.

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	698	45	40	7	5	3
Kurrachee	706	37	36	10	11	6
Bombay	705	52	41	4	3	...
Beypore	703	15	29	12	18	26
Madras	679	34	28	11	18	9
Vizagapatam	680	35	43	12	8	2
False Point	706	31	38	12	10	9
Amherst	701	30	35	13	17	5
Port Blair	706	35	42	13	9	1
Dublat	706	30	36	13	13	8
Diamond Harbour	703	28	38	11	15	8
Kidderpore	704	27	41	14	12	6
Rangoon	705	29	43	11	13	4
Moulmein	700	34	41	12	11	2

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	698	45	39	6	8	2
Kurrachee	706	39	37	11	9	4
Bombay	706	34	42	12	10	2
Beypore	706	15	19	9	18	40
Madras	679	37	33	12	12	6
Vizagapatam	679	36	40	9	10	5
False Point	705	29	38	11	14	8
Amherst	702	31	38	12	13	6
Port Blair	704	36	47	8	6	3
Dublat	706	28	38	14	15	5
Diamond Harbour	706	23	40	12	17	8
Kidderpore	705	24	40	15	16	5
Rangoon	704	26	38	15	16	5
Moulmein	700	30	41	12	12	5

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* 1883.

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	698	88	11	1	...
Kurrachee	706	81	16	2	1
Bombay	705	72	26	2	...
Beypore	703	84	14	2	...
Madras	679	76	22	2	...
Vizagapatam	680	62	28	9	1
False Point	706	78	17	4	1
Amherst	701	33	24	18	25
Port Blair	706	95	5	...	...
Dublat	706	21	27	26	26
Diamond Harbour	703	48	29	16	7
Kidderpore	704	35	30	19	16
Rangoon	705	50	30	15	5
Moulmein	700	36	25	23	16

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	609	86	13	1	...
Kurrachee	704	78	20	2	...
Bombay	704	76	22	2	...
Beypore	705	69	27	3	1
Madras	679	79	20	1	...
Vizagapatam	680	70	22	8	...
False Point	705	73	22	4	1
Amherst	688	31	20	19	30
Port Blair	704	96	4	...	...
Dublat	705	25	24	22	29
Diamond Harbour	703	42	29	16	13
Kidderpore	705	34	28	22	16
Rangoon	705	44	27	15	15
Moulmein	700	42	19	14	25

Comparing these statements with those submitted last year, I find that, with one or two exceptions, the percentage of predictions, both for high and low water, within 15 minutes of the actuals is increased, which shows that the predictions for time for the last six months of the year 1883 were closer than they were for the first six months. As regards the height-predictions, there appears to be no improvement in the last six months of the year over the first six months, and in some cases, viz. the stations on the east coast of the Bay of Bengal, the height predictions are worse between June and December than they are for the first six months of 1883.

EVALUATION OF TIDAL CONSTANTS.

I shall only report on the results of the analysis of the observations which have been entirely completed during the past year.

As already explained, on account of having to extend the computations so as to determine the values of H and κ for all the work hitherto done, the reduction of the current observations is somewhat in arrears. However, the calculations for those stations which are *not* included in this report are in a very forward state, and the results of the short-period tides for most of them have also been deduced, but as the analysis is not complete, I shall defer discussing the results till next report.

The form in which the several tidal constants are now presented is different from that hitherto adopted. The constants are, however, divided, as usual, into two groups—one composed of the short-period tides, the duration of which in no case exceeds 24 hours, and the other of long-period tides whose duration ranges from a fortnight to a year.

In the harmonic theory of the tides, the principal constituents of the short-period tides are represented by fictitious stars moving in circular orbits at certain known velocities—the arguments of motion—in the plane of the equator. They are usually indicated by the letters M, S, K, O, &c. Each of these is in its turn composed of a number of tidal constituents also moving in circular orbits, but with different velocities which are mutually related, those of the second and subsequent constituents being twice, thrice, or some integral multiple of the first. Their periods are determined in the following manner. When the revolution of the fictitious stars is performed in or about 24 hours, the primary period is the one corresponding to the argument of motion of the star; when it is performed in or about 12 hours, the primary period corresponds to twice the argument of the motion of the star: the subsequent periods are fractions of the primary, corresponding to multiples of the volicity. The tidal constituents are sometimes called diurnal, semi-diurnal, ter-diurnal, quarter-diurnal, and so on; and the smaller of these are usually called *overtides*. These constituents are respectively distingushed by the subscripts 1, 2, 3, representing the relation of their periods to the primary period.

Three only of the fictitious stars, viz. S, M, K, have more than one constituent of sensible magnitude. The constituent which causes any fictitious star to produce its greatest effect on the sea level is rarely the first, and more frequently the second. Thus M_2 (lunar semi-diurnal) produces the greatest effect on the sea level, and after it S_2 (solar semi-diurnal) usually gives the next greatest effect. Sometimes K_1 (the luni-solar diurnal) is as great as the main solar tide (S_2): it is to this constituent (K_1) that the phenomenon of diurnal inequality, which is so marked a feature in the tides on the west coast of India, is chiefly due.

The constituents named $M_2 K_1$, MS, $2M_2 K_1$, &c., are compound tides. Regarding these tides Professor Darwin says: "It may be shown that the result of the interaction of two waves is represented by introducing two simple harmonic waves, whose speeds are the sum and the difference of those of the interacting waves. When the interacting waves are tidal, these two resultant waves may be called compound tides. They are found to be of considerable importance in estuaries."

Every tidal constituent is numerically expressed by two constants, R and ζ, where R is the semi-range of the tide in British feet, and ζ is an angle, such that $\frac{\zeta}{n}$ is the time elapsing

after 0 hours of the first day of the observations until it is high water of the particular tide, n being the speed of the tide in degrees per mean solar hour. It is obvious that ζ may have any value from 0° to 360°, and that the result of the analysis of successive years of observations will not be comparable with one another when presented in this form.

Again, the values of the amplitude (R) of the lunar and luni-solar constituents are dependent on the inclination of the moon's orbit, to the equator, and consequently vary from year to year.

The results of the analysis will therefore be given in the form of the values of H and κ as well as of R and ζ. Here H is the *mean value* in British feet of the semi-range of the particular tide in question; κ is the "epoch," and may be defined as the number of degrees of the orbit which the particular constituent has still to execute from the instant when the fictitious star crosses the meridian till it is high water of that tide.

By presenting the co-efficients in the forms of R and ζ as well as H and κ, we obtain the results of the analysis in the form. R cos (nt—ζ) and f H cos (V+u—κ), and the H's and κ's are strictly comparable year by year. Professor Darwin explains V to be a linear function of the moon's and sun's mean longitudes, the mean longitude of the moon's and sun's perigees, and the local mean solar time at the place of observation reduced to angle 15° per hour. V increases uniformly with the time, and its rate of increase per mean solar hour is the n of the first method, and is called the "speed" of the tide.

It is supposed that u stands for a certain function of the longitude of the node of the lunar orbit, at an epoch half a year later than 0 hours of the first day of observation. Strictly speaking, u should be taken as the same function of the longitude of the moon's node varying as the node moves; but as the variation is but small in the course of a year, u may be treated as a constant and put equal to an average value for the year, which average value is taken as the true value of u at exactly mid-year. Together V+u constitute that function which has been tabulated as the "argument of the constituent tide."

H, as previously explained, is the mean value in English feet of the semi-range of the particular tide in question: f is a numerical factor of augmentation or diminution, due to the variability of the obliquity of the lunar orbit; for all solar tides f is of course unity; and for M_2, the principal lunar tide, $f = \frac{\text{Cos}^4\frac{1}{2}\ \text{I}}{\text{Cos}^4\frac{1}{2}\ \omega\ \text{Cos}^4\frac{1}{2}\ \text{i}}$, when ω=obliquity of the ecliptic, and i=inclination of moon's orbit to the ecliptic.

H is equal to $\frac{\text{R}}{f}$, and κ is equal to $\zeta + \text{V}_0 + \text{u}$, if V_0 be the value of V at 0 hours of the first day.

A_0 is the value of the mean level of the sea in British feet with reference to the zero of the gauge.

VALUES OF THE TIDAL CONSTANTS, ADEN, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Aden, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short-period Tides.

A_0=5·800 feet.

S_1	H	0·094	M_6	R	0·006	Q_1	R	0·134	T_2	R	.....
	κ = ζ	165°00		ζ	310°60		ζ	67°45		ζ	.....
S_2	H = R	0·702		H	0·006		H	0·158		H	.....
	κ = ζ	244°77		κ	358°12		κ	30°63		κ	.....
S_4	H = R	0·004	M_8	R	0·003	L_2	R	0·028	$(MS)_4$	R	0·013
	κ = ζ	244°06		ζ	323°13		ζ	344°43		ζ	2°39
S_6	H = R	0·006		H	0·003		H	0·028		H	0·012
	κ = ζ	185°01		κ	146°48		κ	194°11		κ	138°22
S_8	H = R	0·001	O_1	R	0·562	N_2	R	0·436	$(2SM)_2$	R	0·023
	κ = ζ	221°63		ζ	161°40		ζ	345°41		ζ	242°40
M_1	R	0·094		H	0·060		H	0·423		H	0·022
	ζ	31°04		κ	37°56		κ	217°27		κ	106°56
	H	0·066	K_1	R	1·192	λ_2	R	0·015	$2N_2$	R	0·090
	κ	30°54		ζ	137°87		ζ	217°88		ζ	220°28
M_2	R	1·637		H	1·312		H	0·015		H	0·087
	ζ	88°96		κ	34°47		κ	135°12		κ	188°17
	H	1·588	K_2	R	0·170	ν_2	R	0·143	$(M_2 N)_4$	R	0·047
	κ	224°80		ζ	261°37		ζ	79°81		ζ	64°07
M_3	R	0·020		H	0·215		H	0·130		H	0·044
	ζ	1°16		κ	233°71		κ	254°24		κ	71°77
	H	0·019	P_1	R	0·384	μ_2	R	0·086	$(M_2 K_1)_3$	R	0·039
	κ	204°92		ζ	281°61		ζ	281°52		ζ	306°13
M_4	R	0·008		H	0·384		H	0·081		H	0·034
	ζ	74°41		κ	80°81		κ	193°20		κ	337°66
	H	0·004	J_1	R	0·114	R_2	R	.....	$(2M_2 K_1)_3$	R	0·007
	κ	346°08		ζ	236°76		ζ	.....		ζ	293°48
				H	0·131		H	.....		H	0·007
				κ	39°41		κ	.....		κ	308°61

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·017	153·°53	0·015	57·°50
,, fortnightly ,, ...	0·040	172·22	0·065	15·75
Luni-solar ,, ,, ...	0·012	6·92	0·012	231·08
Solar annual ,, ...	0·363	5·21	0·363	346·01
,, semi-annual ,, ...	0·114	160·92	0·114	122·51

The value of the mean level of the sea (A_o) for 1883-84 is 5·800 feet; the greatest discrepancy between any two values of the determination of the mean level of the sea at Aden is about $\frac{3}{4}$ of an inch, viz. between 5·754 in 1882-83 and 5·814 in 1881-82.

The mean amplitude of the main lunar tide (M_2) is 1·588 feet, which is the highest value yet obtained at Aden but it only differs from the lowest value, that obtained from the 1880-81 observations, by 0·03 of a foot. Regarding this tide it was remarked in last year's report that the amplitude was increasing year by year. This remark is only true as regards the amplitude R, but in no way refers to the mean amplitude H, which ought to come out year by year very nearly the same. The epoch of the main lunar tide is 224·°8. This value differs from that obtained in 1880-81 by 7·°2, which is a very large discrepancy, viz. nearly 15 minutes in time, but it should be remarked that if we neglect the 1880 value, which appears to be outstanding, the greatest discrepancy between any two years is only 3·°6, or about 7 minutes.

The main solar tide (S_2) has an amplitude of 0·702 of a foot, a value which agrees well with that obtained in former years.

The value of the main diurnal tide (K_1) is 1·312 of a foot, which is very accordant with the determination of the *mean* amplitudes (not the R's) of the former years. I should here state that the remarks made last year regarding the decreasing value of the amplitude are not applicable to the mean amplitudes (H) which are, as they should be, very accordant.

The main solar tide (S_2) at Aden for 1883-84 is 44 per cent. of the main tide; theoretically it ought to be 47 per cent., but this proportion is the same as has been observed in former years.

The principal diurnal tide (K_1) is 83 per cent. of the main tide for the year under discussion; theoretically it should be 58 per cent.; but at Aden this tide has always been found to be enormously large, and in 1877-78 it was actually within 6 per cent. of the main tide.

The proportion of the smaller lunar elliptic tide (L_2) is 0·018 against 0·028, the theoretical proportion, while the larger elliptic tide (N_2) is 0·266 of the main tide against 0·194, the theoretical value. This proportion for the latter tide is much the same as has been observed formerly at Aden.

The smaller evectional tide (λ_2) is, as it should be, quite insignificant, and approaches more nearly this year to the theoretical proportion than in any former year.

The larger evectional tide (ν_2) is nearly three times as large as it ought to be, viz. 9 per cent. of the main tide; for the last two years a close approximation to the theoretical proportion (0·038) was found to exist, but in 1879-80 and 1880-81 we obtained a proportion of about 9 per cent., as has also been the case this year.

With regard to the diurnal tides, the proportions to the main tide are as follow:—

	Aden, 1883-84.	Theoretical.
Luni-solar K_1	0·826	0·584
Lunar M_1	·042	·036
Solar declinational P_1	·242	·193
Lunar ditto O_1	·416	·415
Lunar elliptic J_1	·082	·033
Solar ditto Q_1	·099	·080

Thus it will be seen that at Aden the largest component of the diurnal tides (K_1), nearly half as large again as it ought to be, and that the next larger component (O_1) agrees well with the theoretical value; also that the other diurnal tides are from 1 to 5 per cent. greater than the theoretical values.

Regarding the overtides, with the exception of the ter-diurnal lunar (M_3), they are perfectly insignificant at Aden, but the ter-diurnal lunar tide, although barely appreciable, seems clearly to exist, as the results of each year come out almost precisely the same, and show that this overtide has an amplitude equal to 0·01 of the main tide, and its mean epoch would appear to be about 208°, the greatest variation from which is 11°·6, or about 16 minutes in time.

With respect to the compound tides, they are all very small at Aden.

The long-period tide which has the greatest amplitude at Aden is the solar annual, which appears to vary from 22 per cent. to 26 per cent. of the main tide; this year it is 23 per cent.

Its time of maximum would appear to be the 7th March, a date identical with that obtained last year; the greatest variation from this date is only 17 days in any of the five years during which the observations have been taken.

The next important long-period tide is the solar semi-annual, which is 7 per cent. of the main tide for 1883-84. This agrees very well with the mean of former values; its time of maximum is, however, somewhat variable; in 1879-80 it was found to occur on the 6th of May and November, while the following year it occurred on the 10th June and December; for the other years during which observations have been made the times of maximum fall between those dates.

The lunar monthly tide is quite insignificant at Aden according to the 1883-84 value; theoretically this tide should be 5 per cent. of the main tide, and it has been usually found at Aden to be between 2 and 4 per cent.

The luni-solar fortnightly tide does not appear to exist at Aden; compared to the main tide, at Aden we have never obtained a greater proportion than 1 per cent. On the other hand, the lunar fortnightly tide, which has a theoretical proportion of 0·086 of the main tide, is found to be at Aden for 1883-84, 0·041 in its proportion to the main tide; and in the last three years the proportion was from 2 to 3 per cent.; while in the two first years of observation, 1877-78 and 1879-80, the proportion was over 4 per cent.

VALUES OF THE TIDAL CONSTANTS, BOMBAY, 1883.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883 observations at Bombay, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883 observations:—

Short-period Tides.

$A_0 = 10{\cdot}257$ feet.

S_1	H = R =	0·057	M_6	R =	0·013	Q_1	R =	0·111	T_2	R =	0·120
	$\kappa = \zeta$ =	164°·80		ζ =	248°·11		ζ =	260°·39		ζ =	51°·79
S_2	H = R =	1·623		H =	0·012		H =	0·129		H =	0·120
	$\kappa = \zeta$ =	2°·44		κ =	83°·41		κ =	59°·38		κ =	52°·12
S_4	H = R =	0·003	M_8	R =	0·008	L_2	R =	0·030	$(MS)_4$	R =	0·161
	$\kappa = \zeta$ =	5°·19		ζ =	330°·95		ζ =	60°·81		ζ =	201°·72
S_6	H = R =	0·004		H =	0·007		H =	0·032		H =	0·157
	$\kappa = \zeta$ =	193°·09		κ =	351°·34		κ =	241°·72		κ =	20°·82
S_8	H = R =	0·001	O_1	R =	0·570	N_2	R =	1·017	$(2SM)_2$	R =	0·037
	$\kappa = \zeta$ =	53°·97		ζ =	62°·92		ζ =	314°·46		ζ =	301°·10
M_1	R =	0·102		H =	0·663		H =	0·988		H =	0·036
	ζ =	57°·28		κ =	47°·92		κ =	313°·67		κ =	116°·00
	H =	0·067	K_1	R =	1·273	λ_2	R =	0·043	$2N_2$	R =	0·113
	κ =	77°·25		ζ =	208°·12		ζ =	270°·25		ζ =	117°·57
M_2	R =	4·157		H =	1·393		H =	0·044		H =	0·110
	ζ =	143°·74		κ =	44°·04		κ =	205°·57		κ =	290°·66
	H =	4·037	K_2	R =	0·306	ν_2	R =	0·284	$(M_2 N)_4$	R =	0·131
	κ =	328°·84		ζ =	141°·99		ζ =	100°·87		ζ =	81°·95
M_3	R =	0·004		H =	0·383		H =	0·276		H =	0·124
	ζ =	107°·21		κ =	354°·77		κ =	295°·76		κ =	266°·15
	H =	0·061	P_1	R =	0·301	μ_2	R =	0·212	$(M_2 K_1)_3$	R =	0·032
	κ =	24°·85		ζ =	235°·25		ζ =	283°·52		ζ =	193°·05
M_4	R =	0·142		H =	0·291		H =	0·200		H =	0·094
	ζ =	316°·04		κ =	44°·05		κ =	203°·72		κ =	214°·96
	H =	0·134	J_1	R =	0·096	R_2	R =	0·046	$(2M_2 K_1)_3$	R =	0·068
	κ =	326°·24		ζ =	14°·02		ζ =	112°·31		ζ =	256°·05
				H =	0·109		H =	0·046		H =	0·070
				κ =	40°·12		κ =	291°·97		κ =	70°·33

Long-period Tides.

	R	ζ	H	
Lunar monthly tide	0·009	207°·89	0·063	93°·89
,, fortnightly ,, ...	0·033	208·34	0·046	333·44
Luni-solar ,, ,, ...	0·045	15·50	0·044	190·40
Solar annual ,, ...	0·032	4·05	0·032	284·05
,, semi-annual ,, ...	0·157	344·70	0·157	185·89

The value of (A_0) the mean level of the sea is equal to 10·257 feet, which is slightly higher than the value obtained last year, and is a mean between the 1878 and 1881 values. The fluctuation in the values of mean level of the sea, as determined for different years at Bombay, is very slight; the highest value above the zero of the gauge was 10·265 feet in 1878, and the lowest value hitherto deduced was in the following year (1879), viz. 10·184 feet, or a difference of only one inch.

The mean amplitude of the main lunar tide (M_2) as derived from the analysis of the 1883 observations is 4·037 feet. Comparing this with the values obtained for former years, which have been calculated from the determinations of R given in former reports, I find that it approaches very closely to the average of all the amplitudes from 1878 to 1882. The epoch κ of this tide is 328·°84, the lowest value yet obtained, but it only differs from the highest (330·°66 in 1881) by 1·°82, or under four minutes in time.

With regard to the main solar tide (S_2), the value, 1·623 feet, agrees very well with that obtained in former years. I may here mention once for all that in the case of pure solar tides, the mean amplitudes (H) correspond with the amplitudes (R) given in former reports. The epoch of the main solar tide (S_2) is 2·°44 from the 1883 observations, almost precisely the same value as obtained in 1879. The greatest variation in the epoch of this tide at Bombay is 2·°74, or under three minutes in time.

The proportion of the main solar tide (H of S_2) to the main lunar tide (H of M_2) is 0·402; the theoretical proportion is 0·465; the proportion now obtained is the same as was found in 1880.

The amplitude of the smaller lunar elliptic tide (L_2) as compared with the main lunar tide (M_2) is only 0·008, the theoretical value being 0·028: this is the first time at Bombay where the discrepancy from the theoretical proportion has been considerable.

The amplitude of the large elliptic tide (N_2) in proportion to that of the main tide is 0·245, which is about 5 per cent. greater than the theoretical proportion, and thus agrees with what was found to obtain at Bombay from former observations.

The proportions of the two evectional tides (λ_2 and ν_2) to the main tide are precisely the same for this year as they were for last year, the smaller one (λ_2) having an insignificant amplitude, as it ought to have according to theory; while the larger component (ν_2) is 0·28 of a foot in amplitude, which is about double of what it ought to be as compared to the amplitude of (M_2) at Bombay.

The variational tide (μ_2) is again about double of its theoretical value as compared with the main tide, and this agrees with what has always been found at Bombay.

The luni-solar semi-diurnal declinational tide (K_2) is about 10 per cent. of the main tide; theoretically it should be nearly 13 per cent.; but except in 1877 and 1878 the proportion has been always slightly too small.

With regard to the diurnal tides, the largest (K_1), the luni-solar, is 35 per cent. of the main tide instead of 58 per cent., the theoretical proportion. This agrees with the 1880 value. The values for the three years previous to 1880 were from 37 to 40 per cent. of the main tide, and so were more in accordance with the theoretical proportion; for the years 1881 and 1882 the proportions were only 32 per cent. of the main tide, or a little more than half as large as they ought to be.

The next largest diurnal tide, (O_1) the lunar declinational, is 0·164 of the main tide; theoretically it should be 0·415; but the value now determined does not differ materially from that deduced formerly at Bombay.

Regarding the remaining diurnal tides (P_1, J_1, Q_1), they are all considerably less in their proportion to the main tide than they ought to be, the first being 0·097 instead of 0·193, the second 0·027 instead of 0·033, and the last 0·032 instead of 0·080. Thus it will be seen that the diurnal tides at Bombay are from one-half to one-third smaller in amplitude as compared to the main tide, than they ought to be.

Regarding the overtides, they are almost all insignificant, with the exception of the lunar quarter-diurnal (M_4), which is 3 per cent. of the main tide. This remark is equally applicable to the value obtained in former years; thus it may be said that the lunar quarter-diurnal is the only over-tide at Bombay which produces any effect on the sea level. I may remark about the ter-diurnal lunar tides, that it comes out every year at Bombay as about 0·015 of the main tides, or three times the theoretical value.

With regard to the long-period tides, the solar semi-annual has the largest amplitude, viz. 0·157 of a foot, which is 4 per cent. of the main tide, and agrees with the theoretical proportion, as has generally been found to be the case at Bombay. Its epoch appears to be about the 24th December and the 24th of June. Thus the presence of the semi-annual tide at Bombay seems to be perfectly established; its amplitude is, as it should be, 4 per cent. of the main tide, and its epoch would seem to vary between the 22nd of December and June as found in 1880, and the 13th of January and July.

The solar annual tide at Bombay is for 1883 quite insignificant. This tide has generally been found at Bombay to be 4 per cent. of the main tide. I am unable to assign any reason for the outstanding value obtained from last year's observations.

The lunar monthly tide is about 2 per cent. of the main tide for 1883; it should be from 4 to 5 per cent. theoretically, but the present year's value agrees fairly well with that obtained formerly at Bombay.

The lunar fortnightly and the luni-solar fortnightly have always been found to have very small values at Bombay, and this is the case in the present year.

VALUES OF THE TIDAL CONSTANTS, BEYPORE, 1882-83.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1882-83 observations at Beypore, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1882-83 observations :—

Short-period Tides.

A_0 = 5·395 feet.

S_1	H = R =	0·035	M_6	R =	0·013	Q_1	R =	0·067	T_2	R =	.....
	$\kappa = \zeta$ =	172·°85		ζ =	189·°15		ζ =	156·°81		ζ =	.....
S_2	H = R =	0·359		H =	0·012		H =	0·078		H =	.....
	$\kappa = \zeta$ =	11·°58		κ =	132·°67		κ =	67·°28		κ =	.....
S_4	H = R =	0·007	M_8	R =	0·010	L_2	R =	0·023	$(MS)_4$	R =	0·017
	$\kappa = \zeta$ =	147·°53		ζ =	367·°17		ζ =	188·°75		ζ =	208·°01
S_6	H = R =	0·010		H =	0·009		H =	0·025		H =	0·016
	$\kappa = \zeta$ =	247·°65		κ =	161·°87		κ =	1·°09		κ =	69·°18
S_8	H = R =	0·001	O_1	R =	0·307	N_2	R =	0·221	$(2SM)_2$	R =	0·007
	$\kappa = \zeta$ =	339·°44		ζ =	3·°78		ζ =	218·°64		ζ =	211·°24
M_1	R =	0·060		H =	0·356		H =	0·215		H =	0·007
	ζ =	54·°31		κ =	55·°13		κ =	298·°94		κ =	350·°07
	H =	0·032	K_1	R =	0·667	λ_2	R =	0·011	$2N_2$	R =	0·021
	κ =	90·°35		ζ =	240·°62		ζ =	313·°92		ζ =	302·°18
M_2	R =	1·030		H =	0·727		H =	0·011		H =	0·021
	ζ =	102·°50		κ =	47·°07		κ =	354·°41		κ =	241·°81
	H =	1·001	K_2	R =	0·079	ν_2	R =	0·054	$(M_2N)_4$	R =	0·050
	κ =	323·°67		ζ =	225·°00		ζ =	54·°71		ζ =	49·°03
M_3	R =	0·009		H =	0·098		H =	0·053		H =	0·047
	ζ =	221·°74		κ =	17·°06		κ =	276·°57		κ =	3:0·°51
	H =	0·009	P_1	R =	0·211	μ_2	R =	0·032	$(M_2K_1)_3$	R =	0·009
	κ =	193·°50		ζ =	208·°49		ζ =	156·°49		ζ =	192·°95
M_4	R =	0·°27		H =	0·211		H =	0·030		H =	0·010
	ζ =	309·°04		κ =	48·°46		κ =	238·°84		κ =	130·°57
	H =	0·026	J_1	R =	0·030	R_2	R =	.....	$(2M_2K_1)_3$	R =	0·004
	κ =	31·°39		ζ =	80·°05		ζ =	.....		ζ =	188·°97
				H =	0·034		H =	.....		H =	0·004
				κ =	39·°75		κ =	.....		κ =	104·°87

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·065	262·°87	0·050	43·°74
,, fortnightly tide	0·032	47·32	0·044	345·81
Luni-solar fortnightly tide...	0·029	75·12	0·028	213·94
Solar annual tide	0·243	47·98	0·243	298·01
,, semi-annual tide	0·123	74·42	0·123	214·49

The value of the mean level of the sea (A_0) at Beypore for 1882-83, 5·395 feet, is slightly lower than that obtained for the two previous years, but agrees with the value for 1879-80. The greatest difference between the values for any two years is that between the 1878-79 value and that for 1881-82, viz. 0·027 feet, or about $\frac{1}{3}$ of an inch.

The mean amplitude (H) of the main lunar tide (M_2) is almost exactly 1 foot, and is the highest value yet obtained at Beypore. It differs from the lowest value, viz. that obtained in 1880-81, by 0·106.

With regard to the main solar tide (S_2), its mean amplitude (H) is also greater than for any of the former years, and differs from the least value (that for 1880-81) by 0·051 feet. The next largest tidal constituent, viz. the luni-solar diurnal (K_1), has also for this year its greatest value as compared with former years. The same remark applies to the lunar declinational tide (O_1) and to the solar declinational (P_1).

The proportion of the main solar tide to the main lunar tide for this year is 0·359; theoretically it should be 0·465, but this proportion agrees very fairly with the values noticed in former years, which vary from 0·342 to 0·371.

The lunar elliptic tides (L_2) and (N_2) agree well in their proportions to the main tide with their theoretical values, and this has always been observed at Beypore.

Regarding the evectional semi-diurnal tides in proportion to the main tide, the lesser component (λ_2) is about double of what it should be by theory, as has generally been found at Beypore, but this tide is insignificant in amplitude.

The larger component (ν_2) is 0·053 of the main tide, which agrees well with the proportion obtained for the first three years, and is about 2 per cent. greater than the theoretical value.

With regard to the diurnal tides, the following table shows the proportions to the main tides as obtained at Beypore, compared with the proportion which theory would assign :—

				Beypore, 1882-83.	Theoretical.
Luni-solar	K_1	...	...	0·726	0·584
Lunar	M_1	...	...	·032	·036
Solar declinational	P_1	...	...	·211	·193
Lunar ditto	O_1	...	...	·356	·415
Do. elliptic	J_1	...	...	·034	·033
Solar ditto	Q_1	...	...	·078	·080

It will be observed that three of these tides (M_1, J_1, and Q_1) agree well with the theoretical proportions, while the larger component (K_1) is 15 per cent. too great, but the proportion of this tide at Beypore to the main tide has always been found to be from 12 to 24 per cent. too large. The lunar declinational (O_1) is 6 per cent. less than it ought to be, but except in the first year of observation, 1878-79, the proportion of this tide to the main tide has always been somewhat less than the theoretical value. The solar declinational (P_1) is slightly larger than it ought to be: this was generally found the case at Beypore.

The only overtide of importance is the lunar quarter-diurnal, which is 3 per cent. of the main tide.

With reference to the long-period tides, the value of the lunar monthly is 0·059 of the main tide; whereas last year it was 0·159; theoretically it should be 0·046. The proportion this year is the nearest yet obtained to the theoretical value.

The lunar fortnightly tide for 1882-83 is only half as large as it ought to be; whereas in former years it was generally found to be too large.

The luni-solar fortnightly tide, which theoretically is perfectly insignificant, is at Beypore 0·028 of the main tide for 1882-83: the values in former years varied from 2 to 7 per cent. of the main tide.

The solar annual tide is for this year only 24 per cent of the main tide; in the four preceding years it varied from 33 to 38 per cent.: its epoch for 1882-83 was found to be 14 days earlier than usual, giving the time of maximum to be about the 18th January.

The solar semi-annual is about half the size of the solar annual, viz. about 12 per cent. of the main tide, but at Beypore this tide has been found to vary from 16 to 28 per cent. of the main tide. Its time of maximum appears to be between the 20th June and the 12th July, or about the commencement of the S.-W. monsoon.

VALUES OF THE TIDAL CONSTANTS, NEGAPATAM, 1882-83.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1882-83 observations at Negapatam, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1882-83 observations :—

Short-period Tides.

A_0 = 2·048 feet.

S_1	H =	0·044	M_6	R =	0·014	Q_1	R =	0·006	T_2	R =	0·050
	κ = ζ =	99·°39		ζ =	187·°47		ζ =	139·°82		ζ =	236·°79
S_2	H = R =	0·277		H =	0·013		H =	0·007		H =	0·050
	κ = ζ =	285·°69		κ =	126·°07		κ =	218·°60		κ =	254·°78
S_4	H = R =	0·004	M_8	R =	0·004	L_2	R =	0·029	$(MS)_4$	R =	0·017
	κ = ζ =	106·°83		ζ =	270·°69		ζ =	163·°01		ζ =	356·°86
S_6	H = R =	0·000		H =	0·004		H =	0·031		H =	0·017
	κ = ζ =	165·°06		κ =	308·°82		κ =	278·°85		κ =	96·°39
S_8	H = R =	0·001	O_1	R =	0·077	N_2	R =	0·156	$(2SM)_2$	R =	0·006
	κ = ζ =	228·°37		ζ =	38·°40		ζ =	352·°07		ζ =	315·°64
M_1	R =	0·009		H =	0·089		H =	0·152		H =	0·006
	ζ =	97·°35		κ =	323·°24		κ =	245·°55		κ =	216·°11
	H =	0·000	K_1	R =	0·208	λ_2	R =	0·005	$2N_2$	R =	0·026
	κ =	72·°88		ζ =	173·°98		ζ =	253·°54		ζ =	172·°52
M_2	R =	0·748		H =	0·227		H =	0·005		H =	0·026
	ζ =	152·°52		κ =	345·°32		κ =	228·°84		κ =	219·°95
	H =	0·727	K_2	R =	0·060	ν_2	R =	0·048	$(M_2N)_4$	R =	0·034
	κ =	252·°05		ζ =	128·°09		ζ =	162·°44		ζ =	90·°71
M_3	R =	0·003		H =	0·082		H =	0·047		H =	0·033
	ζ =	344·°06		κ =	290·°62		κ =	206·°21		κ =	83·°72
	H =	0·003	P_1	R =	0·085	μ_2	R =	0·026	$(M_2K_1)_3$	R =	0·011
	κ =	133·°35		ζ =	155·°13		ζ =	279·°88		ζ =	273·°24
M_4	R =	0·019		H =	0·085		H =	0·024		H =	0·012
	ζ =	238·°10		κ =	350·°18		κ =	112·°94		κ =	184·°11
	H =	0·018	J_1	R =	0·014	R_2	R =	0·031	$(2M_2K_1)_3$	R =	0·007
	κ =	77·°16		ζ =	286·°55		ζ =	194·°86		ζ =	318·°81
				H =	0·016		H =	0·031		H =	0·007
				κ =	307·°30		κ =	348·°88		κ =	340·°54

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·035	104°39	0·032	310°44
,, fortnightly ,, ...	0·012	268 59	0·017	338·46
Luni-solar ,, ,, ...	0·100	112 66	0·097	13·12
Solar annual ,, ...	0·522	337·09	0·522	232·64
,, semi-annual ,, ...	0·316	344·23	0·316	134 13

The value of (A_0) the mean level of the sea for 1882-83 is 2·048 feet against 1·996 in 1881-82, the first year of observations.

The value of the mean amplitude (H) of the main lunar tide (M_2) is greater than that obtained last year by 0 015 feet. Its epoch (κ) agrees remarkably well for the two years, the difference being only 0·8 of a degree, or less than two minutes in time.

The amplitude of the main solar tide (S_2) is almost precisely the same as the value obtained last year, and its epoch differs by less than 3°, or under six minutes in time from the 1881-82 value.

The diurnal tides (K_1, O_1, P_1, and Q_1) have amplitudes almost identical with the 1881-82 values; the epoch of the first is exactly the same as was found last year, for the second the difference is a little more than 3 degrees, for the third the difference is as much as 7½ degrees, while the epoch for the last (Q_1) is entirely different in value this year from what it was last year.

The proportion of the main solar tide to the main lunar tide is 0·381, or nearly the same as was found last year. It may be here mentioned that the proportion between these two tides is found to be less than the theoretical value at all the stations of the east coast south of False Point, the proportion gradually approaching the theoretical as we go to the north. The above remark does not apply to Pámban, where the proportion of the solar tide to the main tide was considerably greater than the theoretical value.

With regard to the diurnal tides, the proportions compared with the theoretical are as follow:—

	Negapatam, 1882-83.	Theoretical.
Luni-solar K_1	0·312	0·584
Lunar M_1	·008	·036
Solar declinational P_1	·117	·193
Lunar ditto O_1	·122	·415
Do. elliptic J_1	·022	·033
Solar ditto Q_1	·010	·080

Thus it will be seen that the proportions are all very much less than they ought to be, and with the exception of J_1, the proportions are all very accordant with those obtained last year.

Regarding the overtides, except the lunar quarter-diurnal, which is 0·025 of the main tide, they are all insignificant at Negapatam.

Of the compound tides (M_2 N)$_4$ is the greatest, having an amplitude equal to 0·044 of the main tide; and the tide (MS)$_4$ seems to be appreciable at Negapatam, being 0·023 of the main tide.

Regarding the long-period tides, the lunar monthly value this year agrees very closely with the theoretical one (0·046 of the main tide); last year it was found to be too large.

The lunar fortnightly tide, which in 1881-82 agreed fairly well with the theoretical proportion to the main tide, is this year only 0·023 of it.

The luni-solar fortnightly tide agrees very well in its proportion to the main tide with the value obtained last year, appearing to be about 12 or 13 per cent. of it.

The solar annual tide is 72 per cent. of the main tide; last year it was 75 per cent. At Madras this tide is only about 35 per cent., and at Vizagapatam about 48 per cent., while at Pámban it was only 25 per cent. of the main tide, and at Port Blair it appears to be only about 12 per cent. Its epoch seems to be very well determined, last year's value agreeing within two days of the value determined this year, and its time of maximum appears to be about the 12th November, shortly after the beginning of the N.-E. monsoon. At Vizagapatam the time of maximum appears to be about the 24th September, and at Madras about the 24th October, so that the date of the maximum effect of this tide appears to get later and later as we go south.

The solar semi-annual tide at Negapatam is also very large this year. Its proportion to the main tide is 44 per cent.; last year it was 55 per cent., and theoretically it should be only 4 per cent. Its times of maximum are about the 28th May and 28th November, the latter date being about the middle of the N.-E. monsoon.

VALUES OF THE TIDAL CONSTANTS, MADRAS, 1883-84.

The following are the amplitudes (R) and epoch (ζ) deduced from the 1883-84 observations at Madras, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short-period Tides.

A_0 = 2·180 feet.

S_1 H	=	0·026	M_6 R	=	0·006	Q_1 R	=	0·002	T_2 R	=	0·019
S_1 κ	= ζ =	87·°56	M_6 ζ	=	71·°24	Q_1 ζ	=	19·°44	T_2 ζ	=	49·°53
S_2 H	= R =	0·436	M_6 H	=	0·006	Q_1 H	=	0·002	T_2 H	=	0·019
S_2 κ	= ζ =	279·°54	M_6 κ	=	160·°40	Q_1 κ	=	68·°08	T_2 κ	=	19·°34
S_4 H	= R =	0·002	M_8 R	=	0·002	L_2 R	=	0·036	$(MS)_4$ R	=	0·002
S_4 κ	= ζ =	216·°87	M_8 ζ	=	150·°26	L_2 ζ	=	98·°86	$(MS)_4$ ζ	=	246·°80
S_6 H	= R =	0·001	M_8 H	=	0·002	L_2 H	=	0·037	$(MS)_4$ H	=	0·002
S_6 κ	= ζ =	56·°31	M_8 κ	=	29·°13	L_2 κ	=	287·°20	$(MS)_4$ κ	=	36·°52
S_8 H	= R =	0·000	O_1 R	=	0·082	N_2 R	=	0·236	$(2SM)_2$ R	=	0·019
S_8 κ	= ζ =	198·°44	O_1 ζ	=	51·°31	N_2 ζ	=	325·°24	$(2SM)_2$ ζ	=	22·°43
M_1 R	=	0·005	O_1 H	=	0·096	N_2 H	=	0·229	$(2SM)_2$ H	=	0·018
M_1 ζ	=	36·°87	O_1 κ	=	330·°69	N_2 κ	=	244·°21	$(2SM)_2$ κ	=	232·°71
M_1 H	=	0·003	K_1 R	=	0·265	λ_2 R	=	0·009	$2N_2$ R	=	0·046
M_1 κ	=	41·°22	K_1 ζ	=	115·°25	λ_2 ζ	=	266·°08	$2N_2$ ζ	=	181·°01
M_2 R	=	1·065	K_1 H	=	0·291	λ_2 H	=	0·009	$2N_2$ H	=	0·044
M_2 ζ	=	100·°70	K_1 κ	=	342·°39	λ_2 κ	=	215·°60	$2N_2$ κ	=	229·°24
M_2 H	=	1·033	K_2 R	=	0·092	ν_2 R	=	0·081	$(M_2N)_4$ R	=	0·043
M_2 κ	=	250·°41	K_2 ζ	=	354·°78	ν_2 ζ	=	86·°51	$(M_2N)_4$ ζ	=	71·°70
M_3 R	=	0·004	K_2 H	=	0·116	ν_2 H	=	0·079	$(M_2N)_4$ H	=	0·040
M_3 ζ,	=	192·°53	K_2 κ	=	269·°22	ν_2 κ	=	255·°43	$(M_2N)_4$ κ	=	140·°39
M_3 H	=	0·004	P_1 R	=	0·091	μ_2 R	=	0·048	$(M_2K_1)_3$ R	=	0·013
M_3 κ	=	57·°11	P_1 ζ	=	205·°24	μ_2 ζ	=	250·°85	$(M_2K_1)_3$ ζ	=	274·°02
M_4 R	=	0·003	P_1 H	=	0·091	μ_2 H	=	0·046	$(M_2K_1)_3$ H	=	0·014
M_4 ζ	=	214·°99	P_1 κ	=	344·°11	μ_2 κ	=	190·°28	$(M_2K_1)_3$ κ	=	290·°88
M_4 H	=	0·002	J_1 R	=	0·019	R_2 R	=	0·016	$(2M_2K_1)_3$ R	=	0·005
M_4 κ	=	154·°43	J_1 ζ	=	216·°81	R_2 ζ	=	147·°72	$(2M_2K_1)_3$ ζ	=	339·°59
			J_1 H	=	0·022	R_2 H	=	0·010	$(2M_2K_1)_3$ H	=	0·005
			J_1 κ	=	317·°89	R_2 κ	=	357·°92	$(2M_2K_1)_3$ κ	=	51·°89

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·030	53·°99	0·027	284·°73
,, fortnightly ,, ...	0·031	291·°94	0·044	64·86
Luni-solar fortnightly tide	0·024	179·42	0·023	29·70
Solar annual tide	0·520	283·60	0·520	234·73
,, semi-annual tide	0·300	236·83	0·300	139·09

The value of (A_0) the mean level of the sea at Madras for 1883-84 is 2·180 feet, and is precisely the same as that obtained last year, the values for the two former years being slightly greater; but the greatest discrepancy between any two values is a little more than $\frac{5}{4}$ of an inch.

The value of the mean amplitude (H) of the main lunar tide (M_2) is the lowest yet obtained, but only differs from the highest by less than $\frac{1}{4}$ of an inch: its epoch, however, has not been well determined, as there is a discrepancy of 3·°7 (about $7\frac{1}{2}$ minutes in time) between the 1881-82 value and the value for the present year.

The amplitude of the solar tide (S_2) agrees very closely with the values obtained in the three former years.

The amplitude of the main diurnal tide (K_1) is precisely the same for all the four years of observation. The same remark may be said to apply to the diurnal tides (O_1, P_1,) and (J_1), while the solar elliptic diurnal tide (Q_1) has always been found to be perfectly insignificant at Madras.

The proportion between the main solar tide and the main lunar tide at Madras for 1883-84 is 0·422, which is somewhat closer to the theoretical proportion (0·465) than has been observed in the three former years.

With regard to the lunar elliptic semi-diurnal tides, the smaller component (L_2) is 0·036 of the main tide against 0·028, the theoretical value; the larger component (N_2) is 0·222 of the main tide for this year, and agrees very well with the proportions in the former years; theoretically it should be 0·194.

The smaller evectional tide (λ_2) is, as it should be, less than 1 per cent. of the main tide, but in former years it was found to be about 3 per cent. The larger component (ν_2) is 0·076 of the main tide, and agrees pretty well with the value obtained last year, but theoretically it should only be about half that value.

The main diurnal tide (K_1) is only 28 per cent. of the main tide, but this agrees with what we observed in former years; theoretically it should be 58 per cent.

The lunar diurnal tide (O_1) is 9 per cent. of the main tide, as was the case in the three former years; theoretically it should be 42 per cent.: the next largest diurnal tide (P_1) is also 9 per cent. of the main tide. This too was the case in former years; theoretically it should be 19 per cent. of the main tide: the other diurnal tides are very small, as has always been seen at Madras.

The over-tides at Madras are insignificant.

The only compound tide of any importance is the quarter-diurnal $(M_2\ N)_4$ which is 0·039 of the main tide.

With regard to the long-period tides, the solar annual is half as large as the main tide this year; in former years the proportion varied from 32 to 42 per cent.; its epoch agrees very fairly well with what was observed in the three former years, the time of maximum being about the 24th October.

The solar semi-annual tide is 29 per cent. of the main tide for 1883-84; in the three former years it was seen to vary from 24 to 36 per cent.; theoretically it should only be 4 per cent., so this tide is obviously meteorological at Madras: its times of maximum appear to be about the 21st May and 21st November. The combination of the solar annual and solar semi-annual tides must therefore raise the water at Madras about the beginning of November very considerably.

The lunar monthly and lunar fortnightly are 0·026 and 0·043 respectively of the main tide, or almost half of what they ought to be by theory: in former years the lunar monthly tide agreed well with the theoretical proportion, but the lunar fortnightly has always been found to be half as large as it ought to be.

The luni-solar fortnightly tide, although exceedingly small, appears at Madras to be greater than it ought to be.

VALUES OF THE TIDAL CONSTANTS, MOULMEIN, 1883-84.

The following are the amplitudes (R) and epochs (ζ) deduced from the 1883-84 observations at Moulmein, and also the *mean* values of the amplitudes (H) and of the epochs (κ) for each particular tide evaluated from the 1883-84 observations:—

Short-period Tides.

A_0 = 8·737 feet.

S_1	H	0·099	M_6	R	0·102	Q_1	R	0·036	T_2	R	0·151
	$\kappa = \zeta$	150°·78		ζ	190°·66		ζ	8°·40		ζ	277°·82
S_2	H = R	1·349		H	0·093		H	0·042		H	0·151
	$\kappa = \zeta$	140°·26		κ	197°·15		κ	57°·16		κ	173°·75
S_4	H = R	0·062	M_8	R	0·046	L_2	R	0·326	$(MS)_4$	R	0·707
	$\kappa = \zeta$	227°·80		ζ	6°·88		ζ	73°·51		ζ	91°·16
S_6	H = R	0·005		H	0·040		H	0·320		H	0·685
	$\kappa = \zeta$	261·42		κ	135°·54		κ	135°·71		κ	213°·33
S_8	H = R	0·002	O_1	R	0·233	N_2	R	0·675	$(2SM)_2$	R	0·126
	$= \zeta$	319·76		ζ	232°·64		ζ	102°·96		ζ	160°·96
M_1	R	0·039		H	0·275		H	0·654		H	0·123
	ζ	328°·51		κ	51°·38		κ	95°·13		κ	38°·79
	H	0·029	K_1	R	0·385	λ_2	R	0·107	$2N_2$	R	0·123
	κ	144°·52		ζ	100°·69		ζ	55°·03		ζ	216°·87
M_2	R	38°·39		H	0·425		H	0·104		H	0·120
	ζ	351°·09		κ	41°·17		κ	106°·79		κ	70°·06
	H	3·720	K_2	R	0·291	ν_2	R	0·179	$(M_2N)_4$	R	0·134
	κ	113°·24		ζ	103°·60		ζ	112°·48		ζ	275°·98
M_3	R	0·021		H	0·371		H	0·173		H	0·120
	ζ	161°·30		κ	163°·73		κ	125°·65		κ	30°·32
	H	0·020	P_1	R	0·119	μ_2	R	0·369	$(M_2K_1)_3$	R	0·184
	κ	164°·54		ζ	349°·02		ζ	29°·70		ζ	30°·14
M_4	R	0·026		H	0·119		H	0·347		H	0·197
	ζ	286°·76		κ	54°·02		κ	274°·02		κ	92°·78
	H	0·869	J_1	R	0·019	R_2	R	0·133	$2M_2K_1)_3$	R	0·107
	κ	171°·08		ζ	368°·71		ζ	154°·60		ζ	126°·81
				H	0·022		H	0·133		H	0·111
				κ	22°·11		κ	78°·67		κ	69°·06

Long-period Tides.

	R	ζ	H	κ
Lunar monthly tide	0·452	248°·73	0·407	18°·72
,, fortnightly ,, ...	0·261	104°·69	0·377	49°·27
Luni-solar ,, ,, ...	1·128	167°·40	1·091	45°·23
Solar annual ,, ...	2·519	126°·85	2·519	151°·86
semi-annual ,, ...	0·653	248°·35	0·653	298°·34

The value of (A_0) the mean level of the sea at Moulmein for 1883-84 is 8·737 feet, and is higher than the value obtained for any of the three previous years; the lowest value is that obtained in 1880-81, viz. 8,453 feet, or nearly 3½ inches lower than the value for the present year.

The value of the mean amplitude (H) of the main lunar tide (M_2) is 3,720 feet; the fluctuation in the values of this component is not very great at Moulmein, considering the magnitude of the amplitude.

The main solar tide (S_2) has an amplitude of 1·349 feet, which is almost precisely the same as the values for the two former years, and differs from the 1880-81 value by a little more than half an inch.

The next largest semi-diurnal tide (N_2) agrees fairly well in its amplitude as compared with the two former years, and it is also less than the 1880-81 value. But the smaller lunar elliptic tide (L_2) has a considerable fluctuation in the values of its amplitude.

The proportion of the main solar to the main lunar tide is 0·363: this is slightly nearer the theoretical proportion (0·465) than we obtained from former observations.

The lunar elliptic tides (L_2) and (N_2) are 0·086 and 0·176 of the main tide: the latter value is very nearly the theoretical proportion, and this agrees with former years, but the proportion for the former component is three times as great as it ought to be, which is the same as the 1881-82 value, but the value for the two other years of observation was a good deal less.

The smaller evectional tide (λ_2) is theoretically insignificant; at Moulmein it appears to be from 3 to 7 per cent. of the main tide.

The larger component (ν_2) is 0 047 of the main lunar tide; theoretically it ought to be 0·038, but the values in former years ranged from 0·045 to 0·081

The diurnal tides at Moulmein in proportion to the main tide and compared with the theoretical values are as follow:—

	Moulmein, 1883-84.	Theoretical.
Luni-solar K_1	0·114	0·584
Lunar M_1	·005	·036
Solar declinational P_1	·032	·193
Lunar ditto O_1	·074	·415
Do. elliptic J_1	·006	·033
Solar ditto Q_1	·011	·080

Thus it will be seen that all the diurnal tides are exceedingly small in comparison to their theoretical proportions, the largest (K_1) being only 11 per cent. instead of 58 per cent. of the main tide.

Regarding the over-tides, the lunar quarter-diurnal is very large, being 23 per cent. of the main tide. This agrees very closely with the three former values; the other over-tides which are significant, appear to be (M_6) and (S_4) which are 0·025 and 0·017 respectively of the main tide.

The luni-solar quarter-diurnal $(M S)_4$ is 18 per cent. of the main tide.

The compound tides $(M_2, K_1)_3$, $(2M_2 K_1)_3$, and $(M N)_4$ have this year been calculated as well as the compound tide $(2SM)_2$, and have values 0·034, 0·053, 0·030 respectively in their proportion to the main tide; the amplitude of $(2SM)_2$ as compared with that of the main tide is 0·033 which is quite in accordance with the three former values.

With reference to the long-period tides, the most remarkable is the luni-solar fortnightly, which is 29 per cent. of the main tide, and this is almost precisely the same value as was obtained in each of the three preceding years. Its epoch too is remarkably accordant, the greatest discrepancy in any two years being only five degrees, or about five hours in time.

But the long-period tide which has the greatest magnitude is the solar annual, which this year is 68 per cent. of the main tide, and agrees very well with the three former values: its time of maximum occurs about the 20th August: the tide is evidently meteorological and caused by freshets in the river.

The solar semi-annual tide is 18 per cent. of the main tide. This agrees fairly well with the three former values.

The lunar monthly tide appears to be about 11 per cent. of the main tide, but its value is somewhat variable.

The lunar fortnightly tide is this year 10 per cent. of the main tide; in the three former years it varied from 7 to 9 per cent.

Extract from the Narrative Report by MAJOR W. J. HEAVISIDE, R.E., *Officiating Deputy Superintendent, 2nd grade, in charge of Nos.* 1 *and* 2 *Astronomical Parties, Survey of India, for season* 1883-84.

THE two parties left Mussooree about the 31st of October 1883, and had assembled in Calcutta by the 5th of November. Eleven days were occupied there in testing the instruments and taking observations for personal equation. On the 16th I embarked for Akyab, leaving Major Strahan in Calcutta.

The table below exhibits the programme drawn up in recess quarters with the probable dates as estimated for the completion of the work, and also what was actually accomplished during the field season :—

Number of Arc in succession.	Observers and stations.	Estimated date for completion of the Arc.	Actual dates.		Number of nights on which observations were taken.
			Commenced.	Completed.	
28	Major Heaviside at Akyab ... ... ,, Strahan at Calcutta	4th December	27th November	14th December	8
29	,, Heaviside at Akyab ... ... ,, Strahan at Chittagong	20th ,,	26th December	4th January	8
30	,, Heaviside at Prome ... ... ,, Strahan at Chittagong	10th January	21st January	30th ,,	8
31	,, Heaviside at Prome ... ... ,, Strahan at Akyab	27th ,,	8th February	13th February	4
32	,, Strahan at Moulmein ... ... ,, Heaviside at Prome	13th February	8th March	15th March	
33	,, Strahan at Moulmein ... ... ,, Heaviside at Akyab	1st March	26th ,,	1st April	7
	Personal equation before and after the measurement of the arcs	.....	November 8th, 9th, 13th, 14th; April 26th, 28th		
	An azimuth by Major Strahan at the Great Trigonometrical Survey Station of Toungzún, near Moulmein	.....	March 18th to 22nd		5
	Independent observations for pivot error—				
	By Major Strahan	.....	January 26th, 27th; February 11th, 16th, 17th, 18th.		6
	,, ,, Heaviside	.....	November 26th; December 17th, 20th, and 21st; January 6th, 7th; February 3rd, 4th, 23rd, 24th.		0

On the 23rd of November I was ready at Akyab to commence observing, but owing to the Penang-Madras cable being out of order the messages to India and to Europe from China and the Straits were all thrown on to the main lines through Burma, and the line could not in consequence be spared for our work until the 27th of November. On the 28th very stormy weather set in, winding up with a cyclone near Chittagong, and preventing any further observations until the 8th December, after which we made most satisfactory progress with the first arc. The second and third arcs were carried on without any delays other than arose from two or three cloudy nights and the time necessary for one officer to move by sea from one station to the next; but on the fourth arc we were met by some more cloudy weather, and on the 15th of February the Penang-Madras cable again broke down, and the Burma main lines became so choked with traffic that no concession of the line was possible, although Major Strahan arranged a programme of work by which we should have required the line only for periods of five minutes three times during the night, and offered to pay for its use.

We waited on until the 29th, but finding the line still blocked with business, and the cable, though repaired, in a delicate condition, we agreed to be content with what had been done on the fourth arc, and that Major Strahan should move on to Moulmein and take up the fifth arc, which was not on the main line of traffic. The fifth arc was finished in eight nights; we then had to return to the main line for the sixth arc, and after completing seven nights' work the cable again broke down and the line could not be spared: after waiting on for some days we decided to close the season. Major Strahan left Moulmein on the 8th and I left Akyab on the 9th of April, and we both reached Calcutta on the 14th of that month. At that time I was suffering from a severe attack of fever, but was sufficiently recovered to observe for personal equation by the 26th of April. On the 29th I took over charge of No. 2 Astronomical Party from Major Strahan, who proceeded on furlough, and both parties moved up to Mussooree, where recess duties were commenced on the 8th of May.

In the original programme it was considered that six nights of observations would suffice for each arc, but subsequently, on Mr. Hennessey's visit to Calcutta in November 1883, it was resolved, in consultation with Major Strahan, to increase the number of nights on each arc to eight, not with a view to greater accuracy in the final value of ΔL for each arc, but for the better determination of some instrumental errors which will be more fully considered later on. This arrangement was again modified at my suggestion to six or eight nights, according to the arrival of the weekly steamers by which we moved, as it was most desirable that the six arcs should be completed this season before the monsoon weather set in, and a method was pointed out by which the instrumental errors of which we were in search could be determined independently by each observer, while the other observer was moving from place to place.

The delays we were obliged to put up with this season were abnormal.

(*a*) We had anticipated more cloudy weather in a moist country like Burma than is usually met with in India, but the weather reports of averages did not lead us to anticipate nearly so much as we encountered.

(*b*) We had to move from station to station by weekly steamers which did not always arrive or depart on the advertised day; on three occasions we were unable to complete the observations in time to catch the steamers and had to wait six, and on one occasion nine days for the next vessel.

(*c*) The Penang-Madras cable broke down on three occasions, so that we were unable to obtain the use of the telegraph line for periods of some days, and the cable was in weak condition during the greater part of the season, so that considering all things I cannot but think we were fortunate in being able to complete our programme with but one rather weak link, viz. Arc No. 30, which is dependent on only four nights' observations.

The delays were, however, not thrown away, as they gave time for independent investigations of supposed instrumental errors, the result of which was a determination at the close of the field season to send the telescopes to England to the makers, Messrs. Cooke and Sons, for repair.

A considerable advance was also made in the field towards the reduction of the observations.

The health of the parties was on the whole good; one of the recently engaged khalasies died of anæmia, which he had apparently contracted before he joined the department.

The pillars for the instruments having been built, and the connexion of the longitude stations with the triangulation carried out by Mr. Keelan last year, the services of Mr. D. Atkinson were not required in Burma, and he remained at Dehra throughout the field season, employed in reading off the chronograph sheets as they were sent to him and reducing the observations.

In the general report for 1882-83, at pages 53 to 58, Mr. J. B. N. Hennessey investigated the results and the circuit and residual instrumental errors obtained from the observations of 1875 to 1883, and in paragraph 260 he stated that a system would be adopted in the observations of 1883-84 by which the residuals for each telescope might be determined and the facial difference removed.

It is here proposed to give a short account of the system of observation pursued, with the results and the conclusions to which they have led.

The system of observation was by similar and dissimilar pivots, so that if the first night's work for the measurement of any one arc of longitude was undertaken with the illuminated pivots of both telescopes east (symbolically I P.E.), the second night's work was carried out with one telescope I P. E. the other I P. W.; the third night with both telescopes I P. W.; the fourth with one I P. W. the other I P. E.; and on the fifth night in positions similar to what they were on the first night.

The east station as usual always took the initiative in changing, so that the positions were—

	At West Station.	At East Station.
First night	... I. P. E.	I. P. E.
Second ,,	... I. P. E.	I. P. W.
Third ,,	... I. P. W.	I. P. W.
Fourth ,,	... I. P. W.	I. P. E.
Fifth ,,	... I. P. E.	I. P. E.

and so on in regular succession.

It will be seen that on this system it requires four nights to complete the several instrumental combinations, and consequently the usual six nights' observations which were in former seasons considered sufficient to ensure a good final result were extended to eight nights, though owing to circumstances previously mentioned eight nights could not always be adhered to.

On the arcs 27 and 28 two systems of observation were adopted, one being that known as "observations of transits at both stations with the same clocks," the other "observations of transits with local clocks combined by clock comparisons," thus giving two results for each night for each position of the telescopes; and throughout these two arcs the telescope at the west station remained in position for the first two successive nights, while the other telescope was reversed, and then the telescope at the east station remained in position for two nights, while the other was reversed.

On the last four arcs the procedure was altered; observations were taken only "with the same clocks" and the position of the telescope at the east station was reversed from I. P. E. to I. P. W., or *vice versâ*, half way through each night's observations, while the telescope at the west station was reversed between each two nights of observation. Thus for eight nights' work there would be sixteen different values, four for each combination of instrumental position.

This will be more fully understood by a reference to Table I.

It must be understood that this paper is based on the supposed existence of constant error following change of pivots; inconstant errors due to actual shakiness in the instruments, or to personal peculiarities in the observers, are beyond the bounds of this investigation.

ΔL stands for the measured value of an arc:—

$\overline{\Delta L}$ its true value, which is unattainable:

e its accidental errors of observation, which are unattainable; and the instrumental disposition primarily provided for is—

No. 1 Telescope at the west station of the arc ... ... (1)
„ 2 „ „ east „ „ ... ... (2)

and the right and left hand subscripts will invariably represent the telescopes and their instrumental position at the east or west station respectively; for instance—

$$\underset{E_1\ W_2}{\Delta L} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

means that the measure of longitude was taken with No. 2 telescope at the east station and its illuminated pivot west; while No. 1 telescope was at the west station with its illuminated pivot east.

Again, it is assumed that with I. P. E. the effect of the residual in either instrument is to cause the telescope to describe an arc west of the meridian, and consequently to give a *positive* error in time of transit, and therefore with I. P. W. to give a *negative* error.

Let x_1, x_2 stand for the errors or instrumental residuals of No. 1 and No. 2 telescope respectively.*

Then for the four pivot combinations adopted this season we have—

$$\underset{E_1\ E_2}{\Delta L} = \left\{ \underset{E\,E}{\overline{\Delta L} + e} \right\} + (x_1 - x_2) \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

$$\underset{W_1\ W_2}{\Delta L} = \left\{ \underset{W\,W}{\overline{\Delta L} + e} \right\} - (x_1 - x_2) \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

$$\underset{E_1\ W_2}{\Delta L} = \left\{ \underset{E\,W}{\overline{\Delta L} + e} \right\} + (x_1 + x_2) \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

$$\underset{W_1\ E_2}{\Delta L} = \left\{ \underset{W\,E}{\overline{\Delta L} + e} \right\} - (x_1 + x_2) \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Or if the instruments be transposed, No. 1 telescope being at the east station and No. 2 at the west station, —

$$\text{Then } \underset{E_2\ E_1}{\Delta L} = \left\{ \underset{E\,E}{\overline{\Delta L} + e} \right\} - (x_1 - x_2) \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

$$\underset{W_2\ W_1}{\Delta L} = \left\{ \underset{W\,W}{\overline{\Delta L} + e} \right\} + (x_1 - x_2) \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

$$\underset{E_2\ W_1}{\Delta L} = \left\{ \underset{E\,W}{\overline{\Delta L} + e} \right\} + (x_1 + x_2) \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

$$\underset{W_2\ E_1}{\Delta L} = \left\{ \underset{W\,E}{\overline{\Delta L} + e} \right\} - (x_1 + x_2) \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

Assuming, as we are bound to do, that the quantities within brackets thus $\left\{ \right\}$ eliminate in differences, then from (3) and (4) or from (7) and (8) we obtain $(x_1 - x_2)$; and from (5) and (6) or from (9) and (10) we obtain $(x_1 + x_2)$; and hence x_1 and x_2.

In Table I the observed values of ΔL corrected for personal equation are given for each instrumental position followed by the values of x_1 and x_2 deduced as explained above, and finally the values of ΔL corrected by the mean values of the quantities x_1 and x_2 obtained for each arc. It will be seen that after these corrections the mean results are brought into much closer agreement, showing, it is considered, that a residual of the character supposed does exist.

Table II exhibits the circuit errors. The quantities in columns 5 to 7 (abstracted from Table I) are the means in the various instrumental positions corrected by the residuals x_1, x_2.

The mean by EE and WW should in each case agree with that by EW and WE, and the results tend to show that the values EF, WW for arc 31 form a weak link. Unfortunately, owing to the telegraph line not being available, as stated above, this arc is dependent on four instead of eight nights' observations.

It has been previously stated that each observer took observations independently for the determination of the residual instrumental errors x_1 and x_2. The method adopted was to observe about 20 stars on one night with the telescope in one position, say, I. P. E. and on any subsequent night to observe the same stars one-half with the telescope I. P. E., the other half with the telescope I. P. W. Then presuming that the clock rate does not vary during the time the observations are being taken, that is during about one hour on each night, the mean rate obtained from the first ten stars should be the same as the mean by the last ten, and half the difference between the two means will give x_1 with telescope No. 1, or x_2 with telescope No. 2. Occasionally 30 stars were observed, and the instrument was reversed twice on the second night, the positions being, say, I.P.E., I.P.W., I.P.E. The results obtained are given in Table III.

* In the General Report for 1882-83, page 54, x_1, x_2 were assumed to be the errors of the telescopes with I. P. E. and $-y_1 - y_2$ with I. P. W.; but x_1, x_2 are now assumed equal to y_1, y_2 respectively.

A certain number of zenith stars were, as is usual, observed independently every night under both aspects during the progress of the work on each arc, the procedure adopted being to observe the zenith star over the first ten wires, the observer facing north or south; he then moved round the telescope, and observed the same star over the last ten wires with his face in the opposite direction. The difference between the mean of the times reduced to the centre wire under each aspect was deduced, and the mean at each station of all these differences will be found in Table IV, and is the quantity which when applied to the time by a star of south aspect will make it comparable with the time by the same star observed under a north aspect. It is scarcely necessary to state that about an equal number of observations were taken commencing with each aspect, and that the telescope was as often in position I. P.E. as I. P.W.

It was pointed out last year that each observer had a regular tendency to intersect a star sooner over the last wires than over the first wires, irrespective of the star's aspect. This personal equation termed the (1st—2nd) equation has been derived from the same zenith stars as the (N—S) equation. The mean results are given in Table IV for each observer, and are the quantities that require to be applied to the time deduced from a star over the last ten wires to make it accord with the time of the same star over the first ten wires. This equation has been eliminated from the results of the (N—S) equation. It will be seen that Major Strahan's (1st—2nd) equation has the opposite sign to Major Heaviside's, and shows that the former anticipates the transits over the first wires and the latter over the last wires.

For 1882-83 these equations were—

$$S_1 - S_2 = +0^s{\cdot}040$$

$$H_1 - H_2 = +0{\cdot}051$$

Table V exhibits the results obtained when both observers were together and could observe the same stars with the same telescope, one observer taking a star over the first ten wires, the other over the last ten wires, then changing the order of observation for the next star, and so on alternately.

Table VII exhibits the probable error of the observation of one wire and of the mean of all the wires over which a star was observed. Two nights on each arc, when the work was not interrupted by clouds, were taken at random, and for each night and each observer three slow and three quick moving stars were selected, giving 12 values for each observer on each arc, the means of which are given in Table VII. On the first two arcs each star was observed over 15 wires, but for subsequent arcs over only 10 or 11 wires. This alteration was made at the risk of increasing the probable errors with the hope that the (1st—2nd) equation might then disappear. It will be seen by Table VII that the reduction in the number of wires observed did not increase the probable errors, nor had it the effect of reducing the (1st—2nd) equation as is shown in Table VI.

To form Table VI, two nights when there were no clouds were chosen for each station of each arc, and for the first two arcs when each star was observed over 15 wires, the difference between the mean of the times by the first five and last five wires were taken out for every star observed, and on the last four arcs when the stars were observed over only 10 or 11 wires, the difference between the first three and last three wires were abstracted. The mean of all the differences for the two nights by each observer are given in Table VI and represent the quantities which applied to the mean of the times by the last five wires in the case of the first two arcs, or to the mean of the times by the last three wires in the case of the last four arcs, will make those times comparable with the times by the first five, and first three wires respectively.

TABLE I.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS, 1863-64.

Abstract of Values of ΔL in the various instrumental positions.

* Name and symbolical number of arc.	Hours and minutes.	Observed values of ΔL corrected for Personal Equation.								Deduced values of residual instrumental error.		Values of ΔL corrected for residual instrumental error.			
		Astronomical date.	Values of ΔL [illegible]	Astronomical date.	Values of ΔL [illegible]	Astronomical date.	Values of ΔL [illegible]	Astronomical date.	Values of ΔL [illegible]	x_1	x_2	[illegible]	[illegible]	[illegible]	[illegible]
	H. M.	1863.	Sec.		Sec.		Sec.		Sec.			Sec.	Sec.	Sec.	Sec.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Means ...	[illegible]	......	[illegible]	......	[illegible]	......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						General mean ...			[illegible]			General mean			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Means ...	[illegible]	......	[illegible]	......	[illegible]	......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						General mean ...			[illegible]			General mean			[illegible]
[illegible]	[illegible]	1864. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Means ...	[illegible]	......	[illegible]	......	[illegible]	......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						General mean ...			[illegible]			General mean			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		Means ...	[illegible]	......	[illegible]	......	[illegible]	......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						General mean ...			[illegible]			General mean			[illegible]
[illegible]	H. M. [illegible]	1864. March [illegible]	[illegible]	1864. March [illegible]	[illegible]	1864. March [illegible]	[illegible]	1864. March [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	......	[illegible]	......	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						General mean ...			[illegible]			General mean			[illegible]
[illegible]	[illegible]	March [illegible] April [illegible]	[illegible]	March [illegible]	[illegible]	March [illegible] April [illegible]	[illegible]	March [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]	......	[illegible]	......	[illegible]	......	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
						General mean ...			[illegible]			General mean			[illegible]

* Where the name of an arc is entered, it has invariably been the practice to place the east station first and the west station second, while in the symbolical number of the arc the subscripts are written left or right according as the instruments to which they refer were at the east or west station.

Explanation of the table.—

In column 1.—The name of the arc is given with its symbolical number; the right and left hand subscripts represent the number of the telescope at the east and west station, respectively.

In column 2.—The amplitude of the arc in hours and minutes is given.

In columns 3, 5, 7, 9.—The dates of observation are given.

In columns 4, 6, 8, 10.—The deduced values of ΔL corrected for Personal Equation are given for each instrumental combination. The letters E. W., &c., in the headings notify the direction of the pivots of the telescopes, the right and left hand letters referring to the telescope at the east and west station, respectively. In the first two arcs there are two values for each position for each date due to two evenings of observation as previously explained.

In columns 11, 12.—The deduced values x_1, x_2 of the residuals for telescopes Nos. 1 and 2 respectively are given, the negative or positive sign showing that with [illegible] pivot east that telescope [illegible] east or west respectively of the true meridian.

In columns 13 to 16.—The values of ΔL corrected for the residuals x_1, x_2 are given, and below, the general means for each arc before and after the application of these residuals.

The quantities in brackets were not observed, but are the means of three other quantities in the same column, and are introduced to give equal weight to the observations in the different instrumental positions.

TABLE II.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS.

Circuit errors for different Instrumental Positions, 1883-84.

Position.	Symbolical.			Numerical.			Circuit error.	Mean circuit error.
	+	−	−	+	−	−		
				h m 0 — 13	h m 0 — 4	h m 0 — 9		
				sec.	sec.	sec.		
EE	$\binom{30}{2\ 1}$	$\binom{29}{2\ 1}$	$\binom{31}{2\ 1}$	30·534	14·204	16·207		
WW				·535	·203	16·207	+	
			Means ...	30·535	14·204	16·207	0·124	
EW				30·401	14·175	16·249		·08
WE				·459	·175	·251		
			Means ...	30·460	14·175	16·250	0·035	
				h m 0 — 18	h m 0 — 9	h m 0 — 9		
				sec.	sec.	sec.		
EE	$\binom{33}{1\ 2}$	$\binom{31}{2\ 1}$	$\binom{32}{1\ 2}$	54·947	16·207	38·672		
WW				·948	16·207	38·671		
			Means ...	54·948	16·207	38·671	0·070	
EW				54·923	16·249	38·663		0·04
WE				54·923	·251	38·663		
			Means ...	54·923	16·250	38·663	0·010	
				h m 0 — 18	h m 0 — 13	h m 0 — 4		
				sec.	sec.	sec.		
EE	$\binom{28}{2\ 1}$	$\binom{24}{2\ 1}$	$\binom{29}{2\ 1}$	9·344	55·268	14·204		
WW				·347	54·969	·203		
			Means ...	9·346	55·119	14·203	0·024	
EW				9·368		14·175		
WE				·368	Not observed.	·175		
			Means ...	9·368		14,175		

TABLE III.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS.

Results of Observations taken independently for the Determination of the Residuals x_1 x_2.

Observer and Telescope.	Stations of observations.	Dates of observation.	Deduced values of the residuals	
			x_1	x_2
Major Strahan	Chittagong	January 26th to 27th	.....	+0·115
Telescope No. 2	Akyab	February 11th to 12th	.....	·180
	Ditto	Ditto 16th to 17th	.....	·154
	Ditto	Ditto 17th to 18th	.....	·111
		Mean	.....	+0·140
Major Heaviside	Akyab	December 17th to 20th ...		−0·019
Telescope No. 1	Ditto	Ditto 20th to 21st ...		·036
	Ditto	Ditto 21st to January 6th ...		·046
	Ditto	January 6th to 7th ...		·004
	Prome	February 3rd to 4th ...		·020
	Ditto	Ditto 23rd to 24th ...		+·004
	Ditto	Ditto 24th to March 7th ...		·043
		Mean ...		−0·011

TABLE IV.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS, 1883-84.

Results of the absolute (*N—S*) *Equation and of the* (1*st*—2*nd*) *Equation deduced from the same Zenith Stars.*

Station of observation.	Mean date of observation.	Deduced Equations.			Station of observation.	Mean date of observation.	Deduced Equations.		
		S − S. N S	S − S. 1 2	Number of measures.			H − H. N S	H − H. 1 2	Number of measures.
	1883.	s.	s.			1883.	s.	s.	
Calcutta ...	11th December ...	+0·030	−0·052	55	Akyab ...	11th December ...	+0·014	+0·024	44
Chittagong ...	31st ,, ...	−0·009	−0·059	55	Do. ...	31st ,, ...	+0·030	+0·032	45
	1884.					1884.			
Chittagong ...	26th January ...	−0·007	−0·055	32	Prome ...	26th January ...	+0·020	+0·048	47
Akyab ...	11th February ...	−0·017	−0·049	23	Do. ...	11th February ...	+0·020	+0·031	23
Moulmein ...	12th March ...	+0·021	−0·059	30	Do. ...	12th March ...	+0·024	+0·023	39
Ditto ...	29th ,, ...	−0·001	−0·059	21	Akyab ...	29th ,, ...	+0·036	+0·028	27

Table V.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS, 1883-84.

Results of Relative Personal Equation.

Date of observation.	Number of stars observed under each aspect.	Relative Personal Equation. $S_N - H_N$.	Relative Personal Equation. $S_S - H_S$.
1883.		s s	s s
8th November	22 north : 18 south	+0·034 ±0·011	+0·017 ±0·010
9th ,, ...	20 ,, 21 ,, ...	+0·009 ±0·007	+0·020 ±0·009
13th ,, ...	10 ,, 10 ,, ...	−0·038 ±0·012	+0·064 ±0·012
14th ,, ...	12 ,, 12 ,, ...	−0·010 ±0·023	+0·005 ±0·014
1884.			
26th April	17 ,, 17 ,, ...	−0·017 ±0·010	+0·034 ±0·008
28th ,, ...	12 ,, 13 ,, ...	−0·024 ±0·012	+0·030 ±0·007

Table VI.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS.

Abstract of Results of the (1st—2nd) Equation as deduced from transits of stars used in the determination of ΔL, 1883-84.

Arc.	Date.	Number of wires over which each star was observed.	Resulting (1st—2nd) Equation. Major Strahan $S_1 - S_2$.	Number of measures from which deduced.	Major Heaviside $H_1 - H_2$.	Number of measures from which deduced.
			s		s	
Akyab—Calcutta	Dec. 8th and 14th ...	15	+0·005	52	+0·029	54
Akyab—Chittagong	,, 28th and Jan. 4th	15	·009	55	·018	57
Prome—Chittagong	Jan. 23rd and 30th ...	10	·015	88	·029	84
Prome—Akyab	Feb. 8th and 13th ...	10	·017	81	·015	77
Moulmein—Prome	Mar. 11th and 15th ...	11	·045	70	·028	81
Moulmein—Akyab	,, 29th and Apl. 1st	11	·025	78	·017	78

Table VII.

ELECTRO-TELEGRAPH LONGITUDE OPERATIONS.

Probable errors of the Transit Observations, 1883-84.

Arc.	Number of wires over which each star was observed.	Major Strahan. Probable error of		Major Heavisid Probable error of	
		Mean of all the wires.	One wire.	Mean of all the wires.	One wire.
		s	s	s	s
Akyab—Calcutta	15	±0·0123	±0·0168	±0·0118	±0·0457
Akyab—Chittagong	15	±0·0103	±0·0397	±0·0112	±0·0432
Prome—Chittagong	10	±0·0 13	±0·0344	±0·0104	±0·0329
Prome—Akyab	10	±0·0123	±0·0390	±0·0119	±0·0380
Moulmein—Prome	11	±0·0117	±0·0386	±0·0096	±0·0319
Moulmein—Akyab	11	±0·0099	±0·0328	±0·0102	±0·0338

NOTE.—The capitals in the headings of the columns in Tables IV, V, VI stand for the observer's initials: S for Major Strahan; H for Major Heaviside. The subscripts N, S denote the aspects under which the star was observed, and the subscripts 1, 2, denote the order in which certain wires were observed.

Summary of the outturn of Field Work of the Parties of the Survey

Scale of survey.	Name and *locale* of Field operations.	Instruments 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.	Triangulation. 2nd class triangulation, in which each angle is usually observed on two zeros. Number of stations fixed.	Number of triangles.	Triangular error in seconds.	Error per mile in feet.	Number of heights.	3rd class or tertiary triangulation, in which two angles of each triangle are observed. Number of intersected points fixed.	Number of triangles.	Error per mile in feet.	Number of heights.	Number of extra heights determined.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
32″ = 1 mile ...	Benares and Basti districts	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	1
16″ = 1 mile ...	Ajmere-Merwara district ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Bassein and Henzada districts	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Benares and Basti do.	.....	.....	...	...	...	...		.....	.....	...	...	...	.....	...	...	
	Chhattisgarh division ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	5
	Dehra Dún district ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Gorakhpur do. ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Kamrup do. ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Pegu and Shwegyin districts	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Prome and Akyab do.	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	10
12″ = 1 mile ...	Hissar district	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Mysore	6″, 8″, 12″	57	28	0·3	0·3	22	34	7	0·2	22	150	333	1·0	157	...	
	Rajputana	12″, 14″	97	45	0·2	0·2	40	136	4·3	0·3	25	379	688	0·4	67	...	
8″ = 1 mile ...	Andaman	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Darjeeling	6″, 7″, 10″, 12″	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	15
6″ = 1 mile ...	Hissar district	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
4″ = 1 mile ...	Aligarh and Etah districts...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Andaman	5″, 7″, clinometer.	328	21	3·6	5·3	15	40	6·7	0·3	17	80	127	1·9	57	41	
	Burma forests	5″, 7″	450	28	15	15	8	10	17	0·4	8	21	38	0·9	21	117	
	Gorakhpur district	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	20
	Guzerat	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Thana district	.....	680	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
2″ = 1 mile ...	Aligarh and Etah districts	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Andaman	7″	600	10	21	84	1	3	5·7	0·4	1	27	40	3·3	7	...	
	Baluchistan	5,″ 6″, 7″	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	25
	Burma	5″, 7″	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Cutch	5½″, 10″	2,100	82	3·0	3·5	74	152	7·9	0·4	70	711	1,101	0·5	529	...	
	Guzerat	6″, 7″	2,199	111	3·4	3·8	86	233	12·7	.....	86	563	812	0·6	500	683	
	Hissar	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Mirzapur	12″	344	23	3·1	4·4	18	44	5·9	0·5	17	87	139	1·3	62	...	30
	Prome and Akyab districts	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Rajputana	7,″ 8,″ 12″, 14″.	4,133	85	...	...	72	116	6·2	0·1	...	...	...	.....	...	...	
	South Deccan	.....	1,415	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Thana district	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
1″ = 1 mile ...	Malwa	5,″ 6″, 10″.	1,300	44	3·2	44	44	97	13·6	0·6	43	340	591	0·8	228	200	35
	Mysore	6,″ 12″, Pris. compass.	1,400	20	7	7	12	35	6·2	0·1	12	181	331	0·8	181	1,025	
	Nepal boundary	6,″ 7,″ 10″, 12″.	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Rajputana	12″, 14″	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
— 2 miles ...	Assam and North-East Frontier.	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Baluchistan	5,″ 6″, 7″	6,100	59	33	54	62	78	8·5	1·0	44	110	186	3·6	58	30	40
	Sikkim and Darjeeling ...	6,″ 7,″ 10″, 12″.	.....	109	...	...	...	...	...	.....	...	708	...	.....	...	...	
1′ — 4 miles ...	Assam and North-East Frontier.	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Baluchistan	6″	22,000	55	175	145	51	145	14	2·3	51	75	150	1·8	46	54	
	Kashmir	7″	2,100	15	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Spirit levelling, Burma ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	45
	Ditto, India ...	.....	.....	...	...	...	...	...	.....	.....	...	...	...	.....	...	...	
	Orissa and Ganjam coast ...	.....	6210	...	...	...	9	17	3·0	.....	32	30	...	.....	...	...	

of India Department during the year 1883-84.

	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 plain table fixings per square mile.	Number of linear miles of test line by which the work has been tested.	Number of villages.	Number of fields.	Average size of fields in acres.	
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	
1	...	...	...	...	.....	.....	.....	.....	.....	11	.....	.....	44	40,899	0·17	Benares City Survey.
	...	...	...	...	.....	.....	.....	.....	154*a*	.....	.....	.....	...	.....	...	*a* Including 91 square miles of interior traverses.
	...	...	...	...	.....	.....	.....	.....	976	758	.....	1,068	314	723,810	0·41	
	...	...	...	...	.....	.....	.....	.....	677	723	.....	2,018	1,730	831,245	0·56	
5	...	...	...	...	.....	.....	.....	.....	275	231	.....	275	22	40,000	0·12	
	...	...	...	...	.....	.....	.....	.....	386	269	.....	319	279	98,687	0·78	
	...	...	...	...	.....	.....	.....	.....	929	744	.....	1,359	1,883	891,996	0·53	
	...	...	...	...	.....	.....	.....	.....	568	228	.....	556	334	148,438	0·98	
	...	...	...	...	.....	.....	.....	.....	522	585	.....	496	250	241,744	0·36	
10	...	...	...	...	.....	.....	.....	.....	686	406	.....	734	239	642,551	0·22	
	...	...	...	...	.....	...	.....	.....	.....	4	.....	.....	...	.....	...	Hissar City Survey.
	...	...	...	...	452	66	22	0·6	.....	24	.....	*in situ*	...	.....	...	Mysore City and Bangalore Cantonment Surveys.
	...	...	...	...	.....	10	.....	.....	.....	10	353·2	*in situ*	...	.....	...	Ajmere and Jeypore Cities Surveys.
	...	...	...	...	.....	.....	.....	.....	.....	6	14	*in situ*	...	.....	...	
15	...	...	...	...	.....	.....	.....	.....	.....	30	.....	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	64	.....	.....	...	.....	...	Government Cattle Farm Survey.
	...	...	...	...	.....	.....	.....	.....	.....	98	.....	.....	...	.....	...	
	...	...	...	...	1,507	68	.....	.....	.....	28	07	1·3	...	.....	...	
	...	...	...	...	11,508	642	6	5·0	.....	211	246	2·9	...	.....	...	
20	...	...	...	...	.....	.....	.....	.....	.....	49	.....	.....	31	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	452	62·4	423·0	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	612	612	.....	190 also *in situ*.	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	944	1,507	.....	377	...	.....	...	
25	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	4,840	1·0	33	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	53	45	.....	...	.....	...	
	...	...	...	...	819	670	15	3·6	.....	215	0·8	266·5	...	.....	...	
	...	...	...	...	2,116	376	16	2·1	.....	710	20·6	89·4	...	.....	...	
30	...	...	...	...	.....	.....	.....	.....	1,206	1,782	.....	249	...	.....	...	
	..	...	..	...	.....	.....	.....	.....	.....	436	47	8·3 also *in situ*.	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	163	.....	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	120	14·2	*in situ*	...	.....	...	
	...	...	...	...	.....	1,158	.....	.....	925	1,832	.....	160 also *in situ*.	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	289	288	.....	.....	...	.....	...	
35	...	...	...	...	47	7	8	0·3	.....	1,597	10·8	*in situ*	...	.....	...	
	...	...	...	...	2,107	150	12	0·6 & 10·0	.....	3,051	11·8	40·7	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	685	1·7	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	1,213	8·3	*in situ*	...	.....	...	
	...	..	...	...	.....	143	.....	.....	.....	622	0·1	.....	...	.....	...	Aka Military expedition.
40	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	1,650	.....	.....	...	.....	...	Sikkim. *b* Besides numerous points in the Himalayas.
	...	...	...	...	.....	.....	.....	.....	.....	1,934	0·1	.....	...	.....	...	Aka and Bhutan Hills.
	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	Lieutenant Wahab's reconnaissance not included.
	...	...	...	...	.....	.....	.....	.....	.....	2,100	.....	.....	...	.....	...	Kishanganga Valley.
45	160	...	...	169	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	
	425	30	8	231	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	
	...	...	...	...	.....	.....	.....	.....	.....	.....	.....	.....	...	.....	...	*c* The area triangulated includes 510 square miles of revision and 43 square miles exterior to main series.

Statement showing the cost-rate of work executed by the several Field Parties of the Survey of India Department during the year 1883-84.

Names and *locale* of Field Parties.	Cost-rate per square mile.		Cost-rate per square mile for each scale of detail survey in rupees.										Rate in annas.				Total cost of party.	Remarks.
													Scale 16″ = 1 mile.		Scale 32″ = 1 mile.			
	Triangulation.	Traversing.	4″	1″	1″	2″	4″	6″	8″	12″	16″	32″	Per acre.	Per field.	Per acre.	Per field.		
Topographical Surveys.													A. P.	A. P.	A. P.	A. P.	Rs.	
Aligarh and Etah districts	18·3		.....	.....	.....	30·7*	49·9*	.....	.....	.....	.....	.....	.....	.....	.....	.....	51,220	(*a*) Exclusive of Rs. 1,338-7-10 expended on permanent marks.
Andaman	15·5	35·8	.....	.....	.....	.....	178·2	.....	382·3	.....	.....	.....	.....	.....	.....	.....	22,358	(*b*) Exclusive of Rs. 2,670-3-9 expended on permanent marks; inclusive of Rs. 23,225 on the revision of previous season's maps, and of Rs. 1,135 for Forest survey on the 4-inch scale, area 6 square miles.
Assam and North-East Frontier ...	.....	89·7	12·3	33·9†	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	53,071	
Baluchistan	4·0	.....	4·6	5·5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	84,261	
Cutch	8·1	8·7	.....	9·5	.....	14·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	55,676	(*c*) Exclusive of Rs. 11,607 expended on permanent marks.
Guzerat	6·9	11·7	.....	.....	.....	36·4	103·9	.....	.....	.....	.....	.....	.....	.....	.....	.....	92,496	(*d*) Exclusive of Rs. 4,264 expended on the survey school.
Malwa	16·5	.....	.....	.....	19·0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	48,707	(*e*) Exclusive of Rs. 1,326-5-2 expended on permanent marks.
Mirzapur	23·1	.....	.....	.....	.....	81·1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	60,480	(*f*) Exclusive of Rs. 6,408-15-3 expended on permanent marks, and of Rs. 7,269-5-11 expended on completion of Mirzapur maps.
Mysore	5·0	61·4	.....	.....	13·3	.....	.....	.....	.....	306·0	.....	.....	.....	.....	.....	.....	79,557	
Rajputana	4·3	.....	.....	.....	12·7	70·1	.....	.....	.....	109·0	.....	.....	.....	.....	.....	.....	50,647	(*g*) Exclusive of Rs. 3,520-7-2 expended on completing maps of the Hooghly River survey and of Rs. 187-8 expended on permanent marks.
South Deccan	11·0		.....	.....	.....	27·3*	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49,964	(*h*) Exclusive of Rs. 5,085-7-11 expended on permanent marks, and inclusive of Rs. 21,·87 expended on revision of present and previous seasons' maps.
Mouzawar and Forest Surveys.																		
Burma Forests	19·4	97·1	.....	.....	.....	57·6	215·3	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,04,287	(*i*) Exclusive of Rs. 8,026-2-5 expended on permanent marks, Rs. 1,852-6-0 furlough allowance of one assistant, Rs. 1,775 cost of Prome Town Survey on 64-inch scale, and inclusive of Rs. 19,117-8-2 expended on the revision of previous season's maps.
Hissar district	.....	20·1	.....	.....	.....	30·9*	.....	40·7*	.....	492·4*	.....	.....	.....	.....	.....	.....	51,331(*a*)	
Thana do.	19·0		.....	.....	.....	35·1*	63 5*	.....	.....	.....	.....	.....	.....	.....	.....	.....	48,995	
Cadastral or Field Surveys.																		(1) Boundary and interior skeleton Traverse Survey; very hilly and difficult ground.
Ajmere-Merwara district	.....	82·4(1)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,466	(2) Includes writing of khasras under the Benares system and intricate City Survey.
Bassein and Henzada districts ...	.....	52·8	.....	.....	.....	.....	.....	.....	.....	.....	260·6*	.....	6 6	4 0	.....	.....	1,97,544(*b*)	(3) Cost-rate of Field Block Survey.
Benares and Basti ditto	.....	21·9	.....	.....	.....	.....	.....	.....	.....	.....	161·1*	687·7*	4 0 (2)	2 3	17 2 (2)	2 11	1,24,067(*c*)	(4) Includes writing of khasras under the Benares system.
Chhattisgarh division	.....	31·5 70·1(3)	.....	.....	.....	.....	.....	.....	.....	.....	173·3*	.....	4 4 1 9 (3)	.....	.....	.....	21,768(*d*)	(5) This cost rate is for the survey and settlement records completed for attestation and assessment with soil maps.
Dehra Dún district	.....	37·5	.....	.....	.....	.....	.....	.....	.....	.....	167·6*	.....	4 2 (4)	7 4	.....	.....	45,098(*e*)	
Gorakhpur do.	.....	28·1	.....	.....	.....	.....	56·4*	.....	.....	.....	178·7*	.....	4 6 (5)	2 5	.....	.....	1,35,734(*f*)	(6) This cost-rate is for the area in which the Cadastral Survey has been completed, and includes the cost of writing the khasras under the Benares system. First season's operations.
Kamrup do.	.....	56·7	.....	.....	.....	.....	.....	.....	.....	.....	327·9*	.....	8 2 (6)	8 1	.....	.....	94,041(*g*)	
Pegu and Shwegyin districts ...	.....	80·5	.....	.....	.....	.....	.....	.....	.....	.....	290·6*	.....	7 3	11 3	.....	.....	1,70,019(*h*)	
Prome and Akyab do.	.....	63·4 74·6	.....	.....	.....	38·3	.....	.....	.....	.....	386·1*	.....	9 8	3 11	.....	.....	1,63,013(*i*)	
Spirit-levelling, India	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	56,662	
Orissa and Ganjam coast	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22,620	

* Inclusive of Triangulation and Traversing.

† Cost, high, as the party was engaged in the Aka hills with the Military Expedition, and little work could be done.

Abstract of areas and cost-rates of the Revenue Branch parties according to Jurisdictions.

Provinces.	Scale of Survey.	Area in square miles.	Cost.	Rate per square mile.	Remarks.
			Rs. A. P.	Rs. A. P.	
North-West Provinces	32 inches = 1 mile.	11	7,565 0 0	687 11 7	Cadastral, including khasra writing, &c.
	16 do. = 1 do....	1,736	2,94,670 2 9	169 10 11	Ditto ditto.
	4 do. = 1 do....	147	7,656 5 11	52 1 4	
	2 do. = 1 do....	1,507	46,330 9 7	30 11 11	
Punjab	12 do. = 1 do....	4	1,969 6 11	492 5 9	
	6 do. = 1 do....	64	2,603 1 8	40 10 9	
	2 do. = 1 do....	1,782	46,759 5 11	26 3 10	
Assam	16 do. = 1 do....	228	94,041 14 3	327 15 1	This cost-rate is for the area in which the cadastral survey has been completed and includes khasra writing, &c.
British Burma	16 do. = 1 do....	1,749	5,24,326 15 9	299 12 7	
	2 do. = 1 do....	163	6,249 9 1	38 5 5	
Bombay	4 do. = 1 do....	612	38,884 5 0	63 8 7	
	2 do. = 1 do....	2,120	60,076 0 3	28 5 5	
Central Provinces...	16 do. = do....	31	21,768 2 11	173 9 3	Cadastral.
		200		70 1 10	Skeleton field blocks.
Rajputana	16 do. = 1 do....	91	11,466 8 5	126 0 1	Skeleton traverse.
	Total ...	10,154 sq. miles + 291 blocks	11,64,267 8 5	.....	

Districts completed since last Report.

District.	Number of villages.	Number of fields.	Area in square miles.	Cost.	Rate per square mile.	Nature of survey, by whom, and when surveyed.	Remarks.
				Rs.	Rs. A. P.		
Ballia	1,502	887,089	725 (*a*)	113,795	156 15 4	Surveyed cadastrally on the scale of 16 inches to a mile by Majors W. Barron and S. H. Cowan during 1880 to 1884.	(*a*) Exclusive of parganas Bhadaun and Sikandarpur surveyed during seasons 1874 to 1876 in Azamgarh district and which have since been transferred to Ballia.
Benares	2,316	992,674	1,003	152,725	152 4 3	Surveyed cadastrally on the scale of 16 inches to a mile by Majors W. Barron and S. H. Cowan during 1882 to 1884, together with the khasrahs.	
Mirzapur	2,053	1,548,996	2,416	365,942	151 7 5	Surveyed cadastrally on the scale of 16 inches to a mile by Colonel F. C. Anderson during 1879 to 1883, together with the khasras during 1881-82.	
Aligarh	.....	.....	2,041 (*b*)	59,179	28 15 11	Surveyed topographically on the scale of 2 inches to a mile by Messrs. E. T. S. Johnson, J. O. N. James, and Major E. H. Steel during 1882 to 1884. A line of villages, area 101 square miles, along the rivers Ganges and Jumna have been surveyed on 4-inch scale. Excluding 4-inch work, the cost rate of the 2-inch work is Rs. 28-11-7 per square mile.	(*b*) Includes 4·6 square miles of Aligarh city surveyed on 6-inch scale.
Hissar	.....	.....	3,511 (*c*)	114,809	32 11 6	Surveyed on the scale of 2-inches to a mile by Colonel D. Macdonald and Colonel F. Coddington during 1882 to 1884, together with skeleton traverses for a subsequent cadastral survey by Settlement Department.	(*c*) Includes 64 square miles of Government Cattle Farm surveyed on 6-inch scale and 4 square miles of Hissar city surveyed on 12-inch scale.

Surveyor-General's Office,
Calcutta, 1st October 1885.

H. R. THUILLIER, *Lieut.-Col.*, R.E.,
Deputy Surveyor-General.

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 1884.

Province and District.	Survey Party.	Mapping.						Traverses.		Field Books.		Area Books.		For Settlement Department.		Remarks.
		Original field sections.	Cadastral 16-inch sheets.	Sheets, 4-inch = 1 mile, 7½′ × 3¾′	Quarter sheets, 2 inch = 1 mile, 15′ × 7½′	Index maps.	Triangulation charts.	Main circuit with azimuth computations.	Village or sub-circuit.	Main circuit.	Village or sub-circuit.	Villages.	Fields.	Sheets or traces.	Village areas or khasras.	
North-Western Provinces.							Cadastral Surveys.									
Benares	No. IV	.....	1,115 62 on 32″	.....	6	... ..	.....	1	1 Trav. 1 Az.	1	By. 9 1	1,420				
Ballia	Ditto ...	.....	10		.....	.....	.....	.....	.....	.....	.....	44	872,144	2,076	1,768	
Basti	Ditto ...	.....	185	.....	.....	1	.....	1 1 As.	4 1 Az.	1	By. 2 7	1 309		.....	.....	
Dehra Dun	Detacht.	.....	525	.....				2	5	1	10	279	98,687	343	317	
Gorakhpur	No. V ...	.....	1,500	10	12 (*a*)	1	.....	3	7	1	10	1,883	.....	3,141	1,455	(*a*) Only plotted.
Ballia and Azamgarh...	Ditto ...	9 on 4″	.....	.....	.....	.....	.....	.....	.....	.....	.....	31	.....	.....	.....	
Assam.															334 Villages. 517 Nisfkhiraj.	
Kamrup	No. VI	.....	381	.....	3	1	.....	1 1 Az.	4	1	16	334	148,438	334	46 Lakhiraj. 2 Waste Land Grants.	
Burmah.																
Pegu	No. II	.....	789	.....	24		.....	3	4	3	9	219	.....	.....	.....	
Hanthawaddy	Ditto ...	.....	.....	.....	.....		.....	.....	.....	.....	.....	31	.....	.....	.....	
Prome	No. VII	5 Irrawaddy river on 2″	10 on 6¼″ 109	...	.....	1	.....	.....	1	.....	1	16 Vols.	.....	31	.....	
Tharrawaddy	Ditto ...	.....	.....	.....	19	... ..	.....	.....	.....	.....	.....	14 Vols.	.....	.....	.....	
Akyab	Ditto ...	3 Magu river on 2.″	460	.....	.....	1	.....	2	2	2	4	.....	.....	76	.....	
Bassein and Henzada..	No. VIII	.....	840	.....	.....	.....	.....	1	4	.....	6	314	723,810	181	.....	
Central Provinces.																
Raipur	Chhattisgarh Detacht.	.....	42	.....	.....	1	.....	1	1	1	4	23	40,000	19	.....	Also 180 sheets mapped on 16″ of Field Blocks.
Rajputana.																
Ajmere-Merwara ...	Detacht.	.....	78	.....	.....	2	.....	1	1	1	1	.....	.....	.....	.....	
Punjab.							Village and Topographical Surveys.									
Hissar	No. I	56 on 2″ 13 on 6″ 6 on 12″	9 on 6″ 2 on 12″	.....	29 (*b*)	6 Atlas reductions.	.....	1	3	5	31	.....	.....	.....	Copies of all traverse data.	(*b*) In duplicate for reproduction and reduction.
Rawalpindi	Ditto ...	.....	.....	34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
North-Western Provinces.																
Aligarh, Etah, and Budaun.	No. III	1 on 6″ 11 on 4″ 82 on 2″ 8 (incomplete)	1 on 6″	.....	20 (*c*)	3 Atlas reductions. 1 Trace of reductions. 1 Contour map of height.		2 main 1 river	2 block. 1 river ...	1	4	.....	.....	2	.....	(*c*) 15 in duplicate for reduction and reproduction.
Bombay.																
Thana	No. X ...	55 on 4″ 9 on 2″	.....	44	7	1	.....	1	2	1	2	.....	.....	52 on 4″	Copies of all traverse data.	
Ratnagiri, Sholapur, Satara.	No. XI	25 on 2″	.....	.....	11	1 Tr. (Sheets 58, 59, 64 & 65).	.....	.....	1 (Sheets 58, 59, 64, & 65).	.....	2 (Sheets 58, 59, 64, & 65).	.....	.....	.....	.....	

Revenue Survey Branch Office,
Calcutta, the 1st October 1884.

H. R. THUILLIER, *Lieut.-Col.*, R.E.,
Deputy Surveyor-General.

CALCUTTA DRAWING OFFICE.

SECTION I.

Statement showing the nature of the work performed and the progress made from 1st October 1883 to 30th September 1884.

TITLE OF MAP.	Scale. In. Mls.	REMARKS AND PROGRESS.
India (crop map)	1 = 32	Specially prepared for Calcutta International Exhibition.
,, (forest map)	1 = 64	
,, (trade map)	1 = 64	
,, (telegraph map) ...	1 = 64	
,, (showing Missionary stations)	1 = 64	
,, (showing irrigation) ...	1 = 32	
,, in four sheets... ...	1 = 64	Additions for engraving.
,, for Education Commission report	1 = 96	Corrected railways.
Compilations.		
Guzerat (in 1 sheet) ...	1 = 16	A new compilation which is being made from all the recent surveys. It will include Guzerat, Kattywar, and Cutch, and will ultimately be engraved.
North-Western Provinces (in 2 sheets).	1 = 16	Compiled in outline from the latest surveys, and has been photo-zincographed.
Punjab (in 4 sheets)	1 = 16	Corrected to date in boundaries, &c., and published by photo-zincography. It will ultimately be engraved on copper.
Central India Agency (in 2 sheets)	1 = 16	Additions up to date in outline and hill shading. The engraving of the map is far advanced.
Rajputana Agency (in 2 sheets) ...	1 = 16	Ditto ditto ditto.
Peshawar	1 = 4	With tribal names corrected to date.
District Gurdaspur (in 4 sheets) ...	1 = 2	Compiled by special request for Punjab Government. It has been taken from revenue survey material adjusted to modern great trigonometrical survey values, and has been reproduced by photo-zincography.
Berars, Hyderabad Assigned Districts (in 1 sheet)	1 = 8	Hills in brush work finished and sent for engraving. The map has been compiled from the 1″ = 1 mile topographical sheets, and will shortly be published.
Punjab (in 4 sheets)	1 = 16	Corrected to date owing to recent changes in boundaries, and is published in skeleton form by photo-zincography. It will be shortly engraved on copper, when hills will be added.
Burma (Fitzroy's map) in 4 sheets	1 = 4	Corrected to date, boundaries, railways, roads, &c.
District maps.		
District Dera Ismail Khan (in 2 sheets)	1 = 4	Specially called for by the Punjab Government on the ¼-inch scale. Proofs were sent and the corrections and additions suggested by them have been carried out, and the map photo-zincographed. These compilations are being utilized for incorporation in the new revised sheets of the Atlas of India.
District Bannu (in 1 sheet) ...	1 = 4	
Do. Peshawar (in 1 sheet) ...	1 = 4	
District Jubbulpore	1 = 4	Prepared for lithogrgphy from copper-plate transfers of Atlas sheets.
,, Chanda	1 = 4	
,, Hoshangabad ..	1 = 4	
,, Chittagong	1 = 4	
,, Howrah	1 = 4	
,, Hooghly	1 = 4	
,, Naga Hills	1 = 4	
Province of Assam	1 = 16	Has been corrected up to date from information received from district officers, &c., &c.
British Burma, Pegu Division ...	1 = 4	Ditto ditto ditto.
District Damoh	1 = 4	Ditto ditto ditto.
Bengal, Behar, and Orissa ...	1 = 32	Ditto ditto ditto.
Rohilkhand Division	1 = 4	Ditto ditto ditto.
District Peshawar	1 = 4	Ditto ditto ditto.
,, Sylhet	1 = 4	Ditto ditto ditto.
N.-W. Provinces and Oudh ...	1 = 32	Ditto ditto ditto.
Punjab	1 = 32	Ditto ditto ditto.
District Cachar	1 = 4	Ditto ditto ditto.
,, Lakhimpur	1 = 4	Ditto ditto ditto.
,, Furreedpore	1 = 4	Ditto ditto ditto.
,, Midnapore	1 = 4	Ditto ditto ditto.
,, Mymensingh	1 = 4	Ditto ditto ditto.

CALCUTTA DRAWING OFFICE.

SECTION I.—*continued.*

	TITLE OF MAP.	SCALE.	REMARKS AND PROGRESS.
	District maps—contd.	In. Mls.	
	N.-E. Frontier of Bengal ...	1 = 32	Showing tribal names.
	District Peshawar, Revenue Survey Sheets Nos. 3, 4, 6, 7, and 10 ...	1 = 1	Inserted boundary canals, railway, &c., &c.
PROVINCE OF BENGAL.	District Hazaribagh ...	1 = 8	Specially prepared for administration reports, and so drawn as to fit into a full or half-sheet of foolscap, and in accordance with latest instructions received from Surgeon-General, *vide* his memorandum of 6th June 1884. They have been drawn for the 8-mile district maps, or from the Atlas sheets reduced by pentagraph.
	,, West Duars ...	1 = 8	
	,, Orissa Tributary Mehals.	1 = 8	
	,, Chota Nagpore ...	1 = 8	
	,, Jashpur	1 = 8	
	,, Bankoora ...	1 = 8	
	,, Beerbhoom ...	1 = 8	
	,, Midnapore ...	1 = 8	
	,, 24-Pergunnahs ...	1 = 8	
	,, Khoolna	1 = 8	
	,, Dinagepore ...	1 = 8	
	,, Rungpore ...	1 = 8	
	,, Darjeeling ...	1 = 8	
	,, East Duars ...	1 = 8	
	,, Udepur	1 = 8	
	,, Julpigoree ...	1 = 8	
	,, Sundarbans ...	1 = 8	
	,, Backergunge ...	1 = 8	
	,, Chittagong ...	1 = 8	
	,, Ditto Hill Tracts	1 = 8	
	,, Patna	1 = 8	
	,, Gya	1 = 8	
	,, Shahabad ...	1 = 8	
	,, Mozufferpore ...	1 = 8	
	,, Sarun	1 = 8	
	,, Chumparun ...	1 = 8	
	,, Monghyr ...	1 = 8	
	,, Sonthal Pergunnahs...	1 = 8	
	,, Cuttack	1 = 8	
	,, Balasore ...	1 = 8	
	,, Morbhanj ...	1 = 8	
	,, Pooree	1 = 8	
	,, Lohardugga ...	1 = 8	
	,, Manbhoom ...	1 = 8	
	,, Singbhoom ...	1 = 8	
	,, Korea	1 = 8	
NORTH-WESTERN PROVINCES AND OUDH.	District Dehra Dún ...	1 = 8	
	,, Muzaffarnagar ...	1 = 8	
	,, Meerut	1 = 8	
	,, Bulandshahr ...	1 = 8	
	,, Bareilly	1 = 8	
	,, Budaun	1 = 8	
	,, Mainpuri ...	1 = 8	
	,, Etawah	1 = 8	
	,, Cawnpore ...	1 = 8	
	,, Allahabad ...	1 = 8	
	,, Hamirpur ...	1 = 8	
	,, Jaunpur ...	1 = 8	
	,, Basti	1 = 8	
	,, Jhansi	1 = 8	
	,, Lalitpur	1 = 8	
	,, Saharanpur ...	1 = 8	
	,, Bijnor	1 = 8	
	,, Shahjahanpur ...	1 = 8	
	,, Farukhabad ...	1 = 8	
	,, Banda	1 = 8	
	,, Gorakhpur ...	1 = 8	
	,, Garhwal (British) ...	1 = 8	
	,, Garhwal ...	1 = 8	
	,, Tarai	1 = 8	
	,, Unao	1 = 8	
	,, Barabanki ...	1 = 8	
	,, Sitapur	1 = 4	
	,, Hardoi	1 = 4	
	,, Kheri	1 = 4	
	,, Fyzabad	1 = 4	

CALCUTTA DRAWING OFFICE.

SECTION I.—*continued.*

TITLE OF MAP.	Scale. In. Mls.	REMARKS AND PROGRESS.
Sheets of the Atlas of India.		
4 N.E.	1 = 4	Compiled from recent surveys in North Afghanistan for engraving.
4 S.E.	1 = 4	
4 S.W.	1 = 4	
5 S.E.	1 = 4	
5 N.E.	1 = 4	Compiled from the 1″ = 1 mile standards of the Punjab Revenue Survey.
6 N.E.	1 = 4	
6 S.E.	1 = 4	
8 S.W.	1 = 4	
12 N.W.	1 = 4	Outline and hill shading in brush for engraving.
12 S.W.	1 = 4	
13 S.E.	1 = 4	Hills in brush for engraving.
14 S.E.	1 = 4	Compiled from new surveys in Northern Afghanistan.
14 S.W.	1 = 4	
14 N.W.	1 = 4	
15 N.W.	1 = 4	New compilation, outline finished for engraving.
15 S.W.	1 = 4	
16 S.W.	1 = 4	
16 N.W.	1 = 4	
18 N.E.	1 = 4	Compiled from the 1″ sheets of the Rajputana Topographical Survey, outline, sand hills and hill shading in brush for Engraving Branch.
18 S.E.	1 = 4	
19 N.E.	1 = 4	
19 S.E.	1 = 4	
20 N.E.	1 = 4	
20 S.E.	1 = 4	
22 N.W.	1 = 4	Outline and names for engraving.
28 Full sheet	1 = 4	Hills in brush shading, Hazara district, in hand.
29 Ditto	1 = 4	Insertion of railways.
30 Ditto	1 = 4	
33 N.E.	1 = 4	
35 N.E.	1 = 4	Outline and printing of a part.
35 S.E.	1 = 4	Hills redrawn for engraving.
35 S.E.	1 = 4	Corrections and additions.
37 S.E.	1 = 4	
38 N.W.	1 = 4	Hills in brush for engraving.
38 N.E.	1 = 4	Additions in hills for engraving.
38 S.E.	1 = 4	Outline and names of a part.
39 N.W.	1 = 4	Correcting outline.
48 N.E.	1 = 4	A small portion outlined for engraving.
48 S.E.	1 = 4	Outline and names of a portion and also hill shading in brush.
49 N.E.	1 = 4	A portion compiled in outline and names.
51 N.E.	1 = 4	Correcting sub-division boundary.
54 Full sheet	1 = 4	Correction to canals and railways.
65 Ditto	1 = 4	Additions in hills for engraving.
67 S.W.	1 = 4	Compiled from new revenue surveys, North-Western Provinces.
67 N.W.	1 = 4	
68 Full sheet	1 = 4	Additions in railways and canals.
69 S.E.	1 = 4	Hill shading in brush, of a part, for engraving.
88 N.E.	1 = 4	In course of completion.
88 S.W.	1 = 4	Outline and names.
89 Full sheet	1 = 4	Hill shading in brush of part.
103 Ditto	1 = 4	Additions to railways.
112 Ditto	1 = 4	
114 S.E.	1 = 4	Compiled outline of portion.
114 Full plate	1 = 4	Territorial names inserted.
115 N.E.	1 = 4	Outline and names for engraving.
120 Full plate	1 = 4	Additions, railways, and roads, &c.
121 Ditto	.....	
122 Ditto	.....	
Special maps.		
Behar Opium Agency... ...	1 = 16	Compiled specially for the Opium Department.
Benares ditto	1 = 16	
Country in the vicinity of Aden ...	1 = 4	Trace made and kept on record.
Earthquake map	1 = 250	To illustrate the supertidal wave caused by the eruption at Java.
Map of the Paropamisan mountains.	1 = 8	Drawn specially for reproduction by photo-zincography.
India	1 = 32	For geological survey, showing geological symbols.

CALCUTTA DRAWING OFFICE.

SECTION I.—*continued.*

TITLE OF MAP.	Scale.	REMARKS AND PROGRESS.
Special maps—continued.	In. Mls.	
India, miniature map	1 =500	For meteorological survey.
Do.	1 = 32	Showing density of population.
Do.	1 =128	Drawn to illustrate reports showing internal railway trade.
N.-W. Provinces and Oudh ...	1 = 16	Showing positions of dispensaries, &c., &c.
Map of Persia	1 = 16	Plotted several stations, and entered route of Colonel Gerard's journey into Kurdistan.
Sketch map of Bengal ...	1 = 32	Showing routes and distances in miles.
Atlas sheet 37 and adjoining portions	1 = 4	Map compiled from Atlas sheets illustrating the different boundaries claimed by Holkar.
Province of Assam	1 = 16	For Sanitary Commissioner.
United States of America ...	.....	Specially called for by Revenue Commissioner's Department and prepared for reproduction by photo-zincography.
Map of Khorasan	1 = 24	Drawing on tracing cloth for reproduction by photo-zincography.
Kattywar	1 = 16	Specially prepared for Geological Survey.
Nerbudda valley	1 = 4	
British Garhwal	1 = 4	
India	1 = 32	
Do. (miniature)	1 = 50	
Map of Bengal	1 = 16	Showing ground under canal irrigation.
Peshawar	1 = 4	Showing tribal distributions for photo-zincography.
Map of Malwa	1 = 4	Trace from Sir J. Malcolm's map for Governor-General's Agent, Central India.
Central India, sheet No. 367 ...	1 = 1	A new edition of these sheets is being prepared. They are being completed up to margin by including the adjacent portions of the North-Western Provinces, and are numbered according to the new index of the sheets of Central India and Rajputana.
Ditto, ditto 368 ...	1 = 1	Sheets Nos. 367, 368, 369, and 399 have been drawn and sent for photo-zincography.
Ditto, ditto 369 ...	1 = 1	
Ditto, ditto 385 ...	1 = 1	
Ditto, ditto 386 ...	1 = 1	Sheets Nos. 386, 387, 400, 401, and 402, are far advanced in drawing and typing.
Ditto, ditto 387 ...	1 = 1	
Ditto, ditto 388 ...	1 = 1	
Ditto, ditto 399 ...	1 = 1	
Ditto, ditto 400 ...	1 = 1	
Ditto, ditto 401 ...	1 = 1	
Ditto, ditto 402 ...	1 = 1	
Ditto, ditto 403 ...	1 = 1	Sheets Nos. 403, 404, 405, 412, 413, 414, 415, 416, 417, 388, and 385 are in hand.
Ditto, ditto 404 ...	1 = 1	
Ditto, ditto 405 ...	1 = 1	
Ditto, ditto 412 ...	1 = 1	
Ditto, ditto 413 ...	1 = 1	
Ditto, ditto 414 ...	1 = 1	
Ditto, ditto 415 ...	1 = 1	
Ditto, ditto 416 ...	1 = 1	
Ditto, ditto 417 ...	1 = 1	
Ditto, ditto 423 ...	1 = 1	
Ditto, ditto 424 ...	1 = 1	
Southern Afghanistan and Pishin Valley maps, sheet No. 5 ...	1 = 4	Hill shading in verticals. Published.
Ditto, ditto 6 ...	1 = 4	Hill shading in verticals. Published.
Ditto, ditto 7 ...	1 = 4	Hill shading in verticals and addition in printing. Published.
Ditto, ditto 8 ...	1 = 4	Hill shading in verticals. Published.
Ditto, ditto 9 ...	1 = 4	
Ditto, ditto 10 ...	1 = 4	Additions and corrections in names and hill shading. Published.
Ditto, ditto 11 ...	1 = 4	Hill shading in verticals. Published.
Ditto, ditto 12 ...	1 = 4	Outline and hill shading. Published in preliminary form.
Baluchistan.		
Northern half D. sheet X ...	1 = 2	Compiled from best survey. Outline, printing and hills. These sheets only require examination. They will be published by photo-zincography.
Southern ditto X ...	1 = 2	
Northern ditto VII ...	1 = 2	
Southern ditto VII ...	1 = 2	

CALCUTTA DRAWING OFFICE.

SECTION I.—*continued.*

TITLE OF MAP.	Scale.	REMARKS AND PROGRESS.
Special Maps.	In. Mls.	
Index map, Central Provinces ...	1 = 32	Prepared in accordance with the orders of the Surveyor-General. The numbering of the standard 1-inch sheet is continuous throughout the whole province.
Ditto, Bengal	1 = 24	
Ditto, Central India and Rajputana Agency, sheet I	1 = 24	
Ditto ditto, sheet II ...	1 = 24	
Original standard sheets of the Mysore Topographical Party, sheets Nos. 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 49, and 50.	1 = 1	The divisional, district, and taluka boundaries have been altered since the survey was made, and the new boundaries have been inserted on the original sheets.
Miscellaneous Maps, &c.		
Rewah survey, sheet No. 6 ...	1 = 1	Touching up hill shading, names, &c., of original for photo-zincography.
Punjab	1 = 32	Inserted railways and telegraphs up to date.
Mallaby's map of Rajputana ...	1 = 4	Touched up for reproduction by photo-zincography.
City and environs of Ajmere ...	12 = 1	Additions up to date.
Muttra city and cantonment with environs.	2 = 1	Prepared for Gazetteer.
District Allahabad, No. 2 ...	1 = 8	
Ditto ditto ...	1 = 8	For R. A. C. Department.
Route map to Bagdad ...	1 = 16	For Quarter-Master-General.
Trace of boundary between Nepal and Oudh.	1 = 4	
Rajputana sheet No. 53 ...	.....	Corrected boundary on original and 200 copies of the photo-zincographed sheets.
Gwalior and Central India sheet No. 96.	.....	
Skeleton plan of Darjeeling ...	.....	Corrected to date.
Projection of maps and charts on different scales.	.....	
285 Originals and proofs examined and corrected for photo-zincography and lithography.	Various scales.	Entered on counterfoil receipt book and despatched.
11,281 Sheets of various maps ...	ditto	Coloured as standard office copies.

N.B.—In addition to the above, various other small jobs, such as tracings, typing hand-printing, colouring and plottings have been performed in the compiling branch when necessary.

G. A. McGILL, *Surveyor, 1st grade,*
Chief Draftsman.

C. STRAHAN, *Major*, R.E.,
Assistant Surveyor-General,
In charge Drawing Office

SURVEY OF INDIA OFFICE,
Calcutta, 1st October 1885.

CALCUTTA DRAWING OFFICE.

SECTION II.

TITLE OF MAP.	Scale.	REMARKS.
Punjab.	Inch Mile.	
Districts Bannu, Dera Ismail Khan, and Thal of Muzaffargarh in 44 standard sheets, 30′ × 15′.	1 = 1	The remaining 10 standard sheets Nos. 34, 35, 37, 38, 39, 40, 41, 42, 42A, and 42B, scale 2 inches=1 mile, were examined, completed, and sent to press for reduction to ½ scale. The above standard sheets have been all published, with the exception of standard sheets Nos. 39 and 42. Number of standard sheets published up to date, 42.
District Hissar.		
In 14 standard sheets, 30′ × 15′ ...	1 = 1	The standard sheets, Nos. 275, 276, 277, and 278, drawn on the scale of 2 inches =1 mile for reduction to scale of 1 inch =1 mile, in the Executive's office, have been completed up to margin by the insertion of the topography from the surveys of district Rohtak and the Patiala and Jind States, which adjoin the district of Hissar. The first two standard sheets have been examined and sent to press; the other two are in a well-advanced state.
Do. in quarter sheets, 15′ × 7½′ ...	2 = 1	The standard sheets prepared for reproduction to scale in the Executive's office were compared with the plane-table sections, all necessary corrections made, and sent to press for publication.
Indus River.		
In six sheets	2 = 1	Thirty-four original 4-inch sheets, survey of 1872-73, were prepared and sent to press for reduction into six sheets. These maps were specially prepared to suit the requirements of the Financial Commissioner of the Punjab. The proofs of these sheets were all passed with final press order.
North-West Provinces.		
Districts Moradabad, Budaon, Tarai, and part of Rampur State in 22 standard sheets, 30′ × 15′.	1 = 1	The proofs of standard sheets, Nos. 30 and 46 reported last year, were examined and passed with final press order. All published.
District Banda in 16 standard sheets, 30′ × 15′.	1 = 1	The proofs of standard sheets Nos. 112, 112A, 127, 125, 141, 142, 143, 155, and 156 were examined and passed with final press order. This completes the publication of the district.
District Banda, 4 sheets, showing Forest Reserves.	4 = 1	Geographical lines were inserted on the 4-inch sheets Nos. 67, 68, 85, 86 of this district. These maps were specially prepared to meet the requirements of the Superintendent of Government Forests. They were re-examined and sent to press for publication to scale.

CALCUTTA DRAWING OFFICE.

SECTION II.—*continued.*

TITLE OF MAP.	Scale.	REMARKS.
Jumna River Survey.	Inch Mile.	
From the trijunction of districts Dehra Dún, Umballa, and Shaharanpur to the City of Delhi.	4 = 1	The original maps of this survey were prepared in the Executive's office in 53 sheets. These were reduced by photography to 33 sheets, and an index map was prepared in this office showing their position and numbering. The sheets with the index map were sent to press for reproduction. The proofs were examined and the final press order was issued.
City of Kasganj.		
District Etah in 9 sheets for reproduction.	20 = 1	The original sheets Nos. 1-9, which were prepared in the Executive's office, were re-examined and sent to press for publication. These sheets were prepared to meet the requirements of the Municipality of Etah.
Meerut Division.		
Districts Saharanpur, Muzaffarnagar, Meerut, Bulandshahr, and Aligarh in quarter sheets, 15′ × 7½′.	2 = 1	The proofs of standard sheets Nos 8, 9, 19, 20, 32, and 33 were all examined and passed with final press order. The original sheets Nos. 21, 22, 34, 35, and 51 drawn in the Executive's office were carefully compared with the plane-table sections, all corrections made, and sent to press for publication on the same scale. These show village boundaries.
Ditto ditto in standard sheets, 30′ × 15′.	1 = 1	The proofs of standard sheets Nos. 8, 9, 19, 20, 32 and 33, which were sent to press last year, were passed with final press order, standard sheets Nos. 21, 22, 34, 35, and 51 drawn in the Executive's office were completed up to margin by the insertion of the topography from the adjoining districts of Gurgaon and Muttra in this office; they were examined and sent to press for reduction to half scale. These maps do not show village boundaries. Number of standard sheets published up to date, 25.
Oudh.		
New edition in 64 standard sheets, 30′ × 15′.	1 = 1	The proofs of standard sheets Nos. 106, 121, 123, have been passed with final press order. Standard sheets Nos. 135, 137 and 152 were sent to press for corrections to be made and all omissions supplied. The proofs of standard sheets Nos. 88, 150, and 164 have been sent to the different Deputy Commissioners for examination of thana and pargana boundaries. Their return is awaited, when they will be examined and sent to press with final press order. Number of standard sheets published up to date, 18.

CALCUTTA DRAWING OFFICE.

SECTION II.—*continued.*

TITLE OF MAP.	Scale.	REMARKS.
	Inch Mile.	
Bengal.		
District Jalpaiguri. Old edition in 13 standard sheets, 30′ × 15′.	1 = 1	The proofs of standard sheets Nos. 1-13 were compared with the proofs received from the different local officers and sent to press for correction and preliminary publication.
New edition in 15 standard sheets, 30′ × 15′.	1 = 1	The first proofs of standard sheets Nos 270, 271, 293, 294, 315, 316, 337, and 338 of the new edition with the second proof of standard sheet No. 337 have been sent to press.
District Pooree, Killah Khorda.		
In 65 imperial sheets	4 = 1	The remaining 25 sheets were completed in this office, carefully examined, and sent to press. The first proofs of the above sheets have been examined and returned to press for correction.
District Cuttack.		
In 3 standard sheets, 30′ × 15′ ...	1 = 1	Geographical lines were inserted on 24 sheets of the 4″ maps, comprising standard sheets Nos. 194, 195, 196, and sent to press for photographic reduction to half scale, and blue prints called for.
Hooghly River Survey.		
Sheets Nos. 1-9 comprising 116 sections.	16 = 1	These sheets are all now undergoing examination, and all necessary corrections are being made to fit them for reproduction by photography to scale. The sections of sheet No. 7 were sent to press for reproduction by photography. These sections were reduced into five sections to meet the requirements of the Port Commissioners. The proofs of these were all passed with an order for a preliminary edition.
Sheets Nos. 1-4 were surveyed on scale 16″ = 1 mile and reduced by pentagraph to 8″ = 1 mile.	8 = 1	
Sheets Nos. 5-9 surveyed on scale 16″ reduced to 6″.	6 = 1	
Sheets Nos. 1-10	3 = 1	
Sheets Nos. 1-10 reduced by pentagraph to two sheets Nos. 1 and 2.	1 = 1	
Mymensingh.		
District Mymensingh in 23 standard sheets, 30′ × 15′.	1 = 1	An error having been discovered in the compilation of these sheets, the work of computing had all to be revised. This furnished the drawing office an opportunity of completing the sheets up to margin. The skeleton standard sheets, which were prepared for the guidance of the lithographic office in preparing the transfer drawing to be put down on stone, with the 1″ original pargana maps, have been sent to the lithographic office.
Burma.		
District Hanthawaddy in quarter sheets, 15′ × 7½′.	2 = 1	The original standard sheets Nos. 114, 116, and 125 drawn in the Executive's office were re-examined, carefully compared with the cadastral plans, and sent to press. The press order proofs of the above-mentioned sheets, with sheets Nos. 123, 124, 132, and 133, were passed for publication.

CALCUTTA DRAWING OFFICE.

SECTION II.—*continued.*

TITLE OF MAP.	Scale.	REMARKS.
Burma— concluded.	Inch Mile.	
District Bassein in quarter sheet, 15′ × 7½′.	2 = 1	The original sheets Nos. 103, 104, 112, 113, 121, 122 drawn in the Executive's office were re-examined, compared with the cadastral plans, all needful corrections made, and sent to press for reproduction to scale.
District Tharrawaddy in quarter sheet, 15′ × 7½′.	2 = 1	The original sheet No. 90 drawn in the Executive's office was re-examined and compared with the cadastral plans, all needful corrections made, and sent to press for reproduction to scale.
Town of Rangoon.		
In 19 sheets	16 = 1	Nineteen original sheets with an index map showing the disposition of the sheets were received from the Executive's office and sent to press with orders for a preliminary edition, to meet the immediate requirements of the Rangoon Municipality.
Bombay.		
Konkan survey	1 = 1	The standard sheets Nos. 78 and 83 drawn in the Executive's office on the scale of 2″ = 1 mile for reduction to half scale were compared with the plane-table sections and sent to press for publication.
Ditto	4 = 1	The sections of standard sheets Nos. 78, 79, 83— Sheet 78 N. W. (1, 2, 3, 4,) N. E. (1, 2, 3, 4,) S. W. (1, 2, 3, 4,) S. E. (1, 2, 3, 4), Sheet 79 S. W. (2,) S. E. (4), Sheet 83 N. E. (1, 2, 3, 4,) S. E. (1, 2, 3, 4,) S. W. (2, 4), and the original field sections of standard sheet 79 S. W. (1, 3, 4,) and S. E. (1, 2, 3) received from the Executive's office were examined, all necessary corrections made for reproduction to scale, and sent to press for publication. Proofs of sections of standard sheet No. 79 S. W. (1, 2, 3, 4,) S. E. (1, 2, 3, 4) were passed on to press with an order for a preliminary edition, to meet the requirements of the Forest Department.
Deccan Survey	1 = 1	The proofs of standard sheets Nos. 60, 66, 67, and 90 were examined and passed with final press order. The fair standard sheets Nos. 51, 58, and 59 drawn in the Executive's office on the scale of 2′ = 1 mile for reduction to half scale were compared with the plane-table sections and sent to press for publication.
Ditto	2 = 1	The original sheets Nos. 32 S. W. and N. W. 37, prepared in the Executive's office, were re-examined and passed with final press order for reproduction to scale to meet the requirements of the Executive Engineer of the Irrigation Department, Poona Division.

CALCUTTA DRAWING OFFICE.

SECTION II.—*continued.*

TITLE OF MAP.	Scale.	REMARKS.
Index Maps.	Inch Mile.	
Districts Rawalpindi and Hissar (Punjab), Meerut Division; districts Gorakhpur, Basti, Dehra Dún, Ballia, Benares and Mirzapur (N.-W. P.); Ajmere-Mhairwara (Rajputana); district Raipur (Central Provinces); district Kamrup (Assam); Hanthawaddy, Bassein, Prome, Akyab (British Burma); the Deccan and Konkan (Bombay Presidency).	On various scales.	The Index maps of Hissar, Dehra Dún, Raipur, Kamrup, Prome, Akyab and Gorakhpur have been redrawn; the others have been revised and brought up to date for the annual report of 1883-84.

DESCRIPTION OF WORK.	REMARKS.
Computations Examined.	
District Hanthawaddy, Seasons 1880-82.	
Districts Ghazipur and Ballia, Seasons 1878-81.	
District Mirzapur, Seasons 1878-81.	
Traverse Data, &c., supplied.	
Of Main Ct. 2 and 3, Mirzapur along Benares ...	For Deputy Superintendent.
Of Main Ct. 1, Pargana Jalesar along districts Agra, Etah, and Aligarh.	Ditto.
Of Main Ct. 7, district Bassein along district Thôngwa	Ditto.
Of Main Ct. 1, district Tharrawaddy along district Hanthawaddy.	Ditto.
Of district Dera Ghazi Khan along Sindh ...	For Settlement Commissioner, Punjab.
Of certain villages of Patna (old and new surveys) ...	For Collector.
Of 11 villages of district Pubna	Ditto.
Of 28 villages of district Furreedpore	Ditto.
Of 5 villages of district Tirhoot	For Sub-divisional Officers.
Of district Sylhet along the Balisira hills ...	For Officer in charge of No. 6, Topographical Party.
Of certain Ganges Dearah villages, district Sarun ...	For Collector.
Plotting columns of 321 villages of district Budaun ...	For Deputy Superintendent.
Plotting columns and distances of Khorda villages (88 pages).	For Settlement Officer.
Miscellaneous Works.	
Computations for the projection of district Mymensingh, Allahabad City, Saugor Cantonments, a portion of Jind State and a portion of district Lakhimpur.	
Calculation of Lat. and Long. of Revenue Survey points for the ¼-inch projection of districts Jhansi and Jalaun. Preparation of summary and other tables for annual report, and examination of tables received from Executives, &c.	

CALCUTTA DRAWING OFFICE.

SECTION II.—*continued.*

TITLE OF MAP.	Scale.	REMARKS.
Miscellaneous Traces, &c.	Inch Mile.	
Gogra river between Azamgarh and Gorakhpur showing a line of villages along bank of former district, in duplicate.	4 = 1	For Deputy Superintendent.
An index to the above	1 = 2	For Deputy Superintendent.
Meercha Deara, &c., showing old and new survey district Rajshahye.	4 = 1	For Collector.
Plan of 1 village, district Bhagalpur	4 = 1	Ditto.
Sheet No. 67, district Jessore ...	4 = 1	Ditto.
Sheet No. 7, civil station of Hissar ...	4 = 1	For Deputy Superintendent.
Boundary between districts Muttra and Gurgaon showing one line of villages.	4 = 1	For Settlement Officer.
Plans of 2 villages of district Monghyr.	4 = 1	For Collector of Patna.
Portion of Kidderpore ...	6 = 1	For Port Commissioners.
2 Sheets of boundary between Nanukmutha and Pilibhit.	4 = 1	For Superintendent, Tarai district.
Ganges Deara Survey, district Rajshahye.	4 = 1	For Collector.
Ditto ditto ...	1 = 1	For Collector.
15 Traces of boundary between Tipperah Raja's dominions and British territory (in duplicate).	8 = 1	For Collector of Tipperah.
Boundary between Dera Ghazi Khan and Sindh.	4 = 1	For Settlement Commissioner.
Plan of 5 villages of district Nuddea.	4 = 1	For Collector.
Boundary between Maler Kotla, Shahpur, Patiala State.	2 = 1	Ditto.
2 Sheets of district Tipperah (in duplicate).	8 = 1	Ditto.
1 Sheet of district Furreedpore ...	4 = 1	Ditto.
Mozufferpore city and surrounding country.	8 = 1	For Collector of Mozufferpore.
Fyzabad city and cantonment ...	8 = 1	For Executive Engineer, Oudh Division.
Portion of Ganges Deara between districts Bhagalpur and Maldah, season 1847-48.	4 = 1	For Collector.
The same portion surveyed in season 1865-66.	1 = 1	For Collector.
Boundary of pargana Balisira, district Sylhet.	4 = 1	For Officer in charge No. 6 party, Topographical Branch.
Boundary between districts Gonda and Basti.	4 = 1	For Deputy Superintendent.
Plans of 2 villages of district Mymensingh.	4 = 1	For Collector of Mymensingh.
Plans of 6 villages, district Sylhet ...	4 = 1	For Collector of Sylhet.
Portion of Tarai district ..	2 = 1	For Deputy Conservator of Forests.
Portion of district Rajshahye bordering on district Maldah showing road from Godagiri to Dinagepore.	4 = 1	For Chairman, Road Committee.
Portion of district Hazara ...	4 = 1	For Executive Engineer, Military Works.
Levels entered on 30 traces of Oudh...	4 = 1	Ditto, Oudh Division.
	Ft.	
Grand division No. 4, sub-division No. 2, Punchannogram.	1 = 99	For Collector.

CALCUTTA DRAWING OFFICE.

SECTION II.—*concluded.*

TITLE OF MAP.	Scale.	REMARKS.
	Inch Mile.	
30 Traces from published maps for comparison of boundaries with settlement maps of Allahabad, Aligarh, Azamgarh, Cawnpore, Etah, Etawah, Farukhabad, Fatehpur, Mainpuri, and Shahjahanpur.	.....	For the Deputy Surveyor-General.
Forest boundaries and roads inserted on 6 sets of maps of district Goalpara.	1 = 1	For Deputy Commissioner, Goalpara.
Villages boundaries inserted on 6 sheets of district Ajmer (in duplicate).	1 = 1	For Major Steel.
Village boundaries inserted on 4 sheets of Mhairwara.	1 = 1	Ditto.
Village boundaries inserted on sheet No. 6, Jessore.	4 = 1	For Collector.
Map Colouring.	No of maps.	
Maps on various scales	146	For Surveyor-General's Office.
Ditto ditto	146	For Deputy Surveyor-General's Office.
Ditto ditto	900	For India Office.
Ditto ditto	1,170	For district officials.
Examination of Proof Sheets.		
Photo-zincographed maps ...	323	
Lithographed maps	61	

S. M. SMYLIE,
Surveyor and Head Draftsman.

C. STRAHAN, *Major*, R.E.,
Assistant Surveyor-General,
In charge Drawing Office.

SURVEY OF INDIA OFFICE;
Calcutta, 1st October 1884.

CALCUTTA DRAWING OFFICE.

SECTION III.

State of publication of Cadastral Maps on the 30th September 1884.

DISTRICTS.	NUMBER OF SHEETS.							REMARKS.
	MAPS PREPARED.			PUBLISHED.				
	Up to 30th September 1883.	Added during past 12 months.	Total up to 30th September 1884.	Up to 30th September 1883.	DURING 1884. By Surveyor-General's Office.	DURING 1884. Total to 30th September 1884.	DURING 1884. Remaining to be published.	
N.-W. Provinces.								
Agra	2,924	.....	2,924	2,924	.....	2,924	.....	
Azamgarh	930	.....	930	930	.....	930	.....	
Balia	1,391	.....	1,391	1,050	293	1,343	48	
Banda	3,317	.....	3,317	3,317	.....	3,317	.....	
Benares	.....	644	644(*b*)	.....	580	586	58	
Bijnour	31	.....	31	31	.....	31	.....	
Ghazipur	3,050(*a*)	.....	3,050	3,034	16	3,050	.....	(*a*) Figures of previous return have been changed to agree with final results.
Hamirpur	2,926	.....	2,926	2,926	.....	2,926	.....	
Jaunpur	3,434	.....	3,434	3,434	.....	3,434	.....	
Moradabad and Tarai ...	4,023	.....	4,023	4,023	.....	4,023	.....	
Muttra	1,658	.....	1,658	1,658	.....	1,658	.....	(*b*) These figures are liable to alteration until publication has been completed.
Mirzapur	3,738	.....	3,738(*b*)	2,606	828	3,434	304	
Terai	94	.....	94(*b*)	55	39	94	.....	
Total ...	27,516	644	28,160	25,988	1,702	27,750	410	
British Burma.								
Bassein	2,716(*a*)	48(*c*)	2,764	1,903	453	2,446	318	(*c*) Sheets of Bassein Municipality surveyed on the scale of 64 inches to the mile.
Hanthawaddy and Pegu ...	3,885	700	4,585	3,048	734	3,782	803	
Henzada	139	64	103	.....	101	101	92	
Prome	.....	726	726	.....	286	286	440	
Tharrawaddy	1,363(*a*)	.....	1,363	1,074	83	1,157	206	
Total ...	8,103	1,528	9,631	6,115	1,657	7,772	1,859	
Bengal.								
Patna and Gya	3,054	.....	3,054	3,054	.....	3,054	.....	
Shahabad...	4,924	.....	4,924	4,924	.....	4,924	.....	
Pooree (Khorda estate) ...	4,629	.....	4,629	1,035	1,641	3,276	1,353	
Total ...	12,607	.....	12,607	9 613	1,641	11,254	1,353	
Assam.								
Sylhet	61	.....	61(*b*)	16	.....	16	45	
Total ...	61	.....	61	16	.....	16	45	
GRAND TOTAL, N.-W. PROVINCES, BURMA, BENGAL, AND ASSAM. ...	48,287	2,172	50,459	41,732	5,060	46,792	3,667	

Detail of examination in connection with Publication.

PROVINCES.	NUMBER OF SHEETS.				REMARKS.
	Examined and rendered suitable for photo-zincography.	Traced and examined for zincography.	Proof copies examined previous to press order.	Coloured and subsequently examined.	
N.-W. Provinces	733	864	1,873	1,702	Scale 16 inches=1 mile.
British Burma	1,483	524	1,710	1,657	Scale 16 inches=1 mile.
Bengal	857	841	1,643	1,641	„ 32 ditto.
Assam	.....	.....	.....	.....	„ 16 ditto.
Total ...	3,073	2,229	5,226	5,060	

R. C. D. EWING,
Assistant Surveyor and Draftsman.

W. H. WILKINS, *Lieut.-Col.*,
Deputy Supdt., Survey of India,
In charge Cadastral Section.

SURVEY OF INDIA OFFICE;
Calcutta, 1st October 1884.

WORK DONE BY THE EXAMINING SECTION FROM 1st OCTOBER 1883 to 30th SEPTEMBER 1884.

Subjects examined ...	Original standard sheets, large scale plans, and triangulation charts of topographical surveys	72
	Original compilations of parts of atlas sheets and other maps compiled in Survey of India Offices	71
	Engraved proofs in outline and names, &c., in various stages, as well as of general and provincial maps	104
	Photographed and lithographed proofs on various scales, including maps, plans, atlas sheets, &c., together with additional work of corrections in territorial changes and public constructions, such as boundaries, canals, roads, &c.	255
Projection of graticule and plotting of points ...	Projection of atlas sheets and provincial maps, &c.	103
Miscellaneous	Tracings of sketches, charts, and supply of geographical data to various officials, computation of graticule for the plates of the Indian atlas, and projection of the same on copper, calculation of areas, &c.	

F. ADAMS,
Surveyor, 2nd grade, and Geographical Examiner.

CHARLES STRAHAN, *Major*, R.E.,
Assistant Surveyor-General, In charge Drawing Office.

Survey of India Office,
Calcutta, 1st October 1885.

PROGRESS REPORT OF THE ENGRAVING OFFICE FROM 1ST OCTOBER 1883 TO 30TH SEPTEMBER 1884.

General Maps, &c.

TITLE OF MAP.	Outline.	Writing.	Hills and sand.	Remarks showing progress.
	Sq. in.	Letters cut.	Sq. in.	
Map of India, in six sheets, scale 1 inch = 32 miles—				
Sheet I ...	.....	7,585	.....	Additional writing done.
" III ...	.....	36	.....	Slight corrections done.
" IV ...	.....	.....	158 H.	Hills well advanced; in progress.
Map of India in four sheets, scale 1 inch = 64 miles ...	155	89	142 H.	Heavy additions and corrections to Afghan frontier. Map published.
Skeleton map of India in four sheets, scale 1 inch =64 miles	.....	15,870	.....	Well advanced; nearly finished, additions in progress.
Map of India in two sheets, scale 1 inch = 80 miles ...	.....	2,300	.....	Corrections and additions to railways and outline.
Map of India, scale 1 inch = 96 miles	.....	457	.....	Ditto ditto.
Map of India in outline, small, "Meteorological" ...	.....	.....	.....	Corrections to outline, sea and dotted ruling engraved.
Central Provinces in two sheets, scale 1 inch = 16 miles ...	.....	.....	.....	Slight corrections done.
Central India Agency in two sheets, scale 1 inch = 16 miles,	127	131	.....	Corrections and additions to outline and writing in progress.
Rajputana in two sheets, scale 1 inch = 16 miles ...	20	5,350	6 H. 25 S.H.	Additional outline and writing in progress.
Assam, scale 1 inch = 16 miles	.....	.....	173 H.	Plate nearly finished; slight additions; in progress.
Berar, scale 1 inch = 8 miles...	.....	431	58 H.	Border taken out and recut title cut; hills in progress.
Map of Himalayan routes, scale 1 inch = 32 miles ...	.....	2,887	.....	Plate finished.
Index chart to Great Trigonometrical Survey ...	.....	14	.....	Slight additions, finished up to date.
Large alphabets, four sets ...	.....	.....	.....	Finished.
Paper graticule plate, scale 1 inch = 1 mile ...	.....	484	.....	Plate finished.
Graticule scales between 7° and 30° 30′	.....	16,356	.....	Comprising 84 scales on twelve plates; engraved and finished.
Tirhoot State Railway forms ...	24	1,050	.....	Two forms on one plate; finished.
Section tints in $\frac{1}{8}''$, $\frac{1}{16}''$, and $\frac{1}{12}''$ divisions, each 22″ square ...	.....	300	.....	Three plates engraved and finished.
Section plate, $18\frac{1}{2}'' \times 12\frac{1}{2}''$, to register the rise and fall of rivers, for the Punjab Government	.....	1,984	.....	In divisions for each day of the year; engraved and finished.
Calcutta International Exhibition certificate	.....	.....	.....	Plate touched up and title engraved.
Map headings	.....	1,750	.....	Additions done.
Imprint plates	.....	2,258	.....	New plates engraved.
Date plates	.....	273	.....	Dates altered.
Heliogravure plates by Major J. Waterhouse	.....	4,019	.....	Touched up and titles cut; in all about 11 plates.
Brass Tangent scales for Math. Instrument office	.....	22,769	.....	Figures engraved and finished to twenty-three scales.
Bronze medal for a native explorer	.....	420	.....	Engraved and finished.
Table drawn for office use				
Total ...	326	86,813	537H. 25S.H.	

ENGRAVING OFFICE—*continued.*

A FULL SHEET OF THE INDIAN ATLAS CONTAINS 927·2 SQUARE INCHES; A QUARTER SHEET 231·8 SQUARE INCHES.

Indian Atlas Sheets (new) completed and published.

TITLE OF MAPS, &c.	Outline.	Writing.	Hills and sand.	Remarks showing progress.
	Sq. in.	Letters cut.	Sq. in.	
13 N.W.	.....	300	8 H.	Hills, marsh, and district names engraved.
22 S.E.	2	3,576	.....	
32 N.W.	.....	261	118 S.H.	Completed up to margin.
36 N.E.	.....	20	28 H.	
48 S.E.	21	4,794	6 S.H.	Published in outline as preliminary edition.
67 N.E.	40	2,289	9 H.	Completed up to limits of survey.
76 S.E.	.....	196	28 H.	Completed up to margin.
Total ...	63	11,436	73H. 124 S.H.	

Indian Atlas Sheets (new) in progress.

4 S.E.	184	.....	.....	Border and outline engraved writing in progress.
12 S.W.	83	860	.....	Outline engraved; writing in progress.
13 S.E.	50	2,805	.....	Additional outline and writing; waterlining; trigonometrical stations and district names engraved; hills about to be commenced.
14 S.E.	52	.....	.....	Outline in progress.
18 N.E.	.....	738	132 S.H.	Plate nearly finished.
18 S.E.	20	.....	.....	Additional outline cut.
19 N.E.	130	1,878	.....	Outline finished; writing in progress.
19 S.E.	57	607	.....	Ditto ditto.
20 N.E.	159	6,376	.....	Outline done; writing well advanced; in progress.
20 S.E.	46	509	.....	New outline and writing done as far as material supplied.
23 S.E.	54	8,047	.....	Additional outline and writing in progress.
35 N.W.	24	2,436	.....	New survey; outline and writing done; awaiting hill drawing.
35 S.W.	79	979	.....	Outline done as far as materials supplied; writing in progress.
37 S.E.	32	820	45 H.	Hills in progress.
37 S.W.	.....	2,404...	.....	Small portion of outline and additional writing cut.
38 N.W.	.....	10,232	5 H.	Outline and writing finished as far as material supplied; hills in progress.
38 N.E.	18	.....	.....	Outline completed as far as material supplied.
38 S.W.	.....	3,479	.....	Writing in progress.
38 S.E.	162	4,718	.....	Outline finished; writing in progress.
39 N.W.	73	.....	.....	Portion of outline taken out and re-engraved.
39 N.E.	198	.....	.....	Outline done up to margin.
39 S.W.	231	.....	.....	Border cut; outline done up to margin.
39 S.E.	131	.....	.....	Outline done up to margin.
40 N.E.	22	9,000	.....	Writing in progress.
40 S.E.	3	1,988	.....	New portion of outline and writing in progress.
48 N.E.	101	.....	.....	Outline nearly finished; in progress.
49 N.E.	.....	10,406	.....	Writing in progress.
49 S.W.	150	.....	.....	Re-projected and border cut; outline in progress.
49 S.E.	231	.....	.....	New scale cut; outline done up to margin.
Carried over ...	2,280	68,282	50 H. 132 S.H.	

ENGRAVING OFFICE—*continued.*

Indian Atlas Sheets (new) in progress—concluded.

Title of Maps, &c.	Outline.	Writing.	Hills and sand.	Remarks showing progress.
	Sq. in.	Letters cut.	Sq. in.	
Brought forward ...	2,280	68,282	50 H. 132 S.H	
50 S.E.	123	8,769	.....	Writing in progress.
61 N.E.	5	14,325	.....	Outline and writing completed as far as material supplied.
61 S.E.	.....	16,532	.....	Writing about $\frac{6}{8}$ths done; in progress.
67 S.W.	55	.....	.....	New outline in progress.
69 S.E.	.....	1,758	.....	Outline and writing of fresh-survey completed; hills about to be put in hand.
75 S.E.	108	.....	.....	Re-projected, border cut, and outline done as far as material supplied.
76 N.W.	119	4,959	.....	Outline finished as far as material supplied; writing nearly completed.
76 N.E.	2	7,573	.....	Marsh and waterlining done; 376 lakes ruled; awaiting hill drawing.
76 S.W.	.....	7,000	.....	Writing in progress.
77 N.W.	.....	4,924	.....	Waterlining and writing finished; awaiting drawing for hills.
77 S.E.	10	669	4 S.H.	Waterlining marsh and sand done; 549 lakes ruled; outline and writing done as far as drawing.
78 N.E.	.....	8,600	.....	Writing in progress.
79 N.W.	137	52	.....	Projected and border cut; outline completed as far as material supplied.
79 S.W.	212	118	.....	Re-projected; outline done as far as material supplied; writing just commenced.
88 S.W.	110	32	.....	Projected and border cut; outline completed as far as material supplied.
114 N.E.	96	.....	.....	Outline completed as far as material supplied.
114 S.E.	165	252	.....	Writing in progress.
115 N.E.	37	.....	.....	Small portion of outline done.
131 N.E.	.....	2,842	28 H.	Hills in progress.
Total ...	3,469	146,687	78 H. 136 S.H.	

Additions and Corrections to the Indian Atlas Sheets.

1A S.E.	.....	154	.....	Title cut.
8 S.E.	.....	.....	.....	Slight corrections finished.
13 N.E.	.....	362	4 H.	Corrections and additions to district names; border cut.
22 S.W.	.....	134	.....	Additional boundaries cut.
23 N.W.	.....	416	.....	Corrections and additions done.
23 S.W.	.....	300	.....	District names cut.
32 N.E.	.....	90	.....	Slight additions done.
32 S.W.	.....	.....	4 S.H.	Slight corrections done.
34 N.W.				
34 S.W.	.....	.....	.....	Corrections and additions done.
34 S.E.				
35 N.E.				
35 S.E.	.....	.....	19 H.	Heavy additions; new portion of survey; corrections and additions to district names done.
44A N.W.	.....	154	.....	Title cut.
66 S.W.	.....	56	.....	Slight corrections finished.
66 S.E.	.....	32	.....	Ditto.
87 N.W.				
87 N.E.	.....	1,049	.....	Additional railways and names cut.
87 S.W.				
87 S.E.				
Total ...	.....	2,747	23 H. 4 S.H.	

ENGRAVING OFFICE—*concluded.*

Repairs and additions to old plates of the Indian Atlas.

Title of Map.	Outline.	Writing.	Hills and sand.	Remarks showing progress.
	Sq. in.	Letters cut.	Sq. in.	
28	150	7,852	.....	Old work taken out; border cut, new outline, sand banks and dry bed of river engraved; heavy alterations and additions; writing in progress.
29	.....	100	.....	Additional railways and names cut.
30	5	107	.....	Additional railways and corrections to outline and writing done.
31	5	300	.....	Additional outline and writing done.
37	.....	100	.....	Additional writing done.
46	.....	.....	104 H.	Hills being repaired; in progress.
47	.....	.....	76 H.	Hills being repaired; 571 square inches of hills stopped out for re-biting by Photo. office.
49	.....	450	.....	Additional writing done.
54	3	100	.....	Additional outline and writing done.
55	4	123	.....	
65	15	221	8 H.	Portion of new survey done.
89	17	500	36 H.	Portion of new survey and old hills touched up, done.
102	8	200	.....	Additional outline and writing done.
103	.....	850	.....	Portion of writing re-cut.
107	.....	.....	303 H.	Hills being repaired; in progress.
112	13	207	.....	Additional outline and writing done.
120	3	.....	.....	
121	.....	329	.....	
Total ...	223	11,439	527 H.	

New plates projected, borders cut, &c.

4 N.E.	.....	.....	.....	Border cut.
5 N.W., S.W., & S.E. ...	.....	.....	.....	Projected and borders cut.
7 N.E. & S.E.	.....	.....	.....	Projected.
15 Four quarters ...	.....	.....	.....	Projected and borders cut.
16 Ditto ...	.....	.....	.....	
17 N.W. & S.E.	.....	.....	.....	Projected.
17 N.E. & S.W.	.....	.....	.....	Projected and borders cut.
27A S.W.	.....	.....	.....	
42 Four quarters ...	.....	.....	.....	
43 N.E.	.....	.....	.....	Projected.
43 S.E.	.....	.....	.....	Projected and border cut.
57 N.E.	.....	.....	.....	Border cut.
78 S.W.	.....	80	.....	Re-projected and border cut.
88 N.W.	.....	.....	.....	Projected.
88 N.E. & S.E.	.....	.....	.....	Projected and borders cut.
125 S.E.	.....	.....	.....	Projected.
131 S.E.	.....	.....	.....	Border cut.
146 N.E.	.....	.....	.....	Re-projected.
Total ...	.....	80	.....	

Abstract of work completed and in progress.

Engraving.

	Plates.
Atlas sheets completed	7
Ditto in progress in various stages	48
General maps, plans, &c.	84
Repairs, corrections, and additions ...	38
Projections, engraved borders cut, &c. ...	33
Total ...	210

Copper-plate printing.

Impressions taken	18,200
Proofs pulled	470
Transfers pulled	384
Total ...	19,054

Steel-facing.

	Plates.
Double elephant plates, steel-faced ...	42
Ditto ditto, steel-removed	32
Quarter-plates, steel-faced ...	45
Ditto, steel-removed ...	38
Miscellaneous plates, steel-faced ...	47
Ditto ditto, steel-removed...	26
Total ...	230

Square inches of hill etching ...	1,527
Ditto of jungle etched ...	50
Ditto of outline engraved ...	4,081
Number of letters engraved ...	250,202

C. W. COARD,

Superintendent, Engraving Office.

C. STRAHAN, *Major*, R.E.,

Assistant Surveyor-General,
In charge Engraving Office.

Extract from the Report of MAJOR J. WATERHOUSE, S.C., *Assistant Surveyor-General in charge, Lithographic Office, Survey of India Department, season* 1883-84.

I HAVE the honour to submit the usual tabular statements showing the amount and cost of the work turned out in the Lithographic Office during the survey year commencing 1st October 1883 and ending 30th September 1884, viz:—

L_1. Statement of departmental work lithographed and printed.
L_2. Statement of work lithographed and printed for other departments.
L_3. Statement of type work.
L_4. General abstract of outturn and value of work done.

The progress of the office during the year will be seen from the tabular abstract given below, in which the outturn of the year is compared with that of the previous one:—

	1883-84.			1882-83.		
	Number of subjects.	Number of copies printed.	Value.	Number of subjects.	Number of copies printed.	Value.
			Rs. A. P.			Rs. A. P.
Departmental maps, &c. ...	153	23,046	17,473 15 2	211	26,667	19,631 0 0
Ditto forms ...	49	54,004	4,427 15 3	53	40,810	4,615 0 0
Extra-departmental maps, &c. ...	500	108,146	23,212 11 11	471	196,366	22,767 0 0
Total ...	702	185,196	45,114 10 4	735	263,843	47,013 0 0
Type work	4,184	351,347	12,148 1 6	3,198	323,817	9,530 0 0
Total value ...	.....	.....	57,262 11 10	.....	.....	56,543 0 0

The number of maps and drawings, both departmental and extra-departmental, lithographed and printed during the year, though somewhat less than last year, is still well above the average. The extra-departmental work shows an increase, and the increase in the type work is again very considerable.

The total number of impressions in the lithographic printing rooms was 178,474, of which 80,169 were departmental and 98,305 for other departments.

The principal items of work done have been noticed in the accompanying abstract (printed in part I), and need not be repeated.

Mr. H. L. Lepage, Head Assistant, returned from furlough on the 5th July. Mr. A. G. Palmer of the Engraving Office, who had been officiating for Mr. Lepage, went on furlough for one year from the 1st of May, and the officiating appointment was held by Mr. L. C. Cunningham till Mr. Lepage's return.

Mr. J. Watson of the Photographic Office remained as officiating head lithographic printer till the arrival from England, on the 18th February, of Mr. D. Deas, who was appointed head printer by the Secretary of State from the 29th November 1883. Mr. B. Wilson who had been working for some time in the Photographic Office was appointed as assistant lithographic printer from the 18th February 1884.

All these assistants have performed their duties very satisfactorily. Mr. Cunningham is an excellent draftsman, both on stone and paper, and is a great acquisition to the office. Mr. Deas, the new head printer, seems to understand his work thoroughly, and does it efficiently.

Mr. DePyvah, type printer, has again had to meet a large increase of work in the type-printing section, and has done it well and cheerfully.

The native assistants and clerks have all worked well. I regret to have to record the death from cholera of Baboo Boloram Nath, who had been in the office for upwards of 32 years, and was an excellent draftsman in various styles. His loss is greatly felt.

Baboo Grish Chunder Biswas, press assistant, who had officiated as head clerk for many years, retired on superannuation pension from the 1st October. He knew the work of the office well, and is also a loss.

Messrs. G. A. LeFrano and E. Dowling have been entertained as apprentices from the 1st August 1884, in conformity with Government Resolution No. 298 (Surveys), dated 11th July 1884. They are both doing well.

General Walker, the late Surveyor-General, having retired in January, made over his interest in the premises No. 1, Camac Street, in which this office is located, to the office, and arrangements have been made with the landlord for a renewal of the lease on its expiry in February next, on the same terms as at present. The premises have just undergone general repairs, but as it was arranged that the repairs in the office rooms should be done during the Doorga Poojah holidays, the work suffered no interruption.

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC OFFICE, SURVEY OF INDIA DEPARTMENT, BETWEEN THE 1st OCTOBER 1883 AND 30th SEPTEMBER 1884.

L 1.

Work done for the Survey Department.

Description of Maps.		Scale of maps.	Size of each sheet.	Number of sheets.	Number of colored copies.	Number of uncolored copies.	Total number of copies.	Number of impressions.	Value.	Remarks.
General Maps.									Rs. A. P.	
Drawn during the year.										
Afghanistan, sheet No. 1 ...	Outline drawn on stone.	1 inch = 4 miles	Atlas ...	1	...	.....	.....	.....	198 0 9	Not yet printed.
India, in 6 sheets, sheets Nos. 1 to 6, 3rd issue.	Re-transfer made with corrections and additions.	1 inch=32 miles	Double elephant.	6	...	1,800	1,800	1,800	953 12 6	
Contour sheets, Nos. 2 and 4, of the Outline Map of India.	Re-transfer made with contour lines, corrections, and additions.	Ditto ...	Ditto ...	2	...	.....	.....	.....	359 0 8	Ditto.
Ditto, Nos. 1 and 3 of ditto	Corrections and additions made.	Ditto ...	Ditto ...	2	...	.....	.....	.....	255 3 11	Ditto.
Irrigation Map of India, in 6 sheets, sheets Nos. 1 to 6.	Re-transfer made with corrections, and color stones prepared.	Ditto ...	Ditto ...	6	...	.....	.....	.....	111 1 3	Ditto.
Missionary Map of India, in 2 sheets.	Ditto ...	1 inch=64 miles	Ditto ...	2	...	.....	.....	.....	135 15 11	Ditto.
India, illustrating Distribution of Languages.	Ditto ...	1 inch=96 miles	Ditto ...	1	...	112	112	112	127 2 5	
India, showing Principal River Basins.	Ditto ...	Ditto ...	Ditto ...	1	...	112	112	112	127 10 7	
Reprints.										
India, in 6 sheets, sheets Nos. 1 to 6, 2nd issue.	.....	1 inch=32 miles	Double elephant.	6	...	387	387	387	295 15 0	
India	.....	1 ,, =96 ,,	Ditto ...	1	...	200	200	200	74 13 4	
British Burmah, sheets Nos. 3 and 4.	.....	1 ,, = 4 ,,	Ditto ...	2	...	180	180	180	66 0 0	
Southern Afghanistan, in 4 sheets, sheets Nos. 1 to 4.	.....	Ditto ...	Double imperial.	4	...	367	367	734	306 10 4	
India, showing the present state of the progress of the Imperial Survey to 1st October 1883, to accompany annual report.	Corrections made and color stones prepared.	1 inch=128 miles	Imperial ...	1	500	.....	500	1,500	212 6 2	
Provincial Maps.										
Drawn during the year.										
Nizam's dominions, including the Assigned District of Berar, in 2 sections.	1st Section drawn on stone.	1 inch=16 miles	Double elephant.	1	...	...	...	...	1,213 1 5	Not yet printed.
North-Western Provinces and Oudh.	Re-transfer made with corrections and additions.	1 ,, =32 ,,	Imperial ...	1	...	...	...	...	17 7 6	Ditto.
Punjab Province	Ditto ...	1 ,, =64 ,,	Foolscap ...	1	...	...	...	...	11 6 4	Ditto.
Transferred previously from engraved sheets, but printed during the present year.										
Bengal, Behar, Orissa, and Chota Nagpore.	Further corrections made.	1 ,, =32 ,,	Double elephant.	1	...	250	250	250	89 5 5	
Drawn previously, but printed during the present year.										
2 Sheets of the title sections of the map of Province of Bengal.	.....	1 ,, =8 ,,	Imperial ...	2	...	200	200	200	41 14 0	
Reprints.										
North-Western Provinces and Oudh, in 4 sections.	.....	1 ,, =16	Imperial ...	4	...	50	50	400	83 5 6	
Central Provinces, in 2 sections...	Corrections made.	Ditto ...	Double royal	2	...	200	200	400	169 8 7	
Bengal, Behar, Orissa, and Chota Nagpore, in 4 sections.	.....	Ditto ...	Atlas ...	4	200	...	200	1,600	309 8 0	
Divisional Maps.										
Madras Presidency	Re-transfer made with corrections and additions.	1 inch=32 miles.	Antiquarian ...	1	...	105	105	105	179 0 2	
Bombay ditto	Ditto ...	Ditto ...	Ditto ...	1	...	102	102	102	91 8 0	
District Maps.										
Transferred from the engraved sheets of the Atlas of India.										
Jubbulpore	Corrections and additions made.	1 inch = 4 miles	Antiquarian ...	1	...	200	200	200	239 2 7	
Lakhimpur	Ditto ...	Ditto ...	Double elephant.	1	...	202	202	202	137 6 11	
Howrah	Ditto ...	Ditto ...	Super-royal ...	1	...	150	150	150	102 4 6	
Chanda	Ditto ...	Ditto ...	Antiquarian ...	1	...	.....	.....	.....	68 5 1	Not yet printed.
Cachar	Ditto ...	Ditto ...	Double elephant.	1	...	.....	.....	.....	101 2 1	
Hoshungabad	Ditto ...	Ditto ...	Double royal	1	...	.....	.....	.....	13 6 1	
Carried over ...	.....	.....	.....	59	700	4,617	5,317	8,634	6,091 0 0	

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC OFFICE—*continued.*

Work done for the Survey Department—continued.

Description of Maps.	Scale of maps.	Size of each sheet.	Number of sheets.	Number of colored copies.	Number of uncolored copies.	Total number of copies.	Number of impressions.	Value.	Remarks.
								Rs. A. P.	
District Maps—*concluded.*									
Brought forward ...	.....	.....	59	700	4,617	5,317	8,634	6,001 9 0	
Transferred previously from the engraved sheets, but printed during the present year.									
Chittagong, in 2 sections	Further corrections made.	1 inch = 4 miles	Atlas	2	...	202	202	404	229 6 3	
Naga Hills	Ditto ...	Ditto ...	Special ...	1	...	150	150	150	141 9 3	
Hooghly	Ditto ...	Ditto ...	Double royal	1	...	150	150	150	94 6 6	
Reprints.									
Furreedpore	Corrections, &c., made.	Ditto ...	Atlas	1	...	233	233	233	110 9 0	
Sylhet	Ditto ...	Ditto ...	Double elephant.	1	...	200	200	200	262 9 9	
Mymensingh	Ditto ...	Ditto ...	Antiquarian ...	1	...	100	100	100	130 6 4	
Baloghat	.....	Ditto ...	Double elephant	1	...	50	50	50	27 1 6	
Khoolna	.....	Ditto ...	Atlas	1	...	150	150	150	46 7 6	
Rajshahye	.....	Ditto ...	Do.	1	...	54	54	54	24 0 6	
Kumrup	.....	Ditto ...	Do.	1	...	54	54	54	24 0 6	
Hoshiarpur, in 4 sections	.....	1 inch=2 miles	Imperial ...	4	...	202	202	808	273 5 4	
Plans of Cantonments and Cities.									
Reprints.									
Plan of Calcutta	.....	3 inches=1 mile	Super-royal ...	1	...	150	150	150	23 11 7	
Ditto	.....	1½ „ =1 „	Foolscap ...	1	...	100	100	100	11 10 2	
Atlas Sheets.									
Transferred from Copper-Plate.									
Indian Atlas, full sheet, Nos. 43 and 62.	.....	1 inch =4 miles	Antiquarian ...	2	...	158	158	158	116 15 4	
Indian Atlas, quarter sheet, No. 124 N.E.	.....	Ditto ...	¼ sheet Atlas...	1	...	100	100	100	20 4 0	
Transferred previously from Copper-Plate.									
Indian Atlas, full sheet, No. 98 ...	Further corrections made.	1 inch=4 miles	Antiquarian...	1	...	200	200	200	141 0 1	
Reprint.									
Indian Atlas, full sheet, No. 48 ..	.....	1 inch=4 miles	Antiquarian ...	1	...	50	50	50	46 5 2	
Standard, Sheets.									
Drawn during the year.									
Oudh Revenue Survey, sheets Nos. 86, 87, 88, 103, 104, 116, 118, 119, 137, and 150, 2nd edition.	Drawn on transfer paper.	1 inch=1 mile...	Double royal	10	...	.....	.....	.....	5,059 10 2	Not yet printed.
District Julpaiguri, sheets Nos. 270, 293, and 337.	Re-transfer made with corrections, &c.	Ditto ...	Ditto ...	3	...	.....	.....	.....	62 13 10	Ditto.
Drawn previously, but printed during the present year.									
Oudh Revenue Survey, sheets Nos. 106, 121, 123, and 165, 2nd edition.	Corrections, &c., made.	1 inch=1 mile...	Double royal	4	...	1,128	1,128	1,128	725 4 9	
District Julpaiguri, sheets Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13.	Ditto ...	Ditto ...	Ditto ...	13	...	571	571	571	1,114 13 2	
Index Maps.									
Drawn and printed during the year.									
Index to the standard sheets of Bengal, on the scale of 1 inch = 1 mile.	Re-transfer made with corrections and additions.	1 inch=32 miles	Double royal	1	...	100	100	100	236 13 0	
Index to the sheet maps of Central Provinces Topographical Survey, on the scale of 1 inch = 1 mile.	Re-drawn on stone and color stone prepared.	.....	Foolscap ...	1	50	.....	50	100	27 10 11	
Index to the standard sheets of Central Provinces, on the scale of 1 inch = 1 mile.	Re-transfer made with corrections and additions.	1 inch=32 miles	Double royal	1	...	50	50	50	87 6 0	
Drawn previously, but printed during the present year.									
Index to the standard sheets of Assam, on the scale of 1 inch = 1 mile.	Further corrections made.	1 inch=32 miles	½-sheet double royal.	1	...	152	152	152	33 14 0	
Index to the standard sheets of Punjab, on the scale of 1 inch = 1 mile.	Ditto ...	Ditto ...	Ditto ...	1	...	100	100	100	33 14 1	
Carried over ...	.....	.....	.....	116	750	9,021	9,771	13,046	15,197 9 8	

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC OFFICE—*continued.*

Work done for the Survey Department—concluded.

Description of Maps.	Scale of maps.	Size of each sheet.	Number of sheets.	Number of colored copies.	Number of uncolored copies.	Total number of copies.	Number of impressions.	Value.	Remarks.
Reprints.								Rs. A. P.	
Brought forward ...	.....	.....	116	750	9,621	9,771	13,946	15,197 9 6	
Index maps, Nos. 1, 2, 5, 6, 7, 8, and 9, Topographical parties, of standard sheets, on the scale of 2 inches, 1 inch, ½ inch, and ¼ inch = 1 mile, to accompany annual report.	Corrections, &c., made and color stones prepared.	Various scales	Foolscap ...	6	3,300	300	3,600	7,450	567 15 10	
Index to the Survey of South Sylhet and Tipperah Hills, on the scale of 1 inch = 4 miles, 1 inch = 2 miles, and 2 inches = 1 mile, to accompany annual report.	Ditto ...	1 inch=8 miles	Ditto ...	1	550	50	600	1,150	96 3 7	
Index to the sheets of the Topographical Survey, district Kohat, on the scale of 1 inch = 1 mile, to accompany annual report.	Ditto ...	1 inch=16 miles	Ditto ...	1	565	50	615	1,180	72 3 2	
Index map of district Terai, on the scale of 1 inch = 1 mile, to accompany annual report.	Ditto ...	1 inch=8 miles	Ditto ...	1	550	50	600	1,150	87 7 6	
Index map of district Hissar, on the scale of 4 inches = 1 mile, to accompany annual report.	Ditto ...	Ditto ...	¼-sheet imperial.	1	555	50	605	1,160	94 4 7	
Index to the Indian Atlas showing the state of the Engraving to 1st October 1883, of sheets on the scale of 1 inch = 4 miles, to accompany annual report.	Ditto ...	1 inch=256 miles	Foolscap ...	1	566	50	616	1,182	81 13 0	
Index to the Indian Atlas showing the sheets that have been published to 1st October 1883, of sheets on the scale of 1 inch = 1 mile, to accompany annual report.	Ditto ...	Ditto ...	Ditto ...	1	525	50	575	1,100	100 9 5	
Index to the Indian Atlas, on the scale of 1 inch = 4 miles.	Ditto ...	1 inch=128 miles	Imperial ...	1	105	.....	105	210	45 15 7	
Index to the standard sheets of the North-West Provinces and Oudh, on the scale of 1 inch = 1 mile.	.....	1 inch=32 miles	Ditto ...	1	...	102	102	102	13 6 4	
Total ...	.....	.....	.....	130	7,466	9,723	17,189	28,630	16,357 8 8	
Miscellaneous maps, &c.	.....	.....	.....	3	...	.....	.....	.....	171 5 0	Not yet printed.
Ditto ditto	.....	.....	.....	20	...	.....	5,857	4,849	945 1 6	
Departmental forms	.....	.....	.....	4	...	.....	.....	.....	35 13 8	Ditto.
Ditto ditto	.....	.....	.....	45	...	.....	54,004	46,690	4,392 1 7	
Grand Total ...	.....	.....	.....	202	7,466	9,723	77,050	80,169	21,901 14 5	

L 2.

Work done for other Departments.

Names of Departments.	Number of maps.	Number of sheets.	Number of sheets colored.	Number of sheets uncolored.	Number of copies printed.	Number of impressions.	Value.
							Rs. A. P.
Foreign Department	54	54	.....	54	4,056	3,202	1,704 0 5
Military Department	97	97	5	92	6,152	3,451	2,047 5 5
Revenue and Agricultural Department	5	5	.....	5	641	577	146 4 6
Telegraph Department	5	5	.....	5	5,650	6,500	566 6 3
Bengal Secretariat	29	29	15	14	8,206	4,799	783 13 1
Quarter-Master-General	11	11	.....	11	2,988	1,856	830 15 11
Meteorological Reporter to the Government of India ...	20	21	5	16	9,536	12,745	2,205 10 6
Ditto ditto ditto of Bengal ...	1	1	.....	1	100	100	34 12 0
Archæological Survey of India	7	7	.....	7	4,025	2,875	931 15 5
Geological Survey of India	8	8	4	4	4,559	7,974	1,109 8 4
North-West Provinces Gazetteer	6	6	.....	6	2,676	2,676	595 6 8
Asiatic Society	14	14	1	13	11,797	8,172	621 7 11
Public Works Department, Government of Bengal ...	5	5	.....	5	746	746	581 1 2
Ditto ditto, ditto of North-West Provinces and Punjab	3	6	3	3	2,627	6,904	2,298 14 7
Public Works Department, Government of India ...	4	4	1	3	763	1,425	424 5 0
Punjab Government	2	2	.....	2	1,324	1,324	283 4 0
Port Commissioners' Office	1	1	1	.....	165	495	175 6 7
Sanitary Commissioner with the Government of India ...	1	1	.....	1	812	1,624	198 0 0
Ditto ditto ditto of Bengal	1	1	1	.....	425	425	465 4 10
Superintendent, Government Printing, India	24	24	.....	24	7,813	2,607	307 7 2
Ordnance Department	12	12	.....	12	11,232	2,530	232 0 1
Board of Revenue	13	13	4	9	6,132	8,752	1,312 3 7
Medical Store Department	2	2	.....	2	300	300	45 12 3
Adjutant-General's Office	12	12	.....	12	2,424	816	169 13 7
Engineer-in-Chief, Behar-Assam State Railway ...	12	12	.....	12	1,200	1,200	487 7 5
Stationery Office	6	6	.....	6	1,525	1,525	327 10 7
Miscellaneous maps, plans, diagrams, &c.	38	38	5	33	10,272	12,705	2,181 15 6
Maps, &c., drawn, but not printed	103	103	10	93	.....	.....	2,144 7 2
Total ...	496	500	55	445	108,146	98,305	23,212 11 11

STATEMENT OF WORK DONE BY THE LITHOGRAPHIC OFFICE—*continued.*

L 3.

Statement of Type-work, exclusive of transfers, &c., already included in the cost of several lithographed maps, &c.

Subject.	Items.	Number of copies.	Number of impressions.	Value. Rs.	A.	P.
Circular Orders	49	10,433	12,033	364	9	0
Memoranda, &c.	476	223,807	324,686	5,459	5	0
Forms, &c., for Survey Department	82	90,071	253,935	4,531	14	0
Transfers of headings, footnotes, references of published maps, for Litho. and Photo. Offices	3,577	27,036	27,036	3,381	0	0
Rubber stamps made for Survey Department	.....	.....	.....	101	13	6
Total	4,184	351,347	617,690	13,838	9	6
Deduct value of transfers, &c., already included in the cost of several lithographed maps	.....	.....	.....	1,690	8	0
Balance	4,184	351,347	617,690	12,148	1	6

L 4.

General Abstract of Outturn and Value of Work performed.

Description of Maps.	Number of sheets.	Number of copies.	Number of impressions.	Value. Rs.	A.	P.
Departmental Work.						
General maps	22	3,658	5,025	2,164	6	4
Provincial ,,	13	900	2,850	693	9	6
Divisional ,,	2	207	207	270	8	2
District ,,	18	2,097	2,905	1,923	10	0
Plans of Cantonments and Cities	2	250	250	35	5	9
Atlas sheets	5	508	508	324	8	7
Standard sheets	17	1,699	1,699	1,840	1	11
Index maps	19	7,870	15,186	1,579	9	0
Miscellaneous maps, &c.	20	5,857	4,849	945	1	6
Departmental forms	45	54,004	46,690	4,392	1	7
Maps, &c., drawn, but not printed	39	.....	.....	7,733	0	1
Total	202	77,050	80,169	21,901	14	5
Work done for other departments	500	108,146	98,305	23,212	11	11
Total of Drawing and Printing in Lithographic Office	702	185,196	178,474	45,114	10	4
Work done in Type Department, items	4,184	351,347	617,690	12,148	1	6
Total Value	.....	.....	.....	57,262	11	10

Statement of Expenditure.

	Rs.	A.	P.
One-third pay of Superintendent	5,200	0	0
Establishment	34,319	2	1
Contingent charges	5,046	13	0
Total	44,565	15	1

Survey of India Department,
Lithographic Office,
Calcutta, the 1st October 1884.

J. WATERHOUSE, *Major*, s.c.,
Assistant Surveyor-General,
In charge Lithographic Office.

Extract from the Report of MAJOR J. WATERHOUSE, S.C., *Assistant Surveyor-General, in charge Photographic Office ;—season* 1883-84.

I HAVE the honour to submit the usual tabular statements of work done, expenditure, &c., in the Photographic Office, Survey of India Department, during the survey year from 1st October 1883 to 30th September 1884, viz :—

A. Abstract of work performed during 1883-84.
B. Comparative statement of outturn of 1882-83 and 1883-84.
C. Statement showing the value of work done for other departments.
D. Statement of expenditure and value of work done.

OUTTURN. —(*Ordinary.*)—The number of original maps and drawings received for reproduction during the year was considerably less than in the previous year ; consequently the outturn generally is smaller, though fairly up to the average. The decrease is principally in standard sheets and other departmental publications. The ordinary extra departmental work was of the same amount and miscellaneous character as usual ; but a large amount of silver printing and also of heliogravure and collotype was done in connection with the Calcutta International Exhibition.

(*Cadastral.*)—The number of cadastral sheets reproduced during the year was 5,202, or 89 more than last year. Of these, 2,976 were photo-zincographed and 2,226 zincographed. The total number of copies printed off was 6,825 less than last year.

The work of the office was somewhat interfered with by a fire which occurred early in November in the upper floor of No. 1, Wood Street, by which three almirahs containing stationery, file-proofs, and valuable chemicals were completely burnt, and more or less damage done to everything in the upper floor by the heat and smoke. Full particulars of the occurrence were reported at the time. Fortunately the building itself was not seriously injured, and as the repairs were overdue, the premises were repaired inside and out. This was done without any extra expense, and arrangements were made for carrying on the work without occupying other premises. Every effort was made to ascertain how the fire originated, but nothing could be discovered beyond the fact that it was caused either intentionally or accidentally by some one who entered the premises and broke open one of the burnt almirahs, which contained ordinary office stationery.

EXPENDITURE.—The expenditure of the office during the year has been Rs. 1,27,763-5, as shown in Table D, or Rs. 30,327 more than last year. This large increase of expenditure is principally due to increase of establishment and pay of Messrs. Haward and Turner, additional house rent for No. 2, Wood Street, cost of four new presses and additional stores procured from England in anticipation of an extension of the cadastral survey, cost of two new presses from Allahabad for printing the new administration maps, also a press and other stores sent out by General Walker for the collotype work. The cost of a new camera indented for in 1882 and supplies of paper indented for in 1883, which arrived late, and should have been included in last year's accounts, have also helped to swell the expenditure during the year beyond its normal amount. The total maount credited to the office is Rs. 1,26,532-11-10. The value of work done for other departments amounted to Rs. 24,468, which is well above the average, but on the other hand the value of the departmental work shows a large falling off, being only Rs. 23,986, and the balance against the office is Rs. 1,230.

PERSONNEL.—Mr. H. Haward, who, as reported last year, was appointed by the Secretary of State, Head Assistant, arrived from England on the 11th January 1884, and took over charge of the collotype work, to which he has been specially trained. On his arrival, Mr. A. W. Turner, who had been officiating as Special Assistant, became supernumerary, but I was able to retain his services in connection with taking photographs of the principal Indian art exhibits in the Calcutta Exhibition, the expense being borne by the Government of Bengal. Afterwards, under sanction of the Government of India, Mr. Turner was appointed temporarily as Special Assistant for eight months, from the 1st of May, in order to work up the process of heliogravure. Baboo Kally Dass Seal, Chief Draftsman of the Marine Survey, was, with the sanction of the authorities of the Marine Survey, transferred to the office as Chief Draftsman and Engraver. He joined on the 1st September, and proved useful in touching up the heliogravure plates. I may take this opportunity of reporting that this assistant, who promised to do valuable service in connection with the heliogravure processes, died early in November last, and his place will be most difficult to fill, as he was an excellent draftsman, a good engraver, an amateur photographer, and generally a man of more varied talent than men of his class usually are.

Mr. Watson returned from deputation at the Lithographic office on the 3rd March, and resumed charge of the cadastral zinc-printing section. Mr. B. Wilson, who had been employed as an assistant zincographer on the cadastral establishment, was transferred to the Lithographic office as assistant lithographic printer from the 17th March.

With the sanction of Government, four apprentices have been appointed to the office and are being trained in various sections.

PROCESSES.—No changes have been made in the ordinary working processes of the office.

Collotype.—Mr. Haward, the new Head Assistant, being specially skilled in the working of this process, it was started again on his arrival, and has been carried on more or less steadily since ; stoppages having occurred for want of suitable paper. The principal work done by this process was printing the gold medal award certificates for the Calcutta International Exhibition, of which 1,150 copies were supplied. A commencement has been made

of producing a series of permanent photographs of objects of art in the Exhibition for publication. Two plates of views of Mussooree and Naini Tal have also been done for the Gazetteer of the N.-W. Provinces. Notwithstanding Mr. Haward's skill in working the process, and the fact that he has been working with excellent and reliable formulæ kindly communicated by the Autotype Company of London, great difficulties have been met with in working in the hot weather. With further experience, however, it is hoped that these will be overcome, and the process be made capable of being worked steadily at all seasons. Mr. Haward also tried some experiments in making grained transfer prints for the reproduction of half-tone subjects on zinc or stone, but they were not more successful than previous attempts of the same kind.

Heliogravure.—Under Mr. A. W. Turner considerable progress has been made in these processes, particularly in a new method which is practically a modification of Fox Talbot's old process of photoglyphic engraving. In this method the image is etched on the copper through a negative pigment print, which forms a reserve of different thicknesses in different parts of the image, thin in the shadows and thick in the lights, which offer a corresponding resistance to the action of the etching fluid, and thus the plate is deeply hollowed out in the shadows where there is little or no gelatine, while in the high lights, where the gelatine is thickest, the copper is scarcely affected, and retains its polish. This method has several advantages over the process we have hitherto used, in which a positive gelatine pigment print is developed on the copper plate and then electrotyped, in being much quicker. Instead of taking three weeks or a month, as required for electrotyping, the preparation and etching of a plate can be finished in a day. A reversed negative is not required, any good ordinary negative being suitable. The effects produced are much richer and fuller in gradation than is generally the case with the photo-electrotype prints. At the same time much more artistic and manipulatory skill is required in producing and working up the plates, and the etched images are so delicate that the greatest care has to be taken not to lose or injure the most delicate half-tones. The etching process seems likely to be most useful for line work, and has already been applied successfully to the production of some of the new district and provincial administration maps, for the illustration of reports, &c.

The following is a description of the new process as worked out by Mr. Turner.

The negative should be of good quality, giving a good brilliant silver print. It should not be reversed.

The first thing to be done is to get a transparency from the negative, and upon the quality of this transparency much of the success of the process depends. The best method of obtaining the transparencies seems to be by taking a pigment print from the negative with the ordinary autotype tissue and developing it upon a plate of glass coated with collodion. The image thus obtained is intensified with permanganate of potash. By modifying the exposure and intensification, good transparencies may be obtained from apparently unsuitable negatives. The transparency should be strong, with clear glass in the highest lights, so as to bear from 20 minutes to half an hour's printing in the shade, and upon development leave almost clear copper in the deepest shadows. For line subjects the exposure necessary to obtain a good transparency is from 3 to 5 minutes in the sun. If, however, there should be a tendency for the lines to leave the plate on developing, a shorter exposure should be given and intensity obtained afterwards. For half-tone subjects the exposure in the shade may vary from 15 minutes to half an hour, according to the density of the original negative. After development, the gelatine image is intensified with a 1 per cent. solution of permanganate of potash, poured on and off till sufficient intensity is obtained, and after washing away all the permanganate, is treated with spirit of wine and dried off.

The next operation is the preparation of the copper plate for receiving the negative pigment print. The plate, having been thoroughly polished, receives a coating of finely powdered bitumen, which forms a grain upon it. For this purpose a large box with a lid is used; a quantity of bitumen very finely powdered is placed in it and blown about with a bellows so as to produce a cloud of dust inside the box. As soon as the coarser particles have subsided, the plate is placed inside the box, the lid being closed, and allowed to remain for 5 or 10 minutes, to allow a sufficient quantity of dust to deposit itself, according to the density of grain required, which is much greater for half-tone subjects than for line work. The nature and perfection of this grain have a great influence on the picture, and some experience and care are required to obtain satisfactory results. Should sufficient dust not be deposited at first, the operation may be repeated.

This loose deposit of powdered bitumen must now be fixed, so that it may remain firmly attached to the plate and not be liable to be rubbed off. One way of doing this is by heating the plate evenly all over until the bitumen is almost melted. Mr. Turner adopted an ingenious method which he considers preferable to heat. Sufficient benzole is poured into a flat dish to cover the bottom of it, and the plate is laid face downwards on two supports about half an inch above the surface of the benzole. The dish is covered over, and the plate left exposed to the fumes of the benzole for about 2 or 3 minutes, the time depending on the distance of the plate from the liquid. When the grain is fixed, the surface of the plate will have lost its dull powdery appearance and be semi-brilliant, while rubbing with the finger will not remove the deposit. The exposure to the benzole should not be too much prolonged, otherwise the grains lose their sharpness. I have found that fuming with oil of lavender is also very effective, and seems to give a sharper and finer grain, though it takes about half an hour to produce the proper effect. In warm weather 15 minutes suffices.

When the grain is fixed, the plate is placed in clean cold water and allowed to remain till the negative print is ready for development upon it. It will be found that after soaking

for some time all greasiness is removed from the plate. I have found that the same effect may be produced more quickly by flowing the plate over with spirit of wine, and it is advantageous in other ways to do so before placing it in the water, when the oil of lavender is used for fuming.

There are other ways of obtaining a resinous grain on the copper plates as employed by aquatint engravers, which would probably answer well, but we have not yet tried them.

A pigment print is next taken from the transparency on the ordinary autotype tissue (standard brown) and developed in the usual way on the prepared copper plate. This gives a negative image on the plate, and considerable care is required in developing, because the lights and shadows being reversed, it is difficult to know when to stop the development. The deepest shadows should show bare copper, and the lights must be quite free of all soluble gelatine, which is best accomplished by slow development with water at a moderate temperature. As the parts of the film forming the lights of the picture are thicker than is usually the case, great care must be taken to keep them adherent to the copper during development in warm weather.

After development the image is flowed over with a 5 per cent. solution of alum and dried off with spirit of wine. This clears up the shadows, and gives a sharper and crisper image than is obtainable by drying spontaneously. It is well to begin with weak spirit containing about equal parts of water and spirit, flowing it over the plate from one corner, so as to drive before it the water in the film, together with the scum which the spirit forms with any loose soluble gelatine remaining on the surface. After treatment with stronger spirit till all moisture is removed, the plate is finally flooded with a solution of—

Glycerine	1 part
Spirit of wine	20 parts.

and left to dry. This last treatment is only necessary in dry weather to prevent the splitting off of the film on drying.

When dry, the plate is ready for etching. The borders of the plate all round the picture are painted with black varnish, and the back of the plate may also be painted with it. The varnish being dry, the plate is placed in a dish and covered with a solution of perchloride of iron and water in equal parts with one-fourth of alcohol added. This immediately attacks the deepest shadows where there is little or no gelatine, then gradually penetrates the half-tones, and ultimately the thicker parts of the film forming the lights of the picture; the highest lights should remain unattacked. It is difficult to estimate the time required for etching the image, but 4 to 5 minutes is usually sufficient for half-tone subjects printed from a good dense transparency. With practice the progress of the etching may be watched, and stopped as soon as it is seen that the high lights are reached, though this is difficult on account of the dark colour of the film.

As soon as the plate is considered sufficiently bitten, the gelatine is quickly washed off under a strong stream of water. Should there be any difficulty in removing it, a little bicarbonate of soda rubbed on it will soon clear it off. Care must be taken not to allow time for the water to penetrate the film, otherwise the high lights will become etched. When clear of gelatine, the plate is dried, and the black varnish cleaned off the back and edges with benzole. The plate is then carefully cleaned with tripoli or other soft polishing powder which brings out the image, and is ready for printing.

Should the plate not be bitten deep enough, it may be improved by skilful rebiting, as practised by aquatint engravers. Mr. Turner's method, with which he was very successful, is as follows.

The etched plate is rolled in carefully with an India-rubber lithographic roller (Lanham's patent), charged with a composition made of—

Hard retransfer ink	2 parts.
White wax	1 „

Cocoanut-oil sufficient to allow the roller to work easily.

The roller is prepared with a hard and almost dry layer of the above ground, and is applied to the plate with considerable pressure, till a thin layer of the same is transferred to the plate. When evenly and sufficiently coated, the plate is heated to melt the composition. Great care must be taken at this stage that none of the fine work gets clogged, and at the same time sufficient of the resist should be applied to allow an application of the etching fluid for a second or two. After this slight rebiting a rather thicker coat of the resist can be applied without danger of clogging, and the etching fluid allowed to act longer. This process of coating the plate with the resist, heating, and etching is continued, increasing the time of rebiting each time till the image is of sufficient strength for printing.

This method of rebiting has also been utilized with great advantage in repairing some of the old and worn-out plates of the Atlas of India. By stopping out the names and other details not required to be bitten, after the plate has been rolled in with the resist composition, and allowing the etching fluid to act on the worn-out hill portions for only a minute or two, an amount of work may be done in a few days that would take an engraver months to go over by hand.

Much of the work done by the new process has been experimental, but three good plates of Indian art-work have been done by it, and nine plates of the district maps. For the latter the rebiting process was of great service in getting the requisite printing depth.

Nine plates of half-tone subjects, among them one 20″ × 18″ for the award certificate of the Exhibition, have been produced during the year by the electrotyping process, but since the introduction of the etching method the electrotyping has rather gone out of use. It is, however, a valuable process, and I propose to continue working it as well as the new method.

Exhibition.—Notwithstanding the fire which occurred just at the time that preparations were being made for the Exhibition, and by which many of our best specimens were destroyed, the office was able to exhibit a large and representative collection of examples of the various kinds of work executed by photozincography, silver-printing, heliogravure, and collotype, and the practical working of these photo-mechanical processes was illustrated as far as it could be by series of specimens showing the different intermediate stages of the operations in each. For these specimens a gold medal was awarded to the office.

A good deal of other work has been done in connection with the Exhibition. Under my superintendence, Mr. Turner took about 200 negatives of the best specimens of Indian art-ware and views of the Exhibition for the Government of Bengal, of which ten sets have been printed by ordinary silver-printing. Many of the subjects have also been reproduced by the collotype and heliogravure processes for practice, and with a view to subsequent publication. The gold medal award certificates were all printed by collotype, and the silver and bronze medal and 3rd, 4th, and 5th class certificates were printed in the copper plate printing section of the Engraving Office from the heliogravure plate prepared here. The total number of copies printed from the latter was 3,500.

A good deal of my time and leisure were taken up in drawing up new plans of buildings for the accommodation of the Lithographic and Photographic Offices, and this and other calls on my time in these two offices have prevented me from devoting so much time as I have usually done to the practical working and improvement of the various processes pursued in the office. There was, however, the less necessity for it, as I had the benefit of the services of Messrs. Turner and Haward for this purpose. At the end of the year, after the office had closed for the Doorga Poojah holidays, I proceeded on a tour of inspection to the field parties in recess at Naini Tal and Mussooree, and also visited Simla. My proceedings on this tour will more properly be noticed in next year's report.

B.

Comparative Statement of the Outturn of 1883-84 *with that of the previous year*

	Ordinary Work.				Cadastral Maps.			
	1st October 1883 to 30th September 1884.	1st October 1882 to 30th September 1883.	Difference.	Difference in square inches.	1st October 1883 to 30th September 1884.	1st October 1882 to 30th September 1883.	Difference.	Difference in square inches.
Originals	941	1,152	−211	.....	5,202	5,113	+89	.....
Negatives	1,869	2,040	−171	.....	2,978	3,462	−484	.....
Ditto, square inches	626,359	580,681	.....	+45,678	2,285,902	2,658,816	.....	−372,914
Photographic transfers	1,929	1,937	−8	.....	2,995	3,629	−634	.....
Ditto, square inches ...	670,202	588,880	.....	+81,322	2,328,798	2,687,066	.....	−358,268
Silver prints	2,211	584	+1,627	.....	.....	.....	.....	.....
Ditto, square inches ...	230,184	141,724	.....	+88,460	.....	.....	.....	.....
Collotype prints	3,313	.....	+3,313	.....	.....	.....	.....	.....
Heliogravure plates	23	.....	+23	.....	.....	.....	.....	.....
Transfers to zinc (plates printed) ...	713	977	−264	.....	5,083	5,174	−91	.....
Number of pulls	99,210	129,984	−30,774	.....	122,544	129,369	−6,825	.....
Ditto of printed sheets (single)	133,844	301,894	−168,050	.....	122,544	129,369	−6,825	.....
Ditto ditto (combined) ...	113,462	286,795	−173,333	.....	58,874	58,344	+530	.....
Proofs	1,237	1,401	−164	.....	5,240	5,027	+213	.....
Transfers	1,025	1,174	−149	.....	5,407	5,214	+193	.....

C.

Statement showing the Amount and Value of the work done for other Departments and despatched between 1st October 1883 and 30th September 1884.

	Number of original sections.	Number of negatives.	Number of pulls.	Number of complete copies.	Silver and other prints.	Collotype prints.	Value. Rs. A. P.
Asiatic Society	3	3	1,485	1,485	.....	.....	127 9 6
Adjutant, Presidency Volunteers	5	.....	4,000	1,200	.....	.....	650 2 11
Agents, Darjeeling-Himalayan Railway	.....	.....	12	12	.....	.....	3 0 0
Calcutta International Exhibition Committee	3	5	810	1,310	15	1,153	785 6 5
Curator of Ancient Monuments	16	16	3,100	21,000	.....	.....	737 14 8
Chief Engineer, Bengal, Public Works Department.	50	150	5,104	4,664	.....	.....	4,123 7 0
Chief Engineer, Irrigation Branch, Public Works Department, Punjab.	18	24	2,500	3,600	.....	.....	1,001 9 0
Director of Garrison Instruction in India	2	3	800	800	.....	.....	157 9 11
Director-General of Railways	1	4	2,000	2,000	.....	.....	511 5 11
Ditto of Telegraphs in India	2	3	1,250	2,500	.....	.....	178 8 3
Eastern Bengal Railway	16	21	975	900	.....	.....	405 12 0
Foreign Department	1	1	50	50	.....	.....	67 8 0
Government of India, Military Department	6	3	168	103	.....	.....	84 11 1
Government of India, P. W. ,,	10	22	2,615	4,135	.....	.....	981 9 7
Government of India, R. and A. ,,	2	2	400	650	.....	.....	58 14 9
Government of Bengal, P. W. ,,	23	72	4,460	8,510	.....	.....	1,812 10 2
Government Architect	0	18	550	750	.....	.....	254 9 4
Inspector-General of Military Works	55	155	5,155	5,035	.....	.....	4,096 0 10
Junior Secretary to the Chief Commissioner, British Burmah.	1	4	210	100	.....	.....	117 15 6
Mayo School of Arts, Lahore	10	.....	.....	.....	44	.....	25 12 0
Meteorological Reporter to the Government of India.	4	4	1,030	350	.....	.....	267 11 3
Manager, Rajputana and Malwa Railway	5	8	1,900	1,000	.....	.....	381 2 2
Port Officer, Calcutta	1	1	150	150	.....	.....	29 3 6
Port Commissioners, Calcutta	40	127	5,395	5,165	.....	.....	3,009 10 3
Provincial Gazetteer, North-Western Provinces	7	8	2,168	2,153	.....	530	483 7 0
Quarter-Master-General in India	26	56	6,859	7,520	.....	.....	1,768 12 5
Sanitary Commissioner, Assam	1	.....	500	250	.....	.....	64 11 3
Settlement Officer, Pegu and Hanthawaddy	1	1	503	1,000	.....	.....	117 3 0
Superintendent, Government Printing, Bengal	1	1	625	5,000	.....	.....	85 2 6
Ditto ditto ditto India	1	1	104	104	.....	.....	24 8 6
Ditto of Stationery	.....	.....	268	268	.....	.....	46 14 0
Ditto of Geological Survey of India	6	9	2,310	2,280	172	.....	544 2 3
Ditto of Carriage and Wagon Department, East Indian Railway.	4	13	150	100	.....	.....	252 2 8
Ditto, Way and Works, Rajputana and Malwa Railway.	31	44	1,000	1,750	.....	.....	979 13 3
United Service Institution, Simla	.....	.....	.....	.....	.....	250	31 8 0
Colonel Tanner	5	5	20	20	11	.....	70 15 6
R. H. Wilson, Esq., C.S., Midnapore	2	2	.....	.....	4	.....	2 8 0
Major R. V. Riddell, R.E.	1	1	.....	.....	1	.....	11 4 0
Colonel Roberts	2	.....	.....	.....	8	.....	7 8 0
Dr. G. King	2	2	12	12	.....	.....	10 0 0
J. F. Fleet, Esq.	1	2	.....	.....	2	.....	15 10 0
G. G. Palmer, Esq.	.....	.....	.....	.....	4	.....	2 8 0
Total	371	791	58,708	86,826	261	1,933	24,568 6 4
Cadastral, N.-W. Provinces photozincographs	856	856	9,240	5,079	.....	.....	13,122 5 0
Ditto, ditto zincographs	906	.....	9,500	7,724	.....	.....	9,438 12 0
Ditto, British Burmah photozincographs	1,155	1,155	30,293	18,495	.....	.....	18,696 11 0
Ditto, ditto zincographs	502	.....	17,068	7,990	.....	.....	5,616 2 0
Ditto, Bengal photozincographs	829	829	33,152	7,620	.....	.....	15,093 8 0
Ditto, ditto zincographs	712	.....	32,238	11,423	.....	.....	11,390 12 0
Total Cadastral	4,960	2,840	140,681	58,321	.....	.....	73,368 2 0
GRAND TOTAL	5,331	3,631	199,289	145,147	261	1,933	97,926 8 4

D.

Statement of Expenditure of the Photographic Office, Survey of India Department, during the Survey year, from 1st October 1883 to 30th September 1884.

	Rs. A. P.	Rs. A. P.
NORMAL ESTABLISHMENT.		
Superintendent's salary	10,400 0 0	
Establishment	28,320 1 7	
Office rent and taxes	4,480 14 0	
Contingencies	1,976 15 5	
		45,177 15 0
CADASTRAL ESTABLISHMENT.		
Establishment	33,858 11 9	
Office rent and taxes	2,769 5 3	
Contingencies	7,696 1 8	
		44,324 8
Chemicals and stores received from England	22,539 2 9	
Paper received from England	9,672 1 9	
		32,211 4 6
Stores received from the Mathematical Instrument Office	136 9 0	
Cost of repairs of articles at Mathematical Instrument Office	333 15 0	
		470 8 0
Paper received from the Lithographic Office	2,001 13 0	
Miscellaneous stores received from other offices	94 11 2	
		2,096 8 2
Paper and map cloth from the Stationery Office	2,123 4 0	
Miscellaneous stores from the Stationery Office	60 5 7	
		2,183 9 7
Work done by the Foundry and Shell Factory and by Public Works Department	176 9 9	
Lithographic presses received from the Superintendent, Government Printing, Allahabad	1,023 7 4	
Shipping and landing charges incurred by the Marine Department	99 4 0	
		1,299 5 1
Total	.....	1,27,763 5 0

Statement showing the amount credited during the Survey year, from 1st October 1883 to 30th September 1884.

	Rs. A. P.	Rs. A. P.
Standard maps and other maps and plans issued to the Survey of India Office	23,287 1 8	
Miscellaneous work done for the other branches of the head-quarter office	698 14 9	
		23,986 0 5
Miscellaneous maps and plans, extra departmental	24,568 6 4	
		24,568 6 4
Cadastral maps, North-West Provinces	22,561 1 0	
Cadastral maps, British Burma	24,312 13 0	
Ditto, Bengal	26,494 4 0	
		73,368 2 0
Old tin and packing cases sent to Mathematical Instrument Office.	172 1 0	
Articles and stores supplied to other branches	431 11 1	
		603 12 1
Sale of unserviceable articles	229 8 9	
Pure silver recovered from silvered paper and collodion films	3,833 0 5	
		4,062 7 2
Articles supplied to Government Printing Office	54 0 0	
		54 0 0
Balance against the department	.....	1,130 9 2
Total	.....	1,27,763 5 0

Narrative Report of the Trigonometrical Branch Office, Survey of India, for the 12*-month ending* 30*th September* 1884.

THE following changes took place during the year under report:—

Lieutenant W. H. Pollen, R.E., was appointed Assistant Superintendent, 2nd grade, and posted to this office on 26th April 1884, and Lieutenant S. G. Burrard, R.E., was appointed Assistant Superintendent, 2nd grade, and posted to the office on the 2nd September 1884. Two newly-passed candidates, viz. Messrs. H. A. Charrier and C. G. S. Wood, Assistant Surveyors, 3rd grade, were posted for instruction to the office from 21st April and 12th August 1884, respectively; and Mr. W. W. McNair, Surveyor, 4th grade, from 17th August, with the view of his bringing up his report on his late explorations. One computer resigned on 1st December 1883 and another was entertained on 3rd March 1884. One compositor was appointed on 5th March 1884. One apprentice draftsman died on 17th October 1883, another resigned on 2nd December 1883, and a third was discharged on 7th January 1884, and three apprentice draftsmen were entertained. Manrakhan, head artificer, after a highly meritorious service of about 20 years, was placed on an invalid pension from 4th April 1884, and Rahmatullah was entertained in his place on 4th August 1884.

The following cost-table of work done in the computing branch is in similar form to that given for last year:—

Cost-table in Rupees.

CLASS.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Average per cent.
1. Records	56	24	18	28	20	31	70	53	58	59	40	42	2
2. Computations	315	452	343	461	554	465	411	331	451	459	420	590	18
3. Account, returns, correspondence	599	581	418	554	504	546	520	595	629	605	631	752	23
4. Supply	55	31	27	42	50	66	25	81	90	44	58	87	2
5. Press copy	335	428	267	256	190	168	317	278	302	227	197	343	11
6. Press proofs	217	258	157	201	336	264	267	345	282	273	211	245	10
7. Charts	...	28	65	60	65	...	...	..	25	...	7	2	1
8. Stations	58	62	21	77	130	136	81	93	92	126	135	61	4
9. Leave and vacations	425	157	700	346	324	279	442	261	102	242	239	217	13
10. Miscellaneous	137	186	150	115	127	244	156	314	275	208	546	264	9
11. Meteorology and general science	241	230	200	222	56	223	105	191	146	239	135	69	7
Total ...	2,437	2,437	2,362	2,362	2,362	2,422	2,422	2,542	2,542	2,542	2,619	2,662	100

The percentage this year under classes 2 and 5, viewed collectively, is again considerably below that for the year 1881-82, and is, moreover, 2 per cent. below that for last year. This decrease is in a great measure due to two causes: *first*, to increments under classes 3 and 10 consequent on the diversion to a considerable extent of the services of Mr. C. Wood to the current duties of the office of the Deputy Surveyor-General; and *secondly*, to Mr. Peychers having been employed for about a month in the preparation of the equipment for the survey party to accompany the Afghan Boundary Commission. The decrease under class 11 is due to the cessation of actinometric observations.

The particulars of the work done, indicated in a general manner in the preceding table, are given hereafter in such detail as appears desirable.

CLASS II.—COMPUTATIONS (IN DUPLICATE).

South-West Quadrilateral.—This is the last section of the principal triangulation of India remaining for final reduction. Certain preliminary calculations in connection with the reduction have been made as opportunity offered, embracing—

Triangles computed up to Log. feet	...	...	208
Ditto ditto Log. sines	...	...	50
First deductions of λ, l and A (real traverse)	..	...	33
Ditto ditto (check traverse)	...	...	28

Southern Trigon.—The calculations connected with the final reduction of the principal triangulation having been completed and the data being in course of compilation for the press, the secondary triangulation, which, together with Colonel Lambton's triangulation of Southern India, forms a large and intricate mass, can now be taken in hand. A small commencement with some of the outlying portions has already been made.

Malabar and Coimbatore Series.—Computed 60 triangles, 27 first and 16 second deductions of λ, *L* and **A**.

Coringa Series.—Adjusted and computed 55 triangles and 77 deductions of λ, *L* and **A**.

Masulipatam Series.—Computed 60 triangles, 1 traverse of 15 stations, and 55 deductions of λ, *L* and **A**.

North-West Quadrilateral.—The Jodhpore and Eastern Sind Series are two chains of triangles appertaining to the North-West Quadrilateral. They were executed subsequently to the final reduction of that Quadrilateral. The principal triangulation was reduced prior to the year under report. The secondary triangulation is now also nearly disposed of. The calculations performed during the year have been :—

Jodhpore Meridional Series.—Secondary triangulation. Computed 15 deductions of λ, *L* and **A**.

Eastern Sind Meridional Series.—Secondary triangulation. Computed 4 traverses of λ, *L* and **A**, 102 ordinary deductions, and 16 first, 16 second, and 16 third deductions of λ, *L* and **A** : 209 triangles have been adjusted and computed, and 101 computed only: vertical angles of the Jeysulmere Minor Series have been deduced and corrected for dislevelment error.

Burma Secondary Triangulation.—(Executed by Moung Shoay Gyoke). Computed 44 triangles, 30 deductions of λ *L* and **A** and 90 deductions of heights, and both the horizontal and vertical angle books were examined.

Survey Detachment in Kashmir.—This detachment consists of a sub-surveyor and a small native establishment. The sub-surveyor both surveys with the plane-table and takes angular observations with a theodolite, but he was unable to work out the latter in the field, and his time in recess was fully occupied in preparing his fair map: hence the necessary calculations had to be performed in this office ; they were as follows :—Adjusted and computed 241 triangles, and computed 143 deductions of λ, *L* and **A** and 101 deductions of heights ; lengths and azimuths of 86 sides computed from the λ and *L* of their extremities ; positions of 31 points determined from observations to three known points ; also the horizontal and vertical angle books brought up and otherwise completed. This work engaged a pair of computers for nearly 3 months.

Andaman Island Survey.—Computed a portion of the observations for azimuth at Chatham Island to assist the officer in charge of No. 3 party, Andaman Topographical Survey.

Observed Latitudes.—Endeavours have been made to push on these calculations, it being at one time hoped that they might be brought to a conclusion before the retirement of Mr. Hennessey, under whom they have been directly carried on since they were commenced ; but interruptions were unavoidable; and partly from having to aid another party with computing power, partly from sickness of one of the computers, and partly from other causes, the calculations are still far from complete. The work done during the twelve months was as follows :—

Data for determination of latitude, by each star, of 27 stations, have been deduced and abstracted from the original computations as last year, and latitudes computed therefrom. Deduced values of latitudes, by each star, have been abstracted for 95 stations in a table as last year. A table has been made showing the errors on the mean latitudes of stations by each star and by means of which the adopted values of N. P. D. (or provisional place) are in course of being checked. Another table has been put in hand to compare the astronomical with the geodetical latitudes of 117 stations (including revisits) and to ascertain thereby the deflections of the plumb lines. With a view to prove the identity of the latitude stations with the geodetic, the original records have been looked into for the necessary information, and their identity, with few exceptions, established. The services of the two pairs of computers engaged on this work could not be employed on it for more than five months.

Electro-telegraphic Longitude.—The computations were done entirely under Major Heaviside's supervision; they appertained principally to season 1883-84; he was assisted for 2¾ months by two computers.

Spirit-levelling.—Levels between Calcutta and False Point were examined and the errors of three circuits were obtained.

Auxiliary Tables.—Tables I, II, VI, XVII, XVIII and XXVI were extended from lat. 36° to 40° for the use of the Afghan Boundary Survey Party.

Captain Barrow's Barometrical Observations in Nepal.—Thirty-three deductions of heights from aneroid observations were computed.

Class 3.—Accounts, Returns, Correspondence.

A portion of the work embraced in this class is of a purely professional nature, but the class also embraces the current work of the office of Deputy Surveyor-General, Trigonometrical Branch, as no special establishment has been yet provided for that office.

Class 4.—Supply.

Requisitions from over 24 officers, for data of various kinds, have been complied with. Some of them involved a good deal of labour and calculation; 1,072 despatches of maps, charts, books, forms and Survey of India Department notes (January to August) have been made during the year.

Class 5.—Press Copy.

North-East Quadrilateral.—Synoptical Volume XXI was completed in respect to preface, table of contents, errata *et* addenda, and reference tables. Assam Longitudinal Series. Co-ordinate lists of stations and points grouped in square degrees were prepared.

Southern Trigon.—The compilation of the descriptions of the principal stations for publication has been proceeded with. Abstracts of heights of principal stations have been made for the South-East Coast and Mangalore Meridional Series in part, and for the South Konkan series in full. Triangles of the Great Arc Series, section 8°—18°, have been corrected up and azimuths abstracted in part, and heights in full. Computations of observed azimuths of the Madras Meridional and Coast Series have been examined.

South-East Quadrilateral.—The introduction of the South Párasnáth Series has been finished, and an abstract of the non-circuit triangles of the South Párasnáth and South Máluncha series, showing the details of their final adjustment, was prepared.

North-West Quadrilateral.—The azimuth and co-ordinate lists of the Jodhpore Series were partly prepared for the press. The introductions for this and the Eastern Sind Series were kindly written by Major Rogers while on leave at Mussooree. The observed angles of the Eastern Sind Series were arranged and compared; also the abstracts of the calculation of heights of principal stations, of the figural reductions, and of the observed azimuths. For the Synoptical Volume of the same series, azimuth and co-ordinate lists were prepared in part, and a portion of the secondary triangles.

Electro-telegraphic Longitude operations.—Examined press copy for season 1881-82.

Miscellaneous.—Descriptions of stations for revised preliminary charts of the Burma Triangulation, seasons 1877-80, compiled. Routes in Western Himalayas (new edition):—Revised and corrected Polymetrical Table No. I; Tables II and III are in hand. Spirit-levelled pamphlets:—Adjusted levels of bench marks between mean sea-level at Bombay, Madras, and Karwar for a revised edition of these levels. Survey of India Department notes supervised through the press.

Class 7.—Charts.

Spirit-levelled chart, Calcutta to False Point, seasons 1881-83, examined and corrected. Revised preliminary chart of Burma Triangulation, seasons 1877-80, compared and finally examined. Burma Secondary Triangulation Chart, seasons 1875-77 and 1879-81, compared. Revised sheets Nos. 1 to 3 of A—K's explorations, examined. Entered numerals of stations, triangle numbers, &c., in two copies of rough reduction chart of the South-West Quadrilateral, and prepared a rough working chart of the Jeysulmere Minor Series.

Class 8.—Stations.

The subjoined table is similar to that given in the reports for the two preceding years. During the year under report 55 new stations have been added, including 15 beacons (on the east coast of India) specially erected and their positions fixed for the benefit of the Marine Survey Department. There were 865 stations repaired at an average of Rs. 4-1 (against Rs. 4-3 per station in the previous year). The number of officers who have not reported during the year is ten less than before, but every endeavour will be made during the ensuing year to make special application to those whose reports are in arrears.

Number of stations.	Number of districts in which stations occur.	Number of lists in which stations are included.	Duplicate (*i. e.* finally disposed of) lists.		Number of lists sent out from this office during the current year		Number of local officers who have—		Number of stations protected during the year.	Number of bills audited and passed.	Total cost.	Average cost per station for repairs.	Number of letters, dockets, &c., issued.
			Number of lists.	Number of stations included.	New.	Supplementary.	Reported during the year.	Not reported during the year.					
											Rs.	Rs. A.	
3,590	330	317	311	3,522	.....	3	240	68	55	212	3,511	4 1	About 380

Class 10.—Miscellaneous.

Great Trigonometrical Survey Synoptical Volumes.—Volumes XIX, XX and XXI: Pages examined and collated; distribution lists prepared and presentation labels written and inserted in Synoptical Volumes XVII to XXI. Transcription of Library Catalogue proceeded with. Mergui Base-line:—Introduction and General Narrative transcribed in one copy and

explanatory notes compared; data for projection of plates prepared. Fifteen candidates for the Junior Branch of the Survey Department examined. A set of examination papers in Astronomy for the Senior Branch prepared. Sixty-eight sets of observations, both to the sun and stars (on 18 days) for determination of local time taken and reduced, and the rating of chronometers and clocks attended to as usual. Lieutenant Pollen, R.E., Assistant Superintendent, and Messrs. H. Charrier and C. G. S. Wood, Assistant Surveyors, received professional instruction. The book of routes in the Madras Presidency (by the Quarter-Master-General's Department) was corrected up to date. All instruments required for the equipment of the Survey Party to accompany the Afghan Boundary Commission were thoroughly cleaned, adjusted, compared and otherwise tested, and suitable mule-trunks were made up for their transport. The klassies for the party had also their wants attended to in respect to warm clothing, &c. In fact the whole party was completely equipped at this office.

Class 11.—Meteorology and General Science.

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-Western Provinces and Oudh, daily weather telegrams were sent from Mussooree to Simla during the six months the office was open at Mussooree, and anemograms for Mussooree for six 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 nine months' observations of deep-sunk earth thermometers have been added. The table of monthly means given in last year's report has accordingly been extended to 30th September 1884. The table has been altered in arrangement to enable a ready comparison to be made.

Mean Monthly Readings of Deep-sunk Earth Thermometers.

Depths 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	76°·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	.....	.....	.....
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°·84	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	.....	.....	.....
6·4	1881	.....	.....	.....	.....	.....	80°·06	81°·01	80°·75	81°·24	80°·33	75°·80	70°·58
	1882	67°·17	68°·06	67°·75	72°·29	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	69°·71
	1884	66°·03	65°·61	67°·95	72°·36	76°·99	80°·76	81°·46	81°·64	81°·10	.....	.....	.....
3·2	1881	.....	.....	.....	.....	.....	85°·03	83°·29	82°·03	82°·40	79°·67	72°·20	65°·63
	1882	62°·57	62°·31	67°·61	75°·40	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	.....	.....	.....
1·1	1881	.....	.....	.....	.....	.....	86°·16	84°·14	82°·55	83°·19	77°·81	67°·81	60°·72
	1882	58°·91	59°·41	60°·50	78°·88	84°·99	88°·24	83°·48	84°·08	82°·80	77°·85	67°·96	62°·17
	1883	57°·08	58°·45	65°·87	79°·63	86°·05	87°·94	84°·55	84°·89	82°·19	76°·70	65°·41	57°·83
	1884	58°·28	59°·89	69°·66	80°·14	88°·27	88°·57	86°·59	82°·03	81°·64	.....	.....	.....
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°·02	83°·47	75°·04	72°·36
	1883	64°·80	63°·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°·42	89°·51	97°·33	89°·09	83°·86	79°·73	80°·30	.....	.....	.....

A—K's explorations in Great Tibet and Mongolia.—Translation of his diary examined and corrected. Tables of observed latitudes and boiling point heights prepared and those of air-temperatures, population, &c., also a vocabulary of certain Tibetan and other words, occurring in the report, compiled.

Sub-Surveyor Ahmad Ali's account of Dardistan translated into English.

Actinometry.—As reported last year, Sergeant Rowland and his assistant started from Dehra on the 3rd October 1883 for Leh; since then no further observations have been taken at Musscoree. A batch of six thermometers was received in November 1883, and remains in store.

TYPOGRAPHIC BRANCH.

The usual table showing the work annually performed by this branch during the past five years is given below, the unit (a page of foolscap) being the same throughout :—

	1879-80.	1880-81.	1881-82.	1882-83.	1883-84.
Pages composed	1,421	1,363	1,283	1,381	1,498
,, printed	494,136	480,672	471,616	475,686	362,386

An analysis of the pages composed furnishes the following :—

		Pages.
Of Professional Volume ...	Longitude Volume	143
	Eastern Sind Series	58
	Jodhpore Series	129
	S. Párasnáth and S. Málúncha Series ...	78
	Southern Trigon	97
	Total ...	505
Of Synoptical Volume ...	Assam Longitudinal Series	33
	Volumes XIX and XX	9
	Volume XXI	20
Of North Afghanistan Triangulation		6
,, Spirit-levelled Heights, Southern India		32
,, Spirit-levelled Heights, Calcutta to False Point		77
,, Notes on the Preliminary Actinometrical Operations at Leh		76
,, Account of Tidal Disturbance owing to volcanic eruption at Java ...		34
,, Survey of India Department Notes		61
,, Report on Kafiristan		22
,, Description of Dardistan		12
,, Auxiliary tables		3
,, Report on A—K's explorations in Great Tibet and Mongolia (including a portion of the reprint for final publication)		220
,, Charts, orders, memoranda, forms, &c.		351
For Forest Department		37
	Total ...	993

The outturn of the printed pages during the year is considerably below that given for preceding years, and is due chiefly to the small number of copies struck off in several cases, such as the prints of A—K's diary and other reports of explorations, of which only a few preliminary copies were printed for submission to the Foreign Office; also to the fact that only 200 copies (reprint) of the Jodhpore Meridional Series Professional Volume were struck off to bring up the number to 500; also a pamphlet on the Actinometric Observations, of which but 30 copies were printed; and the Survey of India Department Notes. The total decrease due to these accounts for fully over 11,000 pages, so that the smaller number of prints this year is due entirely to the limited number of copies required of no less than 500 pages, or about one-third of the total number of pages composed.

PHOTO-ZINCOGRAPHIC BRANCH.

The following are the particulars of the work executed by the Photo-zincographic Branch during the year :—

MAPS.

SUBJECT.	When published.	Number of parts.	Number of sheets printed.
Prints of maps published in former years	.....	29	4,649
Sketch map of routes traversed by European and Asiatic explorers beyond the British frontier (1865-83)	October 1883	1	254
Map of passes from Bannu into North Waziristan	,, ,,	1	185
Guzerát Survey, Sheet No. 49, Section 16 (*Dang Forest*) ...	,, ,,	1	88
Ditto ditto ,, 49 ,, 7 *2nd Edition* (*Dang Forest*)... ...	November ,,	1	86
Ditto ditto ,, 49 ,, 8 *2nd Edition* (*Dang Forest*)... ...	,, ,,	1	85
Ditto ditto ,, 33 ,, 2	,, ,,	1	82
Ditto ditto ,, 33 ,, 4	,, ,,	1	86

Subject.	When published.	Number of parts.	Number of sheets printed.
Nepal Boundary Trace No. 1	November 1883	1	27
Ditto ditto „ 2	„ „	1	28
Ditto ditto „ 3	„ „	1	27
Ditto ditto „ 4	„ „	1	28
Ditto ditto „ 5	„ „	1	28
Kumaun and Garhwál Forest Map, Sheet No. XXXVIII (*for Forest Department*)	„ „	1	70
Ditto ditto LXXVII (*for Forest Department*)	„ „	1	77
Ditto ditto XLIX (*for Forest Department*)	„ „	1	80
Ditto ditto LXXII (*for Forest Department*)	„ „	1	80
Sketch Map showing the Arbáb Lak route between the Upper Sind and Khozdar Valley	„ „	1	200
Index to the Guzerát Survey...	„ „	1	728
Ditto Cutch do.	„ „	1	744
Map of the sources of the Tavoy Rivers showing the boundaries of proposed state reserves, Sheet No. 1 (*for Forest Department*)	„ „	1	95
Ditto ditto 2 (*for Forest Department*)	„ „	1	95
Kattywar Survey, Sheet No. 5 (*2nd edition*)	December „	1	136
Ditto ditto „ 8 (*2nd edition*)	„ „	1	138
Guzerát Survey, Sheet No. 34, Section 3...	„ „	1	85
Kumaun and Garhwál Forest Map, Sheet No. XXXVI (*for Forest Department*)	„ „	1	75
Bashahr Map, Upper and Lower (*for Forest Department*) ...	„ „	2	72
Map of the Gangotri Deodar Forests, Tiri-Garhwál (*for Forest Department*)	„ „	1	384
Guzerat Survey, Sheet No. 17, Section 1	„ „	1	80
Kattywar Survey „ 20 (*2nd edition*)	January 1884	1	136
Guzerát Survey, „ 34, Section 2	„ „	1	82
Ditto ditto „ 34 „ 4...	„ „	1	86
Ditto ditto „ 35	„ „	1	178
Index Map of the Forest Survey of the Melghat Taluk, Berar (*for Forest Department*)	„ „	1	196
Sketch Map to illustrate A—K's explorations in Great Tibet and Mongolia, 1879-82. Sheet No. 2	„ „	1	726
Ditto ditto „ 3	„ „	1	727
Geological Map of the Mussooree Municipality with Landour and Rajpur, North-Western Provinces (*for Forest Department*) ...	„ „	1	554
Map of Deodar Forests at Mundáli, Dháragád Valley, Jaunsár, North-Western Provinces (*for Forest Department*) ...	„ „	1	456
Index to the Sketch Map of A—K's explorations in Great Tibet and Mongolia, 1879-82	February „	1	728
Sketch Map to illustrate ditto ditto, Sheet No. 1 ...	„ „	1	723
General (Geographical Routes, &c.) Map to illustrate Tribal Settlements on the North-Western Frontier	„ „	1	352
Map showing changes in the Sunda Straits caused by the eruption of Krakatao	„ „	1	620
Plan of Lhása to accompany A—K's report	March „	1	106
Cutch Survey, Sheet No. 1	April „	1	131
Ditto, ditto „ 2	„ „	1	136
Ditto, ditto „ 6	„ „	1	130
Ditto, ditto „ 7	„ „	1	130
Ditto, ditto Nos. 8 & 9	„ „	1	130
Ditto, ditto No. 23	„ „	1	115
Guzerát Survey, Sheet „ 49, Section 13 (*Dang Forests*) ...	„ „	1	80
Ditto ditto „ 49 „ 14 (*ditto*) ...	May „	1	91
Map of Bhopal and Malwa Survey (*for Major Wilmer*) ...	„ „	1	14
Kattywar Survey, Sheet No. 10 (*2nd edition*)	„ „	1	78
Revised Sketch Map to illustrate A—K's explorations in Great Tibet and Mongolia, 1879-82. Sheet No. 1	June „	1	660
Ditto ditto „ 2	„ „	1	710
Ditto ditto „ 3	„ „	1	439
Index to ditto (showing also sketch of the Jángthang) ...	„ „	1	621
Kattywar Survey, Sheet No. 10A (*2nd edition*)	July „	1	106
Skeleton Map of the district of Dehra Dún	„ „	1	24
Geological Map of India (*for Forest Department*)	„ „	1	340
Map of Chakrata Cantonment (*for N.-W. P. Gazetteer*) ...	August „	1	568
Kattywar Survey, Sheet No. 11 (*2nd edition*)	„ „	1	148
Maps for Foreign Office	„ „	7	590
Sketch Map of the country within 10 miles around Allahabad ...	September „	1	101
Kattywar Survey, Sheet No. 14 (*2nd edition*)	„ „	1	4
Totals ...	.....	100	19,808

In addition to the foregoing, 326 blue prints and 110 silver prints (13 subjects) were prepared for the Executive Officers.

Charts.

Subject.	When published.	Number of parts.	Number of sheets printed.
Northern Afghanistan Triangulation Chart, between latitudes 33° 0′ and 35° 0′ and longitudes 68° 0′ and 72° 0′ ...	October 1883	1	130
Preliminary Chart of the Aden Triangulation, season 1876-77 ...	December ,,	1	66
Cutch Triangulation Chart No. 1	,, ,,	1	12
Ditto ditto ,, II	,, ,,	1	12
Ditto ditto ,, III	,, ,,	1	12
Eastern Frontier Series :—Final Chart	January 1884	1	395
Ditto Preliminary Chart, seasons 1877-78 and 1879-82	February ,,	2	130
Chart of spirit-levelling operations in Cuttack, Midnapore, Howrah, 24-Pergunnahs, the Sunderbuns and Hooghly districts of Bengal, No. 5, seasons 1881-82-83	May ,,	1	626
Total ...	.....	9	1,383
Diagrams.			
North-East Quadrilateral diagrams for volumes of the Great Trigonometrical Survey, tidal curves, &c., &c.	October 1883	.....	1,053
	November ,,	.....	1,762
	December ,,	.....	368
	January 1884	.....	1,682
	February ,,	.....	368
	March ,,	.....	1,025
	April ,,	.....	692
	May ,,	.....	723
	September ,,	.....	142
Total ...	.....	.....	7,815
Professional and office forms	.....	.....	25,590

Besides the above, 120 copies of 405 pages of the Janam Sákhi, or History of Guru Nának in Gurmukhi, were printed for the Punjab Government. This was a very difficult and laborious undertaking owing to the discoloured state of the paper, which was originally a light brown, but had become many shades darker from age and the unclean fingers of the students.

The total number of negatives taken was 778; the number of chromo-carbon prints 1,307, and the number of transfers to zinc, 181.

Contrasting the work performed since 1879-80, we have—

Year.	Maps.	Blue prints.	Silver prints.	Charts.	Diagrams.	Forms, &c.
1879-80	15,100	588	1,021	3,821	2,271	17,909
1880-81	15,659	414	52	1,886	3,367	19,508
1881-82	13,471	460	726	3,486	4,789	24,987
1882-83	12,300	278	105	2,441	10,495	30,195
1883-84	19,808*	326	110	1,383	7,815	25,590

An abstract of the work executed during the past five years stands thus :—

Subject.	Number of Prints.				
	1879-80.	1880-81.	1881-82.	1882-83.	1883-84.
Maps, charts, diagrams	21,192	20,912	21,746	25,236	26,006
Blue prints	588	414	460	278	326
Silver prints	1,021	52	726	105	110
Forms, &c.	17,909	19,508	24,987	30,195	25,590

The money actually realized and credited to Government from sales of maps, &c., during the year is Rs. 1,105-7-7.

* This great increase is due to a large number of A—K's maps having been printed.

DRAWING BRANCH.

Description of Work.	Number of Sheets or Diagrams.		Scale 1 inch = miles.	Remarks.
	Finished.	In hand.		
Final Charts.				
Assam Longitudinal Series	.....	1	4	For reduction by photo-zincography.
Preliminary Numerical Charts.				
Revised Chart of the Secondary Triangulation executed by the Burma Party, season 1877-80 ...	1	.....	4	For photo-zincography.
Ditto ditto 1875-77 and 1879-81	1	.....	4	
Secondary Coast Series from the town of Pooree to Bodagiri H. S. of the G. T. Survey, season 1882-83...	1	.....	2	
Aden Triangulation...	1	.....	$\frac{1}{3}$ or 1,760 ft.	
Compilations.				
Maps for Foreign Office	4	.....	On various scales.	For photo-zincography.
Chart of Arcs of Longitude, determined through the electro-telegraph, for the Annual Report ...	1	.....	144	For reduction by photo-zincography.
Sketch Map of the country within 10 miles around Allahabad	1	.....	1	For photo-zincography.
Chart of Spirit-levelling operations in Cuttack, Midnapore, Howrah, 24-Pergunnahs, &c., No. 5, Bengal Presidency	1	.....	8	For reduction by photo-zincography.
Map to illustrate Tribal Settlements on the North-West Frontier	1	.....	24	For photo-zincography.
Guide Map of Mussooree and Landour	.....	1	$\frac{1}{6}$ or 660 ft.	
Plan of Lhása to accompany A—K's report ...	1	.....	$\frac{1}{4}$ or 1,320 ft.	
Maps of Astor and Gilgit with the surrounding country brought up to 1883	1	.....	4	
Map of Chakrata Cantonment for the *North-Western Provinces Gazetteer*	1	.....	$\frac{1}{2}$	
Skeleton Map of the district of Dehra Dún ...	1	.....	8	
Revised Sketch Maps to illustrate A—K's explorations in Great Tibet and Mongolia, 1879-82 ...	3	.....	8	For reduction by photo-zincography.
Spirit-levelled Height Charts, Nos. 6 (2nd edition), 67, 81, 83, 88 and 12 (3rd edition)	3	3	$\frac{1}{2}$ or 2,640 ft.	For photo-zincography.
Maps showing changes in the Sunda Straits caused by the eruption of Krakatao, for the Annual Report ...	1	.....	About 8	
Index to the revised Sketch Maps of A—K's explorations in Great Tibet and Mongolia, 1879-82, showing also the Sketch of Jángthang, &c.	1	.....	64	

MISCELLANEOUS.

Examined, reported on, and corrected for the press the following original sheets: those which appeared in last year's annual report received additional corrections. — For reduction and reproduction by photo-zincography.

Sheets Nos. 1, 2, 6, 7, 8, 9 and 23 of Cutch Survey.

Sheets 15 and 40; also sheet 15, sections 1, 2 and 3; sheet 35, sections 2 and 4; sheet 49, sections 13 and 14; sheet 50, sections 7, 9 and 11, with supplemental sections 1 and 3 of Guzerát Survey. Six sections of Surat City and Atlas reduction No. 76.

Sheets 6, 7, 10, 10*a*, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 33, 35, 43 and 45, all 2nd edition, of Kattywar Survey.

Sheets 13A, 14, 15 and 16 of Nepal Boundary Survey.

Plotted line of levels for the chart of the Aden Triangulation.

Inserted predicted tidal curves on 10 sets of photo-zincographed copies of the map to illustrate the effects of the waves caused by the eruption of Krakatao.

Extracted and tabulated latitudes and longitudes of numerous places in the districts of Jaunpur and Fatehpur for Mr. Fisher's Gazetteer of the North-Western Provinces.

Projected graticule and some points of the secondary triangulation of the Burma Party for the projection of additional intersected points observed by Moung Shoay Gyoke.

Prepared a concise statement of all the explorers' services.

Prepared the map showing the disputed boundaries in Bundelkhand for Major Wilson.

Inserted Mr. Floyer's routes in Persia on office copy of Major St. John's map of Persia.

Examined 163 proofs of maps and charts and 421 pages of Janum Sákhi of Guru Nanák.

Coloured 15,940 maps.

Prepared descriptions of bench-marks for level sheet No. 12 (3rd edition) and for level sheet No. 81 ... ... } For the press.

Prepared notes of A—K's explorations for Mr. Hennessey's summary and discussion.

Prepared graticules and plotted points—Great Trigonometrical Survey in Kishanganga valley and neighbourhood, for Ahmad Ali, Sub-Surveyor.

Prepared memorandum showing differences between Dr. Regel and other Russian surveys and the Indian explorers in the Upper Oxus Valley.

Drew 63 diagrams of bench-marks for level sheet No. 81 ... ... } For reduction by photo-zincography.

Prepared copy of a map (with a tracing) of Afghan-Turkistan for office use.

Prepared a tracing of level data in the district of Gorakhpur for Major Sandeman.

Prepared tracings of three sketch maps of Khatmandu valley by Captain Barrow.

Prepared a tracing of the Ranikhet cantonment.

Prepared tracings of Sarda canal.

Prepared tracings of the proposed extension of the Cawnpore Branch Canal.

Prepared copies of Colonel Forbes' levels in Oudh.

Prepared copies of level heights in sheets 36, 43, 47, 48 and 146 of the Oudh Revenue Survey for Major Cunningham.

Prepared a rough map of the Khatmandu valley for Captain Barrow.

Drew a chart of the intersected points observed by Ahmad Ali, Sub-Surveyor

Drew and printed a diagram to illustrate the introduction to Synoptical Volume of S Maláncha and S Párasnáth Series.

Prepared a tracing of the route from Khiva to Dasht Kala.

Prepared a tracing of the Aden Triangulation Chart, 1876-77, for the Executive Engineer, Aden.

Prepared tracings of the charts of the tidal curves to illustrate the effect of the wave caused by the volcanic eruption of Krakatao.

Prepared a tracing of the boundary between Garhwál and Ranigarh, and of the boundary of Kotgarh for the Commissioner of Simla.

Marked the boundaries of districts on preliminary charts of the Eastern Sind and Sehwan Minor Series.

Enlarged sheet No. 46 of the Bundelkhand Topographical Survey for Major Wilson.

Examined and corrected the map of routes in the Western Himalayas, the Punjab, &c ... ... } For the engravers, Surveyor-General's Office, Calcutta.

Prepared drawings of the pillars at the east and west ends of the Mergui base-line.

Miscellaneous.—Current duties, including preparing for the press several maps of the Topographical Surveys and of the Forest Survey, transliterating Russian names, reducing maps by pantagraph, and affording assistance to officers and to the Photo-zincographic Office, &c.

CORRESPONDENCE AND STORES.

The year's correspondence is represented by about 2,800 letters and memoranda (inclusive of those already mentioned in connection with the protection of stations). Of these, some 1,780 are specially debitable to the office of the Deputy Surveyor-General.

Of instruments, &c., received and despatched there were—

Instruments despatched	909
,, received	211
Stores, articles despatched	204
,, ,, received	135
Making up a total of packages and parcels received	235
,, ,, ,, ,, ,, despatched	103

SOLAR PHOTOGRAPHY.

Mr. L. H. Clarke, Surveyor 2nd grade, has continued to work as Solar-Photographer, assisted by Mr. C. F. Guthrie. The working facts for the year are given in the following table :—

1883-84.	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.	None.	Runs.	Total.	Visible.	Absent.
October	31	.....	.....	.....	89	.....	.....	.....	.....	.....	31	.....
November	26	4	.....	4	75	.....	.....	.....	.....	.....	26	.....
December	28	3	.....	3	74	.....	.....	.....	.....	.....	28	.....
January	29	2	.....	2	72	.....	.....	.....	.....	.....	29	.....
February	24	5	.....	5	69	.....	.....	.....	.....	.....	24	.....
March	24	4	3	7	73	.....	.....	.....	.....	.....	24	.....
April	26	4	.....	4	67	.....	.....	.....	.....	.....	26	.....
May	28	3	.....	3	71	.....	.....	.....	.....	.....	28	.....
June	17	13	.....	13	37	.....	.....	.....	.....	.....	17	.....
July	14	17	.....	17	30	.....	.....	.....	.....	.....	14	.....
August	18	13	.....	13	37	.....	.....	.....	.....	.....	18	.....
September	20	10	.....	10	50	.....	.....	.....	.....	.....	20	.....
Total ...	285	78	3	81	744	.....	.....	.....	.....	.....	285	.....

This table shows that during the year photographs of the sun were obtained on 285 days, and that of the 744 negatives taken all exhibit solar phenomena. From these negatives 475 silver prints were made.

Photographs of the sun are always taken at Dehra on every day of the year that the sun is visible, but during the year under report three days' record was lost owing to the sickness of the assistant photographer while the photographer was absent from the station on leave. The number of days, viz. 78, on which the sun was invisible has been unusually great during the year, the rainy season having been exceptionally wet.

The usual table of percentages regarding the daily visibility of the sun and the presence of features (*i.e.*, spots and faculæ) is subjoined :—

Year.	In 100 days the sun was invisible on—	In 100 working 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 ,,

Contrasting the percentages of days of invisibility above given with those for Greenwich as furnished by the Astronomer Royal's Reports, we have—

Year.	At Dehra, year ending 30th September.	At Greenwich, year ending 20th May.
1880-81 ...	15	60
1881-82 ...	10	45
1882-83 ...	13	45
1883-84 ...	21	.....

During the cold season some samples of specially prepared gelatine dry plates were obtained from England through the instrumentality of the Astronomer Royal, and were found to give excellent results ; but when the weather became warm they could not be used, because then the emulsion with which they were prepared melted away in development. Ice is not procurable at Dehra, or this difficulty might have been surmounted. The advantages would be great if such dry plates could be generally used, and perhaps the chemist—Mr. L. Atkinson of 121, Greenwich Road, who prepares the dry plates employed at Greenwich—could in some way modify the emulsion so that it should better withstand heat.

The despatch to England of the negatives and of the silver prints has been made weekly as usual.

I regret to say I have no satisfactory report to give of the large photo-heliograph for taking 12-inch pictures of the sun. The new observatory was completed early in October 1883, and the instrument was at once adjusted in position and negatives taken with it, but for some unexplained cause no good negatives were obtained. Finding that the eye was no certain guide to obtaining actinic focus, attempts were made to get it by a series of experiments. These were to a certain extent only successful, for it was found that of two negatives taken apparently under exactly the same conditions, one might be fairly good, and the other altogether out of focus The picture as viewed on the focussing glass seemed always in a state of unrest; sometimes for a few seconds it would look sharp and then immediately become blurred. Much time and thought were occupied in experiments to ascertain how to work the instrument satisfactorily, and these were continued till 1st February 1884, when Mr. Clarke went on leave and his assistant's time was occupied with the small photo-heliograph. When Mr. Clarke returned in April, the weather had become hazy and unsuited for systematic experiments, and very little could be done until the rainy season was over. Recently, by the Surveyor-General's order, a Committee was assembled to report on the instrument, which it did unfavourably.

In accordance with instructions from the Surveyor-General, certain maps and solar photographs were sent from the Trigonometrical Branch Office, Dehra Dún, to the Calcutta International Exhibition held during the winter of 1883-84. A silver medal was awarded to this office for the excellence of the sun pictures exhibited.

Monthly Meteorological Results taken from the Register kept at the Trigonometrical Branch Office, Survey of India, Dehra Dún.

YEAR AND MONTH.	BAROMETER REDUCED TO 32° FAH.						HYGROMETER.				THERMOMETER.								RAIN.		WIND.	CLOUD.	
	AT 9-30 A.M.			AT 3-30 P.M.			AT 9-30 A.M.		AT 3-30 P.M.		DRY BULB.					WET BULB.							
	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.	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.
1883.																							
October	27·860	27·610	27·747	27·761	27·526	27·656	55·9	·587	55·4	·433	105·2	44·8	86·0	53·6	70·6	72·5	48·1	59·5	.....	.....	N.	.....	1
November	·832	·695	·762	·757	·600	·678	50·5	·709	50·7	·526	91·2	30·7	77·0	44·0	60·6	61·5	41·8	53·0	4	1·52	Calm.	2	2
December...	·941	·764	·867	·839	·677	·781	42·3	·663	44·2	490	81·3	31·5	69·0	39·3	54·4	55·5	37·2	46·7	1	0·09	N.	2	2
1884.																							
January	·924	·697	·850	·834	·632	·756	45·8	·715	47·6	·509	84·5	32·8	71·6	39·6	56·6	61·0	37·5	49·6	.....	.....	N.E.	3	4
February	·866	·599	·735	·790	·526	·657	44·9	·655	45·3	·456	91·2	30·8	79·2	37·2	57·5	61·4	34·8	48·7	2	·53	W.	3	5
March	·944	·531	·674	·830	·456	·588	50·3	·531	48·2	·347	107·6	41·0	90·0	48·6	68·1	73·0	45·0	55·4	4	·64	,,	3	3
April	·722	·500	·604	·619	·430	·509	46·2	·332	43·1	·221	113·2	46·8	94·9	57·1	77·0	73·1	45·6	59·1	.....	.....	.....	3	5
May	·620	·373	·485	·528	·279	·393	52·5	·318	49·9	·234	120·5	56·5	106·3	64·9	84·8	79·5	53·3	64·0	3	·21	N.W.	1	3
June	·501	·306	·418	·461	·252	·347	65·9	·546	65·5	·503	120·6	60·5	104·3	70·0	84·1	85·9	60·4	71·2	13	5·27	,,	3	5
July	·540	·314	·412	·462	·257	·333	73·1	·837	74·0	·737	111·2	67·6	92·3	70·3	80·1	79·5	67·6	74·5	25	24·63	Calm.	8	7
August	·584	·339	·451	·495	·244	·373	72·5	·860	73·6	·825	113·8	63·6	88·7	68·5	77·5	79·7	65·0	73·3	25	36·00	,,	7	8
September	·631	·434	·562	·569	·362	·473	70·7	·840	71·8	·789	118·3	62·4	88·4	66·8	76·4	76·0	64·9	71·5	20	15·87	N.	5	7

NOTE.—The height of the barometer cistern above mean sea-level at Kurrachee is 2,232·41 feet.

Mean velocity, in miles, of the winds which blew at Dehra Dún during the twelve months of 1883-84 *for each hour of the day.*

Civil Hours.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
0 to 1	2·48	1·90	2·03	2·58	2·20	2·32	1·77	1·50	0·89	1·26	0·77	0·86
1 „ 2	2·00	1·63	1·74	2·81	2·12	2·30	1·58	1·82	1·26	1·19	0·83	0·93
2 „ 3	1·68	1·47	1·81	2·90	1·88	2·19	1·31	1·45	1·33	0·87	0·07	1·21
3 „ 4	1·48	1·10	1·42	2·48	1·88	1·65	1·38	1 09	0·89	0·81	1·00	1·03
4 „ 5	1·29	0·97	1·32	1·84	1·76	1·45	1·38	1·27	1·15	0·87	0·60	1·00
5 „ 6	0·97	0·80	1·19	1·71	1·60	2·00	1·50	1·59	1·00	0·87	0·00	1·17
6 „ 7	0·74	0·99	1·35	1·90	1·24	1·48	1·27	1·45	0·67	1·06	0·70	1·21
7 „ 8	0·42	0·80	1·19	1·45	1·04	0·84	1·46	1·05	1·33	1·52	0·73	1·21
8 „ 9	0·52	0·67	0·87	0·77	1·12	1·42	1·58	1·50	1·78	2·06	1·24	1·38
9 „ 10	0·71	0·93	1·13	1·23	1·72	1·77	2·85	2·81	2·81	1·94	2·03	1·79
10 „ 11	1·23	1 23	1·52	1·48	2·42	2·13	3·62	4·00	3·41	2·52	2·17	1·90
11 „ 12	1·74	1·70	1·71	2·42	2·58	2·81	4·42	4·43	2·79	2·13	2·07	1·76
12 „ 13	2·48	1·90	2·32	2·84	3·56	3·45	4·38	5·05	3·26	2·39	2·07	2·10
13 „ 14	2·94	2·13	2·39	2·94	3·70	3·71	5·17	5·05	3·33	2·32	2·70	2·17
14 „ 15	2·45	1·77	2·45	2·94	3·64	3·77	4·80	5·95	3·78	2·45	2·77	2·13
15 „ 16	1·55	1·57	1·71	2·52	3·72	3·65	5·28	6·18	2·89	1·68	2·23	2·27
16 „ 17	0·29	0·70	0·90	1·97	3·48	3·81	5·84	6·21	2·70	1·68	2·20	2·00
17 „ 18	0·58	0·27	0·45	0·74	1·48	2·42	5·32	6·00	2·15	1·42	1·40	0·87
18 „ 19	2·10	1·00	1·06	0·77	0·44	0·61	2·84	4·29	1·59	0·97	0·90	0·79
19 „ 20	2·48	1·73	2·03	1·65	0·64	1·65	1·84	2·38	0·59	1·35	0·60	0·72
20 „ 21	2·71	2·17	2·23	2·19	1·20	1·65	1·84	2·21	0·63	0·84	0·87	0·86
21 „ 22	3·19	2·23	2·58	2·52	1·92	2·52	2·24	2·17	1·41	1·03	0·70	1·14
22 „ 23	2·97	2·30	2·71	2·45	1·96	2·45	1·96	1·54	1·26	0·90	0·80	1·31
23 „ 24	2·90	2·23	2·19	2·52	2·20	1·04	1·96	1·65	1·00	1·06	0·70	1·38
Sums ...	41·90	34·10	40·24	49·59	49·56	54·08	67·59	72·64	43·90	35·19	31·65	33·29
Average ...	1·75	1·42	1·68	2·07	2·07	2·25	2·82	3·03	1·83	1·47	1·32	1·39

Principles agreed upon between the Settlement and the Survey Departments for carrying on the work in Deoria Tahsil, Gorakhpur District.

THE division of labour between the Survey and the Settlement is based on the principle that the Survey undertakes to furnish an accurate record of all undisputed entries. The Survey has its own checks: *munsarims* check 20 per cent. of the entries in the *khasra*; the European staff check 5 per cent. It is waste of time and money for the Settlement to put on a staff of *munsarims* to check work which has been already sufficiently checked. The Settlement *munsarims* are men of the same class and attainments as the Survey *munsarims*.

2. But the Survey cannot settle, and must not stop to attempt to settle, disputes. Its duty, shortly, is to record the names of persons found to be in undisputed possession, and to prepare a complete list of all disputes. The Record cannot be accurately made out if this dispute list is not complete.

3. During the survey, therefore, the only duty of the Settlement is to see that the *khewat* is ready when entries begin, and that it corresponds with facts.

4. When the *Khanapuri* of a village is finished, and has undergone the checks to which it is submitted by the Survey, the Survey *munsarims* will send in to the camp office:—

1. The Urdu *khasra*.
2. The Hindi *khasra*.
3. The *jamabandi* slips.
4. The dispute list.

5. The camp officer will then examine the dispute list. If there are no disputes, the papers may be at once arranged and statistics abstracted. If there are disputes, the camp officers will see whether they are of such a kind as can be adjusted by a *munsarim* on reference to the *patwari's* papers. Such are generally disputes as to occupancy. Disputes as to ownership are of a different class, and can only be settled by an authoritative order of the Deputy Collector.

6. If there are no disputes, or if the disputes are of a kind which can only be settled by the Deputy Collector, the papers will be at once arranged and abstracted. If the camp officer considers that there are disputes which can be settled by a *munsarim*, and that the non-settlement of these disputes will leave the papers incomplete, and make the statistics inaccurate, he will prepare a tracing of the map and forward it with the Urdu *khasra* and dispute list to the Deputy Collector's office. The Deputy Collector will arrange to forward the papers to a *munsarim*. That officer will go to the village, summon the parties, inspect the *patwari's* records, if necessary, and come to a decision on the disputes. He will make the necessary attestation in the *khasra* so as to fill up all blanks, and in the dispute list, and the Survey Department will be responsible that the Hindi *khasras* and *jamabandi* slips agree with the amended *khasra*. The *munsarims* will return the papers direct to the camp office. Even if the people do not agree, he is bound to come to a decision in the case of every dispute, except cases of ownership, into which he will not enter. He will inform people who are dissatisfied that they may bring a claim before the Deputy Collector. The *munsarim* will be careful to note his decision, and the grounds for it, in the dispute list.

7. Before the abstraction of statistics commences it is necessary that the conventional soils should be checked by a special *munsarim*, called the soil-*munsarim*. As soon as possible after the *misl* is received, a trace, called the assessment trace to distinguish it from the record trace, will be made and coloured so as to show *goind*, *manjhar*, and *palo* according to the *khasra*. The soil-*munsarim* will take this to the village and correct the boundaries of soil tracts so as to correspond with what the people really consider to be *goind*, *manjhar*, and *palo*. The trace will then be returned to office, and the soils will be abstracted according to the new demarcation, and the *khasra* entries corrected accordingly. Both demarcations, however, will be shown on the map. This trace will be the one used by the Settlement Officer next year at assessment, and it must be signed by the soil-*munsarim*.

8. It is understood that the soil entries, both natural and artificial, will in the first instance be made on the responsibility of the *patwari*. The basis of the classification is what the "people" call *goind*, *manjhar*, *palo*, *doras*, *bhat*, &c., and not what an *amin* thinks is any particular soil. The Survey, however, will, on partal, see that the entries are fairly made. The demarcation of the soil-*munsarim* will not be considered final till the Settlement Officer has inspected the villages next cold weather.

9. The soil-*munsarims* will be under the orders of the camp officers. The Settlement *munsarims* will be under the orders of the Deputy Collector. The duty of the latter is to see that the *khewat* is in the hands of the *patwari*, and is properly prepared; to move about their circles adjusting disputed entries; to make local enquiries when required by the settlement, and to revise dispute lists sent from the camp. The Deputy Collector will expect that dispute lists and *khasras* sent from camp will be returned within four days.

Each soil-*munsarim* will have no *muharir*, but three *chuprasis*.

Each *khewat-munsarim* will have a *muharir* and four *chuprasis* to summon parties to disputes. It is part of their duty to see that disputed boundaries are surveyed as decided by the Deputy Collector, and having done so, to return the trace to the Survey Office, marking on it the fact.

10. Settlement work proper begins when the completed *misl* is sent to the Deputy Collector. It is twofold—*firstly*, attestation of the record and settlement of disputes; *secondly* assessment. For the first, the Survey furnishes the record of undisputed entries and a dispute list. The Deputy Collector will first of all cause a rough *jamabandi* to be made from the slips. This rough *jamabandi*, the *khewat*, the *khasra*, and the note on village custom, will be attested at one and the same time, first by a *munsarim* and then by a Deputy Collector, who will have before him all the papers and the original dispute list. The *patwaris* must be present at both attestations. If the whole circle of a *patwari* has not been surveyed, and he is still engaged in *khanapuri*, the Deputy Collector must arrange so that the *khanapuri* be not delayed. No hard and fast rule can be drawn up. The Deputy Collector, knowing that the work of preparing the record for the Pargana is one, must arrange that the *khanapuri* is not hindered.

11. The following points are noted:—

(*a*) The camp officers will issue stamped and numbered sheets of the *khasra* in Urdu to the *amin*, so that no sheet can be removed and another substituted. The *amin* is bound to account for the number of sheets which he receives.

(*b*) Stamped dispute lists, with the name of the village written by the camp officer, will also be issued, so that the lists be not changed.

(*c*) The areas in columns 9, 11, 12, 14 of the *khasra* will be in acres, but the *milan khasra* will show bighas.

J. D. LaTouche,
Settlement Officer.

The 18th January 1884.

J. E. SANDEMAN, *Major*,
Deputy Superintendent of Survey, No. 5 Party.

Note on the Procedure in Gorakhpur for the preparation of Record-of-Rights, dated 8th February 1884, *drawn up by* Major J. E. Sandeman, *Deputy Superintendent, Survey of India, for the information of the Senior Member, Board of Revenue, North-Western Provinces.*

Our endeavour has been to improve on the Benares system, which was the one approved of at the meeting held at Benares on the 11th January 1883. In Benares, Settlement *munsarims* attest the entries as the survey proceeds. The attestations are thus made without areas; the *khanapuri* is delayed to a certain extent, and a good deal of friction is inevitable between the Survey and Settlement staff. The procedure in Gorakhpur is as follows:—

(1). The Settlement *munsarims* get ready the *khewat* and hand them over to the *patwaris*.

(2). The Survey establishment make all the undisputed entries and a list of all disputes: 20 per cent. of the entries are checked by Survey *munsarims* who have had settlement experience, and whose knowledge of *khanapuri*, as laid down in the hand-book of instructions issued for their guidance, is tested and known to be great; an additional 5 per cent. of the entries are tested by the European staff as they check the survey. The executive officer holds himself responsible for the correctness of the entries; that they are in accordance with the *khewat* in column 3 of the *khasra*, and in column 4 with cultivating possession; and that all disputes as to the entries in both columns are inserted in the dispute list. At the same time, the natural soils and their conventional classes are entered on the spot on enquiry from the *patwari*, the *zamindars*, and the cultivators, the proviso being that if the statements are manifestly wrong in any case, they will be referred to the *munsarim*, who will decide as to the correct entry. Not only are 25 per cent. of the entries checked, but another safeguard as to accuracy is that three documents are prepared on the spot at one and the same time.* While the *amin* writes the Urdu *khasra*, the *patwari* prepares a duplicate in Nagri, and a *parcha*, for each cultivator on the spot, which is handed to him as his number is entered. All three documents are read out aloud, and no entry is made unless the *patwari*, the proprietor, and the cultivator are all present. The only drawback to this thoroughness is that if the people are disinclined to help, great delay occurs from the absence of some one or other who should be present.

* This is also the procedure in Benares.

When a village is completed and the papers go into the camp survey office, the areas are at once extracted and entered into the duplicate *khasra* and into the *parcha jamabandis*; the *safawar* and *milan khasra* and a *terij* of the *jamabandis* are then got ready. Here for the present the survey work ends, and the settlement work which was begun in the preparation of the *khewats* is continued.

(3). A race of the map, called the settlement trace, having been made over to the special soil-*munsarim*, he goes out and checks the soil classes as entered by the survey establishment. The natural soils are accepted as correct, the 25 per cent check which has already taken place being considered sufficient. The Urdu *khasra*, with a trace called the record trace, and the dispute list, having been sent out to a settlement *munsarim*, he fills up the disputed entries in column 4 by reference to the *patwari's* papers; and if the cultivators are not satisfied, they have an appeal at attestation: all disputes in column 3 are left blank to be filled up at attestation.

(4). Here the settlement work ends for the present, and the survey office again takes in hand the papers, correcting the *khasras* from the revised settlement trace, and filling up the disputed entries in the Nagri *khasra* form, in the corrected Urdu *khasra*, and in the dispute list, and it then proceeds to extract the statistics for the Settlement Officer, classifying the areas, under-tenures, crops, soils, and castes of cultivators.

This done, the papers are handed over complete in every respect to the Settlement Department, the Survey Department holding itself responsible that the entries in the duplicate *khasra* and in the *parchas* agree; if they do not, the papers are returned for correction, all other trifling mistakes being corrected in the settlement office.

(5). The Survey Department has now all but done with the records, and the settlement work of attestation begins.

(6). After the Settlement Officer has himself finally passed the soils, he once more returns the settlement trace to the survey office.

(7). With this trace the original maps are compared, and the soils are marked out on them by convenient symbols, with the aid of which the maps can be coloured for soils after publication. Thus for the first time the published maps will also be soil maps.

The merits of the system are that the work is done thoroughly in every stage, and that instead of the papers leaving the survey office in an incomplete state, as they did under the Benares system, they are prepared in such a way that on receipt of them the settlement officer can at once proceed to calculate his rates. Also that in their preparation they derive the benefit of the superintendence of the whole European staff of the survey party and of its carefully trained office establishment, which is habituated to dealing with figures in a systematic manner.

The Settlement staff and the Survey staff have distinct duties which cannot clash, and therefore there can be no friction. In the seven stages of the work described above, in which the two departments are associated—

No. 1	stage is performed	by the Settlement	Department.
„ 2	ditto	by the Survey	ditto.
„ 3	ditto	by the Settlement	ditto.
„ 4	ditto	by the Survey	ditto.
„ 5	ditto	by the Settlement	ditto.
„ 6	ditto	by the ditto	ditto.
„ 7	ditto	by the Survey	ditto.

The economy of this division of labour will be apparent in a couple of seasons; the entire work of the Survey Department, including the extraction of statistics, will cost just what the mere survey used formerly to cost, or about 4 annas an acre. The Settlement establishment is a small one, viz.—

2 Deputy Collectors with a staff for fairing the papers.
2 Soil-*munsarims*.
6 *Munsarims* for filling up disputed entries, and a small staff for attestation.

The cost of the above will fall probably within an anna an acre.

This season there are disadvantages which will not occur again: the chief of these is that the establishment is new to the work. The first four weeks were occupied in training it, and during the next four the progress was naturally slow. Nearly half the men are new, and to the rest the training in Mirzapur has been of little advantage, for there the tenure was comparatively simple; only one document, the Urdu *khasra*, was prepared by the *amin* on the spot, the Nagri *khasra* and the *parchas* being made up from it during the recess. Our difficulty has been to break the men of the habits acquired, and to make them wait for the entry to be made in the *parcha* at the same time as it is in the *khasra*.

Copy of letter No. 72—I 1, *dated* 11*th February* 1884, *from the Settlement Officer, Gorakhpur, to the Commissioner, Benares Division.*

When I had the honour of meeting you and the Senior Member of the Board of Revenue at Basti on the 7th February, I was desired to submit three reports:—the first, on the modifications of the Benares system which have been adopted by Major Sandeman and myself in preparing the Record; the second, on the method by which I propose to proceed in revising the land revenue assessment; the third, on the prospects of the work in general and the arrangements which will be necessary to ensure the announcement of the revised revenue of the district not later than the year 1889. The present letter is the first of the series.

2. We make out the same papers as were compiled in the Benares survey—An attested *khewat* is prepared in advance by the Settlement; the Survey *amin* writes the Urdu *khasra*; the *patwari* or his *gomashta* writes the Nagri *khasra* and the *jamabandi* slips; the list of disputes is made out in Urdu by the *amin*. But the question had to be faced as to which department was responsible for the accuracy of the entries. If the Survey was willing to undertake the responsibility, and could ensure accuracy, it was evidently waste of power for the Settlement to put on a staff of *munsarims* to check work which was already sufficiently checked by the Survey. If the Settlement was responsible and employed its own agents,

the large staff of the Survey would confine its efforts to securing merely accuracy of measurement. Our object was to make all men employed in the field feel that the work of survey and settlement was one, and to avoid friction between the departments, and we found that this could only be done by a fair division of labour. We soon hit upon the broad generalization that the Survey should undertake to furnish an accurate record of all undisputed entries, and a complete list of all disputes. This principle is the basis of the whole work.

3. It is evidently waste of time to test twice over on the field matters about which there are no disputes. The staff of Survey *munsarims* was considerably increased by Major Sandeman. They check 20 per cent. of the entries in the *khasra*. The European staff of the Survey check 5 per cent. The Survey *munsarims* are men of precisely the same class and attainments as the men who would have been employed by the Settlement. The Settlement therefore should accept all undisputed entries in the *khasra* as *primâ facie* correct.

4. It is different when a dispute arises. The Survey cannot settle and must not stop to attempt to settle disputes. If a dispute arises, the *amin* must leave the entry blank, note the claims in the special dispute list provided for that purpose, and pass on to the next field.

5. When the papers of a village are finished and have undergone the checks to which they are submitted by the Survey, the Survey *munsarim* sends into his camp office the Urdu *khasra*, the Hindi *khasra*, the *jamabandi* slips, and the dispute list.

The camp officer then examines the dispute list. If there are no disputes, or if the disputes are about ownership, which can only be settled by an authoritative order of the Deputy Collector, the papers are at once arranged, areas filled in, and the statistics required for assessment are abstracted. If, however, there are disputes as to tenancy, the camp officer prepares a tracing of the map, and sends it with the Urdu *khasra* to the Deputy Collector's office. Here it is at once made over to a Settlement *munsarim*, and this is the first occasion, excepting the *khewat*, on which the Settlement Department has official cognizance of the record which is being framed. The Settlement *munsarim* goes to the village, summons the parties, inspects the *patwari's* records, and even if the people do not agree, he is bound to come to a decision in every dispute, except in cases of ownership, into which he does not enquire. Any person dissatisfied is directed to bring a claim before the Deputy Collector. The *munsarim* fills up the blanks in the *khasra* and notes his decision and the grounds of it in the dispute list. He then returns the papers to the survey office. The survey office is responsible that the Hindi *khasra* and the *jamabandi* slips agree with the Urdu *khasra* as returned by the Settlement *munsarim*, and with each other.

6. While the *munsarim* is settling disputes, the survey office has inked up the map, and filled in the areas of the fields in the Hindi *khasra* and in the slips. A separate tracing of the map for assessment purposes has also been prepared, but of this more hereafter. On receipt of the *khasra* with all blanks filled in, statistics are abstracted. The papers are then complete, and are sent to the Deputy Collector, who gives a receipt. We have agreed that the *misl* shall not be returned for correction to the Survey on any other grounds, except that the tale of slips is not full, or that the three papers do not correspond. This much the Survey guarantees.

7. Settlement work proper begins as soon as the papers are received by the Deputy Collector. First of all a rough *jamabandi* is made from the slips. I do not consider that any proper attestation can be made on the slips alone. Many tenants hold land in more than one *patti*, and under different tenures in each, and it is necessary to bring all the totals together before attestation. A *muharir* takes this rough *jamabandi*, the *khewat*, and the *khasra* to the village and reads out the entries. The Deputy Collector follows and attests the record, having all the papers before him, as well as the original dispute list and the note on village custom. After the Deputy's attestation the papers are ready for fairing. The original slips after being corrected and signed are given to the tenants.

8. The attestation work is hardly yet in full swing, for we have been hampered by the fact that *patwaris'* circles are large, and that even after the settlement receives the complete record of one village, the *patwari* will be occupied in writing up his *khasra* in another. Still the work will soon be well advanced. Both Deputies will be employed in attestation from 1st March. Major Sandeman hopes to hand me over complete *misls* for all villages in Deoria Tahsil by the 1st May. The Deputies hope to attest all these between the present date and July, and I trust that we shall be able to carry out the programme. We then shall be able to give the *patwari* a fair copy of the attested *jamabandi* before October. He has his own Hindi *khasra* and the tracing of the map, and he may begin his annual *khasra* according to new map from October 1884. The entire Survey and Settlement staff, excepting the Settlement Officer, will be out of the tahsil within the year. The only portion of the record which remains to be completed are the columns of the *khewat* showing the distribution of the revenue. These can only be filled in after the new assessments have been declared. They will, it is hoped, be ready by April 1885.

9. At the meeting at Benares in January 1883 it was decided that the *wajib-ul-arz* as an attested record should be given up, but that a note should be made to the *khewat* of the matters which it is compulsory to record. These are enumerated in section 65, Act XIX of 1873, and are only two: the manner of distribution of common profits among the proprietory body, and the manner in which *lumberdars* and co-sharers are to collect rent from the tenants. Most of the matters referred to in section 51 of the Board's circular will be provided for in the *khewat* and in the *jamabandi*, but for general customs it will be perhaps advisable to draw up a Pargana Code. If the custom of any village differs from the ascertained custom of the Pargana, it could be proved when occasion arose.

10. The points at which our procedure seems most to lie open to exception are two,—our method of soil classification, and the fact that the village statistics are compiled by the survey from the unattested records. There was presented to us a choice of evils—either to postpone the compilation of statistics till the villages had been attested and the soils inspected by the Settlement Officer, or to allow the Survey to compile them at the same time as the areas of the fields are taken out. The Survey can do this work much better than the Settlement Department, and much cheaper. They have a staff of eight European assistants to check the work, and their men are much more expert at figures than any men whom I could employ. It is most important that I should have the village statistics before me at time of inspection. Otherwise inspection degenerates into a mere checking of soils. With the figures before me, many questions arise which can be solved at once by a question to the *patwari* or the *zamindars*. Unless, therefore, I am to postpone village assessment till 1886, the statistics must be taken out this year and be entered in the pargana note book by the 1st November 1884.

11. Soils are divided into five natural classes—*Doras* or *domat*, *matyar*, *balua* or *bhur*, *bhát*, and *kachhár;* and into three conventional classes—*goind* or homestead, *miyana* or middle land, and *palo* or outlying. These classes are all well known to, and recognized by, the people. *Doras* (loam) is the prevailing soil; *matyar* (clay) practically corresponds with rice land. Outlying *balua* (sand) certainly pays a lower rate than other outlying; *bhat* is a soil peculiarly retentive of moisture on which sugarcane grows without irrigation: it is common in the north and east of Deoria or in Sidhua Jubna. Whole tappas are composed of *bhát*, and the line between it and the *bangar* (up-lands) or the *doras*, *matyar*, and *balua* tracts is very distinct. *Kachhár* is the alluvial soil along rivers. Rents are not based on these distinctions as a rule; but rice often pays exceptional rates. The eastern or southern *har* of a village will often be found paying a different rate from the western or northern, and the cause is seen to be in the difference of the natural soil. *Kachhár* land varies much in productiveness, but a *kachhár* village has generally a very high rent rate. The natural soils therefore should be shown in the statistics and on the tracing of the map which is prepared for assessment purposes, and which is quite distinct from the record trace.

12. We have decided that the classification of the natural soils shall be left to the Survey Department. Rent rates will not be worked out per natural soils, nor are rents consciously paid according to soils. The people have no great inducement to make a false statement as to the soil, and its classification practically falls into the category of undisputed entries which we have made the province of the survey. Natural soils, in short, are only one of the numerous facts which the settlement officer has before him in village assessment. They are comparable to statistics, as to the density of population, the caste of tenants, the depth of wells, the neighbourhood of markets, and other facts which explain and justify a village rate. I prefer not to deprive myself of the assistance which can be derived from them in framing a fair assessment on a village.

13. With conventional soils it is somewhat different. These are consciously recognized by the people as influencing rent. I intend to frame rates for *goind*, *miyana*, and *palo*, and I must get a correct area to which to apply my rates. It will be admitted that the correct area of *goind* is the area which the people themselves recognize as *goind*, and not what any expert may consider to be *goind*. I disclaim any desire to attempt a scientific demarcation of soils. My duty is to ascertain a fair rate for each soil, and to apply that rate to the area recognized by the residents of the village as coming under each class. There is really only one way of discovering these areas, and that is for the assessing officer to go and do it himself; but he may be helped in one of two ways. A special *munsarim* may be appointed who will take a tracing of the map to the village, and mark on it the boundaries of the *goind* and *manjhar*; or the Survey may at the time of measuring each field, record what the *zamindars* and *patwari* consider to be its class. The tendency of a *munsarim* working alone is to put in too much *goind* and *manjhar*. The *zamindars*, if left entirely to themselves, would not state their real opinions. The system on which we are at present working combines these two methods, and is as follows:—

14. As each field is measured, the *amin* enters the conventional class from the statement of the *patwari*. If he considers the *patwari* to be palpably wrong, he refers the matter to the survey *munsarim* at his next visit. As soon as the papers reach the survey office, a special trace is made for assessment purposes. On this are drawn lines showing the demarcation of *goind* and *manjhar*, and the tracing is then made over to a special *munsarim* attached to the survey camp. He takes the trace to the village and corrects the line where he considers it clearly wrong. The *khasra* entries are changed to correspond to his correction, and statistics are made out according to the amended demarcation. The tracing is signed by the *munsarim*, and is the map which the settlement officer will use in inspection next year. The assessing officer will therefore have before him the original demarcation and the opinion of the *munsarim*, and must make up his mind as to what is a fair demarcation. As soon as he has passed the map, the tracing will be returned to the survey, and the demarcation of the settlement will be printed on the published maps.

15. The question, however, of soil-classification is not so important as might be supposed. Throughout Salempur there are but few large village sites. The population is scattered over the country in minute hamlets. There is but little high garden cultivation, and, except in large villages, hardly any outlying. Where the *miyana* of one hamlet ends, that of another begins. It is very common to find only two rates of rent in a village—one for poppy land, and one for everything else. It is true, however, that a new tenant obtaining land would have to pay for it according to its proximity to the village site.

16. The statistics furnished to me by the Survey show the area classified as required for statement No. II, the soil classification of the *munsarim*, the amount of land held as *sir* in occupancy or at will, the caste of tenants and how much land is held by each caste, the number of wells and how many were built within the last 10 years, depth to water, the crops found on the ground, and in short all the statistics which go to make the "present" columns of the Pargana note-book. I have abstracted from the records in the Collector's office comparative statistics of previous settlements—rent-rolls for the last 12 years, transfers during the currency of the settlement, and census returns. The form of note-book adopted is substantially the same as that used by Mr. Cadell for the assessment of Banda, and all these statistics I shall have before me when I begin village assessment next November.

17. I do not think I have omitted any detail of importance which may serve to explain what is being done. The broad principle of division of work we shall not alter if we are allowed to work in this way, but I would not wish that anything I have said should bind me and Major Sandeman from making alterations which further experience may show to be advisable. The combined work of survey and settlement is still in an experimental stage. Every detail requires to be watched: difficulties must be expected, and it will be some little time before things go on perfectly and smoothly.

Copy of Board's No. 136—IX 19 *of 7th March* 1884 *to the Commissioner, Benares Division.*

I AM desired to acknowledge the receipt of your letter No. 1419—I 15, dated 21st ultimo, and enclosure, regarding the system on which it is proposed to prepare the Record-of-Rights in the Gorakhpur district.

2. In reply, I am to observe that the improvement by Mr. LaTouche and Major Sandeman on Major Barron's system, and the unison in which the Survey and Settlement Departments are working in Gorakhpur, are additional evidence of the success of the present combined system, the advantages of which are summed up in paragraph 9 of your letter.

3. The Senior Member considers that the division of labour in the classification of soils has been wisely made, it being left to the Survey Department to fill in natural soils, the decision of the conventional soils being left to the Settlement Officer.

4. The Senior Member found the most cordial good feeling existing between the heads of the two departments, the best guarantee for the work being well done.

5. With reference to your paragraph 8, I am to say that there is no desire whatever on the part of the Board to stereotype a system which, although successful so far, is still on its trial: while therefore the Board entirely approved the working of the system as far as it has gone, they will be quite ready to welcome the introduction of any further improvement which the experience of the settlement and survey officers may hereafter show to be desirable. Meantime the exertions of both officers merit the Board's cordial acknowledgment.

Copy of letter No. 55—*IC* 2, *dated the* 15*th November* 1884, *from the Settlement Officer of Gorakhpur to the Judge of Gorakhpur.*

I HAVE the honour to address you on the subject of regular suits affecting the boundary of villages in the jurisdiction of the Bansgaon and Deoria Munsifs. I understand that a number of suits have been filed to contest the demarcation made by the Settlement Department, and from the energy displayed in prosecuting and defending appeals in my court, I am led to believe that this class of suit will increase.

2. Many of the boundary disputes which have arisen at this settlement have from time to time been settled by decrees of the Civil Court, in many instances appealed up to High Court, yet one of my greatest difficulties has been to discover what it was that was actually decreed. The suitor claims so many bighas of land, and this has been often decreed on the faith of incorrect maps and a very imperfect survey. For instance, a suitor finds that in the settlement map the width of a plot on the border is 1½ chains, while in reality it is only 1. He sues for the extra land, which, as a matter of fact, does not exist, and many decrees have been given which were incapable of execution.

3. The maps which are now prepared under the Survey Department are mathematically accurate; boundary lines do not overlap, as was too often the case at last settlement, and each boundary line accurately fits into the neighbouring one. Maps have been completed for the Deoria tahsil. In Bansgaon the survey is now at work.

4. It seems to me very important that all decisions passed by the Civil Courts should be accurately laid down on the ground, and transferred to the new maps for permanent record. The maps of disputes which are now prepared by the Civil Court *amins* (I speak of some which I was permitted to see by the courtesy of the Munsif of Bansgaon) are no better than those made half a century ago.

5. I would suggest therefore for your consideration the advisability of the issue of some such rules as the following in cases of disputed boundaries:—

(1.) That in villages which have been surveyed by the Survey Department the Civil Court should call on the Deputy Superintendent of Survey to furnish a trace of the boundary as surveyed, showing as many fields on each side as may be required.

(2.) That the Civil Court, after decision, should mark on the map the line decreed, and forward a trace to the Settlement Office, that the records and the map may be corrected accordingly.

(3.) That in villages which have not been surveyed, an accurate survey of the boundary and the adjacent fields should be made for the Civil Court, and that this survey should be so made as to be capable of being transferred to the new map, and that on receipt of the trace showing the decided line it should be transferred to the new map.

6. As far as I am aware, the *amins* now employed in the Munsifis are incapable of making such a survey as that alluded to in the last clause. I would suggest therefore one of the two courses:—*First*, that the Deputy Superintendent be requested to make a survey of the disputed tract. This, as I have ascertained, Major Sandeman is willing to do, and in tahsils where the cadastral survey is in progress, the preparation of such a map will not entail much extra labour; or *secondly*, that the present Civil Court *amins* be examined by Major Sandeman, and if found incompetent to make as accurate a map as that of the survey, that they should be replaced by fit men to be nominated by the Deputy Superintendent of Survey.

7. If some such procedure as this be adopted, the Civil Courts of first instance will, I believe, find the work of deciding these disputes very greatly simplified; Appellate Courts will see at a glance what has been decreed; litigants will learn to base their claims on actual fields, and not on vague and inaccurate surveys; the Record-of-Rights will correspond with the Civil Court decrees, and all litigation for the future will be stopped since it will be at any time possible to lay down on the ground the line of decision. At present, it is impossible to do this, since the maps of decisions are inaccurate.

Copy of letter No. 49—*ID* 2, *dated Gorakhpur, the* 13*th November* 1884, *from the Settlement Officer, Gorakhpur, to the Deputy Superintendent of Survey in charge No.* 5 *Party, Gorakhpur.*

I HAVE the honour to place on official record the arrangements which we have agreed upon on the subject of soil demarcation.

2. The natural soils which we adopted in Deoria were five in number—*Doras*, *Matyar*, *Balua*, *Bhát*, and *Kachhár*. Our object was to select marked distinctions which affected rent. Experience has shown that the rent-rate of *Doras* and *Matyar* is generally identical in a village; a *Balua* tract generally pays a low rate; the rate on *kachhár* lands may be either higher or lower than the *Doras* of the village. *Bhát* is a peculiar soil much infected with *Usar*, and it is advisable that its area should be separately shown, and it is easily recognized. We might then have joined *Doras* and *Matyar* into one class, but the clay soil is nearly always that on which rice is grown: there is no name known to the people which would comprehend both classes, and you have told me that amalgamation of them will not perceptibly lighten the labour of extracting statistics; we have agreed therefore to retain the five classes.

3. The conventional soils are *Goind*, *Miyáná*, and *Palo*. The procedure of last season was that the Survey's demarcation of natural soils was accepted after the usual checks of that department; but for conventional soils a separate *munsarim* was appointed by the Settlement, who, with the map in his hand, checked and altered the demarcation made by the Survey with a view of ascertaining that it corresponded with the demarcation recognized in the village.

4. The distinctions of the natural soils are all such as are visible to the eye. *Kachhár*, or low-lying land along a river which is flooded every rains, and on which the river leaves a fertile or a sandy deposit, cannot be mistaken. *Bhát* is easily recognized. The only soils likely to be confounded are *Doras* and *Balua*. Light *Doras* cannot often be distinguished from *Balua*: the rent-rate is the only guide. Where land which is doubtful is found paying the same rate as *Doras*, it should be classed as *Doras*; if it is found to pay a lower rate, it should be classed as *Balua*. As I have said, these distinctions can all be recognized by the eye; they are indisputable facts which the Survey can record with as great accuracy as the statistics of a well or of a grove.

5. The demarcation of conventional soils has in recent settlements been considered a scientific process and the work of an expert. The object was to bring together under one name all similar soil in the pargana, so that a general rate could be applied to it. Our object is to mark off in each village the *Goind* and *Miyánd* which the people of that village recognize as affecting rent. It is unimportant to us whether what is called *Goind* in one village is as good as what is called *Goind* in the next village. The demarcation, therefore, no longer demands the services of an expert. All we have to guard against is the dishonesty of the *zamindars* and *patwaris* in writing down as *Palo* or *Miyáná* land which pays the *Goind* rate of the village. The *patwaris* record the rent-rate of each field on the *parcha*, and the demarcation should follow the rate.

6. In some villages it will be found that the people pay an all-round rate, and have no separate rates for the three tracts. Yet in these villages they recognize the tracts, and they should be demarcated.

7. The tendency of the *munsarims*, who were employed by the Settlement in Deoria to check the survey classification, was to consider themselves experts, and to put down as *Goind* and *Manjhar* what they themselves considered as *Goind* and *Manjhar* rather than what the people recognized as such. Your staff is quite as competent as any which I can supply to check the dishonest propensities of the *patwaris*, but they must clearly understand that if the work of checking the demarcation is made over to them, they must not consider themselves experts. I propose this season to appoint no *munsarims* to check conventional soils and to leave the demarcation entirely in your hands. The result will, I trust, give us the soils actually recognized by the people, free from all admixture of a so-called scientific demarcation, showing not what are, but what ought to be recognized.

Copy of letter No. 79—*IA* 6, *dated Gorakhpur, the* 1*st December* 1884, *from the Settlement Officer, Gorakhpur, to the Deputy Superintendent of Survey, No.* 5 *Party, Gorakhpur.*

I HAVE the honour to forward a copy of the revised rules for working the survey and settlement, which have been agreed upon after discussion between you and Mr. Longe, myself, and Deputy Collector Ashfaq Hosein. The rules include the entire procedure up to the fairing of the record, but I have thought it well to exhibit the entire procedure in one paper, that you may know exactly what we propose to do, after we receive the papers from you. If we find that either department is doing unnecessary work, we may adopt a more perfect division of labour. Your experience and that of your assistants will show you where changes or amplifications of the present rules are required, and by the time the attestation of Bansgaon is finished, we should be in possession of as practical a set of rules as the subject admits of.

Revised rules for the working of the Settlement and Survey in Gorakhpur, 1884-85.

1. The Settlement will demarcate the villages and prepare the *khewat* in advance of the survey.

2. At time of survey all undisputed entries will be made by the *amin* and the *patwari* in their respective *khasras*, and by the *patwari* in the *parchas*. If any entry is disputed, the entry will be made in both *khasras*, and in the *parcha* in red ink. The entry to be made is that which the *patwari* says is right, and he is responsible for the entry. At the same time, the *amin* and *patwari* will enter the field as disputed in their respective list of disputes.

3. The Deputy Collector and some Settlement *munsarims* will move about inspecting the work and enquiring into the cause where there are many disputes. The Settlement does not consider it part of its duty to settle disputes during the survey, but only to see that owing to disputes the work be not stopped or hindered. In many cases it will be found, however, that the disputes raised are such as can be best settled on the field. For instance, there may be a dispute about the division of a field, and this can be settled at once by dividing the field; or a large crop of disputes may arise owing to the *amins* working with defective *khewats*. A village may be recorded as *zamindari*, and be really *pattidari*. In cases like these, the Deputy Collector and his assistants, by discovering the cause of the disputes, will be able to put an end to many. When disputes are thus settled, the *munsarims* will note what they have done in the dispute lists, but they will not write in the *khasras*, and no entry which has once been put in in red in the Urdu *khasras*, shall afterwards be written over in black.

4. In short, whereas formerly the Survey left disputed entries blank to be filled in by a dispute *munsarim*, there will now be no blank entries; but all disputed entries will be in red, and the *patwari* will be responsible for them.

5. The demarcation of soils both natural and conventional, has been entirely made over to the Survey. As soon, therefore, as the *Khanapuri* is finished, and has undergone the checks to which it is submitted by the Survey, the papers can be at once sent to the camp office. We thus avoid all delay in getting blank entries filled in, and the papers are not sent backwards and forwards between the survey and settlement officials for the settlement of disputes or for the demarcation of soils.

6. The first work of the Survey in office is to make a tracing of the map in Hindi figures, and to enter the field areas in both of the *khasras*, and in the slips. The dispute lists should also be compared to see that disputes have not been omitted.

It must then be ascertained that the totals of the two *khasras* agree with each other, and with the totals of the slips. This can only be done after the slips have been arranged and a list of holdings or *terij* has been made out. This *terij* should be in Hindi, for the Hindi *khasras*, as will be explained hereafter, remains with the *patwari*, and the fairing office requires a list of names in Hindi, in order that names which are ambiguous in the Urdu alphabet may be correctly written. This list of holdings will be arranged in *jamabandi* form according to *thoks* and *pattis*, and within them according to—*sir*, *khudkasht*, ex-proprietary tenants, occupancy tenants, tenants-at-will, rent-free tenants.

7. The Survey will then send to the Deputy Collector attached to the camp the following papers:—

(1) The map with Hindi figures.
(2) The Hindi *khasra*.
(3) Both dispute lists.
(4) The slips arranged according to the *terij*.
(5) The *terij*.
(6) The *khewat*, which the survey *amin* has got from the *patwari*.

A column in the *terij* will be left blank for the serial number of the holding. This will be added by the Deputy Collector. The Survey will arrange the various classes (occupancy tenants for instance) in alphabetical order, but some changes may be necessary.

8. On receipt of these papers the Deputy Collector will send the map, the Hindi *khasra*, and the Hindi dispute list to the *patwari* with directions that he should write a note upon separate papers about every dispute. The *patwari*, however, will not put a pen to the *khasra* or the dispute list.

9. Meanwhile the Deputy Collector will cause a *jamabandi* to be made in Urdu from the slips. It is necessary to make this *jamabandi* for several reasons. *First*, it is necessary to guard against the loss of a slip; *secondly*, the Deputy Collectors and *munsarims* cannot work rapidly and confidently with papers in the Hindi character; and *thirdly*, space is required on which to record attestation notes. After comparison with the slips, this *jamabandi* and the slips will be taken by a *muharir* to the village. The *muharir* will read out the *jamabandi* to the collected *zamindars* and tenants. Where the holding is free from dispute he will record in the note-column of the *jamabandi* that the *zamindar* and tenant agreed that the tenant held so much land (five bighas) on occupancy or non-occupancy tenure, as the case may be, at so much rent (ten rupees). It is not sufficient to write that the *zamindar* and the tenant agreed to the entries of the *jamabandi*. The land tenure and rent must in every case be specified in words. The *muharir* will make any other changes to which the people agree, taking the signatures of the parties and of the *patwari* to the alterations. The slips, after correction, will then be left with the *patwari*, with orders to explain to any one who desires it any entries which they may wish to verify. The *jamabandi* will be brought away by the *muharir* and handed to the *munsarim* to whom he is subordinate.

10. The *munsarim* will allow at least a week to pass after he receives the *jamabandi* before he goes to the village. He will take with him the *jamabandi*, the Urdu *khasra*, the Urdu map, the Urdu dispute list, and a blank form of dispute list which will be supplied to him. The people will be collected, and the *patwari* will attend with his *khasra* map, dispute list, and notes on disputes. He will also have the old *jamabandi* for reference. The *munsarim* will take the Urdu dispute list of survey, and mark off on it all disputes agreed to be settled before the *muharir*, ascertaining that they have been settled, and signing his name. All other disputes he will transfer to his own list, and proceed to enquire into them. He will record in the proper columns the substance of the *patwari's* note, and his own conclusion, and the grounds of it. New disputes which arise will be added to the list, and a conclusion come to on each of them, the reasons of the conclusion being briefly recorded opposite each dispute. The *jamabandi parchas* and Hindi *khasra* will be brought into agreement, and the *parchas* will then be distributed. A list of names will be made out and signed by *patwari* and *munsarim*, showing how many *parchas* have been given to each person. Dissatisfied persons will be informed that they must apply to the Deputy Collector on plain paper within 15 days.

11. After 15 days the Deputy Collector will proceed to attest. Each cultivator will be called on to state how much land he holds, at what rent, and on what tenure. As the attestation proceeds, a memorandum of orders on a printed form will be prepared showing the decision of the Deputy Collector on every dispute that is raised. If at attestation any changes are made in rents, rates, or tenures, the alteration in the *jamabandi* must be made in words and not in figures, and must be initialed by the Deputy Collector's *munsarim*. All formal objections on which an order is passed must find a place in the memorandum. On the last sheet of the *jamabandi* the attesting *muharir* and the attesting *munsarim* will write their names and designations in full, as well as their ordinary signatures. The Deputy Collector's *munsarims* will do the same, so that it may be known to whom the signatures on the record belong. The Deputy Collector will initial each page of the *jamabandi*, that no leaf may be hereafter removed.

12. After the Deputy's attestation, the Hindi *khasra* should be altered to agree with the result of the changes marked in the memorandum of orders, and should then be returned to the *patwari*. The *jamabandi* should be sent to be faired. The *parchas*, after correction, should be given back to the owners. New *parchas* will be prepared where the old *parchas* have been much altered. Any imperfect partitions agreed on at attestation will be shown in the *jamabandi*. The map should never be taken from the *patwari* from the time it is given to him. The Hindi dispute list is mainly useful to obtain the *patwari's* notes on disputes before attestation.

13. The object of this procedure is to obtain a complete record of all changes made subsequently to survey. Disputes are unmistakeably shown by the Survey in red ink, and the history of every dispute can be traced in one or other of the three dispute lists. At present,

it is a common ground of appeal that an objection was made, but was not listened to. It is often difficult to discover whether their statement is true; but with proper dispute lists it will be easy. The dispute lists therefore have acquired a much greater importance than was at first attributed to them, for now the Urdu *khasra*, with the result of the dispute lists, should agree exactly with the attested and faired *jamabandi*.

14. The position of the Urdu *khasra*, thus therefore has been changed. It is the record of the work of the Survey, and the dispute lists are the record of the work of the Settlement: the two sets of papers combined are exhibited in the attested *jamabandi*, which is the settlement record. So far as the *khasra* contains statistics of areas, soils, groves, wells, and such like, it is a record of undisputed facts, which are accepted without further check by the Settlement. It should not be looked at to discover the owner or tenant of a field. This can only be ascertained from the attested *jamabandi*. It is evident that for the facts of survey it is preferable to refer to the original paper than to a copy. It is proposed therefore not to fair the *khasra*, but to bind it in with the dispute lists in original, and deposit it in the Collector's office. No change therefore will be made in the Urdu *khasra* after it has been received from the Survey, nor will a copy of any entries in it be given. The only copies that will be given as regards holdings will be from the attested *jamabandi* and from the Deputy's memorandum of orders.

15. It is now time to retrace our steps to paragraph 7, to the juncture when the Survey has sent the unattested record to the Settlement. The Survey has retained only the Urdu *khasra*, but from this all the statistics required for assessment can be compiled.

They are—

(1) The area statement, showing details of cultivated, culturable, and barren.
(2) Agricultural statistics.
(3) Crop statement.
(4) Caste statement of actual cultivators.
(5) Soil statement showing the soils as held in *sir* and *khudkasht*, and by tenants.
(6) Statement of holdings.

16. The last statement has already been prepared by arranging the *parchas* as described in paragraph 6. This statement will be changed after attestation, but the totals of the attested holdings will not be available in the cold weather after survey, when assessment begins, and it is no extra labour to the Survey to supply it.

17. The fifth statement shows the soils as held by owners and tenants. Under the orders of Government, owners' land will be rated at four annas in the rupee less than tenants' land. It would be possible to dispense with this detail, and to have one statement showing the soil areas without any classification of owners' land and tenants' land. To give this classification however is very little extra labour; merely that of making entries in three columns instead of one, and it is a great help to the assessing officer to know whether the *sir* lands are in the *goind* tract or in the outlying. It is true that at attestation land recorded as *sir* at survey may be changed to tenant's land and *vice versâ*, but the changes will not be extensive, and the Settlement Department will not make out any statistics affecting soils.

18. The caste statement shows the area held by each caste and the number of their holdings, irrespective of whether the cultivator is an owner or a tenant. The other statements relate to facts which will not undergo any change at attestation. The assessment statistics will be finished as soon as possible after the record has been sent to the Deputy, and the statistics in vernacular will then be sent to the office of the Settlement Officer; the Urdu *khasra* and a trace in Urdu of the map being forwarded to the Deputy Collector.

J. J. D. LaTouche,

Settlement Officer.

The 1st December 1884.

Extract from the Official Report of the Calcutta International Exhibition, 1883-84.

The Survey of India Court occupied about forty running feet of the centre part of the eastern verandah in the Indian section, and contained a most interesting and extensive series of exhibits illustrating the operations of the survey in its different branches—Trigonometrical, Topographical and Revenue—as well as the processes by which the results of these operations are reproduced and printed in the head-quarters offices at Dehra and Calcutta.

All surveys are dependent on the use of instruments for observation and measurement, and though the collection of instruments exhibited was not so complete as might have been possible had the conditions of space and *locale* been more favourable, a few of the finest and most representative instruments used in the surveys were shown in two large cases, one at either end of the Court. In the case at the north end was a magnificent zenith sector manufactured by Messrs. Troughton and Simms from designs made specially for the Survey Department by the late Colonel Strange, R. E. The instrument is intended for the determination of astronomical latitudes, and every portion of it has been carefully designed and adapted for this special purpose. In the same case was exhibited one of the large 36-inch theodolites employed in the principal triangulation carried on by the Great

Trigonometrical Survey. This instrument, also, was constructed by Messrs. Troughton and Simms, some 54 years ago, and, notwithstanding its bulk and difficulty of transport, has during that time done good service, having been erected at no less than 516 stations of the Great Trigonometrical Survey, many of them situated on mountain summits, and others on lofty towers. No less than 1,772 angles have been measured with it. This instrument is the largest size of theodolite made, and is used exclusively for triangulation. In contrast with it stood close by a little 3-inch theodolite manufactured by Casella, which is the smallest made, and is intended for the use of explorers.

The instruments exhibited in the other case were of a more miscellaneous character, comprising a Repshold's magnetic dip circle; a 14-inch vernier theodolite of excellent design, by Troughton and Simms; a 7-inch theodolite, with stand, by Cooke; a 20-inch level by the same maker; an arithmometer and other instruments. Among the latter was an Eckhold's omnimeter, a most useful instrument, which, while answering the same purpose as an ordinary theodolite, which it resembles in appearance, is constructed to determine directly the distance of any observed object, and it is therefore a valuable assistance when working in hilly and broken ground.

Between the bays of the west wall and in albums on a table below it were exhibited a very complete collection of maps of various kinds and on different scales produced by the department, as well as specimens of copper-plate engraving, photo-zincography, and lithography.

At the extreme right were cadastral maps, *i.e.*, village maps on the scale of 16-miles to the inch showing every field and holding. Up to the present time the operations of the cadastral surveys have been chiefly confined to the richly cultivated revenue-paying districts of the North-Western Provinces and British Burma, but they are now being extended to Assam and the Central Provinces. The original sheets of these surveys (Imperial size, or $30'' \times 20''$) are reproduced by photo-zincography, and one of the most interesting exhibits in the Survey Court was a series illustrative of the processes employed in reproducing these maps. The sheets are photographed on glass plates 34 inches × 22 inches, so that a whole sheet is taken at one operation, and much time and labour—important considerations, when 3,000 to 4,000 such sheets have to be reproduced annually—are saved.

Next to the cadastral maps were a series of topographical maps on various scales, seldom larger than 2 inches to the mile, and generally 1 inch to the mile in open country and ½ inch to the mile in more difficult and hilly parts. These surveys, as a rule, are carried on in native states and wild hilly tracts not paying revenue. The original sheets submitted by the surveyors in the field are reproduced in *facsimile* by photo-zincography, either at Dehra Dún or in Calcutta. In the same way the maps of the revenue surveys in the more highly cultivated revenue-paying districts are usually published on the scale of 1 inch to the mile, the more recent surveys being photo-zincographed, and the older, lithographed.

In the next bay were exhibited specimens of town and city plans, chiefly European stations and cantonments, but also including plans of the principal cities in Native States. These are on various scales from 6 to 24 inches to the mile, and are executed by the revenue and topographical parties, according as the towns, &c., fall within their sphere of operations. These also are, as a rule, photo-zincographed from the originals.

Next came a collection of General Maps, among which the most prominent was General Walker's admirable map of Turkestan on the scale of 32 miles to the inch, now in its 6th edition, prepared and photo-zincographed at the Trigonometrical Branch Office, Dehra Dún. In this bay was also exhibited a series of maps of India, engraved in Calcutta on the scales of 64, 128, and 256 miles to the inch. A large 32-mile to the inch map of India, belonging to the series, was exhibited separately. It was executed by a combination of engraving and lithography, the outline being taken from the engraved plates and completed with the addition of hills on the lithographic stone.

The next three bays were occupied by specimens of copper-plate engraving, lithography, and photo-zincography in different styles and of various subjects other than maps, illustrative of the varied character of the work turned out by the Survey Department for other departments. Thus among the engravings were a few very delicately engraved plates by Mr. C. W. Coard, of microscopic observations of cholera, and of examination of air made by Drs. Lewis and Cunningham. Among the photo-zincographs were copies of the plans of the proposed new Kidderpore Docks, plans of some of the new public buildings in Calcutta designed by Mr. E. J. Martin, the Government Architect, and a few copies of engravings, &c., while contained in the atlases on the table were specimens of the different kinds of vernacular handwriting passing through the Post Offices in India, photo-zincographs of the ancient inscriptions in Gaur and Malda, copies of Burmese vernacular maps, Russian maps, and other manuscript drawings and documents of which *facsimile* copies are required.

The specimens of lithography and chromo-lithography were particularly good, the execution of some of the geological maps printed in colours being quite equal to similar work done in Europe. Th chalk-drawings included a number of plates to illustrate General Cunningham's reports of the archæological survey and a large and very effective plan of Simla and Jutogh with hills in chalk, copied from an original brush-shaded drawing by Major G. Strahan, R. E. The atlases on the table contained various specimens of lithographed maps and drawings, among which may specially be noticed some very neat maps of districts in the North-West Povinces drawn on stone to illustrate the Provincial Gazetteers.

One of the most noteworthy exhibits was the large relief map of India on the scale of 32 miles to the inch, constructed by Major G. Strahan, R.E., on the basis of a map, also prepared by him, showing the approximate heights by a system of average contours. Prints of this map on stout paper being cut round each contour, they were built up so that each successive contour marks an increase in height on the relief. The first five contours, reckoning from the level of the sea, represent successive rises of 200 feet. From 1,000 feet upwards each contour represented an increased height of 500 feet. The general effect was very striking, and the lie and elevations of the mountain ranges were very different from what would have been anticipated from a study of the ordinary maps.

A very important and interesting series of thirteen large maps, of which ten were prepared specially for the Exhibition, illustrating the material progress and state of India, was shown on the last wall of the Court, and attracted a good deal of attention. The subjects illustrated in these map were—

The Geology of India; the Distribution of Forest Trees; the Missionary Stations (and from the numerous enquiries made for copies of it, this appeared to be by no means the least interesting); the Religions of India; the Telegraph Lines and Stations; the Crops; Irrigation; the External Trade; Density of Population; Rainfall; Languages; and River Basins.

The Crop map was prepared by Captain Gore, R.E., under the direction of Colonel DePrée, Surveyor-General of India, on a very simple and ingenious system, and showed the acreage under cultivation of the eight principal crops in each district, as given by returns furnished by district officers. Each district was divided on the map into ten vertical slips, each slip, whatever its length, being taken to represent one-tenth of the area of the district. The slips or portions of slips were coloured to show the percentage of area under cultivation with the eight principal crops. The area of uncultivable land was also shown. The area in acres of each district was printed across it, so that it was possible to calculate at once the area of any crop growing in the district. Unfortunately the absence of statistics for the Bengal districts rendered the map incomplete.

The map showing the distribution of the various religions in India, prepared by Major Sandeman, was also very interesting. The occurrence of the various religions was shown by spots of colour thus—Islam, green; Hinduism, burnt sienna; Christianity, blue; the Sikh's religion, red; Buddhism, yellow; &c, each spot representing 25,000 inhabitants. The map showed therefore not only the distribution of the various religions, but the density of the population. The last characteristic was specially marked in the Gangetic valley. The large preponderance of Muhamadans in Bengal was also clearly shown, while in Southern India the blue spots, representing Christianity, occurred with comparative frequency.

The geological map and the rainfall map were lithographed from originals prepared in the Geological Survey and Meteorological offices, and were good specimens of colour printing. It is to be hoped that the whole series of these interesting maps will be lithographed and made available to the public, as a glance at them teaches more as to the actual state of the country than volumes of dry statistics.

For this very comprehensive collection of maps a gold medal was awarded to the Survey of India.

The two large tables with sloping backs running along the centre of the Court were chiefly devoted to photographs and specimens illustrating the processes of photo-mechanical printing and lithography. Among the former the most important were a small collection of the photographs of the sun's disc taken daily in the photo-heliograph at Dehra Dún under the superintendence of Mr. J. B. N. Hennessey, M.A., F.R.S., to which a silver medal was awarded. These photographs, though not so large as those taken by M. Janssen at Meudon, near Paris, being only 8 inches in diameter instead of 12 inches, showed the granulation of the solar surface very clearly, and in this respect were a great improvement on the 4-inch photographs hitherto taken. Arrangements are now completed by which 10-inch photographs are taken. These show the granulations and spots with great clearness

The remaining photographs were exhibited by the Photographic office in Calcutta, and comprised reproductions by the ordinary silver-printing process of monochrome drawings by Colonel H. C. B. Tanner, RO. S. C., and a small series of photographs of Indian jewelry, &c., prepared for the Vienna Exhibition of 1872. Among the illustrations of photographic processes the most noteworthy was a series showing the procedure followed in photo-zincographing a sheet of the cadastral survey:—

1st.—The original manuscript map, drawn in the field, measuring 22 × 30 inches.

2nd.—The negative, taken by the ordinary wet-collodion process on a glass plate 34 × 22 inches, special precautions being taken to keep the lines of the map as clear as possible, while the ground is quite black and opaque.

3rd.—The photo-transfer print from the negative, produced by sun printing on sensitive paper coated with a mixture of gelatine and bichromate of potash, the image formed by the action of light through the clear parts of the negative appearing in brown upon the pure yellow ground of the paper protected from light by the opaque parts of the negative.

4th.—The transfer print, coated evenly with a greasy transfer ink, which blackens it all over.

5th.—The photo-transfer print after washing in warm water. The ink and unchanged gelatine and bichromate are washed away from the ground of the print, leaving the image in insoluble gelatine with the greasy ink attached.

6th.—The zinc plate with the greasy ink image transferred to it.

7th.—The finished print.

This process, introduced in 1863, is most extensively used in the Survey of India offices, both at Calcutta and Dehra, for the reproduction of maps. The great majority of the maps exhibited were produced by means of it, and no other process would enable the department to meet the large demands upon it for copies of maps, plans, and drawings of all kinds.

The other two photo-mechanical processes exhibited were photo-collotype and heliogravure. These, though eminently useful for certain classes of work, will never supersede photo-zincography for the rapid and cheap reproduction of large maps.

The process of photo-collotype was shown by a series comprising—

1*st.*—The original, an engraved quarter-sheet of the atlas of India.

2*nd.*—A reversed negative made from the original reduced to half the scale.

3*rd.*—The printing plate, consisting of a plate of glass, half an inch thick, coated with a thin film of hardened gelatine. This film is made sensitive to light with bichromate of potash, and when dry is exposed to light under the negative. The light passing through the clear parts of the negative, representing the shadows of the subject, still further hardens the gelatine, and renders it unabsorbent of water just in proportion to the amount of the action of light upon it. The plate is then washed to remove all the bichromate salt, and removed while wet to an ordinary printing press, where it is inked in with a roller charged with printing ink, just in the same way as a lithographic drawing. The ink will take only on the parts hardened by the light, and if the subject be in half-tone, such as an ordinary photograph, the ink will take just in proportion to the amount of action of light—strongly on the deep shadows, less so on the dark half-tones, less again on the lighter half-tones, and not at all on the high lights, and thus a picture is obtained in printing ink with all the exquisitely fine gradation of an ordinary photograph.

A collection of specimens of this process showed its capability of reproducing various subjects in fine lines or half-tones, and it may be mentioned that it was employed for the production of the certificates of award of gold medals, photographed from the original drawing by A. P. Bagchi of the School of Art.

Another valuable photo-mechanical process shown, was *heliogravure*, a method of photographic engraving by which an engraved copper plate may be obtained of any subject in line or half-tone. The process consists in printing a photographic image on a tissue prepared by coating paper with coloured gelatine and rendering it sensitive by immersion in a bath of bichromate of potash. The printed tissue is then made to adhere under water to a polished copper plate thinly silvered. After a short time the plate with the tissue is treated with warm water which loosens the supporting paper and enables it to be removed, leaving the greater part of the coloured gelatine and the image on the copper plate. By continuing the washing all the soluble gelatine is removed, leaving only the thin film of gelatine forming the image and rendered insoluble and hardened by the action of light. This film is of varying thickness according to the amount of the action of light. It is thickest in the deepest shadows of the image, and progressively thinner through the dark and light half-shades down to the high-lights, which should be represented by the bare copper.

If the subject be in line, no further treatment of the gelatine relief is necessary beyond a slight hardening in a bath of alum or bichromate of potash, after which it is washed and dried before being black-leaded and prepared for electro-typing.

If, however, the gelatine relief be produced from an ordinary photograph, or any other subject in half-tone, it has to undergo a further operation by which a grained or roughened surface is given to it, in order that the surface of the deposited copper-plate may also be roughened, and hold the printing ink in the proper proportion to give the relative value of the different tones of the picture. This is done by a method introduced by Major Waterhouse, which has proved simple and effective. After the treatment with warm water, and while the gelatine relief is still soft and swollen, it is powdered all over with some granular material, such as sand or emery, which has been previously treated with a greasy substance to prevent its sticking to the gelatine. The plate is left to dry, and as it dries the sand, &c., is drawn into the gelatine and pits its surface in different depths according to the thickness of the film, thus producing a graduated grain, coarse in the shadows and fine in the lights. The plate being wetted, the sand is easily removed by gentle rubbing. When dry, the grained relief is ready to be black-leaded and electro-typed—an operation which takes about three weeks or a month, according to the thickness of the deposit. The deposited copper is then separated from the matrix, and after being cleaned is ready for printing in the copper-plate press.

The series exhibited showed—

1*st.*—The original, which in this case was a drawing in monochrome by Colonel C. J. Cramer Roberts of a view of Kinchinjinga from Birch Hill, Darjiling, represented by a photographed copy.

2*nd.*—The negative, which has to be reversed in order to produce a reversed image on the deposited plate.

3*rd.*—The gelatine tissue adhering to the copper plate.

4*th.*—The developed and grained image.

5*th.*—The same black-leaded and ready for electro-typing.

6*th.*—The deposited copper plate ready for printing.

7*th.*—The proof from the plate.

In a frame were shown various specimens illustrating the applications of this process to copies of maps, shaded drawings, portraits, and views from nature.

On the same side of the table was a small series comprising a stone with outline in black; three colour stones with proofs of each colour, and the completed copy of an index map of the Geological Survey, illustrating the process of printing in colours by lithography.

Gold medals were awarded to both the Photographic and Lithographic Offices for the excellence of their exhibits.

On the other side of the central table were an array of imposing-looking volumes recording the operations of the Great Trigonometrical Survey, and prepared under the immediate superintendence of Lieutenant-Generel J. T. Walker, C. B., R. E., late Surveyor-General of India. The annual reports of the department which, it may be mentioned, contain a vast quantity of interesting and valuable information regarding little known parts of the country, were shown with other reports.

The last exhibits requiring notice are the tidal diagrams on the central table illustrating the very important work done by the Tidal and Levelling party of the Great Trigonometrical Survey under Major Baird, R.E. The tidal observations were first started in 1872 with the object of ascertaining by a series of observations extending over many years whether any gradual difference of relative level of land and sea is taking place in the Gulf of Cutch, as was surmised by the late Dr. Oldham, Superintendent of the Geological Survey, and the early operations of the party were confined to that neighbourhood. The tidal observatories have, however, since been extended round the Coast of India and British Burma from Kurrachee to Moulmein, and there are also stations at Aden and at the Andaman Islands. The observations are effected by self-registering instruments, which record the rise and fall of the tides in a curve upon a sheet of paper rolled round a metallic drum. Besides their scientific value in determining variations of the level of the land and sea, these observations are of considerable practical use in enabling tide-tables to be drawn up for the different Indian ports for the use of mariners. They have also been found very valuable to science in another direction, as giving records of earthquakes and other submarine volcanic disturbances taking place in Indian seas. Thus the earthquake of the 31st December 1881 was clearly recorded at Port Blair, Negapatam, and other stations on the east coast of the Bay of Bengal. The effect of the more recent volcanic eruption of August last in Java was also distinctly traceable on the registers of most of the Indian tidal stations, extending as far as Aden.

This slight sketch of the various interesting exhibits of the Survey of India can only give a very faint idea of the extent of the operations of the department in its several branches, and of the steady progress that is being made in accurately mapping this vast empire. Although the lines of tringulation, upon which so much depends in survey operations, have now been almost completely fixed all over the country with an accuracy equal, if not superior, to that of any country in the world, and much has also been done in the Topographical and Revenue branches to get a good general first survey, much detail work still remains, and there are yet many openings for valuable explorations on and beyond the frontiers and in other little known regions.

W. J.—Reg. No. 10543J—400—30-4-86.

ERRATA ET CORRIGENDA.

On pages (18) *to* (40) *of Appendix to the General Report of the Operations of the Survey of India Department, during* 1882-83.

Page			
(18)	*passim*	*for* E	*read* ϵ
	line 12 from bottom	„ R^s	„ Rs
	„ 9 „	„ H^s and K^1	„ Hs and κs
	„ 9 and 8 from bottom	„ H Cos. $(\nu + \mu - \kappa)$	„ f H cos $(V + u - \kappa)$
	„ 8 from bottom	„ H^1 and K^s	„ Hs and κs
	„ „ „	„ K	„ κ
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	„ „ „	„ "$\nu + \mu$"	„ "$V + u$"
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	„ 14 „	„ K	„ κ
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(25)	„ 5 „ top		
(30)	in table, line 4 from top, last col.	*for* 0·00	*read* 0·007
(34)	„ „ 3 from top, col. 2	„ 4°·752	„ 47°·52
(35)	„ „ 2 „ „ 3	„ 0·033	„ 0·023
„	„ „ 5 „ „ 5	„ 85°·8	„ 85°·85
(39)	line 2 from bottom	„ 4·697	„ 5·697
(40)	in table, line 5 from top, col. 9	„ 309°·35	„ 309°·85

Circular No. $\frac{1178.}{98—2}$

Extract from the Proceedings of the Government of India in the Revenue and Agricultural Department (Surveys),— dated Simla, the 12th September 1885.

Read—

The General Report on the Operations of the Survey of India Department for 1883-84.

RESOLUTION.

Several changes took place in the *personnel* of the Survey Department of India during the year under report, of which the principal were due to the retirement from the service of the Government of Lieutenant-General J. T. Walker, R.E., C.B., and Mr. J. B. N. Hennessey, M.A., F.R.S., late Deputy Surveyor General in charge of the Trigonometrical Branch. The Government of India has already recorded its appreciation of the long and distinguished services rendered to the Department by the former officer, and His Excellency in Council has observed with satisfaction that Her Majesty the Queen-Empress has been pleased to recognize the valuable scientific work done by the latter by conferring on him the companionship of the Order of the Indian Empire. PERSONNEL.

2. The results of the working of the three Branches of the Department are described in Part II. of the report.

3. The Secondary Triangulation Party visited and erected beacons on the old stations of the East Coast Series, from Puri to Balasore. The positions of the beacons and buoys of False Point Harbour and the Dhamra river were accurately fixed, as were those of all prominent objects on the coast which could be used as land marks for ships. This work will, it is hoped, facilitate navigation and the future work of the Marine Survey. TRIANGULATION.

The connection by triangulation of the Peninsula of India with the Straits Settlements and Malacca has been held in abeyance during the year, and it has recently been decided in view of financial exigencies that it shall not be undertaken for the present.

4. Eleven Topographical parties were employed. Of these three were in the field in Bombay, two in the North-Western Provinces, and one each in the Andaman Islands, Assam, Baluchistan, Central India, Mysore, and Rajputana. TOPOGRAPHICAL SURVEYS.

5. The three Bombay parties worked in Cutch, Guzerat, and the South Deccan respectively.

In Cutch 2,154 miles were surveyed topographically on the scale of two inches to the mile, and 1,086 miles on the scale of half an inch to the mile, and 2,100 square miles were triangulated in advance. The Guzerat party executed some topographical surveys of Native States on the two-inch scale, and completed the survey of the Panch Mahals on the four-inch scale, including the demarcation of village and forest boundaries. The area already surveyed in Guzerat amounts to 18,191 square miles, or about two-fifths of the whole. In the South Deccan the area surveyed amounted to 1,832 square miles of a more mountainous and difficult country than any with which the party had previously met. It is estimated that the 15,200 square miles, which still remain unsurveyed in the area assigned to the South Deccan party, will occupy about 8 years.

6. The parties in the North-Western Provinces were employed in the Aligarh and Etah districts, and in the Mirzapur district, respectively. In the Aligarh and Etah districts 1,503 square miles were surveyed on th 2-inch scale. The riparian tracts on either side of the river Ganges covering an extent of 98·09 square miles were surveyed on the 4-inch scale. It has recently been decided to suspend the topographical survey of the remainder of the North-Western Provinces and Oudh, the existing revenue maps being

sufficiently accurate to answer the present requirements of the Civil Administration, and topographical surveys of other tracts being more urgently required. The work of the Mirzapur party consisted of a survey of a portion of the district on the 2-inch scale, and the execution of theodolite traversing round the village boundaries of the Dudhi pargana, and certain villages of the hilly tracts of Robertsganj. This work was of a very laborious description, owing to the nature of the country.

7. A suitable map of the South Andaman Island being much needed by the Settlement officers, a party was deputed in November 1883 to make a complete survey of that island. The only datum available on which to base the survey was the position of a point on Chatham Island in the harbour of Port Blair, the latitude and longitude of which had been determined astronomically in 1863. The result of the season's work is a map of Barren Island and the Island of Narcondam on the scale of 8 inches = 1 mile and sheet No. 14 on the 4-inch scale. It has been decided that the survey shall extend to the remainder of the Andaman Islands. The general survey will be executed on the $\frac{1}{2}$-inch scale, though certain portions of the South Andamans will be surveyed on the 4-inch scale. Advantage is being taken of the survey to investigate the geology and flora of the Island.

8. The Assam and North-Eastern Frontier party was originally to have been employed in the survey of the Noa Dihing valley up to the Patkai crest, but the Aka raid on the Darrang district having necessitated the despatch of a punitive expedition against the offending tribes, it was determined to take advantage of the opportunity offered for the Survey of the Aka Hills. Subsequently the Daphla country was also surveyed. The detailed survey executed covers 1,934 square miles of the Aka and Daphla hills on the scale of 1 inch to 4 miles; 622 square miles on the scale of 1 inch = 2 miles and 143 linear miles of route and river survey by native explorers within British territory.

9. The Baluchistan party was divided into three sections, of which one was employed with the Takht-i-Sulaiman Expedition; one accompanied Sir R. Sandeman's Mission into South-Western Baluchistan, and one was employed on the regular detailed survey. The area triangulated amounted to 6,100 square miles, and the area topographically surveyed to 4,840 square miles on the half-inch scale. This work was carried out in the Thal-Chotiálí territory and the Kachi desert.

10. The Malwa party executed 1,390 square miles of triangulation and 1,587 square miles of detail survey on the 1-inch scale besides completing the triangulation and traversing for the large scale survey of the Dúngarpur city and the Kherwára cantonment. The country is intricate and much cut up by small streams and hillocks. The party has now completed its work, and a portion of it will, during the ensuing field season, probably be sent into Ajmere, the remainder being transferred to Bengal.

11. In Mysore 1,417 square miles, including the work required as a basis for the Mysore city survey, were triangulated. The area topographically surveyed on the 1-inch scale amounted to 3,975 square miles in the districts of Shimoga, Kadur, Mysore, and Bangalore.

12. The Rajputana party was chiefly employed in surveying on the scale of 1 inch=1 mile portions of the Sirohi and Palanpur States and the sanitarium on the Abu Range. The Sunda and Dorra ranges were surveyed on the 2-inch scale; and the revised survey of the city and environs of Ajmere was nearly completed for the Municipality on the scale of 12 inches = 1 mile. The total area surveyed was 1,211 square miles on the 1-inch scale and 120 square miles on the 2-inch scale, besides the 12-inch survey of Ajmere city; 4,133 square miles were also triangulated.

MAUZAWAR, RIVERAIN AND FOREST SURVEYS.

13. Three parties were employed in mauzawar, riverain and forest surveys in British Burma, the Punjab and Bombay, respectively. The first-named party surveyed 211 square miles of reserved forest tracts on the scale of 4 inches = 1 mile; and 52 square miles of unreserved forest and ground likely to be brought under cultivation on the scale of 2 inches = 1 mile. The area prepared in advance for next season was 321 square miles. The surveyed area lies on the western slope of the Pegu Yoma range in the Tharrawaddy district. The

country is very difficult for survey on account of the almost impenetrable undergrowth and the rugged, and in many parts inaccessible, character of the range. The several high ridges running parallel to the range are covered with forest, and intersected by streams while the Yoma or back-bone of the range stands up like a wall above the lower hills. In a part of the Thonze reserve a rise of more than 2,000 feet occurs in a little more than a mile from the crest.

14. The party employed in the Punjab continued its previous year's work in Hissar of a topographical survey on the 2-inch scale, combined with a system of skeleton traverses to aid an approaching settlement survey. In the report the system followed is thus described :—

"The traversing follows village boundaries, in the interior of which sub-traverses are run at distances of about ½ a mile apart, furnishing fixed points at short intervals, all of which are permanently marked. From the data obtained of these points, skeleton plots can be prepared on any required scale, these will furnish an efficient frame-work for the cadastral survey of fields to be undertaken by the *patwaris* of the district under the superintendence of the Settlement Department.

The object of the Hissar experiment is to ascertain by actual trial in what way the Settlement and Survey Departments can best assist each other. While it is hoped that the survey skeletons will on the one hand form a frame-work for patwari field maps, so on the other it is expected that the details furnished by the field maps will be incorporated in the topographical maps. A fuller report on this subject is expected in the Surveyor General's Report for 1885-86, as at present there is no reason to believe that the work of the survey party is to be made in any way the basis of patwaris' maps, as was intended by the Government of India.

The areas surveyed comprised 1,782 square miles of the district on the 2-inch scale, the Hissar farm (64 square miles) on the 6-inch scale, and the city and station of Hissar 14 square miles on the 12-inch scale.

On the completion of the survey of Hissar, it had been intended to employ detachments of the party in Ferozepore, Umballa, Jullundur and Ludhiana. The experience gained in Hissar has, however, shown that in the plains districts of the Punjab, so elaborate a system is unnecessary; and in future the operations will consist of a modified skeleton traverse survey, two trijunction platforms being utilized for stations, and fixed in each village, and of a scientific survey of all riverain tracts subject to fluvial action. The topography of revised 2-inch maps of the province will be taken from the settlement maps, the details being tested and additions made where necessary.

15. The third mauzawar survey party was employed in the Thana district of the Bombay Presidency. The work done by it embraced the survey of the Thana Collectorate on the 4-inch scale, and the 2-inch survey of the Jawhar State. On the larger scale, 612 square miles were surveyed and 288 square miles on the smaller. The country surveyed lies between the Western Ghats and the sea, and is very difficult in parts.

CADASTRAL SURVEYS.

16. Cadastral or field survey parties were employed in the Ajmere-Merwara district, in three districts in British Burma, in three districts in the North-Western Provinces, in one district in the Central Provinces and in one district in Assam. The areas surveyed are given in the margin.

North-Western Provinces	1,747	square miles.
British Burma	1,749	„
Central Provinces	31	„
Assam	228	„

The Ajmere-Merwara survey was begun in connection with the revision of the settlement of the district. The fluctuating character of the cultivation rendered an ordinary cadastral survey of the district unsuitable and after consideration it was determined to adopt a system of traverse and village boundary survey, under which fixed points are established by professional traversing, and skeleton maps are provided showing the boundaries of each village and the position of each permanent mark within it. On these data the *patwaris* map in the cultivation at the time of their survey and whenever changes may become necessary.

17. The three cadastral parties in British Burma were employed respectively in the Bassein and Henzada districts, the Pegu and Shwegyin districts, and the Prome and Akyab districts. All the cadastral work required in the

Pegu and Prome districts has been completed; and now only one and a half parties are employed in Burma, half a party having been withdrawn altogether for financial reasons and another party having been diverted to topographical work.

18. In the North-Western Provinces the parties employed worked in the Benares and Basti districts, the Dehra Dun district (a detachment) and the Gorakhpur district.

The so-called Benares system under which the survey and settlement establishments work together, each preparing its own copy of the *khasra* and *jamabandi*, was followed in the Benares-Basti survey. In Gorakhpur a slightly different system has been adopted. There the survey officer furnishes with the map a correct record of all undisputed facts of ownership and tenancy, a complete list of all disputes, and a classification of the soils and statistics for assessment purposes. The Revenue Officer then fills up the dispute list and checks the soil classification. The success of this system in respect both of expedition and economy, when compared with cadastral work hitherto turned out by the Survey Department, has been shown by the result of the operations of the work of the first season. The detachment in Dehra Dun was employed in surveying the cultivated lands on the Benares system.

19. The detachment in the Central Provinces was employed in the Raipur district in the cadastral survey of a certain number of villages as a test of the accuracy of the settlement maps. The survey establishments prepare a skeleton survey of the boundaries of villages, together with those of moderately sized blocks of fields, and the interior divisions are afterwards to be filled in by the *patwaris* who also write up the record-of-rights. A survey class has been organized for the instruction of junior civilians, native officials and *patwaris*.

The arrangements for the survey of the remaining districts of the Central Provinces of which the settlement will expire within the next few years is now under the consideration of the Government of India.

TRAINING OF CIVILIANS, &c.

20. The cadastral survey of the Kámrúp district was begun on the completion of the Hooghly River survey. The Benares system of survey has been adopted in Kámrúp at the instance of the Chief Commissioner.

21. A new system of training young Civilians in cadastral survey work by attaching them to regular field parties has been begun. In the North-Western Provinces, seven Civil Servants have been thus instructed in field surveying; and native soldier students from the Roorkee College have also been attached to the regular field parties of the Topographical Branch, and instructed in the method of delineating ground by plane-table survey.

EXPLANATION OF THE THREE SYSTEMS OF CADASTRAL SURVEY.

22. In explanation of the foregoing paragraphs it may be stated that there are three systems of cadastral survey now at work, one in the Punjab where, except possibly in the case of the Hissar experiment, no use is made of the Surveyor General's Department, all field maps being constructed by patwaris under the control of the Settlement Officer. The actual cost of this work has not been ascertained, but it is believed to be cheap, and sufficiently accurate for revenue purposes, although it has the drawback of not fitting in with sufficient precision into the general survey maps of the country. The next system is that now under adoption in the Central Provinces, where, as already explained, the field plotting will be filled in by patwaris on a traverse skeleton provided by the Survey Department. The third is that in progress in the Gorakhpur and Basti districts of the North-Western Provinces, where the entire survey map of each village together with a considerable portion of the village record is turned out by the Survey Department. This system is the most accurate and complete in its results, but is probably the most expensive, and can only be justified in districts where the patwaris are insufficiently trained to do the field plotting. The Surveyor General is requested to bring forward in his next annual report as clear a statement as he can furnish of the cost and results of each of these systems. The subject of cost is more fully dealt with in paragraph 28 of this review.

GEOGRAPHICAL AND MISCELLANEOUS.

23. Under the head of *Geographical* and *Miscellaneous*, the Darjeeling party surveyed the Sumesar Hills, the Daling Hills, and a portion of Sikkim,

besides triangulating and sketching Himalayan topography and demarcating and surveying the Nepal-Bengal Boundary. Explorations were also conducted in Tibet. This party did some interesting work and has helped towards an extended knowledge of Himalayan geography.

TIDAL AND LEVELLING OPERATIONS.

24. The Tidal and Levelling party has continued its scientific work; tidal observations being taken at 19 stations. The reduction of the observations has progressed steadily, and the final results have been determined, so that the co-efficients will be presented in the manner recommended by Professor Darwin and explained in the Report for 1882-3. The Spirit-levelling operations completed a line of levels between two sea-coast stations, *viz.*, from Kurrachee to Agra and thence to Bombay with an error only of ·624 of a foot or less than 4 inches per 1,000 miles. This line was linked with that of last year and its length was over 425 miles over ground with rises and falls amounting in the aggregate to nearly 22,000 feet.

GEODETIC.

25. The two Astronomical parties were engaged in the extension of the electro-telegraphic longitude arcs eastwards of Calcutta, and measured six arcs during the season—Akyab-Calcutta, Akyab-Chittagong, Prome Chittagong, Prome-Akyab, Moulmein-Prome, and Moulmein-Akyab. The link between Kurrachee and Moulmein was thus completed.

HEAD QUARTERS OFFICES.

26. The work of the Head-Quarters Offices, both at Calcutta and at Dehra is dealt with in Part III. The several offices have again turned out a very large amount of work for other departments and Local Governments. The total number of maps issued during the year amounted to nearly 200,000, and their value exceeded a lakh and a half of rupees. Much good work was done in these offices in connection with the Calcutta International Exhibition. The 3,000 ornamental award certificates were produced with the aid of the heliogravure and collotype processes. Some of the special maps which were drawn for the Exhibition have been prepared for publication and the rainfall, railway and telegraph maps have already been published. Maps showing trade routes, distribution of languages, and river basins have also been printed. Maps showing the density of population and the distribution of the different religions and missionary stations are in course of publication. The forest map is, it is understood, now ready. The Government of India attaches great importance to these maps; and a Crop-map of India, shortly to be prepared, will be completed in time for the Colonial and Indian Exhibition of 1886.

MATHEMATICAL INSTRUMENT DEPARTMENT.

27. The Mathematical Instrument Department issued 33,365 instruments valued at Rs. 1,61,529 to departments. The number issued exceeded that of last year by 12,000, their value being greater by Rs. 34,000. The Government of India is also glad to notice that there has been a considerable use of articles of Indian manufacture for this department. An innovation has been introduced into the department by the entertainment of apprentices in the several technical offices. Their work should be carefully watched; and the result of the experiment should be noticed in future annual reports.

COST RATE PER MILE OF SURVEY WORK.

28. The statements at pages LXXX and LXXXI of the Appendix, showing the cost rate per mile of work executed by the several parties are, as far as they go, very valuable. The opportunity is taken however to impress upon the Surveyor General the very great importance of reducing the expenditure on revenue surveys of all kinds to the very lowest limit as urged in the Resolution of September 4th, 1882. Notwithstanding the comparatively small cost, compared with the charges of former years, of the North-Western Provinces Surveys, the charge is still too high to admit of the system being extended to any Province in which it is possible to utilize patwaris under the supervision of local officers for field plotting. Great credit is due to Majors Barron, Sandeman and Steel for their unremitting efforts to make the cadastral parties serve the Provincial Governments in the most effective manner, but it is now a question whether similar efforts should not, on account of the financial exigencies of the case, be directed to the perfection of a system in which the very utmost use should be made of the village officers for field plotting, under the control of an efficient staff of native supervisors. The fact that the Government, whether Imperial or Provincial, is obliged in any case to provide payment for a village staff, makes it imperative to require the education of that staff in the duty of making and

maintaining village maps so that the cost of a second establishment may be avoided, and it will be found that unless the Survey Department can make the above system the goal of its efforts, it will be difficult for it on financial grounds to maintain that connection with the cadastral surveys still remaining to be accomplished which it is very desirable to preserve. The two points to be aimed at, in modification of the North-Western Provinces system, seem to be the more liberal employment of the village staff, and the reduction of the charges for supervision. The Government of India would be glad if in future reports the information as to "cost" could, with the assistance of the Provincial authorities, be made to comprise a comparison between the total cost of various systems adopted in any districts in which the Survey Department is employed, whether to do the whole work as in the North-Western Provinces, or a part of the work as in the Central Provinces and Hissar. At present the table in page LXXX is not sufficiently instructive. The cost per acre for instance of a complete cadastral survey (including traverse, field plotting, and survey record) in Ajmere cannot be compared with that of a complete cadastral survey in the North-Western Provinces.

29. In conclusion, the Government of India thanks Colonel DePrée for his interesting report.

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.

Madras.	Central Provinces.
Bombay.	British Burma.
Bengal.	Assam.
North-Western Provinces and Oudh.	Coorg.
Punjab.	

Ordered also, that it be published in the supplement to the *Gazette of India*.

(True extract.)

E. C. BUCK,

Secretary to the Government of India.

FILE No. 98.
SERIAL No. 2.

1885.

GOVERNMENT OF INDIA.

REVENUE AND AGRICULTURAL DEPARTMENT.

SURVEYS.

RESOLUTION.

Circular No. $\frac{117S.}{98-2}$

Dated Simla, the 12th September 1885.

SUBJECT.

Reviews the Survey Report for 1883-84.

Govt. C. B. Press, Simla.—No. 503 R. & A. D.—15-9-85—1 100.