

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1904-05.

PREPARED UNDER THE DIRECTION OF

COLONEL F. B. LONGE, R.E.,

SURVEYOR GENERAL OF INDIA.



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1904-05.

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Survey of India Offices, Calcutta, May 1906.

J. R. Hobday.

From a photograph by Messrs Johnston & Hoffmann.



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Survey of India Offices, Calcutta, August 1905.

RAI BAHADUR KISHEN SINGH MILAMWAL.

SURVEY OF INDIA.

THE "A-K" OF TIBETAN EXPLORATION.

1869-83.



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CONTENTS.

PART I.

SUMMARY.

	PAGE.
Administration	1
Field Parties	7
Outturn	8
Topographical Surveys	9
Forest Surveys	9
Cadastral and Traverse Surveys	10
Trigonometrical Surveys	11
Special Operations	11
Geographical Surveys	12
Head-Quarters Offices, Calcutta	12
Branch Offices, Dehra	17
Local Drawing Offices	19
Establishment	20

PART II.

THE OPERATIONS OF FIELD PARTIES.

PARTY.	TOPOGRAPHICAL SURVEYS.	PAGE.
1. Central Provinces		23
2. Berar		24
3. Lower Burma		25
10. Upper "		26
11. North-West Frontier		28
12. Sind		29
14. United Provinces of Agra and Oudh		30
15. North-West Frontier		31
18. Punjab		32
	FOREST SURVEYS.	
9. Forests		34
17. Bombay Presidency		35
19. Madras "		37
20. Burma		38
	CADASTRAL AND TRAVERSE SURVEYS.	
4, 5 and 6. Bengal		40
7. Burma		45
8. United Provinces of Agra and Oudh		47
Detachment, Assam		50
	TRIGONOMETRICAL SURVEYS.	
24. Triangulation		51
	SCIENTIFIC OPERATIONS.	
22. Latitudes		51
23. Pendulums		52
25. Tidal and Levelling		54
26. Magnetic		56
	TABULAR STATEMENTS.	
Outturn of work of Field Parties		62
Cost-rates		66
" of Scientific Parties		68

APPENDIX.

	PAGE.
Report on Survey Operations with the Somaliland Field Force by Captain G. A. Beazeley, R. E.	i

ILLUSTRATIONS.

Portrait of Colonel J. R. Hobday, I.A.	Frontispiece.
„ of Rai Bahadur Kishen Singh Milamwal the “A—K” of Tibetan Exploration	„

MAPS.

	TO FACE PAGE.
1. Index to Sind Survey	29
2. Index to Survey Operations in Burma (Revenue) North of Latitude 18°	46
3. „ „ „ „ „ South of Latitude 18°	46
4. Index to the Survey of Rangoon city	45
5. Index to the Indian Atlas shewing sheets published up to 1st October 1905	13
6. „ „ „ work in hand on 1st October 1905	13
7. Index to recent Cadastral Traverse and Topographical Surveys in the Brahmaputra and Surma Valleys (Assam Detachment)	50
8. Index to Survey Operations in the United Provinces (14 Party)	30
9. Index to Cadastral Surveys, United Provinces	47
10. „ „ Traverse „ „ „	47
11. „ „ Central Provinces Surveys (1 and 2 Parties)	23
12. „ „ Cadastral Surveys in Bengal	41
13. „ „ Traverse „ „ „	41
14. Map of India shewing progress of Forest Surveys	34
15. „ „ „ „ „ „ on 4" and larger scales	34
16. Index to Survey Operations in the Punjab	33
17. India shewing progress of Imperial Surveys	1
18. Index to degree sheets, Burma	19
19. India shewing stations of magnetic observations	60
20. Index to Trigonometrical Survey of India	1
21. Diagrams illustrating the results of Pendulum Observations in Bengal	53
22. Index to Survey Operations in Burma (Topographical), North of Latitude 18°	26
23. „ „ „ „ „ („ „), South of Latitude 18°	26

GENERAL REPORT
ON THE
Operations of the Survey of India

DURING THE SURVEY YEAR

1904-1905.

PART I.
SUMMARY.

ADMINISTRATION.

1. This report deals with the operations of the Department for the survey year ending the 30th of September 1905. The general administration remained in the hands of Lieutenant-Colonel F. B. Longe, R.E., until the 9th November 1904, when he was placed on special duty as a member of the Indian Survey Committee and was temporarily replaced as Surveyor General by Colonel J. R. Hobday, I.A., until the close of the Committee's deliberations on the 3rd of May 1905 when he again resumed his substantive appointment of Surveyor General. The office of Deputy Surveyor General was held by Colonel J. R. Hobday, I.A., until he relieved Lieutenant-Colonel Longe, R.E., as Surveyor General and again from the 4th of May until the 15th July 1905 when he retired from the Department on superannuation. In his place, Colonel R. A. Wahab, C.B., C.M.G., C.I.E., was appointed Deputy Surveyor General, but as he was on leave and unable to take up the appointment, Lieutenant-Colonel G. B. Hodgson, I.A., was appointed to officiate for him and on Colonel Wahab's retirement from the service on the 31st of August 1905, Colonel Hodgson's appointment was confirmed. Colonel Hodgson also officiated as Deputy Surveyor General while Colonel J. R. Hobday, I.A., officiated as Surveyor General. Lieutenant-Colonel S. G. Burrard, F.R.S., R.E., retained his appointment of Superintendent, Trigonometrical Surveys, throughout the year, and Major C. W. H. Symonds, I.A., held the office of Superintendent, Forest Surveys, until the 3rd of November 1904 when he was relieved by Major P. J. Gordon, I.A., the permanent incumbent, on his return from furlough.

2. This year will be memorable in the history of the Department on account of the appointment by the Government of India of a Committee to consider (1) the state of the maps in each province and the measures required to bring them up to date; (2) methods and expense of survey; (3) methods of reproduction; and (4) the organisation of the Department.

The Committee was composed as follows:—

President.

Mr. J. O. Miller, C.S.I., I.C.S.

Members.

Colonel Sir John Farquharson, K.C.B., (late) R.E. and a former Director General of Ordnance Surveys.

Colonel F. H. Kelly, (late) R.E.

Lieutenant-Colonel F. B. Longe, R.E., Surveyor General of India.

Mr. C. A. Barron, I.C.S. (Secretary).

In addition to these officers, Colonel S. C. N. Grant, C.M.G., R.E., of the Ordnance Survey of Great Britain was specially deputed from England to examine the existing methods of reproduction in the Photo-Litho. offices at Calcutta and Dehra Dún and to advise the Committee as to future organisation and methods of reproduction.

As a full report of the proceedings and recommendations of the Committee has been published separately and is available for reference by such as are interested in it, it is unnecessary to do more than give a brief account of its proceedings and recommendations.

3. The Committee assembled in Calcutta in the latter half of November 1904 and finally dispersed in the end of April 1905. Colonel Grant's enquiries were made during the months of January and February and the period allowed for them was insufficient to enable him to draw up any definite scheme for the re-organisation of the Drawing and Reproducing offices, though his report will be of great value to such officers as may be appointed later to prepare such a scheme and to arrange for the future execution of the extra-departmental work now carried out in those offices which has been found in the past to seriously interfere with the regular work of the Department.

4. The Committee spent the latter part of November, parts of December and January and greater part of March on tour, visiting Gauháti and Shillong in Assam; Káthiár and Dinapore in Bihár; Rangoon, Toungoo, Mandalay, Maymyo and Katha in Burma; Madras, Bangalore, Poona, Bombay and Badnera in Berar; Lucknow, Dehra Dún and Rájpur in the United Provinces; Lahore in the Punjab and Pesháwar in the North-West Frontier Province. The President and Colonel Longe also visited Hyderabad, and the President paid a short visit to Roorkee. Time did not allow of further touring as it was necessary to complete the report by the end of April.

5. A mass of evidence was taken and recorded and the existing maps of practically the whole of India were examined in Calcutta with the result that it was found that while these maps were undoubtedly good at the time they were made, and their accuracy as far as they went was unquestionable, they were published in an inconvenient size and they were not up to modern standards in quality of reproduction; that they had not been prepared on any one uniform system, nor were they necessarily complete to margin; that the symbols used on them were not uniform and they were deficient in heights and levels. Besides which, in many parts of India, they were so out of date as to be of little use and in some cases even misleading owing to the changes in roads, etc., since they were prepared.

6. The Committee recommended the preparation of a series of maps of half the present standard sheet size on the scale 1-inch=1 mile to cover the whole of India, which should be reproduced in colours. It stipulated that a far greater number of heights and levels should be shewn, that one system of symbols should be employed throughout the whole series and that a selection of these symbols should be published on every map. The Committee further laid down that the surveys should in future, as a rule, be made on the scale of 2-inches=1 mile for reduction and publication on the 1-inch scale.

7. In order to carry out these decisions it will be necessary to revise in the field practically the whole of the existing one-inch maps of India and to survey on either the two or the one-inch scale the whole of the country for which maps on neither of those scales have ever yet been prepared.

The class of revision was gone into as carefully as the very limited time at the disposal of the Committee permitted and omitting the Baluchistan Agency and the tribal area of the North-West Frontier Provinces it is estimated that an area of 525,800 square miles of original survey will have to be made, that a practical re-survey will have to be made of 479,000 square miles, while the maps of 266,300 square miles may be capable of revision in the field, such revision being, it is hoped, merely the addition of new roads, rail roads, etc., the insertion of additional heights and correction of the contouring.

Taking the total area excluding Baluchistan and North-West Frontier tribal areas as 1,673,300 square miles, there remains an area of 266,300 square miles for which cadastral maps are or will be available from which to prepare topographical maps with inconsiderable corrections in the field and 135,900 square

miles, chiefly in Burma, for which the maps are modern and merely require redrawing.

8. It is proposed that the whole of this work should be carried out within 25 years while the survey of Baluchistan, North-West Frontier Province and the country adjacent thereto should be completed within a much shorter period.

9. The Committee further recommended that cadastral operations should be left entirely under the control of Provincial Governments and local authorities and conducted at their expense, but that the Survey of India should lend for the execution of such surveys such Imperial and Provincial officers as local Governments might from time to time require, such officers being invariably seconded in the Survey of India. It further recommended that the Survey of India should no longer be called upon to execute special forest surveys on scales larger than 2-inches=1 mile in any but exceptional cases, and that where such surveys were executed the cost should be debited to the Forest Department, and further that in future village boundaries should not be shewn on ordinary topographical maps, but that if local governments desired to have maps showing village boundaries special editions should be published for their benefit under certain conditions. It also recommended the abolition of the engraved atlas sheet series commonly known as the Atlas of India, on account of the antiquity of most of the information shewn thereon and the substitution for it of a series of engraved maps on the scale 1-inch=4 miles, each map covering one degree of latitude by one degree of longitude and that this series should be called the "degree sheet" series. It will be readily understood that these proposals involve an enormous amount of work and will, if approved, necessitate a large increase in the staff of the Department and a very careful re-organisation.

10. Perhaps the most important recommendation of the Committee is that a definite programme should be laid down for India as a whole and that this programme should not be departed from without grave reason and then only under the orders of the Government of India. One of the main reasons for the want of uniformity in the topographical maps of the past is to be found in the fact that no such programme has ever been attempted, but surveys have been carried out from time to time by provinces, states or even districts, regardless of the scale or quality of the maps of the country adjacent thereto. The dates of such surveys vary enormously. They were carried out under the orders of a great number of Surveyor Generals and under many different systems. From an artistic point of view many of the older maps are better than those of later years, but in former days, the actual topography and fair mapping were executed almost entirely by highly trained Provincial officers and the triangulation was generally the work of Imperial officers, while for the last 20 years or more the policy of making greater use of native agency and thereby reducing the cost of surveys and increasing the outturn, has undoubtedly caused deterioration in the class of work done in the Department and the necessity for economy has led to the employment of cheap and in many cases unsatisfactory workmen, but with the enormous areas to be dealt with in the immediate future, it will seem impossible to change the system at the present time, though every endeavour will be made to secure the services of a superior class of native for the subordinate grades.

11. The enormous extent of our Indian possession, the lack of communications and the distances between the various field parties, have in the past rendered it practically impossible for Surveyor Generals or Deputy Surveyor Generals to inspect the various parties in the field and to check the methods of their subordinate officers and the style in which the work of any one party has been carried out has been therefore more dependent on the idiosyncrasies of the officers in charge at the time than on any general principle.

The policy of the Committee therefore in suggesting that the Government of India should lay down a definite programme for the future and should formulate certain rules as to the maps that should be prepared, the scales on which surveys should be made, and the style in which maps should be drawn and reproduced, is therefore a subject of great importance and one that should be welcomed by the Department.

12. The Committee estimate that it will require 15 parties of the following strength to carry out their recommendations within a period of 25 years, *viz.*, 2 Imperial officers, 5 to 7 Provincial officers, 32 Surveyors and a proportion of writers, etc. Each party will have to deal yearly with an area of nearly 4,500

square miles and if the work is to be of high standard, the surveyors employed on it will have to be most highly trained, while the officers will require to exert all their energies in superintending the work in the field and recess.

13. If it is conceded that the Surveyor General in past times has been unable to exercise the supervision that is necessary to ensure uniformity it is obvious that with such a large increase in the yearly outturn and with 15 parties scattered all over India it would be still more impossible for him to exercise efficient control without material assistance and it is to be hoped that this assistance will be afforded to him by the creation of at least 4 Superintendents of Circles, each being charged (under the general superintendence of the Surveyor General) with the control of the parties working within the areas assigned to his circle.

14. As an outcome of the Committee's deliberations, and more especially in compliance with the request of the military authorities, the old system of numbering standard sheets by provinces will be discontinued and one series of numbers will in future be employed for the whole of the maps of India and adjacent countries.

Owing to the reduction in the size and shape of the 1-inch standard sheets and to the abolition of the atlas sheets series and substitution for it of the degree sheets series this is rendered a comparatively easy matter, for 16 1-inch standard sheets will in future make up exactly one degree sheet, while 16 degree sheets will be contained in one sheet of the 1-millionth series. Thus by giving a number to each (1-M) sheet, letters from A to P to each of its component degree sheets and an additional number 1 to 16 to each of the 1-inch standard sheets, these letters and numbers having definite positions in the 1-M map in which they fall, we shall be able to locate and ask for any (1-M) one to a Million sheet, degree sheet or 1-inch standard sheet by reference to a single index map for the whole of India; but in order to simplify matters, index maps for each 1-M map showing its component degree and standard sheets will be prepared.

15. The production of these 3 series, each map of which covers an area of either 4°, 1° or 15' Latitude and Longitude according to the series to which it belongs will enable us to publish atlas volumes of convenient dimensions.

Thus the degree sheet atlas series would consist of a (1-M) one to a Million sheet followed by its 16 component degree sheets, while the 1-inch atlas series would consist of a degree sheet followed by its 16 component standard sheets and in time these atlases might be supplemented by an index of the village and other names shown on maps.

16. The Department is at present quite unequal to coping with the work suggested for it and it will take several years before it will be possible to train the required number of native surveyors, though it will be a comparatively easy matter to procure the necessary number of Imperial and Provincial officers.

17. The increase in the field establishments and consequent increase in the yearly outturn of mapping will swell enormously the work of the reproducing offices and their present organisation is unsuited to cope with it, but it is hoped by re-arrangement that it may be possible to carry out all that is necessary without any material increase in expenditure, but when it is remembered that the survey and preparation of a 1-inch standard sheet for reproduction amounts probably to not less than ₹10,000 and that the cost of reproduction by helio-zincography amounts to approximately but ₹84 per hundred copies, it would seem advisable not to fear some extra expenditure under the latter head, but rather to endeavour in every possible way to make our resultant maps as good as possible by employing the best methods that are at our command.

18. It is understood that all the sheets of the 1-M and degree sheet series will eventually be engraved and possibly a large number, if not all, of the 1-inch standard sheets.

19. Great trouble is experienced in getting good lithographic stones and a considerable number of "faked" stones have broken up under the pressure of continuous printing.

20. Many complaints have from time to time been made in the Department of the quality of the paper on which our maps are printed and one of the greatest difficulties to be contended with in the printing section is registration.

This difficulty will be much more felt in the future when we shall have to print our maps in 4 or 5 colours instead of at the most 2, which was the custom for the topographical maps of the past and some special arrangements seem necessary to insure an adequate supply of reliable paper from England in future.

21. Perhaps the most difficult problem that a Surveyor General of India has to deal with when attempting to survey and map on a uniform system a vast country containing such mountain ranges as the Himalayas and such plains as those of the Punjab, Bengal and Rajputana with such elevated plateaux as Baluchistan, etc., is to decide on a vertical interval between contours on any one scale that will suit all classes of country and meet the requirements of the people for whom the maps are most useful.

The scale with which we are at present most closely connected is that of 1 inch = 1 mile. For ordinary purposes it is probable that an interval of 50 feet between the contours would be sufficient, though a much smaller interval would, in flat or gently undulating ground, be much more valuable; but in the massive hills and mountains of India, to attempt to show contours at such intervals would be impracticable and utterly disproportionate to the value of the labour involved in surveying them. I believe that no system has yet been evolved by any country which deals satisfactorily from a systematic and artistic point of view with this question. If any light can be thrown on this question by any student of the subject, his conclusions would be most gratefully welcomed. My present suggestion is to show on each map a coloured line below which contours may be accepted as representing differences of level of 50 feet and above which the hills will be merely artistically defined, as great a number of heights being shown on the hill tops, at passes and along the ridges and where possible on spurs, as may be convenient.

22. It must be recognised that in an enormous area such as India, cut up as it is by so few permanent roads or railways, and inhabited by but few wealthy or educated communities, it is out of the question to hope to be able to either establish or maintain bench marks on the scale found to be possible in European countries, without involving the country in an ever-recurring expenditure of considerable magnitude and no survey that is made at the present time except in highly cultivated tracts can be so made as to insure a re-survey being carried out from the marks that may be found on the ground hereafter, without very considerable expense and revision.

23. In the Ganges valley, the plains of the United Provinces and of the Punjab, the village trijunctions will, let us hope, always be maintained and will thus form permanent marks on which to base our surveys, but in the less populated tracts and in the hills no such marks are of any practical value to a surveyor working on the small scale on which it is proposed to survey the country, and every succeeding generation of surveyors will have to clear and supplement such of the old marks as may be found on the ground before it can attempt to revise the maps.

24. The courses of the large rivers and even of comparatively small ones are absolutely unconfined in the plains of India and the influence they exert on the features of the country can hardly be realised by persons not engaged in the actual preparation of maps of any particular district. As a consequence it will probably be found in the future as in the past that the maps of one year cannot be satisfactorily joined up with those of any previous years, where rivers are involved. To attempt to revise maps yearly or even at intervals of ten years, however, for the purposes of co-ordinating adjacent maps would be out of the question and in consequence the Committee recommended limiting the revision of the maps during the first period of 25 years to the insertion of fresh roads, rail-roads and canals, but the construction of either new roads, rail-roads or canals involves a large increase of population and consequently the growth of new villages and other artificial works and the conversion of jungle or waste land into cultivation—all or any of which changes render maps immediately obsolete and somewhat misleading, and it would seem necessary to make the occasional revision more frequent in areas in which important changes were from time to time occurring.

25. One very satisfactory point in the Committee's report is the recommendation that the scientific work of the Department should not be curtailed beyond the handing over to the local authorities of the tidal observatories and work

connected with them. It would probably however be found impossible to find at the various posts officers capable of carrying out the work, and a central office under a special officer would in any case be necessary. The effect of such a transfer would have no practical effect on the topographical work of the Survey of India, as it does not even now claim the whole time services of even one Imperial officer.

The Committee recommended that the present strength of Imperial officers attached to this branch should be increased by two in order to meet present requirements.

26. The photozincographic office, Calcutta, labours under great difficulties at the present time. Its establishment is a fixed one and there is no elasticity: there is no supply of trained men in India capable of dealing with any of the technical duties, from which this office could recruit its members or fill its casualties, and consequently except in the case of men specially recruited in England to fill the more important posts every member has to be trained in the office itself and while under training occupies a post that should be filled by a competent man. Further there is no regular supply of work and purely departmental work has constantly to be set aside in order to comply with the urgent demands of other Government offices and departments, and the Survey of India work is consequently almost invariably in arrears.

There is urgent need for reform and a complete reorganisation as regards the distribution of the work and the payment of the employees and it is hoped that this will shortly be effected.

27. Under the present organisation the drawing and reproducing offices are under different officers and are entirely independent of each other. They are under different roofs and consequently a certain amount of friction is inevitable. In any re-organisation it would seem advisable to place these offices under one authority each as a section of one and the same office.

28. The work of the Drawing and Reproducing offices during the year under report was very materially interfered with by the work thrown on them by the Survey Committee. This is not tangible but is none the less real, and all members in both offices did their utmost to supply all the information that was required of them.

29. I do not consider the shortcomings of these offices are due to the inattention of the assistants, who have worked well in as trying a climate during the greater part of the year, as any in the world for Europeans, but that they are due to the system. There can be no doubt that a move to some station where the climate is better and the fluctuations in humidity are less frequent and sudden will materially improve the work and enable a greater out-turn to be produced yearly.

Inspection Tours of Administrative Officers.

30. Colonel Hobday, I.A., Officiating Surveyor General, left Calcutta on the 20th March for Dehra Dún, where he inspected the offices of the Superintendent, Trigonometrical Surveys, and the Superintendent, Forest Surveys. From there he proceeded to Ráwalpindi on the 1st April to inspect the field work of No. 18 Party and of the Cantonment Section of No. 15 Party. He returned to Calcutta on the 14th April. On the 1st of May he proceeded to Simla and on the 4th idem handed over charge of the office of Surveyor General to Lieutenant-Colonel Longe, R.E., who remained at Simla till the 14th July, during which period he inspected the recess office of No. 18 Party on several occasions. He left Simla on the 15th July and arrived at Dehra Dún on the following day. While at Dehra Dún he held a conference of Survey officers which discussed various questions in connection with the future preparation and reproduction of standard maps and other questions connected with the Department. On the 26th July he proceeded to Mussooree and inspected the offices of Nos. 14 and 15 Parties and the North-West Frontier Drawing Office located in that station. On the 9th August he left for Bhím Tál to see whether suitable sites for the location of a drawing office and for the recess quarters of field parties could be found there. He proceeded to Naini Tal on the 15th and inspected the Drawing Office there and also conferred with the Secretary to the Government of the United Provinces and the Superintendent, Provincial Surveys, regarding future survey work in that province and the future of the Drawing Office and returned to Calcutta on the 24th August. He had intended to inspect the offices at

Bangalore and Poona, but was compelled to abandon this trip and to proceed again to Mussooree to settle the composition and field programmes of Nos. 12, 14 and 15 Parties until the 12th. October when he proceeded to Dehra Dún. While in Mussooree he again inspected the office of No. 1 Party and the North-West Frontier Drawing Office on several occasions. While at Dehra he inspected the office of the Superintendent, Forest Surveys, and that of No. 20 Party, and in connection with the Superintendent, Forest Surveys, prepared a scheme for the future working of the Forest Survey Branch parties which was duly submitted to the Government of India. He returned to Calcutta on the 20th October.

31. Lieutenant-Colonel Hodgson, while officiating as Deputy Surveyor General, inspected Nos. 1 and 2 Parties in the Central Provinces and Berar during January 1905 and inspected the work of two Provincial officers and two surveyors in the field. Before returning to Calcutta he proceeded to Lucknow to meet Captain Coldstream, Superintendent, Provincial Surveys, in the United Provinces with a view to discussing various matters with him in connection with the future conduct of surveys in those provinces. Colonel Hobday after handing over the office of Surveyor General to Lieutenant-Colonel Longe at Simla in May 1905 proceeded to Dehra and inspected the progress of the Tibet mapping. He then proceeded to Mussooree and inspected Nos. 1 and 14 Parties. Thence he proceeded to Darjeeling and attended a conference of the Board of Revenue of the Lower Provinces, when proposed changes in procedure (which have since been carried out) were discussed.

In June he inspected the four field parties recessing at Bangalore and the Bangalore Drawing Office.

32. Lieutenant-Colonel Burrard, Superintendent, Trigonometrical Surveys, proceeded to Karachi and inspected No. 12 Party (Sind) in March 1905. He visited Mussooree in June 1905 and inspected the detachment of No. 25 Party and in September 1905 he inspected the recess offices of Nos. 23, 24 and 26 Parties. He also inspected Nos. 22 and 25 Parties (Tidal and Levelling) and the Survey Training School during the year from time to time.

33. Major Gordon inspected No. 20 Party in the field in Burma and also the detachments of No. 9 Party working in Assam, Bengal and Burma. He inspected the recess offices of No. 17 Party at Poona, No. 20 Party at Dehra Dún and No. 19 Party at Bangalore. While at Bangalore he attended a conference held by direction of the Madras Government, at which the Conservators of circles and the Deputy Director of the Madras Revenue Survey were present to discuss matters connected with forest surveys in the Presidency.

DISTRIBUTION OF FIELD PARTIES.

34. Field operations were carried on by 23 parties and 2 detachments; of these 9 were employed on topographical surveys, 4 on forest surveys, 5 parties and 2 detachments on cadastral surveys, 1 on triangulation, and 4 on scientific operations. In the following statement the whole of the operations are grouped according to the nature of the work on which the parties were employed.

No. of Party.	Nature and <i>locale</i> of operations.	Page in this Report.	Executive Officers.	Scale of survey.	Administrative Superintendent.
	<i>Topographical.</i>	PAGE.		Inches. Miles.	
1	Central Provinces	23	Captain A. H. B. Hume, R.E. Mr. W. M. Kelly	2 = 1	D. S. G.
2	Berar	24	Captain E. T. Rich, R.E.	2 = 1	Ditto.
3	Lower Burma	25	Mr. E. F. Litchfield	1 = 1	Ditto.
10	Upper Burma	26	Captain C. P. Gunter, R.E. " E. T. Rich, R.E.	1 = 1	Ditto.
11	North-West Frontier	28	Major J. M. Burn, R.E. Lieutenant C. M. Browne, D.S.O., R.E. " R. H. Phillimore, R.E.	2 = 1	S. G.
12	Sind	29	Mr. C. F. Erskine " R. F. Warwick	Various	Supdt., Trig.

No. of Party.	Nature and <i>locale</i> of operations.	Page in this Report.	Executive Officers.	Scale of survey.	Administrative Superintendent.
		PAGE.			
14	United Provinces	30	Captain H. L. Crosthwait, R.E.	2 = 1	S. G.
15	North-West Frontier	31	Captain F. W. Pirrie, I.A. Major C. L. Robertson, R.E.	} Various	S. G.
18	Punjab	32	Captain E. A. Tandy, R.E. „ M. O'C. Tandy, R.E. . . . .			} Do.	S. G.
	<i>Forests</i>				
9	Bengal	34	Major C. W. H. Symonds, I.A. „ P. J. Gordon, I.A.	} 4 = 1	} Supdt., Forest Surveys.
	Assam				
	Punjab				
	North-West Frontier Prov.				
	Central Provinces				
Burma					
17	Bombay Presidency	35	Mr. B. G. Gilbert-Cooper	} 4 = 1 } 8 = 1	} Supdt., Forest Surveys.
19	Madras Presidency	37	Major C.L. Robertson, R.E. Mr. G. T. Hall	} 4 = 1	
20	Burma	38	Captain A Mears, I. A.	4 = 1	
	<i>Cadastral and Traverse.</i>				
4	Bihár	40	Lieutenant L. C. Thuillier, I.A.	16 = 1	S. P. S., Bengal.
5	Chota Nagpur	41	Captain F.J.C. Hirst, I.A.	16 = 1	Ditto.
6	Eastern Bengal	42	Mr. A. W. Smart	16 = 1	Ditto.
Det.	Calcutta Suburbs	44	„ R. B. Smart	1056 = 1	Ditto
7	Burma	45	Lieutenant-Colonel G. B. Hodgson, I.A. Major C. W. H. Symonds, I.A.	16 = 1 528 = 1	} D. S. G.
8	United Provinces	47	Captain W. M. Coldstream, R.E.	16 = 1		Ditto.
Det.	Assam	50	Mr. T. Shaw . . . . .	.....	Ditto.
	<i>Trigonometrical.</i>				
24	India (Triangulation)	51	Captain H. H. Turner, R.E. . . . .	.....	Supdt., Trig.
	<i>Scientific.</i>				
22	India (Latitudes)	51	Lieutenant-Colonel S. G. Burrard, F.R.S., R.E. Captain H. M. Cowie, R.E.	}	Supdt., Trig.
23	Do. (Pendulums)	52	Major G. P. Lenox-Conyngham, R.E.		
25	Do. (Tidal and Levelling)	54	Major J. M. Burn, R.E. Mr. J. P. Barker	}	Ditto.
26	Do. (Magnetic)	56	Major H. A. D. Fraser, R.E. Captain R. H. Thomas, R.E.		

OUTTURN.

35. The total outturn of detail survey during the year amounts to 121,588 square miles which includes 88,850 square miles of geographical surveys; the area surveyed during the previous year amounted to 58,464 square miles which included a geographical survey of 24,100 square miles; the total area triangulated is 28,230 square miles against 22,496 last year.

The total area traversed for cadastral purposes is 7,645 square miles, *viz.*, 323 square miles in the United Provinces, 6,326 square miles in Bengal, 645 square miles in Burma, and 32 square miles in the Central Provinces and 80 square miles in Assam.

TOPOGRAPHICAL SURVEYS.

36. During the year under report the locale of operations of No. 11 Party was changed for the year from the Shan States to the North-West Frontier; with this exception, the work was carried on in continuation of previous years.

37. *Punjab*.—No. 18 Party continued the supplementary surveys in the province on the 2-inch scale, utilizing and verifying the detail compiled from settlement *masavis* fitted together by means of traverse points. The area completed was 1,511 square miles in Multán and Muzaffargarh districts. The originally sanctioned programme had to be considerably modified on account of a special 6-inch survey which the party was ordered to make for the military authorities on which the most experienced surveyors of the party were employed.

38. *United Provinces of Agra and Oudh*.—No. 14 Party topographically surveyed on the 2-inch scale an area of 1,908 square miles, and completed 518 square miles of revision and supplementary survey in districts, Allahabad, Fatehpur and Cawnpore. The survey of the first two districts mentioned above is now complete. No. 8 Party completed 167 square miles on the 2-inch scale.

39. *Central Provinces*.—No. 1 Party completed the supplementary topographical survey on the 2-inch scale of 2,719 square miles, and 483 square miles were surveyed by No. 2 Party on the same scale.

40. *Sind*.—An area of 3,937 square miles was topographically surveyed by No. 12 Party in this province.

41. *Baluchistan and North-West Frontier Province*.—An area of 1,509 square miles was topographically surveyed by No. 15 Party and 982 square miles were completed by No. 11 Party.

42. *Burma*.—Nos. 3 and 10 Parties were employed on topographical surveys in Burma and surveyed 7,513 square miles on the 1-inch scale, of which 4,365 square miles consisted of supplementary survey and 1,070 square miles on the Burma-China Boundary.

43. *Bengal*.—The survey of the bed of the Kosi river on the 4-inch scale was continued and 252 square miles was completed during the season in conjunction with the cadastral survey in the Bhágalpur and Purnea districts.

In the Backergunge Sundarbans 227 square miles were surveyed on the 4-inch and 93 miles on the 2-inch scale.

44. The total outturn for the year under the head of new topographical survey and supplementary survey on the scale amounts to 20,582 square miles as follows:—

	Square miles.
Punjab	1,511
United Provinces	2,593
Central Provinces	3,202
Sind	3,937
Baluchistan and North-West Frontier	2,491
Burma	7,513
Bengal	572

FOREST SURVEYS.

45. The operations of the Forest Survey Branch are fully reported on in the Forest Survey report and are therefore only briefly mentioned here. They were generally in continuation of those of the previous season. By the end of next year the survey on the 4-inch scale of the most important forests in the North-West Frontier Province, the Punjab, the United Provinces, and in the Central Provinces, with the exception of Berar, will have been completed. In Burma, Assam, and in the Central Provinces the local Governments have, at the instance of the Inspector General of Forests and with the approval of the Surveyor General, agreed in principle to the remaining forest areas being surveyed on the 2-inch scale, the cost of such surveys being borne by the Survey of India. In Bengal the only important forest tracts for which special surveys are now required, are the extensive reserves in the Sundarbans; as special training and arrangements are necessary for this work, it is proposed that it should be carried out by one of the Revenue parties at present employed on the survey of the

non-forest portions of the delta. These proposals are in accord with the recommendations of the Indian Survey Committee.

46. The Madras Government has been approached with a view to a similar policy being adopted in that Presidency.

In Bombay forest surveys are so far advanced that no change in the present general programme is contemplated.

47. *Madras*.—No. 19 Party in addition to triangulation and traversing surveyed an area of 750 square miles on the 4-inch scale in Ganjám, Gódávári, North Coimbatore and South Canara. A test survey on the 1-inch scale over an area of 135 square miles was also made for the Indian Survey Committee and a surveyor was lent to the Madras Government to assist in the demarcation of the Mysore—South Canara boundary. These operations to a certain extent affected the outturn of 4-inch surveys and consequently the cost rates.

48. *Bombay*.—No. 17 Party in addition to triangulation, surveyed an area of 187 square miles on the 8-inch scale in Násik and Thána and of 597 square miles on the 4-inch scale in Násik, Khándesh and Sátára. A portion of the boundary between Khándesh and the Barwáni State was also traversed at the request of the Bombay Government.

49. *Burma*.—No. 20 Party surveyed an area of 680 square miles on the 4-inch scale in Upper and Lower Chindwin Pakòkku and Thayetmyo districts. Two strong detachments of No. 9 Party were also employed in Burma and surveyed an area of 501 square miles in the Irrawaddy basin chiefly in Katha and Shwebo. A large area was also traversed and triangulated in advance by both parties. Recent forest surveys in Burma have brought to light the rapidity with which the coast line on the western side of the Gulf of Martaban is advancing, the margin of the sea being now at some points as much as 6 miles from where the surveys of 12 years ago show it to have been then.

50. *Bengal*.—A detachment of No. 9 Party completed the survey on the 4-inch scale of the forest reserves in Angul, an area of 232 square miles.

51. *Assam*.—In Assam an area of 148 square miles of forest was surveyed on the 4-inch scale by No. 9 Party in the Gáro Hills, Nowgong and Kámrup in addition to traversing and triangulation in Darrang and Sibságar.

52. *Punjab and North-West Frontier Province*.—A small detachment of No. 9 Party under a native surveyor was employed throughout the year and completed the survey of an area of 202 square miles chiefly in Jhelum and Hazára.

53. Traversing and triangulation were carried out in advance of detail survey in Berar and five surveyors were lent to the Forest Department for the purpose of surveying the boundaries of recently demarcated mica-mine grants in Kodarma.

54. Except in Madras the cost rates do not call for special notice, being as a rule practically the same as for last year. In Madras the outturn for the year is the smallest and the cost-rates are the highest that have been reported in No. 19 Party for many years and this state of affairs cannot be altogether satisfactorily explained by the undoubted disadvantages which this party suffers from in respect of the scattered nature of the work and the difficulties of supervision; the work lies entirely in unhealthy tracts generally remote from villages; it is of a monotonous character and extremely distasteful to the class from which the surveyors are recruited, and continued ill-health has helped to discourage them. The work however is generally of good quality, and it is hoped that better results will be obtained next season.

The total outturn of topography done by the Forest Survey Branch during the year was 3,358 square miles made up as follows:—

Scale 4-inches = 1 mile	3,171 square miles.
„ 8 „ = 1 mile	187 „

CADASTRAL AND TRAVERSE SURVEYS.

55. One party was employed on cadastral and traverse operations in the United Provinces, three parties and one detachment in Bengal and one party in Burma. One detachment was employed on traversing only in Assam.

56. In the United Provinces in the Moradabad district, 323 square miles were traversed and 349 square miles surveyed cadastrally. Three hundred and nineteen square miles of previous cadastral surveys on the 16-inch scale were

revised and the records written of 895 square miles. The cadastral maps were revised and the annual records written of 720 square miles in the Bánda district and of 782 square miles in Hamirpur district. The survey of Cawnpore city done in 1900-02 on the 64-inch scale was revised and a survey on the scale of 24 inches to the mile was made of an extension of the Hápur Remount depôt area 1·6 square miles.

57. In Bengal 935 square miles were traversed for topographical survey and 5,388 for cadastral survey: 4,476 square miles were surveyed cadastrally on the 16-inch scale and the records written of 4,507 square miles.

The survey of the suburbs of Calcutta and Panchánnagrám Government Estate was continued; 3 square miles were traversed and surveyed on the scale of 32 inches to the mile and 2 square miles surveyed on the scale of 50 feet to the inch. The records of the entire area were written.

58. In Burma the survey of the Pakòkku district was continued; 747 square miles were traversed and 819 square miles surveyed on the 16-inch scale.

The survey of the town of Rangoon was extended over an additional area of 9·3 square miles.

59. In the Central Provinces an area of 32 square miles consisting of forest excisions and scattered villages was traversed by one of the topographical parties for survey by local agency in the Chánda and Hoshangabad districts.

60. In Assam 60 square miles of tea grants and 20 square miles for survey by local agency were traversed. In addition 28 linear miles were traversed along the Dibrú-Sadiya railway.

61. The total areas traversed and surveyed cadastrally are as follows:—

Province.	Traversing.	Cadastral survey.
United Provinces	323	2,171 (a)
Bengal	6,326	4,481 (b)
Burma	747	645
Central Provinces	32	.....
Assam	80	.....
TOTAL	7,308	7,297

(a) Includes 1,821 square miles of revision survey.

(b) Includes 11 square miles of miscellaneous surveys.

TRIGONOMETRICAL SURVEYS.

62. The triangulation party (No. 24) was transferred from Eastern Burma to Baluchistan, and commenced work on a series of principal triangulation trending westwards from Kalát. As points were required for topographical purposes, the new series was made to emanate from a side of the secondary triangulation of Kalát, and its connection with the principal triangulation of India was postponed till a later date. It extended the triangulation westward, a distance of 130 miles: nine triangles were completed and the average triangular error was 0·667 seconds.

SPECIAL OPERATIONS.

63. To complete the geodetic data furnished by the great arc of parallel between Karáchi and Moulmein, it was necessary to take astronomical observations for latitude and azimuth at the four longitude stations east of Calcutta, namely Chittagong, Akyab, Prome and Moulmein. In 1905 Captain H. M. Cowie observed for azimuth and latitude at Chittagong, and for latitude at Akyab, Prome and Moulmein azimuths having been already observed at these places.

64. Pendulum observations were taken at ten stations situated on the Calcutta meridian. The most southerly station was at Cuttack in Orissa and the most northerly at Sandakphu in Sikkim. Of the ten stations, three were in the Himalayas, two at the foot of the Himalayas and five on the flat alluvial plains of Bengal and Orissa. Owing to the unceasing vibrations of the ground, satisfactory pendulum observations in Calcutta itself were found to be impossible.

65. Tidal operations were continued by No. 25 Party, observations being recorded at nine stations.

Levelling operations were carried through Sind along the left bank of the Indus. During the recess season a second levelling detachment was organised.

66. Four detachments of No. 26 Party extended the field-work of the magnetic survey over different portions of the country. The base station at Tougoo was opened during the year and is now working satisfactorily: in the original design of the magnetic survey, five base-stations were included and they are all now at work.

GEOGRAPHICAL SURVEYS.

67. Under this head are included surveys and reconnaissances which are executed on the $\frac{1}{2}$ -inch and smaller scales. The survey detachment with the Somaliland Field Force completed an area of 1,253 square miles on the $\frac{1}{2}$ -inch scale and 17,687 square miles on the $\frac{1}{4}$ -inch scale. A narrative report of this work from its commencement in 1903 will be found in the appendix. The maps were prepared by Captain Beazeley in England and have not been published by the Survey of India.

Captains Ryder and Wood, R.E., completed 40,000 square miles of survey on their return journey from Gyang-tse *via* Shi-ga-tse and Gartok to Simla. This, although actually surveyed during the year under report, was fully described in the General Report of last year and is only mentioned here.

The survey detachment with the Seistan Mission completed 42,000 square miles, of which 15,000 square miles were reported last year.

One native Provincial officer and three Surveyors were detached from No. 10 Party (Burma) to accompany two expeditions despatched by the Burma Government to determine and demarcate the Burma-China boundary, and 1,070 square miles were surveyed on the 1-inch scale and 2,970 square miles on the $\frac{1}{4}$ -inch. The 1-inch survey included the road from Bhamo to Tengyueh (Momiën). One Surveyor was sent with Dr. Stein and another with Mr. Lorimer.

HEAD-QUARTERS OFFICES, CALCUTTA.

68. The general direction of these offices remained in the hands of Colonel F. B. Longe, R.E., except for the period from 10th November 1904 to 3rd May 1905, when Colonel J. R. Hobday directed the offices. The Surveyor General's and the Mathematical Instrument Offices were under Brevet Lieut.-Colonel T. F. B. Renny-Tailyour, R.E.; the Drawing, Engraving and Map Record and Issue Offices under Major W. J. Bythell, R.E., and the Photo.-Litho. Office under Mr. T. A. Pope, throughout the year.

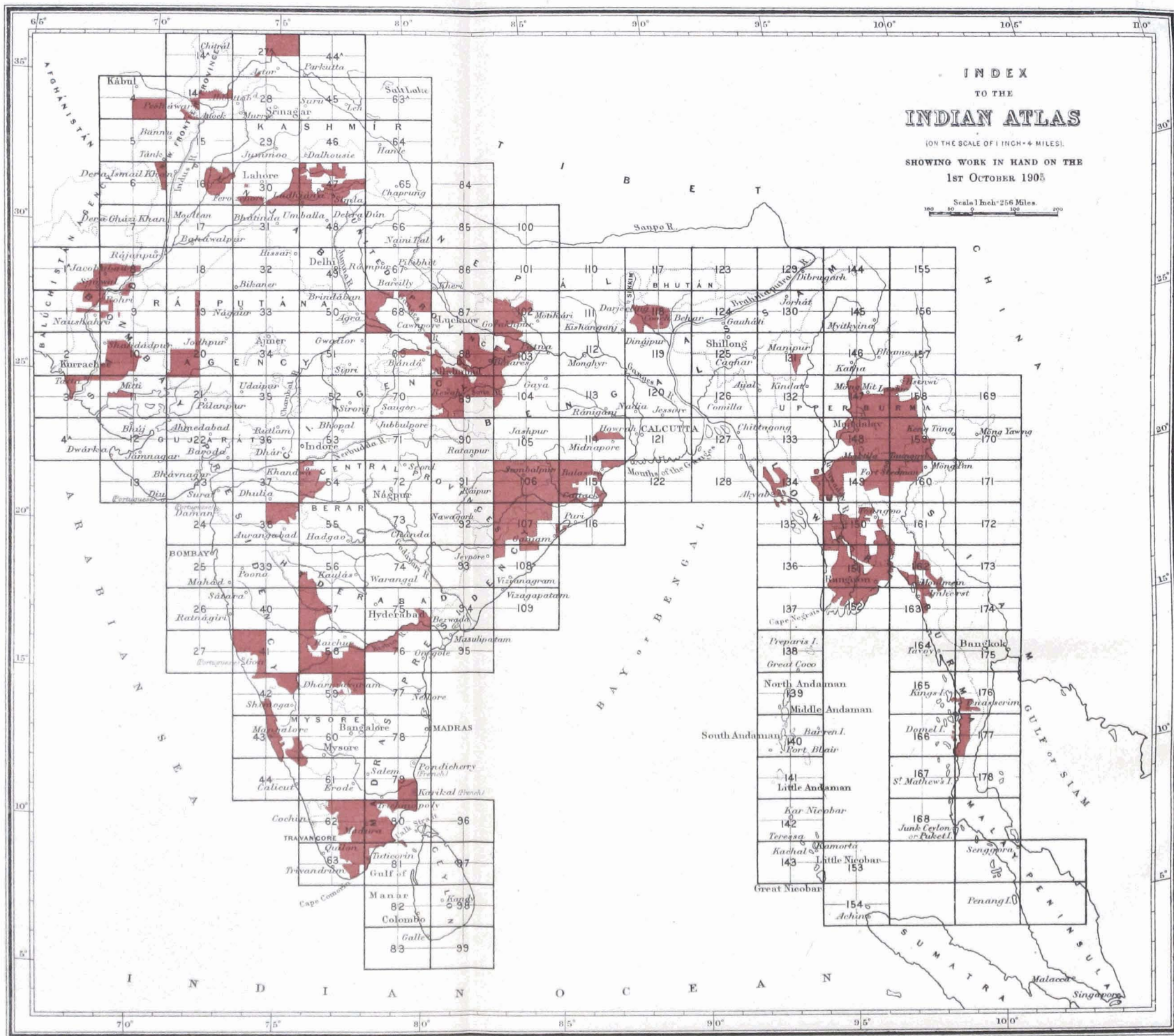
69. *Drawing Office.*—The General Section has, throughout the year, continued the work of the compilation and preparation of the general maps together with their revision, and the addition of new material to the sheets of the Atlas of India for the Engraving Office. A large amount of work has been done on the standard sheets by the addition of new material and by their general revision when new editions and reprints are required.

One hundred and eighty-one sheets of the Atlas of India have been brought up to date for the Engraving Office by additions and corrections to railways, roads, canals and boundaries. Eight sheets have been similarly prepared to be printed after transferring to stone in the Photo.-Litho. Office. The hills of four sheets have been brush shaded as samples for the engravers to work from, and the brush shading of five more is in hand.

Eleven general maps of India on scales ranging from 32 miles to 256 miles to the inch have been in hand during the year, and of these, new editions of the 32 and 64-mile maps should shortly be ready. The publication of these, which, as noted in last year's report at paragraph 43, had been considerably delayed was again retarded by extensive boundary changes in the Central Provinces, Bengal and Assam.

Seventeen sheets of the map of India and adjacent countries on the scale of $\frac{1}{1,000,000}$ were in hand, and fourteen were published or under publication.

Thirty-seven sheets of provincial maps, on the scale of 16 or 32 miles to the inch, have been in progress during the year, of which six were new publications and three new editions. Of the total seven were published or under publication.



Engraved at the Survey of India Office, Calcutta.

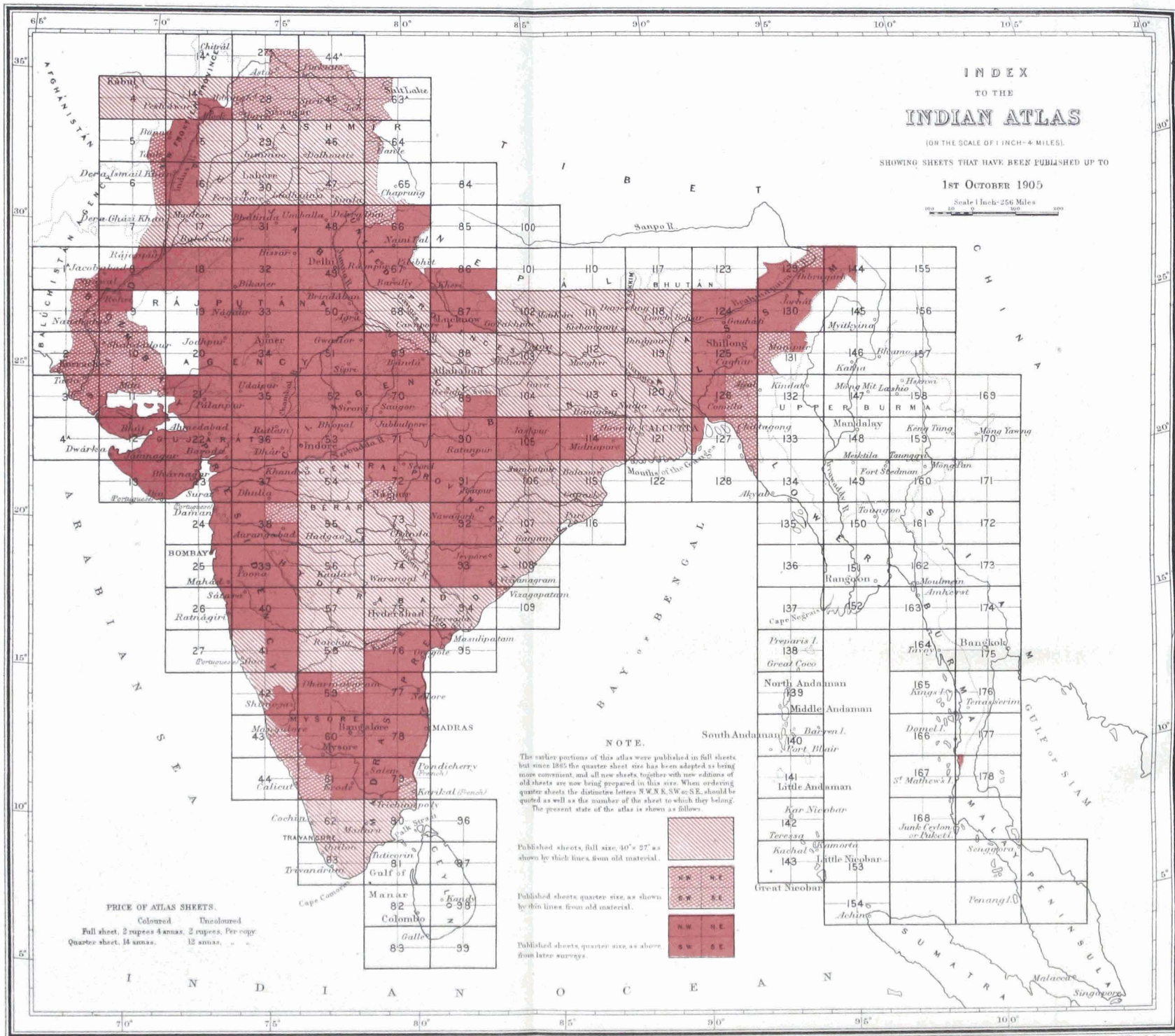
Published under the direction of MAJOR F. H. LONGE, R. E. Officiating Surveyor General of India.

July, 1902.

N° 639-S. 1902.

No. 538, S. I.—Dep. 03.—503.

Litho., S. I. O., Calcutta.



Sixty-one district maps on the quarter inch to the mile scale were brought up to date or completed, of which twenty-one were published, and twenty-one are under publication. Ten of the above are new publications, and five new editions.

The large total of two hundred and eighty-six Standard Sheets on the 1-inch scale have been in hand during the year, of which one hundred and forty-one have been published, and sixty have gone to press for publication. Of the above thirty-one are new publications, and thirty-two are new editions. Seventy-nine of these sheets were of Central India and Rajputana, thirty-four of Bombay, forty-six of Burma, twenty-nine of Madras, forty-four of the North-West Trans-Frontier and sixteen of Bengal.

Four of the Burma Degree sheets on the quarter-inch scale were in hand during the year and all were sent to press for publication.

Twenty-six Administration Report maps on the scale of eight miles to the inch were in hand during the year, of which twelve were published, four are under publication, and ten are in hand.

Twenty-three Index maps were in progress. Of these, eleven were brought up to date and published, seven were completed and published for the Survey Committee, and the remainder are either under publication or in hand.

A total of one hundred and thirteen sheets of large scale plans of cities and Cantonments have been dealt with, of which sixty-three were published, twelve are under publication, twenty-six have been brought up to date for publication, and twelve are in hand. Some thirty miscellaneous maps have also been dealt with, whilst two triangulation charts have been published, and nineteen are under publication.

As usual the demands for extra-departmental work in this Section have been very heavy, entailing the permanent loss throughout the year of the services of a considerable number of skilled draftsmen who might, could this work have been carried out elsewhere, have been employed on purely departmental work. The arrears mentioned in paragraph 44 of last year's report have, if anything, increased, and there seems to be no possibility now of coping with them.

The Postal maps have constituted a heavy item of the extra-departmental work, as those of no less than six provinces, involving an aggregate of one hundred and ten sheets have been dealt with. The Postal map of Bengal has been published, and those of the Central Provinces and United Provinces are under publication.

70. The "Examining Section" has passed 2,352 sheets and has carried out a considerable amount of miscellaneous work, such as the supply of geographical data to various officials, computation of graticules, notes on orthography of names, etc.

71. In the "Revenue Section" four hundred and seventy-three sheets have been dealt with, of which one hundred and thirty-eight are new publications. Sixty-three are new editions, and one hundred and seventy-seven are reprints. Ninety-five plans and tracings of villages have been supplied to Local Governments. The 138 new publications were all received from Drawing Offices elsewhere or from the field parties. These were cursorily examined and sent to press.

The preparation of one inch Standard Sheets of Bengal from old materials, mentioned in the second section of paragraph 46 of last year's report was stopped on the 15th of July by order of the Survey Committee, and the Provincial Officer in charge and the ten draftsmen comprising the "Arrears Section," as it was called, transferred elsewhere. During the year the draftsmen were employed they showed considerable improvement in drawing, and completed 34 sheets in all.

All the computations of the Gó dávari Detachment's work, comprising the work of two field seasons, were examined in this Section; and a very considerable amount of typing has been carried out on the original traces of the Survey.

Two thousand four hundred and ninety-seven pages of traverse data have been copied and examined and supplied to local or district officers, the majority of the work falling in Burma.

The miscellaneous work of this Section has been very heavy throughout the year and included the preparation of full statements showing the area, season, scale and date of every class of survey in each province and district of India and Burma from the year 1830 to the present date. This statement was prepared for the Survey Committee. The number of applications received

from private individuals for copies of maps, etc., during the year amounted to 1,146, in response to which 2,008 authenticated copies were issued, the Government fees realized thereon amounting to Rs. 1,225-8-0.

72. In the Office Copy Section, the formation of which was noted in the last section of paragraph 46 of last year's report, a total of 25,352 coloured copies of maps were examined and passed. Nine hundred and twenty-six sheets were coloured for office copies. One thousand eight hundred and seventeen office copies on various scales were corrected, and 549 were examined and certified.

73. *Engraving Office.*—The outturn of work completed by this office is much the same as last year:—

Five new quarter sheets of the Atlas of India, Nos. 21 N. W., 25 N. E., 36 N. W., 40 S. E., and 59 S. E., Punjab 16 miles without hills in four sheets and sheets 86 and 87 of India and adjacent countries on the one-millionth scale have been completed and published, the last two sheets being engraved for printing in black and brown.

The new map of India on the 64-mile scale is in hand, two sheets Nos. 2 and 3 for outline, and sheet 1 for the insertion of G. T. points. The duplicate map on the same scale is having the hills completed on sheets 1 and 2. Sheet 4 has been completed in outline and writing, and the hills will now be put in hand. The original map has had the railways brought up to date. The 80-mile map has been in hand throughout the year with corrections to date. The corrections to the 96-mile map have been completed. The writing on the new skeleton map of India 128 miles has been completed, and corrections have been carried out on the map of this scale with hills. Corrections have also been carried out on the 192 and 256 mile maps, but all the maps of India must now have the boundaries altered on account of the territorial changes in Bengal, Assam and Central Provinces. The additions and corrections to the Himalayan Route map have been completed, but as the hand-book is being revised, further corrections are expected before copies can be printed.

The boundaries and district names have been cut on the 1-inch=16 mile provincial map of Bengal, and slight corrections carried out on the Central India agency map on the same scale. The map of the Madras Presidency has been undergoing final corrections before publication. The maps of Mysore (1-inch=16 miles) have been in hand for correction. The writing on the 1-inch=32 mile Punjab is in progress. Thirteen provincial and seventeen district maps for Administration Reports, and four Index maps have been corrected and added to.

Sheet 2 of the sixteen inch plan of Calcutta is being corrected. Some additional names have been cut upon the 6" plan of Calcutta, but it has now been stopped, as the spelling list supplied by the Municipal Corporation does not agree in spelling with the names placed on the streets. The 3" plan of Calcutta has been completed in outline and many of the street names, which are unlikely to be changed, have been cut.

Twelve new scale plates have been engraved, eleven miscellaneous plates cut and added to, and seventeen Heliogravure plates for the Photo.-Litho. Office have had titles and foot-notes engraved.

Seventy-one new quarter sheets of the Atlas of India have had new material cut on them, 107 published quarter and full sheets have been brought up to date, and 23 quarter plates have been projected or had borders cut.

The copper plate printing office has worked well throughout the year and 43,450 impressions have been pulled.

The steel facing section has dealt with 420 plates, and 46 plates have been corrected from the surface by electro deposition.

74. *Photographic and Lithographic Office.*—The total outturn of printed copies of maps, plans and diagrams, both for the Survey of India and other departments, again shows a slight falling-off as compared with previous year's results. The total number of copies printed was 912,349 as against 968,145 in 1903-04 or 55,751 copies less. This shortage is largely accounted for by the increased outturn of departmental maps, which with their shorter runs involve much more frequent changes of plates. These last show an increase on the previous year's figures of 23,371 copies. The total number of departmental copies printed was 273,901, while of extra-departmental subjects, 579,573 copies were produced. This last is a considerable reduction on the last year's figures of

83,702 copies. Much outside work which was unsuitable for immediate photographic reproduction was declined, and it is intended to act still more on this line in future. It is evident that many who now submit inferior work which entails redrawing here, could easily, if so disposed, send in work suitable in every way.

75. In the Type Section there was a considerable increase in the outturn, the pulls amounting to no fewer than 2,292,749.

76. In the Heliogravure Section, while an increased (61) number of plates was prepared, many fewer prints were required from them, and the number of half-tone blocks required was also smaller than in the previous year, 51 having been prepared.

Experiments have been carried on by Mr. Turner with a view of ascertaining if brush shaded hill originals can be satisfactorily reproduced photographically and utilized on our maps, and with a considerable measure of success. These will be continued, and will be described when a method has been finally determined upon.

The want of efficient European supervision has been much felt during the year. The additional Assistants sanctioned, though on their way from England, had not arrived at the close of the year. The large increase of colour printing, owing to the adoption of colour in our standard sheets, will necessitate a large increase of work in the negative section, particularly in its retouching branch, and an increase in this establishment is inevitable. A better class of workmen is also required if good results are to be expected, and the services of a skilled operator on glass may be necessary to instruct the men in the latest methods which apparently are in advance of ours in this particular branch. The electric lighting plant for the illumination of the plan boards in the negative section has not yet arrived, but is expected any day, and its installation should much facilitate the work during the short cold weather days and in the rains. As the present method of graining plates is far from satisfactory, both as regards outturn and quality, an adaptation of the Block process is proposed. By this the ink is removed by turpentine and a caustic potash bath, and the plate is then placed with sand in a trough rocked on a ball and socket joint, glass marbles are then run over the surface of the plate until it is properly grained. Plant for working the above is now being prepared at the Mint, and is shortly expected.

77. In the Zinc Printing Branch the following were the more important departmental publications of the year.

Eight sheets of the map of India and adjacent countries were published, 300 copies of each being printed. The total number of standard sheets dealt with in the Negative Section was 375, and of these 181 were published, 14 being printed in two colours. The provincial map of Bengal on the scale of 1 inch = 16 miles was published and 800 copies were printed, while maps of Simla and Jutogh and Aden Cantonment and of the Civil Station and City of Delhi and of Secunderabad Cantonment were issued. For the Director of Land Records, Gwalior, 7,400 copies on cloth of 60 sheets of the Central India and Rajputana Surveys were printed, extra paper copies being at the same time printed off for stock. Of the Military Traffic Map of India on the scale of 1-inch = 80 miles in four colours, a further 1,500 copies, involving 6,000 pulls, were printed. Other extra-departmental work includes several maps for the Foreign Office. The map of India on the scale of 1-inch = 32 miles showing railways with stations was also published, and 37 diagrams for the Irrigation Conference for the Public Works Department of which over 25,000 copies were printed. A telegraph chart for the Director of Indian Telegraphs was issued, as also nine districts maps for the Assam Gazetteer, and a map of Nágpur City and Civil Station for the Executive Engineer, and 37 sheets of Pakòkku Town Survey for that Municipality.

78. In the Litho. Section, the most important work has been that on the stones of the new map of India on the scale of 1-inch = 32 miles. Corrections have been made to all the outline stones and proofs supplied, and these have been again received with what it is hoped may be final corrections. The work on the hill stones has progressed as opportunity offered throughout the year. Sheet 1 is approaching completion, and when this and a little work required on sheet 6 is finished, all the stones will be ready, and it is hoped the map may

be issued during the ensuing year. The provincial maps of Bengal on the scale of 1-inch = 16 miles and 1-inch = 32 miles, and of Assam and the United Provinces on the scale of 1-inch = 16 miles have also been in hand. The maps of the Madras and Bombay Presidencies on the scale of 1-inch = 32 miles have also been worked upon. Of district maps 36 have been taken up. Proofs of most of these have been submitted for approval, and 18 have been printed off. For the Bengal Government separate maps of each of the thirty Native States included in the province are being prepared on stone from copper plate transfers, and these are rapidly approaching completion. For the Foreign Office 36 maps have been drawn during the year, of which 30 have been printed off. Two Telegraph maps of India on the scale of 1-inch = 32 miles in 6 sheets, and of 1-inch = 64 miles, have been worked on and printed off. The map of India on the scale of 1 inch = 80 miles showing railways, present and proposed, was corrected up to June 1904 and printed off, as was also the Railway Systems map in nine colours on the same scale. Copies of the military map of India and of the railway and canal map, both on the scale of 1-inch = 32 miles and involving much colour printing, have also been supplied during the year. Among other maps four maps for the Director General of Remounts have been in hand as opportunity offered, final corrections with press order having been received. Five maps for Dr. Grierson's Linguistic Survey have also been dealt with, and of these four have been completed while the remaining one is in proof.

79. The Lithographic Printing machine, the arrival of which was noted in last year's report, has been working throughout most of the year, but considerable trouble has been experienced with it. The remainder of the machinery has given little trouble. The change of motive power from steam to electricity still proves an unqualified success. A larger number of experienced pressmen for these expensive machines is however needed, and the marvel is that break-downs are not more frequent, bearing in mind the staff at present employed on most of them. All over the office a better class of man is required. Wages which would obtain good men twenty years ago will not secure them now. At the same time really good work will never be obtained from *any* staff until the officer in charge has greater powers to regulate the pay and promotion of his men.

80. *Map Record and Issue Office.*—Ninety-five thousand three hundred and eighty-seven sheets of an aggregate value of ₹1,08,480 were issued during the year, an increase of 8,898 in number and of ₹4,380 in value on last year's figures. Of this total a sum of ₹13,516 was realized from private sales. The clerical work in connection with this office still continues very heavy, though there is a slight decrease on last year's figures.

The number of new maps received for publication was 128, whilst 795 were published, of which 296 were reprints. The number of original maps, volumes of records, etc., issued from store to other departments amounted to 5,831 of which 4,936 were received back again.

The transferring of the original Cadastral sheets from this office to various head-quarters of Local Governments or districts has been carried on steadily throughout the year. Those of 11 districts in the United Provinces of Agra and Oudh, of 10 districts in Bengal, of 3 districts in Assam and of one district in Burma, making a total of 44,861 sheets were duly despatched; 563 volumes of Field Area Statements were also despatched to various centres. This work is now practically finished as only 26 volumes of Cadastral maps and 182 volumes of Field Area Statements of District Gorakhpur remain to be despatched to complete the transfer of these records.

The rack accommodation at Dehra for the storage of Forest maps has not yet been completed, and in consequence the transfer of the large scale Forest maps and the opening out and re-storage of the special maps have had to be held in abeyance.

The work of revising the catalogues has also had to be suspended, owing to the presence of the Survey Committee at Head-Quarters, which threw much additional work on the staff, etc.

81. Two extra clerks on a salary of ₹60 per mensem were appointed to the Map Record Office during the year. With this small addition to the staff and the temporary re-employment of the late Head Clerk of this office who had retired in July 1904, a beginning has been made of a much needed overhauling,

re-arranging and re-classifying of the records and fair maps. For many years maps have been pouring into the office, many of them in a most fragmentary condition and owing to this accumulation and the hitherto imperfect manner of registration, it has not for a long time past been found possible either to accommodate the incoming new maps in their proper racks, or to keep pace with the growing needs of the Department. New registers have therefore been opened out in proper classified order, and the registration of the standard sheets comprising in all some 5,000 maps has been got through during the year. The re-arrangement of these by provinces will be undertaken as soon as space has been provided by the removal of other sheets. The work of overhauling the miscellaneous maps, plans and charts, general reports, computation volumes, angle books, etc., is being steadily proceeded with and it is hoped that before very long all obsolete maps and plans will have been weeded out and re-registered, and all those that are current, listed and made easily accessible when required.

82. *Mathematical Instrument Office.*—During the year under report, *i.e.*, from 1st April 1904 to 31st March 1905, the large demands which were made on this office in the preceding year have been maintained. For each of the last three years the value of instruments, etc., issued was ₹3,10,348, ₹3,64,646 and ₹3,54,005 respectively, and the value of repairs to instruments received for that purpose and returned in a serviceable condition was ₹32,242, ₹37,449 and ₹40,069 respectively. The value of instruments received from Government officers when "no longer required" during each of the last three years was ₹64,998, ₹74,066 and ₹85,994 respectively.

The book value of the stock in the serviceable store in hand at the end of each of the last three years was ₹4,72,065, ₹3,85,145 and ₹3,92,653 respectively. As this office receives no estimates from Government officers as to the probable number or class of instruments that they will require, it is impossible to keep this figure low and at the same time to comply satisfactorily with all the demands that are made. The privilege of being able to submit emergent indents on the Director General of Stores in addition to the annual indent has proved advantageous and since its introduction the value of the stock in hand has been greatly reduced.

The book-value of the stock in the repairable store at the end of each of the three last years was ₹1,80,999, ₹1,64,474 and ₹1,46,734 respectively. This stock mainly consists of obsolete instruments of historic value and of instruments for which there is only a very occasional demand; the latter are consequently not worth repairing until an actual indent is received when they are at once sent to the workshop, made serviceable and issued. Practically no instrument for which there is likely to be a demand remains in the repairable store for any length of time.

The "profit and loss statement" for the workshop shows a profit. The number of men and boys employed at the end of each of the last three years was 255,320 and 352 respectively. The extension of the piecework system continues to give beneficial results and the value of the total work done in the workshop during each of the last three years was ₹1,25,722, ₹1,50,567 and ₹1,58,958 respectively.

The value of instruments, etc., manufactured in the workshop for the serviceable store during each of the last three years was ₹47,729, ₹57,095 and ₹64,188 respectively; this continued increase represents a material saving to Government, as the issue price of these instruments has been considerably decreased. The value of instruments, etc., purchased locally for the serviceable store during each of the last three years was ₹13,329, ₹11,641 and ₹14,405 respectively.

83. The value of instruments, material, etc., obtained from England through the Director General of Stores during each of the last three years was ₹1,01,594, ₹1,46,509 and ₹1,91,113 respectively. These amounts must continue to rise, as there is no signs of the demand for instruments, etc., decreasing, and there is at the present time practically no reserve stock in the repairable store to fall back on.

BRANCH OFFICES, DEHRA.

84. *Trigonometrical Surveys.*—The superintendence of the Trigonometrical Branch was in the hands of Lieut.-Colonel S. G. Burrard, R.E., F.R.S., during

the year 1904-05. Mr. J. Eccles, M.A., was in charge of the technical offices up to the 2nd May 1905. Colonel Burrard, R.E., then held charge of this section till relieved by Lieut. C. M. Browne, D.S.O., R.E., on the 24th May 1905.

Messrs. W. M. Kelly and J. H. Nichol, Extra Assistant Superintendents, joined on 24th March and 1st May 1905 respectively. Ten Sub-Assistant Superintendents went through a course of training during the year.

The Computing section supplied manuscript data to 63 officers from the original records. Meteorological observations were taken as usual.

The following computations were carried out:—

- (a) The Darjeeling revisionary triangulation including the snowpeaks observed by Messrs. Barckley and Pocock. The results are required for incorporation in the Synoptical Volume of N. E. Longitudinal series.
- (b) The compilation of the N. E. Longitudinal series, Synoptical Volume was begun.
- (c) The revision of certain tables of the 4th edition of the Auxiliary Tables was finished.
- (d) The reduction of Lieut. Thomas's work in Tehri-Garhwál, and of Major Ryder's and Captain Wood's work with the Tibet Mission was completed.
- (e) A provisional adjustment of the triangulation of the Burma Coast, Mandalay Meridional and Manipur Longitudinal series was made for Professor Helmert.
- (f) A symbolical solution of equations for simultaneous reduction of spirit levelled heights was carried as far as the equations between indeterminate factors.
- (g) Computations in connection with the deflection of the plumb line and many other computations of astronomical latitudes were done for incorporation in the G. T. Survey, Volume XVIII.
- (h) One observed azimuth was computed and three others checked.

The revised pamphlet of rainfall has been printed, and large portions of Volume XVIII and of the 4th edition of Auxiliary Tables have been passed through the press.

In addition to those of this office proofs sent by the Calcutta Office were also compared and examined.

The necessary professional aid in connection with the protection of G. T. S. stations has been rendered by the Computing Section to the office of the Superintendent, Trigonometrical Surveys. 710 stations were repaired by district officers at a cost of ₹3,933.

An investigation was made by the Superintendent, Trigonometrical Surveys, of the azimuthal errors generated in the Principal Triangulation. For this purpose La Place's equation was formed at each of the Longitude Stations.

In the Drawing Section eighteen Tibet maps, one magnetic, one astronomical, five triangulation charts and one level sheet of Punjab were compiled and sent to press. Two sheets of India and Adjacent Countries on the scale of 1 to 1,000,000, numbers 62 and 70 and 4 level sheets are nearly ready for press.

Fifteen level sheets, eleven frontier maps, several diagrams for the Superintendent, Trigonometrical Surveys, and other maps are in hand. 2,746 maps were coloured.

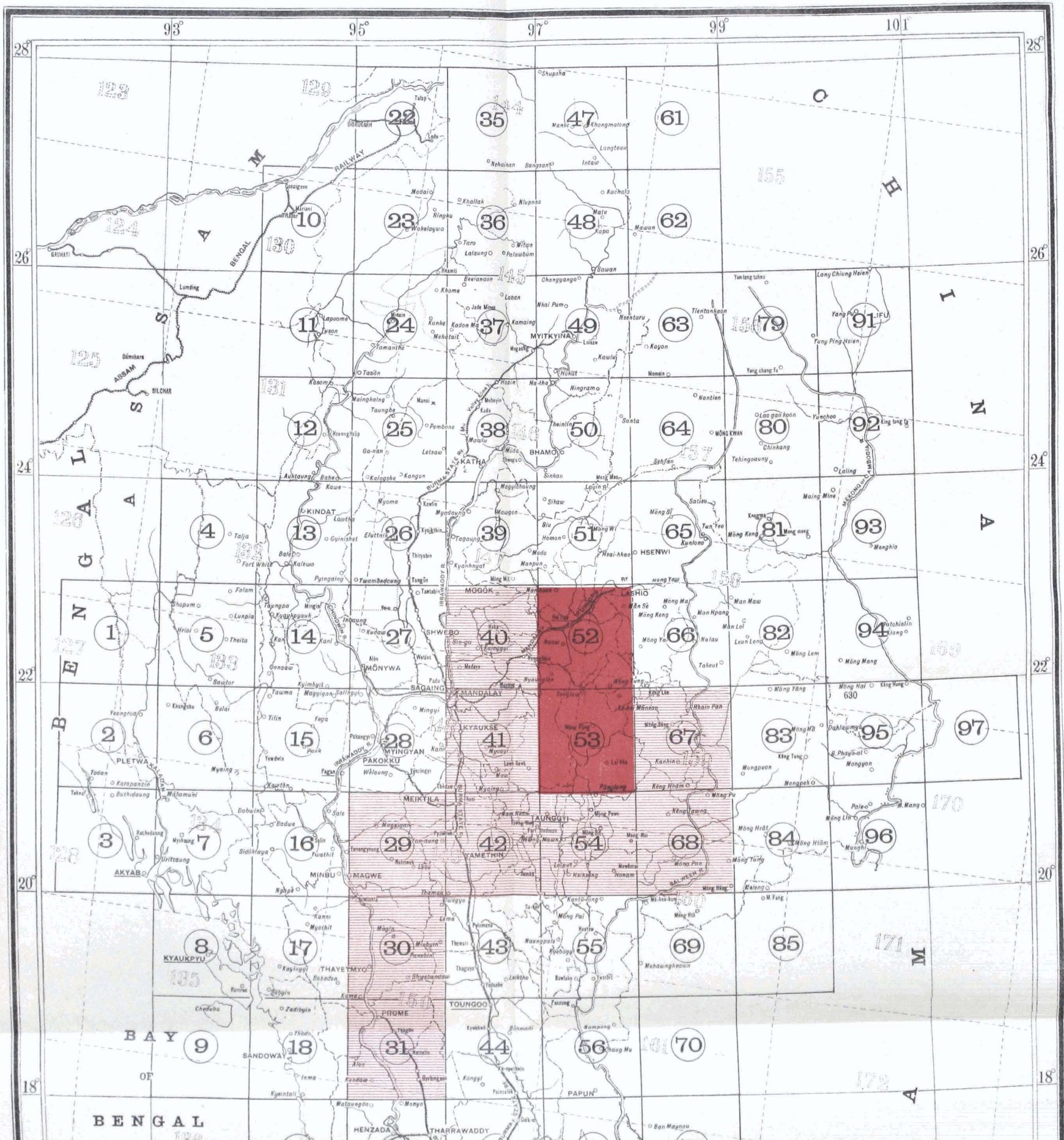
Good progress was shewn in the work of the Photo.-Zinco. Section, 1,099 maps and diagrams being photographed against 864 and 85,066 pulls taken as against 57,464 in the previous year. The photo-helio section carried on its work as usual.

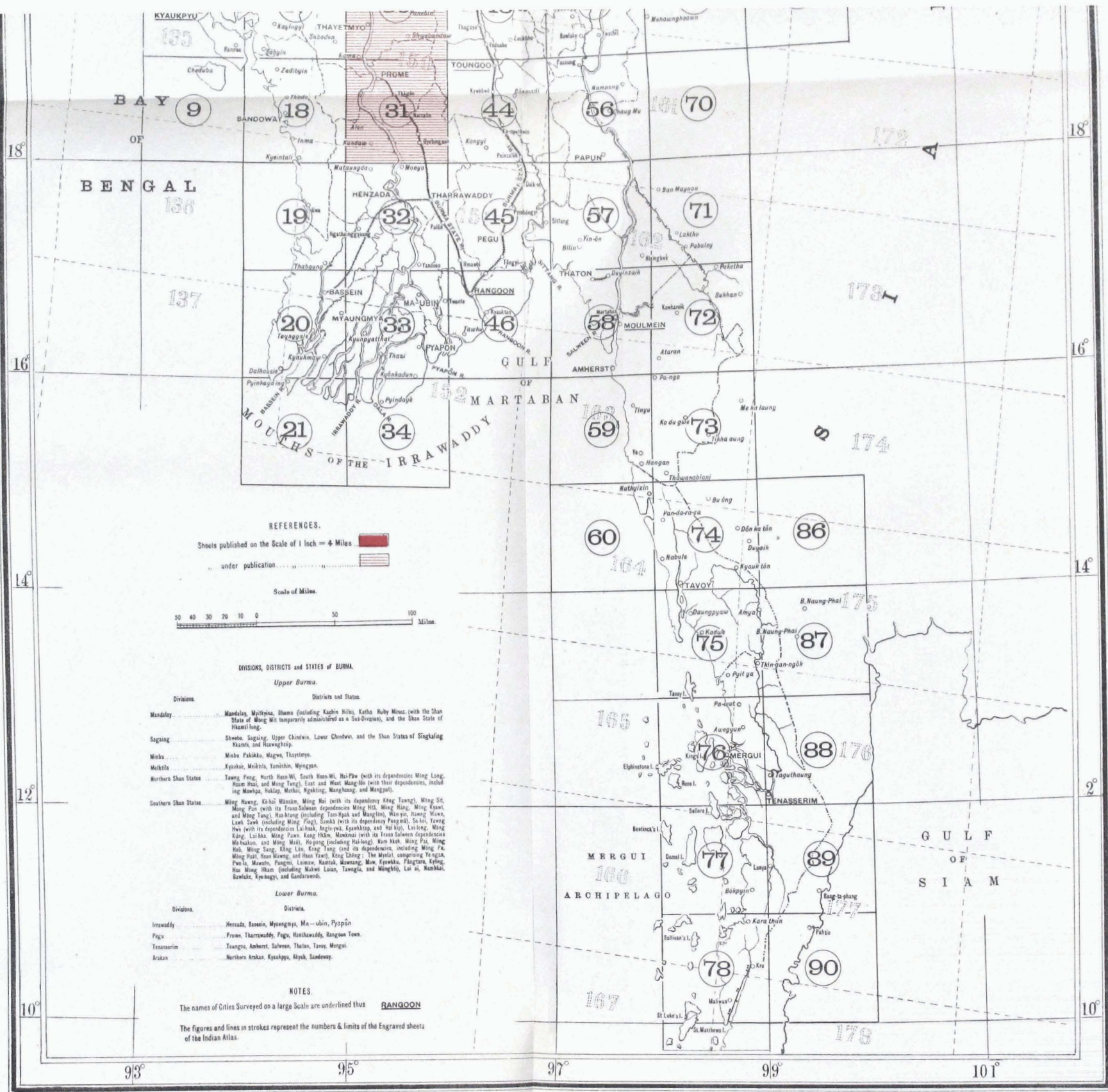
85. *Forest Surveys.*—The offices of the Forest Survey Branch were under the superintendence of the Superintendent, Forest Surveys, and were employed as usual on correspondence and Accounts, Computations, Area statements, the mapping of field surveys, the compilation of special Working Plans and other maps, the distribution of published maps and the upkeep of the Map Records of the Forest Department.

During the year 480 maps were sent to press and 497 were published at Calcutta, Dehra Dún and Poona.

INDEX TO THE DEGREE SHEETS OF BURMA

Season 1904-05.





No. 178, S. I.—April 08.—300.

No. 90, S. I.—Apr. 06.—550.

Published under the direction of Colonel St. G. C. Gore, C.S.I., R.E., Surveyor General of India,
 April 1903.

Photo. S. I. O., Calcutta.

Reg No. 706-S. 03.

Fifteen thousand six hundred and twenty-two printed maps were distributed of which 8,476 were coloured and 3,142 mounted in book form. The work of this section of the office has been nearly doubled since the formation of the Forest Survey Branch.

A certain number of copies of each map published are now printed on cloth and these cloth maps have proved serviceable and convenient for use in the field.

During the year a sum of ₹409 was realised by the sale of maps, but the demand for Forest Survey maps by the general public is not a large one.

Among special maps compiled in this office were two of India on the scale of 48 miles = 1 inch, one showing all forests under Government control, and the other the progress of Forest Surveys and Working Plans.

LOCAL DRAWING OFFICES.

86. These continued the compilation of topographical maps at the following localities:—

87. *North-West Frontier Drawing Office, Mussooree.*—The main work of

Personnel.
Mr. R. R. Dickinson, Extra Assistant Superintendent, 1st grade,
in charge.
Mr. W. J. Cornelius, late Extra Deputy Superintendent (retired).
Mr. F. E. Warde, Sub-Assistant Superintendent, 1st grade.
1 Surveyor, 13 draftsmen, 1 writer, etc.

this office during the year has consisted in the fair mapping of 19 standard sheets of the North-West Trans-Frontier series and the

South-West Asia series on the scale of $\frac{1}{4}$ -inch = 1 mile. Of these, 4 sheets have been submitted for publication and 9 for the preparation of cyanotype proofs, which will be sent to the military authorities for the classification of roads, and 6 are still in hand.

One sheet of the Northern Trans-Frontier series on the scale of $\frac{1}{8}$ -inch = 1 mile has also been prepared and submitted for publication. Good progress has been made with the "Map of India and Adjacent Countries," scale $\frac{1}{1,000,000}$. Four of the five sheets of this map which were begun last year have been completed, the fifth is in hand, and work has been commenced on a sixth. The map of Turkestan, scale 1-inch = 32 miles, has been projected, and work is in progress on the two Northern sheets.

The miscellaneous work has included the entry of Major Wanliss' route surveys in 7 of the $\frac{1}{4}$ -inch sheets and 3 of the $\frac{1}{8}$ -inch sheets of the North-West Trans-Frontier series, other additions and corrections to 4 of the $\frac{1}{8}$ -inch sheets of the same series, and the colouring and examination of a large number of maps, index charts, etc.

The total cost of the office during the year has been ₹23,380-6-4.

88. *Bangalore Drawing Office.*—The compilation of the degree sheet maps of Burma from the 1-inch standard maps of the topographical parties was continued. Sheets Nos. 29 and 42 were completed and submitted to head-quarters for publication. Sheets 31, 54 and 67 will be completed before the end of 1905 and sheets 30 and 68, for which complete materials are available, are in hand. Sheets 27 and 28 have also been commenced, but materials are not available at present to quite complete them. Full materials will be available next season for the preparation of sheets 16 and 28.

In addition to the above, four 1-inch standard sheets of Burma are being re-drawn in the new form for publication in 4 colours, Nos. 242-E., 243-E., 244-E. and 195-W. and sheet 339 has been re-drawn in the old form for publication in 2 colours. A special map in 3 sheets has been prepared on the 1-inch scale of the road from Bhamo to Tengyueh and additions have been made to sheets 22 S.-E. and 23 N.-E. of the North-East Trans-Frontier series on the $\frac{1}{4}$ -inch scale. The special map of the Burma-China Boundary Commission, southern party, published in 1900 has also been brought up to date.

89. Local drawing offices at the following centres, carried on as usual the compilation of 1-inch standard maps from cadastral surveys, *i. e.*, one at Naini Tal in the United Provinces, one in Bengal at Calcutta and a third in Assam at Shillong. The work done by these offices is contained in part II of this report.

ESTABLISHMENT.

During the year, the Department lost the services of two of its most valuable officers by the superannuation of Colonel J. R. Hobday, I.A., and the retirement of Colonel R. A. Wahab, C.B., C.M.G., C.I.E., R.E., on account of ill-health.

Colonel Hobday was the last Imperial officer appointed to the Department before the amalgamation of the three branches in 1878. Having served with the 2—25th King's Own Borderers and the 38th Regiment, Bengal Infantry, he was appointed to the Survey of India on the 11th September 1874 and was attached to Central India Survey as Assistant Superintendent until 1878 when he proceeded on furlough. He was recalled in December of that year for service in Afghánistán and was attached to the Kandahár Column as Survey Officer. In December 1879 he was invalided and on rejoining in April 1881 he was attached to the Gujarát Survey under Colonel Haig. In November 1883, he organized and took charge of a party for the survey of the Andaman Islands, on the completion of which he was placed in charge of the Survey detachments attached to the Upper Burma Field Force and conducted the Survey operations with great skill and energy under exceptionally difficult circumstances and was specially commended for the excellent services he rendered to the Intelligence Branch of the Quarter Master General's Department and these were signalised by his appointment to a Brevet Majority. From 1891 to 1897 he was employed on survey work in the Bombay Presidency and worked up his party to a high state of proficiency. He was transferred in February 1897 to the Head-Quarters Office, Calcutta, as Assistant Surveyor General and subsequently officiated as Deputy Surveyor General from 19th April to 9th November of that year, and from 27th May to 3rd September 1898 when he was confirmed in that appointment. He also officiated as Surveyor General from 9th November 1904 to 3rd May 1905.

For his services in the field he received the Afghán and the Burma medals, he was mentioned in despatches and received a Brevet Majority.

Colonel Hobday was an excellent officer, few men have the thorough knowledge of practical surveying and power of executing surveys of all classes more highly developed in them than he had. He was an accomplished draftsman and of an enthusiastic temperament which communicated itself to his assistants and did much to keep them going under most trying circumstances, especially during the period immediately following the annexation of Upper Burma when an encouraging strong personality was necessary to keep the men at work.

Colonel Wahab joined the Department on 8th January 1883. Except for short periods when he was attached to a cadastral party and the Head-Quarters Office, Calcutta, he was employed on frontier surveys throughout his service. He served during the first Afghán War from January to June 1879 as Assistant Field Engineer and Adjutant, Royal Engineers, Pesháwar Valley Field Force, and during the second campaign from October 1879 to August 1880 as Assistant Field Engineer. He was attached to the expedition against Mahsud Waziris during April and May 1881 as Assistant Field Engineer and in charge R. E. Park. During 1883-84 he accompanied Sir R. Sandeman's Mission to Khasan and Panjgur; in 1884 he was with the Zhob Valley Expedition as Survey Officer. In 1888 he was attached to the Hazára Field Force; in 1891 he served as Survey Officer with the Miranzái and Hazára Field Forces; in 1892 he was with the Isazái Field Force. During 1897-98 he was employed with the Tirah Expeditionary Force, where he was latterly Chief Survey Officer. From December 1901 to June 1904 he served as British Commissioner with the Aden Boundary Delimitation Commission.

Colonel Wahab was appointed Deputy Surveyor General from 16th July, but owing to ill-health he could not come out to take up the appointment. He was an enthusiastic and accomplished surveyor; his services on the North-West Frontier are quite exceptional and his retirement is a serious loss to the Department at the present time. For his services prior to 1901 he received the Afghán medal and both the Frontier medals with clasps and the Companionship of the Indian Empire, while his work in connection with the Aden boundary delimitation has been rewarded by his being gazetted a C.B. and C.M.G.

The following were appointed during the year: Lieutenant M. N. MacLeod, R.E., and Lieutenant F. F. Hunter, I.A.

90. In the Provincial Service the Department has lost the services of seven officers during the year by the retirement of Messrs. C. H. Mc A'Fee, J. McHatton, J. Bond, T. H. Dunne and S. O. Madras, by the death of Mr. E. F. Berkeley and by the resignation of Mr. H. I. Rice.

91. Six additional appointments in the Imperial service and twenty in the Provincial service have been sanctioned, the latter to be filled up in two years.

92. During the year under report an ex-officer of the Department, Colonel J. Waterhouse, I.A., was deputed as a representative of the British Government at the St. Louis Exhibition and he has contributed a very valuable report on matters affecting surveys which will have been published under the orders of the Government of India before this report sees daylight.

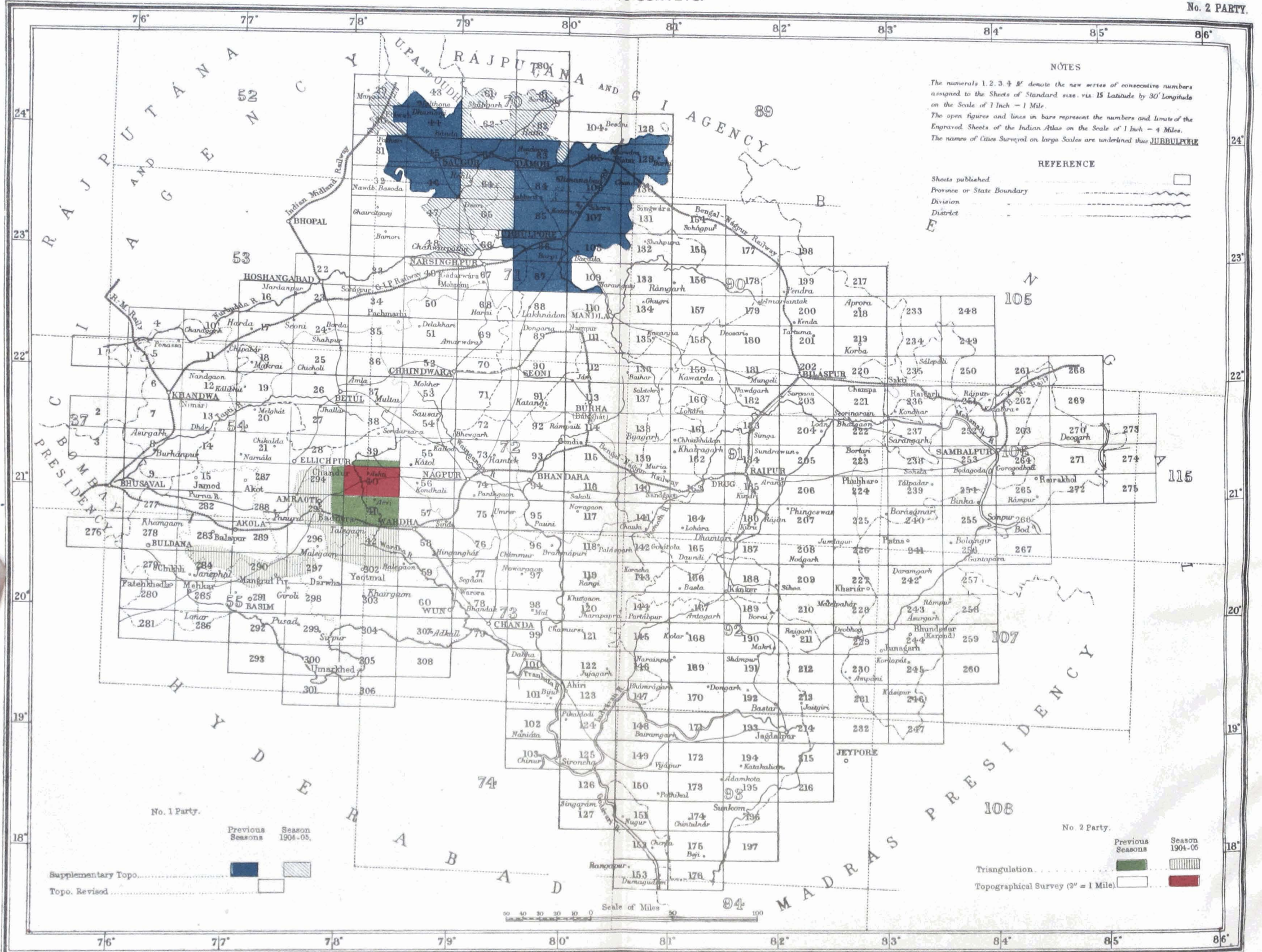
CENTRAL PROVINCES.

INDEX TO SURVEYS.

1904-05.

No. 1 PARTY.

No. 2 PARTY.



NOTES

The numerals 1, 2, 3, 4 & E denote the new series of consecutive numbers assigned to the Sheets of Standard size, viz. 15 Latitude by 30' Longitude on the Scale of 1 Inch = 1 Mile.
 The open figures and lines in bars represent the numbers and limits of the Engraved Sheets of the Indian Atlas on the Scale of 1 Inch = 4 Miles.
 The names of Cities Surveyed on large Scales are underlined thus JABALPUR

REFERENCE

Sheets published
 Province or State Boundary
 Division
 District

No. 1 Party.

Previous Seasons Season 1904-05

Supplementary Topo.
 Topo. Revised

No. 2 Party.

Previous Seasons Season 1904-05

Triangulation
 Topographical Survey (2" = 1 Mile)

Scale of Miles 0 10 20 30 40 50 60 70 80 90 100

PART II.

THE OPERATIONS OF FIELD PARTIES,

TOPOGRAPHICAL SURVEYS.

CENTRAL PROVINCES.

NO. 1 PARTY.

93. The operations were in continuation of those of former seasons, and

Personnel.

Captain A. H. B. Hume, R.E., Deputy Superintendent, 2nd grade, in charge, except while on examination leave, from 4th December 1904 to 18th March 1905.

Mr. W. M. Kelly, Extra Assistant Superintendent, 1st grade, in charge, from 4th December 1904 to 18th March 1905.

Mr. B. M. Berrill, Sub-Assistant Superintendent, 1st grade.

Munshi Ikbaluddin, K. S., Sub-Assistant Superintendent, 1st grade.

Mr. F. C. Glass, Sub-Assistant Superintendent, 3rd grade.

37 Surveyors, computers, draftsmen, etc.

consisted of a supplementary topographical survey of maps compiled on the scale of 2 inches to a mile from cadastral surveys executed by local agency and based on traversing

carried out by the Survey of India. No triangulation was done. The cadastral maps were reduced by pantagraph and the details which were entered on the plane-table sections in blue were examined and supplemented where necessary. The area thus surveyed during the season is 2,719 square miles and consists of the Central Provinces portions of sheets 29, 30, 47, 48, 61, 62, 81 and 82, the Central India portion of sheet 83 and the whole of sheets 64 and 65.

94. Field work commenced on the 24th October 1904 and closed during the early part of May. The field season was generally a healthy one. The country in sheets 29 and 30 was for the most part flat and open, with a good deal of land that has gone out of cultivation and is now covered with grass. The ground in the rest of the sheets was generally hilly and covered in places with forest or scrub jungle. The valley of the Nerbudda river in sheet 48 is well cultivated, but the immediate vicinity of the river is cut up by ravines covered with short thorny jungle which impeded progress considerably. The average daily outturn per man was 0.6 square mile, and the cost rate ₹12.8 per square mile, which is slightly higher than that of last season owing to the scattered nature of the work and to the time spent by the surveyors in examining the Forest Survey maps as explained below.

95. An area of 866 square miles of reserved forests falls into the sheets that were surveyed this season and is not included in the above outturn. These forests had been surveyed in recent years by the Forest Department on the scale of 4 inches to a mile, and the maps were reduced by photography to the 2-inch scale, and the details entered on the plane-table sections. These details were in some instances examined to a certain extent by the surveyors who did the survey of the adjoining tracts, and in others were tested by the supervising staff, and the work generally found correct, but a thorough examination of the larger forests was not made.

96. The traversing of forest excisions and scattered villages was continued as called for by the local authorities, and 25 plots were traversed enclosing an area of 32 square miles in the Chánda and Hoshangabad districts.

97. The mapping of standard sheets on the 2-inch scale for publication on the scale of 1-inch to a mile has been completed as far as possible, but owing to various alterations that were introduced after the close of field work in the form and graticule of the standard maps, in accordance with the recommendations of the Survey Committee, most of the sheets surveyed this season require additional work in the field; consequently it was only possible to submit to headquarters for publication 2 sheets of the present season's work which are both in the new form, Nos. 64W and 65W. All 1-inch standard maps will in future be published in 4 colours, in the form of 15-minute squares, the graticule being brought into accordance with the latest value of the longitude of Madras.

98. Seven sheets, Nos. 43, 44, 46, 105, 109, 128, and 129, which were only partially surveyed last season, as topographical maps of portions of them were already in existence, have been completed this season by office revision of the old work and will be published as preliminary editions. The system of office revision which was described in para. 165 (2) of the report for 1902-03 was strongly condemned by the Committee and has been found to be extremely unsatisfactory in practice. It has therefore been discontinued, and in future any old topographical work falling into sheets under survey will be thoroughly revised in the field or re-surveyed.

99. In addition to the standard sheets, a map of Jubbulpore district has been prepared on the scale of $\frac{1}{2}$ an inch to a mile for publication on half the scale in 2 colours. The preparation of district maps will now be discontinued and degree sheet maps will be prepared instead, as soon as sufficient reliable material is available.

100. Combined triangulation and traverse charts are being prepared by this party on the 1-inch scale for publication on the $\frac{1}{2}$ -inch scale. As such charts have not been prepared hitherto, one sheet only was completed and submitted as a specimen for the approval of the Surveyor General.

101. The programme for next season consists of the supplementary survey on the 2-inch scale of cadastral and forest maps in sheets 66 and 67, and in the United Provinces portions of sheets 43 and 44, while a re-survey will be made of the portions of sheets 29, 30, 31, 32, 46, 47, 48, 61, and 62 which are exterior to the Central Provinces. The composition of the party has, however, undergone considerable changes and a large number of men have been attached to it for training with a view to eventual employment in the frontier parties and it is possible this large programme will not be completed.

102. The party was inspected by the Surveyor General during the recess and during both the field and recess seasons by the Deputy Surveyor General.

BERAR.

No. 2 PARTY.

103. The party was newly formed this season for the further training of

Personnel.

Captain E. T. Rich, R.E., Officiating Deputy Superintendent, 2nd grade, in charge to 10th September 1905.

Mr. C. F. Erskine, Officiating Superintendent, 2nd grade, in charge from 11th September 1905.

Lieutenant H. S. May, R.E., Officiating Assistant Superintendent, 1st grade.

Lieutenant M. N. MacLeod, R.E., Assistant Superintendent, 2nd grade.

Mr. W. A. Fielding (retired and temporarily re-engaged), Assistant Instructor and 5 Sub-Assistant Superintendents on probation, 1 computer and 1 clerk.

same time. Progress will be necessarily slow, the chief object aimed at being the training of the officers in correct methods and accurate work. Although the number now assigned to this party was formerly borne by the double party employed on cadastral surveys in the United Provinces, there was no transfer of establishment or records.

104. Field work commenced on the 1st October 1904. The triangulation included a minor series emanating from the side Pilkher P. S.--Kopdi H. S. of the Great Arc meridional series of the Great Trigonometrical survey which, running westwards through sheets 297, 290, 284 and 279, will eventually close on the Khánpisura meridional series. The distance is about 120 miles, of which about 70 were covered by this season's work. The area triangulated during the season is 1,690 square miles and comprises the whole of sheet 42 and portions of sheets 294, 295, 296 and 302. The whole area required very careful preliminary reconnaissance, as it was devoid of prominent features everywhere, while in places it was flat and thickly wooded and the triangulation was carried out with considerable difficulty. The average number of square miles to each point trigonometrically fixed is 3'6.

105. The detail survey of one sheet only, No. 40, was completed, the area surveyed being 483 square miles. The greater portion of this sheet lies in the Wardha district, in which were some reserved forests which had previously been surveyed by the Forest Department on the 4-inch scale covering an area of about 72 square miles. Similar forests occur in the Berar portion, but they had not been surveyed previously and have now been done on the 2-inch scale by this party at the request of the Forest Department. Field work ceased on the 30th April 1905. The average monthly outturn of plane-tableing per man was 19.3 square miles and the average per working day 0.7. The country surveyed consisted of the level bed of the Wardha river, which is open and cultivated, with groups of trees dotted about, and flanked on both sides by low bare hills rising to a height of 200 to 400 feet, and presented no difficulty to the survey which was carried out entirely by interpolation.

106. The party was inspected by the Deputy Surveyor General during both the field and recess seasons. Neither the mapping nor computations were completed during the recess owing to the urgent demand for officers in other parties which necessitated the transfer of one Imperial and two of the Provincial officers at the commencement of the recess. In addition to the standard mapping a combined triangulation and traverse chart was prepared of sheet 40 on the 1-inch scale for reduction to half.

107. Next season the triangulation of sheets 294, 295 and 296 will be completed and that of sheets 28 and 39 taken up. The secondary series commenced this season will also be completed and sheets 41 and 295 will be surveyed in detail, including all reserved forests which have not already been surveyed, while the maps of those that have, will be tested and supplemented to meet the requirements of the Forest Department.

LOWER BURMA.

No. 3 PARTY.

108. The work of this party consists of a topographical survey on the scale of 1-inch=1 mile

Personnel.
 Mr. E. F. Litchfield, Deputy Superintendent, 1st grade, in charge.
 Mr. W. M. Gorman, Extra Assistant Superintendent, 6th grade.
 Mr. J. O'B. Donaghey, "
 Mr. E. Claudius, Sub-Assistant Superintendent, 1st grade. "
 Munshi Asmatulla Khan, " 2nd "
 Mr. H. D. W. Stotesbury, " 3rd "
 18 Surveyors, 6 computers, draftsmen, etc.

based on triangulation, combined with a supplementary topographical survey of such areas as have been surveyed cadastrally. The season's out-

turn and cost rates are as follows:—

	Square miles	R
Triangulation	1,218	24.9 per square mile.
New detail survey	2,078	23.9 " " "
Supplementary survey	425	18.0 " " "

The triangulation was confined to a narrow strip of country on the eastern margins of sheets 302 to 307 and the adjoining portion of sheet 351, as the greater part of these sheets has been surveyed cadastrally and will come under supplementary survey. The number of square miles to each point trigonometrically fixed is 9. The traversing of the cadastral survey was connected with the present triangulation which was also supplemented by 53 linear miles of simple traversing, giving 498 extra points of which the heights of 431 were determined.

109. The sheets that came under detail and supplementary survey are the whole of 298, 299 and 300 and portions of 251 and 252, the two latter of which had been partially surveyed topographically on the scale of 4 inches to the mile in 1903 to 1905 by the Forest Survey Branch. The supplementary survey was done on "tracing prints" prepared by pasting bankpost paper over printed copies of the maps compiled from the cadastral survey, a convenient and expeditious method when the area for supplementary survey is extensive and the survey is done on the same scale as the maps, as the labour of tracing the details on to the plane-table sections is avoided.

110. The field season was slightly curtailed this year on account of the arrears of mapping still remaining. The recess office at Bangalore closed on the 16th November 1904 and re-opened on the 11th May 1905 but the time actually occupied on field work was barely $4\frac{1}{2}$ months. The number of surveyors was 19 and the average outturn *per man per working day* was 1.3 square mile of new detail survey and 2.0 of supplementary. The average number of plane-table fixings per square mile was 4.8 for new survey and 15.8 for supplementary. In sheets 251 and 252 a vertical interval of 50 feet was employed for the contouring but elsewhere the interval was extended to 100 feet.

111. The Paunglaung range of hills, the eastern watershed of the Sittang river, runs right through the season's work and forms a distinct dividing line between two widely differing varieties of ground. The western slopes are covered with a dense growth of bamboo and intersected with innumerable water-courses necessitating a good deal of clearing and the constant use of the chain. On the eastern side, plane-tabling was comparatively easy as the hills are bold and bare-topped though the lower slopes and valleys are well wooded. The health of the party during the field season was on the whole good. The hills are infested with a small fly that possesses a peculiarly virulent sting and gave a good deal of trouble last season and the *khalasis* were therefore provided on this occasion with what are called Jodhpur breeches and spats to protect their legs and feet, a precaution which amply repaid the expenditure incurred.

112. The cost-rate for the triangulation this season is high, owing partly to the small area triangulated, but it includes observations made at 3 stations for the purpose of connecting the traversing of the cadastral survey with the present operations, to which no area can be credited. The rates for new detail and supplementary survey differ but little from last season's but are slightly higher for which no particular reason can be assigned.

113. A considerable advance has again been made with the arrears mapping and the following 12 sheets were submitted to head-quarters for publication, Nos. 75, 76, 113 to 116, 157, 158 and 211 to 214. Two others, 206 and 207, were almost completed at the close of the recess and only two, Nos. 204 and 205 of the old arrears mapping remain unfinished and they are well advanced. The maps of the current season's work are being drawn in the new form, 15 minutes square and have all been completed with the exception of 3 sheets, 298, 299 and 300, of which a strip along the eastern margin remains to be surveyed owing to the change in graticule which is to be introduced with the new form of maps. Two triangulation charts of degree sheets 18N and 18S were submitted for publication and three others, 30N, 30S, and 43N, are in hand.

114. The programme for next season consists of the triangulation of sheets 347 to 350 and 394, 395 and 397 (which has been substituted with the approval of the Government of Burma for the original programme) and the detail survey of sheets 301 to 306.

115. The Survey Committee visited this party during the field season and inspected two plane-tables at work and the Deputy Surveyor General inspected it during the recess.

UPPER BURMA.

NO. 10 PARTY.

Personnel.

Captain C. P. Gunter, R.E., Assistant Superintendent, 1st grade, in charge to 31st May 1905.

Captain E. T. Rich, R.E., Assistant Superintendent, 1st grade, in charge from 1st June.

Mr. R. Waller-Senior, Extra Assistant Superintendent, 3rd grade.

Mr. P. J. Barrington, Extra Assistant Superintendent, 4th grade.

Mr. W. G. Jarbo, Sub-Assistant Superintendent, 1st grade.

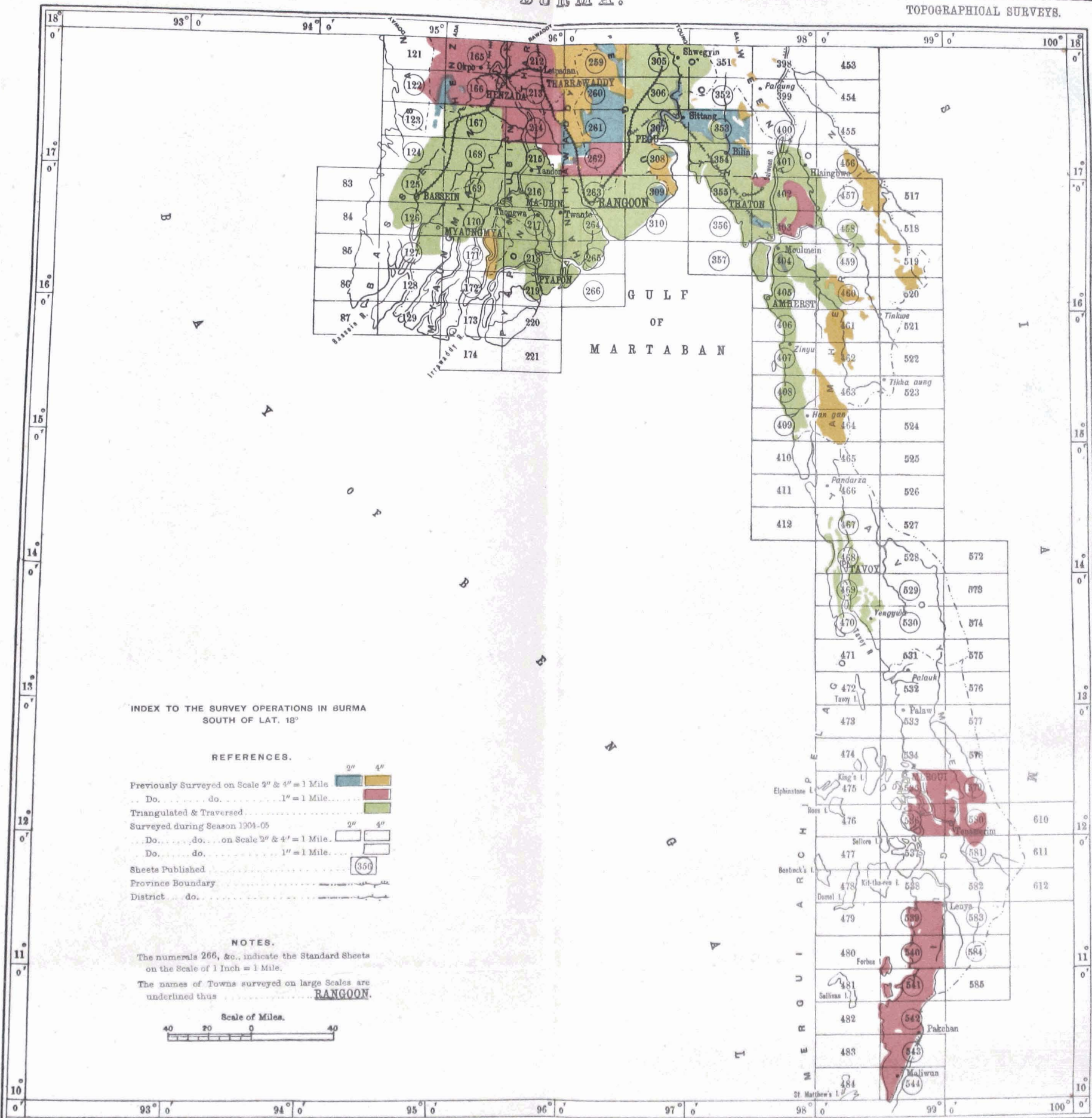
Mr. C. West, Sub-Assistant Superintendent, 2nd grade.

Mr. F. M. Kenny, Sub-Assistant Superintendent, 2nd grade.

Munshi Abdul Rahim, K.S., Sub-Assistant Superintendent, 3rd grade.

21 Surveyors.

116. The party is employed in the same way as No. 3, but this season the work was all supplementary survey. One native Provincial officer and 3 Surveyors were employed during part of the season on reconnaissance surveys in connection with two separate expeditions despatched, one to determine the Burma-China boundary and the other to mark it out where it had already been determined.



INDEX TO THE SURVEY OPERATIONS IN BURMA
SOUTH OF LAT. 18°

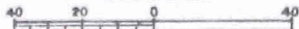
REFERENCES.

Previously Surveyed on Scale 2" & 4" = 1 Mile	
Do. do. do. 1" = 1 Mile	
Triangulated & Traversed	
Surveyed during Season 1904-05	
Do. do. do. on Scale 2" & 4" = 1 Mile	
Do. do. do. 1" = 1 Mile	
Sheets Published	
Province Boundary	
District do.	

NOTES.

The numerals 266, &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.
The names of Towns surveyed on large Scales are underlined thus RANGOON.

Scale of Miles.



117. The programme was completed and the outturn and cost-rates of the ordinary work of the party for the season are as follows :—

	Outturn.	Cost-rates.
Triangulation . . . Square miles	3,912	₹ 6.9 per square mile.
Supplementary survey " " "	3,940	" 16.9 " " "

The triangulation occupied three Provincial officers for an average of 5 months each and one Sub-Surveyor for 3. It covered the whole of sheets 71 to 74 and 106 and portions of 104, 105 and 107. The greater part of sheets 71 to 74, representing about half the area triangulated, was mountainous and wooded, necessitating a good deal of clearing but not otherwise difficult. The rest was open and easy ground where cadastral operations were in progress or had just been completed, with low bare hills rising here and there in detached groups.

118. The detail survey embraced the whole of sheets 148 to 150, 196 and 197 and the western halves of 194, 242, 243 and 244. The average number of plane-table fixings was 7 per square mile. The plane-table sections of 5 sheets were prepared for supplementary survey by entering on them in blue the details traced from the 1-inch standard maps which had been compiled from the cadastral survey, while "tracing prints," as described at paragraph 109 of this report, were used for the rest. Field work was actually in progress for close on six months, and the party was away, from recess quarters from the 19th October 1904 to the 5th of May 1905. The number of plane-tables was 22 and the average outturn of supplementary survey per man per working day was 1.48 square mile.

119. The cost-rates are considerably lower than those of last season when the work nearly all consisted of supplementary survey also. This is due to the easier nature of the country surveyed this year and the larger outturn and also to the fact that no distinction was made this season between wet and dry cultivation.

120. For various reasons, among which may be mentioned the unfinished state of Mr. Walsh's triangulation last season when he fell ill, the computations have fallen into arrears. Triangulation charts of degree sheets 27S and 28N were submitted for publication, and those portions of sheets 40S and 41N which had been triangulated by this party were drawn and the charts handed over to No. 11 Party for completion. Charts of sheets 16N, 16S and 28S are in hand. The standard maps of the season's work were all drawn in the new form of 15 minutes square with graticules adjusted to the latest adopted value of the longitude of Madras, with the exception of sheet 194, of which half was surveyed and drawn last season in the old form, and this form was consequently retained. Sheet 193 which had been drawn and nearly completed last season in the old form was completed and forwarded to head-quarters. The eastern half of sheet 195 was redrawn in the new form to avoid a gap between it and sheet 242. Of the present season's work only 3 sheets were submitted for publication, Nos. 194, 196 and 197. The rest will be completed in the Bangalore Drawing Office and should be submitted shortly.

The party was inspected by the Deputy Surveyor General during the recess.

121. The programme for next season is the triangulation and traversing where necessary of sheets 142 to 145 and 189 to 191 and the detail survey of sheets 71 to 74, 109 and 152.

122. The reconnaissance work done on the Burma-China boundary during the season was —

	Square miles.
Triangulation	1,950
Detail survey on the scale of 1-inch to the mile	1,070
" " " ½ " " " "	2,970

One Sub-Surveyor was employed on this work throughout the field season and one native Provincial officer and 2 Surveyors for about two months. The fair mapping of this work is being done in the Bangalore Drawing Office and details regarding it will be found in the report of that office at page 20. The ½-inch survey was done in connection with the determination of the Burma-China boundary to the north-east of Bhamo and 810 square miles of the 1-inch survey was done in connection with the demarcation of another portion of the boundary

which had been previously determined. The rest of the 1-inch work, 260 square miles, consisted of a survey of the road from Bhamo to Tengyueh (Momien).

NORTH-WEST FRONTIER.

NO. 11 PARTY.

Personnel.

- Major J. M. Burn, R.E., Officiating Superintendent, 2nd grade, up to 22nd October.
- Lieutenant C. M. Browne, D.S.O., R.E., Assistant Superintendent, 2nd grade, in charge up to 23rd May.
- Lieutenant R. H. Phillimore, R.E., Assistant Superintendent, 2nd grade, in charge from 23rd May.
- Babu Pramadaranjan Roy, Sub-Assistant Superintendent, 1st grade.
- Mr. H. C. Stotesbury, " " "
- Mr. V. W. Morton, " " "
- Mr. A. B. Hunter, " " "
- Mr. P. Simpson, " " "
- 19 Surveyors and probationer surveyors.

123. Lieutenant C. M. Browne, D.S.O., R.E., took over charge of No. 11 Party on 23rd October 1904, and on 23rd May 1905 handed over to Lieutenant R. H. Phillimore, R.E., who remained in charge till the end of the year.

124. The party arrived at Quetta from Bangalore during the last week of October, and received orders to co-operate with No. 15 Party in carrying out work on the 2-inch scale in

Baluchistán and Waziristán.

125. No triangulation was available in Waziristán, so detail survey was confined to Baluchistán during November and December, while triangulation was pushed on as rapidly as possible in Waziristán. In January after the completion of 283 square miles of revision survey on the 2-inch scale in an area some 30 miles south-west of Quetta, the bulk of the party was moved to Waziristán, and took up work near Bannu. Mr. V. W. Morton and five surveyors were left to continue the work in Baluchistán, where an area of 44.5 square miles was surveyed by the close of the field season in June. The work of this detachment was suspended for two months in winter owing to severe weather.

126. By the middle of January the triangulation in Waziristán was sufficiently advanced to enable the detail survey to begin, and an area of 214 square miles in the Bannu district was distributed among the plane-tablers. As each man completed the survey of his section, he was moved to the Tochi valley where most of the plane-tablers were employed by March. Work was carried on till May 15th, when it was closed owing to opposition on the part of the tribesmen, after the completion of 325 square miles in the Tochi valley.

127. Both in the country near Bannu and in the Tochi valley, guards were required during the whole period of the operations, and during the last fortnight, work on several plane-tables had to be stopped as the surveyors could not be permitted to go to their work.

128. The triangulation in Baluchistán was carried out by Mr. Morton who completed an area of 506 square miles. Two triangulators, Babu Pramadaranjan Roy and Mr. H. C. Stotesbury, were employed in Waziristan, their united outturn amounting to 891 square miles.

129. The outturn of the party during the season under report consisted of—

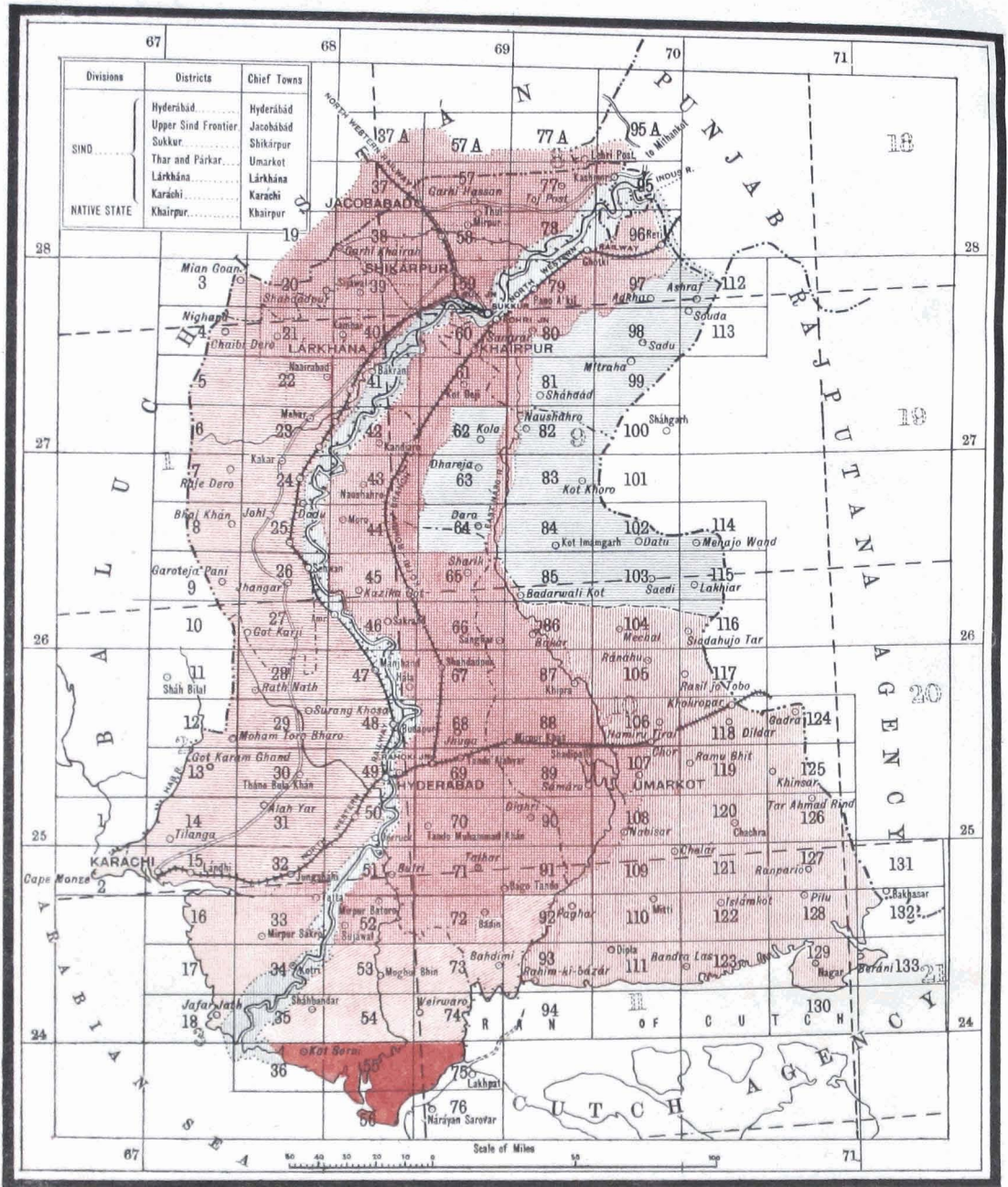
Triangulation	1,396.9 square miles.
Detail survey on the 2-inch scale	981.66 " "

The cost-rates were:—Rs. 24-8-0 per square mile for triangulation and Rs. 64-7-5 for detail survey.

130. During recess the fair drawing of two Baluchistán sheets, Nos. 332-S.E. (3) and 345-N.E. (1), and of four Waziristán sheets, Nos. 442-S.E. (1) and (3) 443-N.E. (1), and 443-N.W. (2) was completed up to the limits of survey. The former were drawn on the 2-inch scale for reproduction, and the latter on the 2-inch scale for reduction to the 1-inch scale. Sheets 442-S.E. (1) and (3), 443-N.E. (1) and 442-N.W. (2) will be published as preliminary editions, and the other sheets will be retained in the North-West Frontier Drawing Office for additions which will be surveyed in 1905-06.

SIND SURVEY.

1904-05.



Revised at the Office of the Trigonometrical Branch, Survey of India, Dehra Dun, December 1906.

No. 3, S. I. 11-18-1903-580

REFERENCES.

- Surveyed in Previous Seasons Scale 1" = 1 Mile [Shaded Box]
- Do. " " " " 1" = 1 Mile [Light Shaded Box]
- Do. " " " " 2" = 1 Mile [Medium Shaded Box]
- Do. " " " " 4" = 1 Mile [Dark Shaded Box]
- Indus Riverton Survey " " 1" = 1 Mile [Light Shaded Box]
- Surveyed in 1904-05 " " 1" = 1 Mile [Red Shaded Box]
- Do. " " " " 2" = 1 Mile [Light Shaded Box]
- Triangulated in advance " " " " " " [Light Shaded Box]

Reg. No. 1310-S. 05.

NOTES.

The numerals 63, etc., indicate the Standard sheets on the Scale 1 Inch = 1 Mile.
The figures and lines in strokes represent the numbers and limits of the Improved sheets of the Indian Atlas.

131. The health of the party was good on the whole. There were three deaths from pneumonia and several cases of scurvy in the menial establishment.

132. In October 1905 No. 11 Party was reduced in strength to 1 Imperial officer, 2 Provincial officers, and 12 surveyors, and returned to the Southern Shan States to resume the 1-inch survey beyond the Salween river, in standard sheets 564, 565, 566 and the western half of 604. Sheets 606, 607 and 608 will be triangulated in advance for detail survey in the following year. The party will in future recess in Burma.

SIND.

NO. 12 PARTY.

133. Mr. C. F. Erskine was in charge till the 31st August 1905, when he was transferred to No. 2 Party (Berar) and Mr. R. F. Warwick took over charge of the party for the remainder of the year.

Personnel.

Mr. C. F. Erskine, Officiating Superintendent, 2nd grade, in charge up to 31st August 1905.

Mr. R. F. Warwick, Extra Assistant Superintendent, 3rd grade, in charge from 1st September 1905.

Munshi Rahmatullah, Extra Assistant Superintendent, 5th grade.

Mr. E. C. J. Bond, Extra Assistant Superintendent, 6th grade.

Mr. H. A. Charrier, Sub-Assistant Superintendent, 1st grade.

Babu Dhani Ram " " " 2nd "

Mr. R. E. M. Saubolle " " " 2nd "

30 Surveyors, computers, draftsmen and writers.

The survey operations were of the same nature as in former years and the following programme was completed:—

- (a) Net-works of secondary triangulation over the Thar and Parkar districts in sheets 92, 93, 108, 109, 110, 111, 120, 121, 122, 123, 126, 127, 128, 129, 130, 131, 132 and 133 covering an area of about 7.775 square miles.
- (b) Detail survey on the 2-inch scale in sheets 34, 35, 53, 54, 72, 73, 74, 92, 93 and 94.
- (c) Detail survey on the 1-inch scale in sheets 36, 55, 56, 75 and 76.
- (d) Traversing and detail survey of 13½ square miles on the 12-inch scale in extension of the Karachi Cantonment Survey.
- (e) A line of traverse along the railway from Badin Railway Station to Hyderabad Fort.

134. The area surveyed in detail on the 2-inch scale amounts to 2,787 square miles and that on the 1-inch scale to 1,150 square miles, the work was tested by 999 *in situ* fixings and was carried out under the direct supervision of the officer in charge.

The cost-rates for survey and fair mapping are—

						R	a.	p.
Scale	2-inches = 1 mile	.	.	.	.	.	13	14 4
"	1-inch = 1 mile	:	:	:	:	.	6	14 4
"	12-inches = 1 mile	.	.	.	.	.	507	3 0

Work in the field was closed by the end of March 1905, and the party returned to Karachi for recess.

135. During recess the fair mapping of the entire areas surveyed in detail on the 1-inch and 12-inch scales, and the greater portion of that on the 2-inch scale was completed. The mapping comprised 4 sheets on the 1-inch scale, 7 sheets on the 12-inch scale and 30 quarter sections on the 2-inch scale. The 1-inch and 12-inch sheets were drawn for reproduction, and those on the 2-inch scale for reduction to 1-inch.

All sheets on the 1 and 12-inch scales and most of the sheets on the 2-inch scale have been despatched to the Trigonometrical Survey Office, Dehra Dún, for publication, and the remaining sheets will be submitted shortly on completion of the drawing. The triangulation charts of the work of this party during the year under report, together with the list of points shown on the charts with the values of their co-ordinates, are being prepared and will be submitted to the Dehra Office.

136. During the ensuing field season the party will be employed on the North-West Frontier.

137. The health of the party during the field season was only fair, there being many cases of pneumonia; from this complaint four *khalasis* died in the field and two after the close of the field season.

The party was inspected by the Superintendent, Trigonometrical Surveys, during the field season.

UNITED PROVINCES OF AGRA AND OUDH.

NO. 14 PARTY.

138. The party continued the topographical survey, on a scale of 2 inches

Personnel :

Captain H. L. Crosthwait, R.E., Deputy Superintendent, 2nd grade, in charge.

Lieutenant M. N. MacLeod, R.E., Assistant Superintendent, 2nd grade, from 1st June to 30th September 1905.

Mr. C. A. Norman, Extra Assistant Superintendent, 2nd grade, from 4th July to 20th September 1905.

Mr. C. George, Extra Assistant Superintendent, 3rd grade.

Mr. J. H. S. Wilson, Extra Assistant Superintendent, 6th grade.

Mr. E. J. Biggie, Extra Assistant Superintendent, 6th grade.

Mr. H. B. Simons, Sub-Assistant Superintendent, 2nd grade.

16 Surveyors, 13 surveyors under instruction, 6 computers, 10 draftsmen, 1 writer, etc.

to one mile, of the districts Allahabad, Fatehpur and Cawnpore. The survey of the first two districts is now complete. The field office opened at Cawnpore on 25th October 1904 and closed on 25th April 1905.

139. The outturn of field work of the party for the season is as follows:—

Original 2-inch survey	1908.26 square miles.
Revision survey	300.12 " "
Supplementary survey	217.66 " "
TOTAL	<u>2,426.04 " "</u>

These areas were included in standard sheets Nos. 156, 167, 139, 138, 123, 107, 108, 109, 91 and 92 of the United Provinces series.

140. The origins of survey remained the same as reported last year.

141. In consequence of the employment of surveyors, who would otherwise have been engaged in fair mapping during the recess, on special duty in connection with the manœuvre map near Delhi, the drawing of the party is very much in arrears. Arrangements have been made to bring it up to date during the coming field season.

142. Owing to so great a proportion of the strength of the party consisting of men under instruction, and to the fact that very little of the area surveyed could be mapped, any cost rate that could be obtained for the work of the past year would be misleading.

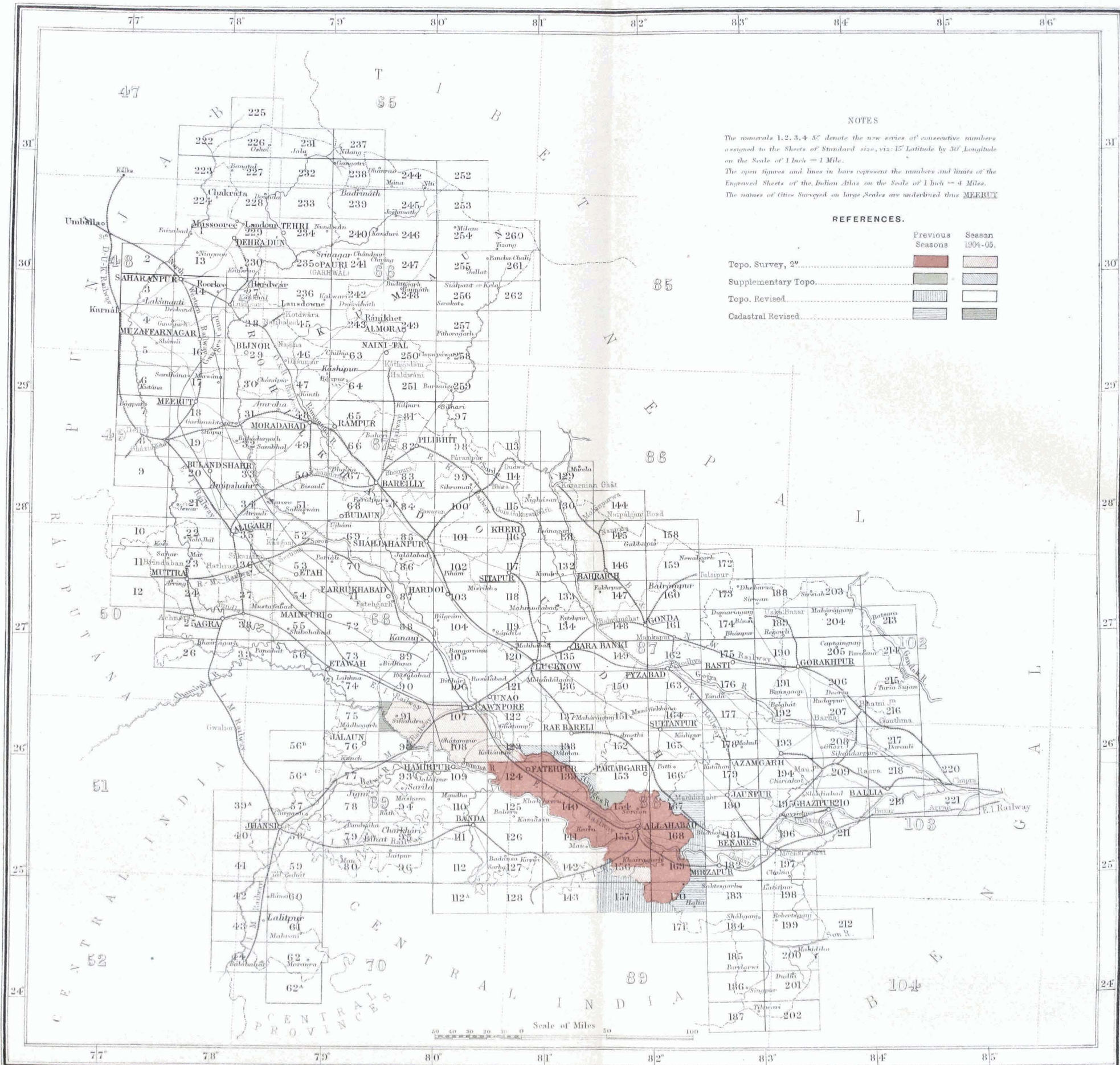
143. The character of the country surveyed was of the same nature as that reported last year and calls for no further special remark.

144. The party, having been transferred to the North-West Frontier, will be engaged on special military surveys.

145. The Surveyor General inspected the party in August 1905.

UNITED PROVINCES.

INDEX TO THE SURVEY OPERATIONS



NOTES

The numerals 1, 2, 3, 4 &c denote the new series of consecutive numbers assigned to the Sheets of Standard size, viz: 15' Latitude by 30' Longitude on the Scale of 1 Inch = 1 Mile.

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

The names of Cities Surveyed on large Scales are underlined thus MEERUT

REFERENCES.

	Previous Seasons	Season 1904-05.
Topo. Survey, 2"		
Supplementary Topo.		
Topo. Revised.		
Cadastral Revised.		

NORTH-WEST FRONTIER.

NO. 15 PARTY.

146. Captain F. W. Pirrie was in charge of the party during the whole survey year.

147. The party continued to carry out special surveys for military purposes on the scale of 2-inches to 1 mile in Baluchistán, the North-West Frontier Province, and adjacent tribal territory.

Personnel.

Captain F. W. Pirrie, I.A., Deputy Superintendent, 2nd grade, in charge up to 14th September 1905.

Major C. L. Robertson, C.M.G., R.E., Deputy Superintendent, 1st grade, in charge from 15th September 1905.

Lieutenant R. H. Phillimore, R.E., Officiating Assistant Superintendent, 1st grade, up to 23rd May 1905.

Mr. J. McHatton, Extra Deputy Superintendent, 2nd grade, up to 16th July 1905.

Mr. G. A. Knight, Extra Assistant Superintendent, 1st grade.

" J. A. Freeman, " " " 5th " up to 6th

October 1904.

Mr. H. C. H. Cooper, " " " 6th " "

" D. J. Hunter, " " " 6th " from 1st

September 1905.

Subadar Kanak Singh, Sub-Assistant Superintendent, 2nd grade.

Mr. E. B. West, " " " 2nd " "

" P. Simpson, " " " 2nd " from 22nd

August 1905.

Mr. E. C. O'Sullivan, " " " 2nd " "

" E. A. Wainright, retired Provincial Officer.

" J. McHatton, " " from 1st August 1905.

50 Surveyors, etc.

148. These surveys were temporarily interrupted during the field season by the change of the locality of survey and by unrest among the local tribes.

149. On the completion of the regular work for the year the survey of a small

tract of country near Campbellpur, urgently required for an artillery practice camp, was taken up; also in conjunction with a detachment of No. 14 Party a survey on the scale of 1-inch = 1 mile was carried out for a military manœuvre map in the neighbourhood of Delhi. These surveys were carried out during the hot weather under trying conditions, and necessitated the retention of the surveyors employed on them in the field for a whole year.

150. The survey of cantonments and cantonment bazaars in the Punjab were continued by a detachment of the party under the supervision of Mr. McHatton, who introduced and satisfactorily carried out the system of preparing the field maps for reproduction without re-drawing. This enabled the special drawing section of the cantonment detachment to clear off all arrears of cantonment mapping.

The following cantonments with their bazaars were surveyed on the scale of 16 and 64-inches to 1 mile respectively:—

Siálkot.	Cherat.
Dera Ismail Khan.	Ráwalpindi.
Murree (partly).	

Mr. J. McHatton retired on pension after a year's extension of service in July 1905 but was re-employed shortly afterwards and remained in charge of the detachment for the remainder of the year.

Various trans-frontier reconnaissance and detail surveys were also carried out by members of the party for the Foreign Department.

151. The training in regular surveying of soldier surveyors who had previously been taught military surveying at Roorkee was continued and a certain proportion of their work was utilized in the fair mapping.

152. Owing to the want of suitable triangulation on which to base the 2-inch detail survey, a secondary series was carried out by Lieutenant Phillimore, R.E., and minor network triangulation by other officers who all computed their observation and prepared plane-tables therefrom for the detail surveyors, in the field.

153. The 2-inch survey on the North-West Frontier was done conjointly with No. 11 Party, the officer in charge of No. 15 Party being responsible for the general arrangements, distribution of work and methods of survey of both parties.

154. The party left Mussooree in the beginning of September 1904 and returned to recess about the end of May 1905.

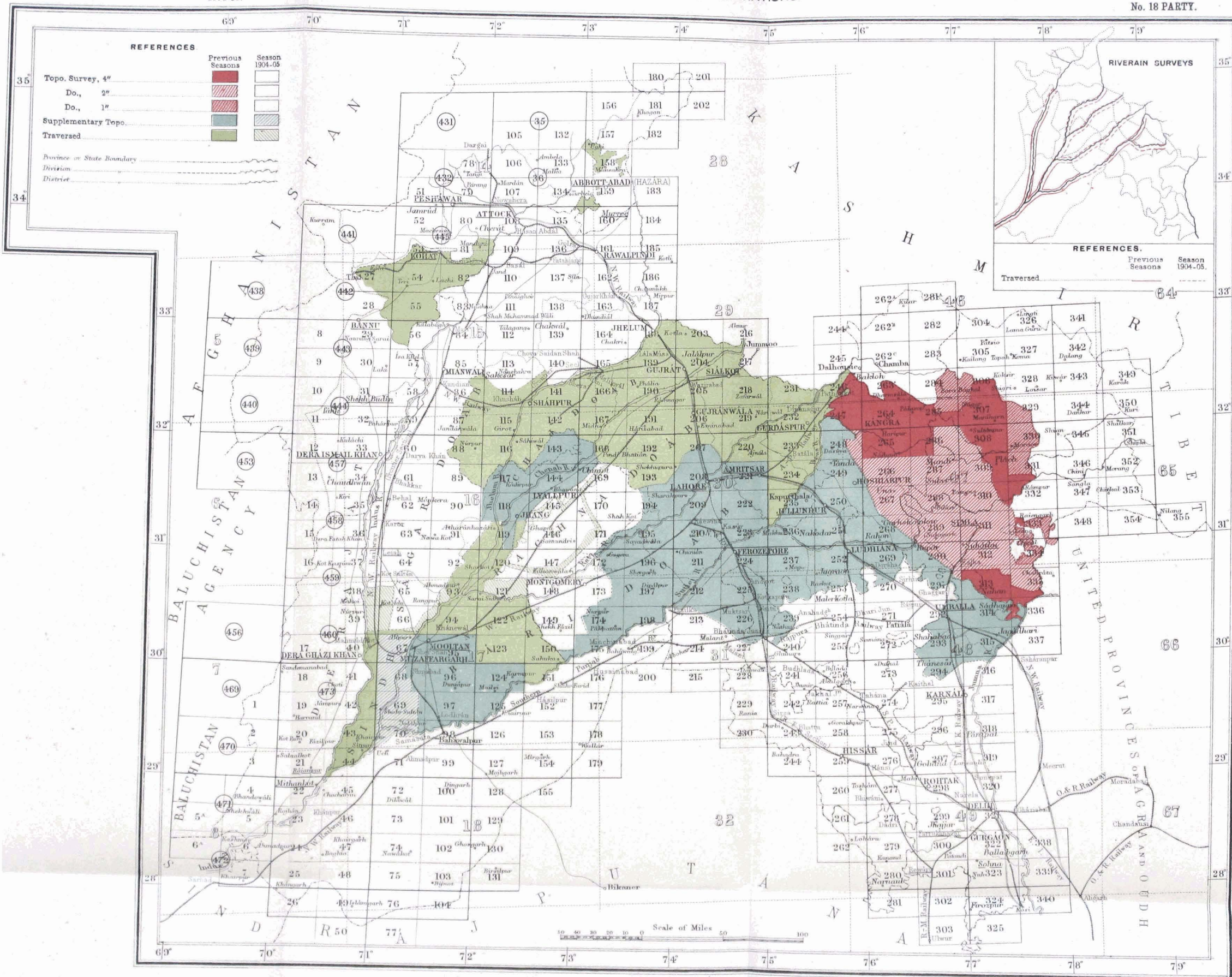
The recess season of 1905 lasted only three months from the beginning of June to the end of August, as the party again left for the field during the first week of September.

PUNJAB & N. W. FRONTIER PROVINCE.

INDEX TO SURVEY OPERATIONS.

1904-05.

No. 18 PARTY.



Published under the direction of Colonel H.R. Thellier, R.E., Surveyor General of India.

Additions to 1905.

NOTES.

The numerals 1, 2, 3, 4, &c., denote the new series of consecutive numbers assigned to the Sheets of Standard size, viz., 15" Latitude by 30" Longitude on the Scale of 1 Inch = 1 Mile.

The open figures and lines in bars represent the numbers and limit of the Engraved Sheets of the Indian Atlas on the Scale of 1 Inch = 4 Miles.

The names of Cities Surveyed on large Scales are underlined thus,

LAHORE.

Himalayan work, and the other those of the 2-inch supplementary survey miscellaneous drawing, which will be mentioned later, had also to be undertaken.

161. The field season commenced at the beginning of November and finished at the end of May, but a strong party was kept in the field until the end of June on the 6-inch survey; but for several cases of fever and dysentery towards the end of this work the health of the party was good, one draftsman died of consumption while on medical leave in May and one *khalasi* of fever at Kohát in June.

162. *Supplementary Topographical Survey on the 2-inch scale for preparation of 1-inch standard sheets.*—This work consisted, as in previous years, of testing by plane-table, a compilation of settlement *masavis* fitted together by means of traversed points. The area completed was 1,511 square miles in Multán and Muzaffargarh districts.

The Surveyor General in inspecting the previous season's work was of opinion that the survey of waste and desert areas had been pushed on too rapidly and with not sufficient regard to detail; efforts have been made to correct this fault during the field season, but have necessarily resulted in a slightly reduced output and increased cost; this work suffered from the fact that as the most experienced surveyors of the party were employed on the special surveys for the military authorities it had to be largely entrusted to beginners.

163. *District traverse.*—This was continued in Multán and Muzaffargarh districts, as in previous years. The outturn was small compared with that of previous years and with that proposed in the programme, this is due to the greatly reduced strength of the section employed on this work.

164. *Riverain traverse.*—This section was greatly strengthened with a view to nearly finishing the work during the season; it completed about 3,000 square miles of traverse work on the Indus, Jhelum, Chenab, Ravi and Sutlej rivers and in districts Jullundur, Ludhiána, Ferozepur, Montgomery, Siálkot, Amritsar, Lahore, Multán, Gujrát, Gujránwála, Jhang, Shahpur, Miánwáli, Dera Ismáil Khan and Baháwalpur State. Special efforts were made to give as much assistance as possible to officers actually engaged in settlement duty with, it is hoped, satisfactory results.

165. *Fair drawing.*—The drawing staff has been again increased during the year and although not yet strong enough to deal satisfactorily with the outturn of survey, it is as large as the staff of assistants can possibly supervise. A very large number of *masavis* has been dealt with in the riverain fair drawing, this work is now being pushed on as fast as possible, but will probably not be finished for about four years although the actual survey work will be completed during the coming field season.

The fair drawing of the current work in Multán and Montgomery has been carried out at Simla throughout the year and is now almost up to date.

The Himalayan section has also worked continuously at Simla and the arrears of this work should be finished within the next two years.

During the year, copies of the Simla survey sheets were coloured and this work is now finally disposed of. Some 4—7 draftsmen have been employed on special maps, such as the Aden Boundary and Aden general maps, and 6 special maps for the Foreign Office, throughout the recess season and on a smaller scale this work will continue throughout most of the coming field season.

166. The total expenditure of the party during the year has been Rs. 1,28,196, and of this Rs. 35,880 was expended on riverain surveys for the Punjab Government and Rs. 35,471 on special surveys for the military authorities. The cost rate for 2-inch supplementary survey, including compilation of maps, traversing and mapping, is approximately Rs. 16 per square mile.

167. *Programme for next field season.*—This allows for the supplementary survey on the 2-inch scale of some 4,000 square miles in Multán, Muzaffargarh, Dera Gházi Khán districts, and Baháwalpur State, district traverse in Baháwalpur State and Jhang and Lyallpur districts and the completion of all riverain surveys in the Punjab.

FOREST SURVEYS.

NO. 9 PARTY (FORESTS).

168. The Superintendent of Forest Surveys held charge of this party in addition to his other duties.

Personnel.

Major C. W. H. Symonds, I. A., Offg. Superintendent, to 3rd November 1904.

Major P. J. Gordon, I.A., Superintendent, Forest Surveys, from 4th November 1904.

Mr. James Marten, Extra Assistant Superintendent, 3rd grade, on leave to 4th May 1905.

Mr. A. Ewing, Extra Assistant Superintendent, 4th grade, to 27th October 1904.

Mr. J. Smith, Extra Assistant Superintendent, 4th grade, from 1st November 1904.

Mr. C. Litchfield, Extra Assistant Superintendent, 5th grade.

Mr. C. J. Veale, Extra Assistant Superintendent, 6th grade.

Mr. P. A. T. Kenny, Sub-Assistant Superintendent, 1st grade.

75 Surveyors.

Shwebo, Ruby Mines and Mandalay districts; in Assam a detachment under Mr. Litchfield continued 4-inch detail survey in the Gáro Hills, Kámrup and Nowgong and carried out preliminary triangulation and traversing in Darrang and Sibságar; in the Punjab and North-West Frontier Province a small detachment under a native surveyor was employed throughout the year on 4-inch detail survey in Lahore, Jhelum and Hazára. In addition to these operations five surveyors were placed at the disposal of the Forest Department for the purpose of surveying the recently demarcated boundaries of mica mine leases in Kodarma and three surveyors were employed on triangulation and traversing in Berar.

170. The outturn and cost-rates for the year under report and the two previous years are given in the following table:—

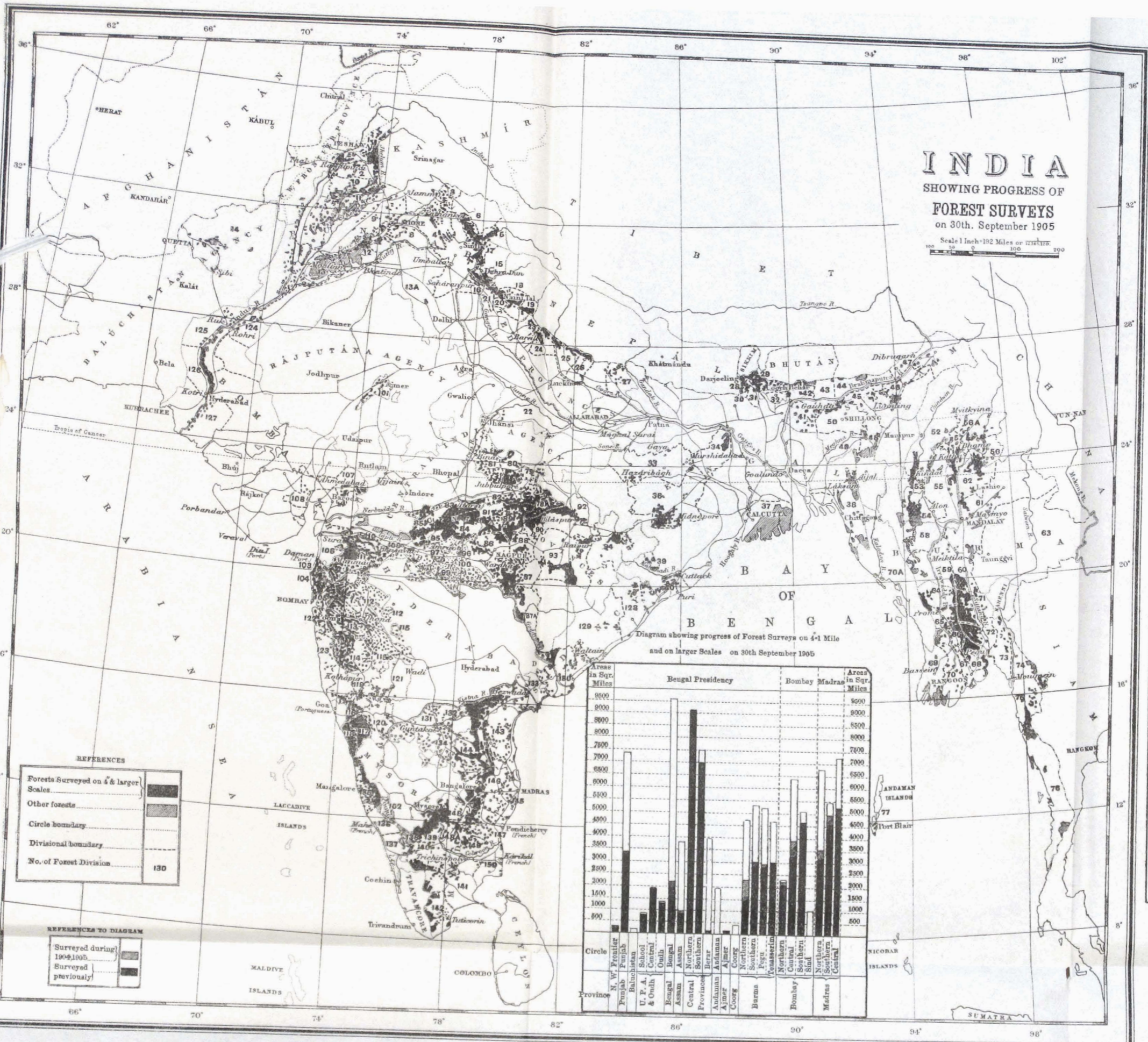
DESCRIPTION OF SURVEY.	OUTTURN IN SQUARE MILES.			COST-RATES PER SQUARE MILE.		
	1902-03.	1903-04.	1904-05.	1902-03.	1903-04.	1904-05.
<i>Detail survey 4 inches = 1 mile.</i>						
Bengal	232	310	232	64·0	64·0	78·8
Assam	134	160	148	97·8	85·2	87·9
Punjab and North-West Frontier	300	209(a)	262	35·3	25·0	25·3
United Provinces	100	36	...	29·7	27·1	...
Burma	303	447	501	63·5	90·7	94·0
Central Provinces	226	25	...	25·7	57·6	...
TOTAL	1,295	1,164·5	1,143	...	...	...
Traversing	1,251 (b)	1,552 (b)	1,444 (b)	22·9(c)	23·9(c)	19·8(c)
Triangulation	990	2,483	2,242	10·4	7·7	6·4

(a) Outline survey. (b) Linear mile. (c) Per linear mile.

The cost-rates of triangulation and traversing are under the average, while those of detail survey are practically the same as for last year, except in the Punjab, where they are lower owing to the detachment employed there having worked throughout the year, and in Bengal where they are higher; this increase is partly due to the fact of the survey being in a new district, it being found that rates are generally higher in such cases; the distance of Angul from headquarters and the consequent expenses of transporting the detachment to and from the field helped to increase cost-rates in this district.

171. The average monthly outturn of a surveyor was 4 square miles with 187 fixings per mile.

172. Most of the field work has been mapped and will be sent to press before next recess. The triangulations and traverses have been completed and,



LIST OF FOREST DIVISIONS.

Province or Circle	Reference No. on Map	Division	Province or Circle	Reference No. on Map	Division
N.W. Frontier	1	Hazara	Burma	75	Ataran
	2	Rawalpindi	Tenasserim	76	South Tenasserim
	3	Chamba	Andamans	77	Andamans
	4	Kangra		78	Mandla
	5	Bahawalpur		79	Jubbulpore
	6	Rawal		80	Dismoh
	7	Simla		81	Saugor
	8	Lahore		82	Narainpur
	9	Chenab		83	Hoshangabad
	10	Jhelum		84	Betul
	11	Shahpur		85	Nimar
	12	Montgomery		86	Nagpur Wardha
	13	Mooltan		87	North Chanda
	13A	Hissar		87A	South Chanda
				88	Bhandara
				89	Seoni
				90	Balaghat
				91	Chhindwara
				92	Bilaspur
				93	Raipur
				94	Sambalpur
				95	Etichpur
				96	Amraoti
				97	Buldana
				99	Basim
				100	Wun
				101	Ajmer-Merwara
				102	Coorg
				103	North Thana
				104	Central Thana
				105	South Thana
				106	Surat
				107	Dang
				108	Panch Mahals
				109	Ahmedabad
				110	East Khandesh
				111	West Khandesh
				112	Nasik
				113	Ahmednagar
				114	Poona
				115	Satara
				116	Sholapur
				117	North Kanara
				118	South Kanara
				119	Belgaum
				120	Dharwar
				121	Bijapur
				122	Kolaba
				123	Ratnagiri
				124	Sukkar
				125	Naushahro
				126	Hyderabad
				127	Jerruc
				128	Canjam
				129	Vizagapatnam
				130	Godavari
				131	Bellary
				132	Kurnool
				133	Kistna
				134	Anantapur
				135	South Canara
				136	North Malabar
				137	South Malabar
				138	Nilgiris
				139	North Coimbatore
				140	South Coimbatore
				141	Madura
				142	Tinnevely
				143	Nellore
				144	Cuddapah
				145	Chinglapet
				146	North Arcot
				147	South Arcot
				148	Salem North
				149	Salem South
				150	Trichinopoly
					Tanjore

No. D. 6, For 20-1-1906-255
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with the exception of the triangulation in Berar which was done by a native surveyor, the work has proved well.

173. Except in Assam, where there was a good deal of fever, health of the party was satisfactory.

174. The programme for 1905-1906 consists of—

- (1) *North-West Frontier Province*.—Completion of Forest Surveys in Hazára.
- (2) *Punjab*.—Boundary survey of the Rakhs of the Salt Range in Shahpur and some unimportant detail surveys in Ráwalpindi, Lahore, and Bashahr.
- (3) *United Provinces of Agra and Oudh*.—Survey of leased Chir Forests in Tehri-Garhwál and of the Surai Banbasa forest in Oudh.
- (4) *Eastern Bengal and Assam*.—4-inch detail survey of the Sitapahár reserve in Chittagong and of the remaining reserves selected for surveys in the Gáro Hills, Kámrup and Nowgong. The 2-inch detail survey of sheet No. 60 in Darrang.
- (5) *Burma*.—Completion of 4-inch detail surveys in Shwebo and Katha districts east of the Mu river.

No advance triangulation or traversing for 4-inch surveys beyond what is required for current surveys will be done in view of the general reduction of the scale of Forest Surveys which has been proposed. In Berar two surveyors have been attached to No. 2 Party for the survey of the boundaries of the more important reserves on the 4-inch scale.

175. The party was inspected by the Surveyor General during October.

BOMBAY PRESIDENCY.

NO. 17 PARTY.

Personnel.

Mr. B. G. Gilbert-Cooper, Superintendent, 2nd grade, in charge.

Mr. S. F. Norman, Extra Assistant Superintendent, 2nd grade.

Babu Amar Singh, Extra Assistant Superintendent, 6th grade.

Mr. P. R. Anderson, Extra Assistant Superintendent, 6th grade.

37 Surveyors, etc., and 1 writer.

176. Mr. B. G. Gilbert-Cooper held charge of the party throughout the year under report.

177. The party left Poona for the field at the end of November 1904, and returned to recess quarters at the end of May 1905, giving a full working season of six months.

The party, divided into three camps under Messrs. S. F. Norman, Amar Singh and P. R. Anderson, continued the survey on the 4 and 8-inch scales of forest areas in the Northern and Central circles of the Bombay Presidency.

The operations comprised:—

- (1) *Northern Circle*.—Continuation of the detail survey of teak reserves in the Thana District on the 8-inch scale.
- (2) *Central Circle*.—Continuation of the supplementary triangulation and detail survey on the 4-inch scale of forests in the Sátára District. Detail surveys on 4 and 8-inch scale in the Násik District.

Continuation of the supplementary triangulation, and detail survey on the 4-inch scale in the Khándesh District.

In addition to the above $22\frac{1}{2}$ miles of the boundary between the Khándesh District and the Barwáni State, Central India Agency, were traversed by theodolite at the request of the Bombay Government. The triangulation and traversing were done entirely by native agency.

On the recommendation of the Forest Department the Government of Bombay approved of the scale of survey in the Peint Táluka of Nasik being reduced from 8-inches to 4-inches to the mile and also sanctioned the abandonment of the survey of proposed forests in Sátára.

178. The health of the party was on the whole good; one surveyor died of sunstroke in the field and 1 sub-surveyor and one probationary sub-surveyor died of plague during the recess season in Poona; the death of the two former, both highly trained surveyors, being a serious loss to the party.

179. The following table shows in detail the outturn and cost-rates for the year under report and the two previous years :—

DESCRIPTION OF SURVEY.	OUTTURN.			COST-RATES.		
	1902-03.	1903-04.	1904-05.	1902-03.	1903-04.	1904-05.
Triangulation (square miles) .	1,373	677	1,010	1'11	15'3	12'2
Traversing (Linear miles) .	...	...	22'5	...	...	13'7
Topography, 4-inch scale (square miles).	486'73	576'19	597'48	61'0	67'5	62'3
Topography, 8-inch scale (square miles).	439'97	157'75	187'47	130'0	138'8	144'8

The cost-rate of triangulation is less than that of last season and that of 4-inch detail survey is also less than that of similar work for the past two years. The cost-rate of 8-inch detail survey is, however, somewhat higher than last year's rate. This increase is principally due to the party having to bear for the first time in its history a charge of 4 per cent. on its total expenditure on account of instruments supplied. The decrease in the cost-rate of 4-inch surveys is mainly due to the area surveyed on that scale being greater than formerly. On the whole the cost-rates may be considered satisfactory.

180. The detail survey was tested by one linear mile of test line to 1'7 square miles surveyed.

181. The averages were very consistent. A surveyor working 24 days in the month was found to be able to survey 2'23 square miles per month on the 8-inch scale with 228 fixings per mile and on the 4-inch scale 4'46 square miles with 117 fixings.

182. During the recess the mapping has made good progress, 156 sections having been sent to press during the year.

Every effort has been made to deal with the arrears of mapping, and it is hoped that before the close of the current recess season every section pertaining to the year 1903-04, as well as some of those of the year under report, will be submitted for publication.

183. In the course of the work the Tánša lake from which the main water supply of Bombay is obtained was surveyed and the resulting maps will doubtless prove of great value to the Municipality of that city as well as to the Forest Department.

184. Due attention was paid to the training of young surveyors, seven probationers having been placed under a senior surveyor working in easy country for instruction. Towards the end of the season most of the probationers were able to survey independently and the experiment has proved a decided success.

185. The programme for 1905-1906 is in continuation of that for the past season. The 8-inch surveys in Thána will be completed, thus bringing the programme of the party in the Northern Circle to a conclusion.

Triangulation will be completed in Khándesh and it is hoped that it will also be found possible to complete the triangulation of a small area of about 50 square miles in the Sinnar Táluka of Násik.

The detail survey on the 4-inch scale of the reserved forests in the Western Tálukas of Sátára will be completed and the survey of the Khándesh forests on the same scale will be continued.

186. The party was inspected in September by the Superintendent of Forest Surveys.

MADRAS PRESIDENCY.

No. 19 PARTY.

187. Major Robertson held charge until the 20th August 1905 when, on his transfer, Mr. Hall was appointed to the charge of the party.

Personnel.

Major C. L. Robertson, C. M. G., R. E., Deputy Superintendent, in charge up to the 19th August 1905.
 Mr. G. T. Hall, Extra Assistant Superintendent, 1st grade, in charge from 20th August 1905.
 Mr. W. F. E. Adams, Extra Assistant Superintendent, 5th grade.
 Mr. M. J. Sheehan, Extra Assistant Superintendent, 6th grade.
 Mr. C. C. Byrne, Sub-Assistant " 1st grade.
 Mr. B. G. Newland, " " 2nd grade.
 53 Surveyors and two writers.

The party divided into three camps under Messrs. Hall, Adams and Sheehan was employed on—

- (1) Four-inch detail survey of forest reserves in Gódávári.
- (2) Triangulation and 4-inch detail survey of forest reserves in South Canara.
- (3) Triangulation and 4-inch detail survey of forest reserves in Ganjam.
- (4) Triangulation in North Malabar. In addition to the above camps, Surveyor Balaji Dhondiba with six sub-surveyors was employed on revision surveys in North Coimbatore and a sub-surveyor was deputed to assist in the demarcation of the Mysore South Canara Boundary.

188. The party left Bangalore early in November 1904 and continued field work until May 1905 when it returned to recess quarters. An area of 1,022 miles was triangulated in South Canara, Malabar and Ganjam, but only about one-third of this area was under the Forest Department. Owing partly to the forest blocks being much scattered and also to the absence of secondary series in the Presidency, the area triangulated is necessarily much larger than is actually required for 4-inch topographical purposes.

189. Only 29 linear miles of boundary were traversed by theodolite. This small outturn was partly due to boundary lines not being cleared in advance. It is considered desirable to prevent encroachments that a theodolite traverse should be carried out of all exterior forest boundaries in Madras and where this has been omitted in the past it will be done during the general topographical survey of the country.

190. Seven hundred and fifty square miles inclusive of 134 square miles of revisionary survey in Coimbatore were topographically surveyed on the 4-inch scale. The area was less than for last year. This was partly due to several surveyors having been employed on a test survey on the 1-inch scale for the Indian Survey Committee and partly to the difficult nature of the country.

191. The work was thoroughly tested in the field and proved accurate.

192. The average outturn per man per month varied from 5'5 square miles in Coimbatore to 2'2 in Ganjam.

193. The country presented much the same difficulties as formerly. In the forests of Godavari and Ganjam with their almost impenetrable undergrowth and bad water, difficulty of securing supplies and general unhealthiness were experienced, while in South Canara with its dense ever green forests there were few villages and much time and labour were expended in clearing lines.

194. On the whole the health of the party was better than it was last season but the menials suffered considerably from fever and dysentery. A Hospital Assistant was attached for three months to the Gódávári section and this helped to maintain its efficiency.

195. Most of the computations have been brought up to date during the recess.

196. Inclusive of 49 sheets partially mapped last year the fair mapping comprised 93 sheets; of these, 14 sheets of the Gódávári District are withheld from publication for verification of boundaries. In South Canara 8 sheets cannot be submitted without further references to the District Forest Officer. In Kurnool 13 sheets being arrears or previous years and five sheets of the Guntur Kistna District will be submitted for publication in October. Of the North Coimbatore revision work 13 sheets will be submitted.

197. The actual expenditure for the survey year ending 30th September 1905 inclusive of cost of instruments is ₹1,07,642 as compared with ₹1,07,701 in the previous year.

The following table shows the cost-rates of the different classes of survey and the areas surveyed during the year under report and two preceding years:—

DESCRIPTION OF SURVEY.	AREA SURVEYED.			COST-RATE PER SQUARE MILE.		
	1902-03.	1903-04.	1904-05.	1902-03.	1903-04.	1904-05.
Triangulation .	2,030	1,937	1,022	5	9	14'0
Traversing .	538	247	29	13	19	30'6
Topography (a) .	1,411	803	750	58	102	123'3

(a) Includes 134 square miles of revision survey in North Coimbatore District and excludes 135 square miles test survey on the scale of 1-inch = 1 mile.

The increase in cost rates is partly due to increase of pay of establishment, additional local labour at enhanced rates in certain localities, and to the unhealthiness of the Gódávári and Ganjám Districts. These circumstances do not, however, in themselves satisfactorily account for the increased cost-rates: the increase is principally due to the fact that a large number of the surveyors who had suffered severely from fever during the previous season took the field in a debilitated state and were unable to produce the outturn they otherwise would have done. The party has now been employed for many years on the survey of forest tracts and the majority of the surveyors are now working in the remote and notoriously unhealthy districts of Ganjám and Gódávári which are especially distasteful to the class from which the Surveyors of the Party are recruited. The scattered nature of the work and the difficulties of communication render supervision difficult and the men become disheartened with the poor results obtained after days of monotonous toil in the dense jungles where often even the aborigines refuse to work. Everything that can possibly be done will be done next season to improve results and the prospect of a change of programme will do much to encourage the men.

198. The programme for the ensuing season comprises Malabar and the Nilgiris with a view to the 2-inch topographical survey of sheets 35, 53, 54 and 55; the continuation of the theodolite traversing of the Mysore South Canara boundary and of the boundaries of forest reserves in North Malabar, and the 4-inch detail survey of forests in Gódávári, Ganjám, South Canara, North Malabar and Chingleput. One surveyor will also be deputed to accompany the Joint Commissioners who are demarcating the boundary between South Canara and Mysore.

199. During August the party was inspected by Major P. J. Gordon, I.A., Superintendent, Forest Surveys.

200. Forest right and boundaries, with the exception of those in Gódávári, were verified during recess by the District Forest Officers.

BURMA.

NO. 20 PARTY.

Personnel.

Captain A. Mears, I.A., Officiating Deputy Superintendent, 2nd grade, in charge.

Mr. P. F. Prunty, Extra Assistant Superintendent, 2nd grade.

Mr. M. C. Petters, Extra Assistant Superintendent, 6th grade.

Mr. S. S. Mc. Fielding, Sub-Assistant Superintendent, 1st grade.

Mr. J. H. Williams, Sub-Assistant Superintendent, 1st grade.

Munshi Amjad Ali, Sub-Assistant Superintendent, 2nd grade.

67 Surveyors, etc., and two writers.

201. Captain A. Mears, I. A., held charge of the party throughout the year under report, except from the 9th June to the 22nd July 1905 when, during his absence on privilege leave, Mr. P. F. Prunty officiated.

The party left recess quarters at Dehra on the 12th November and commenced field

work early in December, the field season lasting until the middle of May.

202. The party, divided into five camps and two small sections, was employed on—

- (1) Triangulation and traversing in the Yaw forest division (Pakòkku district).
- (2) Traversing for revision survey in the Thaungyin district.
- (3) 4-inch detail survey of Forest Reserves in the Lower Chindwin, Myittha and Yaw forest divisions (Upper and Lower Chindwin and Pakòkku districts) and in the Thayetmyo district.

203. Subsidiary triangulation based on the Manipur Minor Meridional Series was continued by Mr. Prunty southwards from the previous season's work over an area of about 800 square miles in the Pakòkku district.

204. Owing to the denseness of the forest growth the triangulation had to be supplemented by a network of theodolite traverses for the purpose of furnishing the plane tablers with additional points and heights.

Nine hundred and seventy-six linear miles were traversed in an area of about 1,000 square miles. The theodolite was set up on an average 18 times in every linear mile. With few exceptions all the traverses were set up and proved in the field.

205. An area of 680 square miles comprising reserves in the Upper and Lower Chindwin, Yaw and Thayetmyo forest divisions was topographically surveyed on the 4-inch scale.

The detail survey, owing to the intricate nature of the thickly wooded country, was as usual carried out by plane-table traversing always a slow and laborious process.

The absence of villages in or near the reserves necessitated the establishment of numerous food depôts for supplying the surveyors and followers with provisions, and, owing to the elephant establishment being under strength and local labour scarce, considerable difficulties and anxiety were experienced, especially at the commencement of the season, in stocking these depôts.

206. The area under topographical survey was carefully examined in the field by one linear mile of test line to every 1.77 square miles of 4-inch detail survey.

The work, rigorously tested in this manner by the officer in charge and his assistants, proved satisfactory.

207. The average outturn of 4-inch detail survey was 3.36 square miles per man per month. The plane table was set up on an average 171 times in every square mile surveyed.

208. The health of the party was generally good. There were seven deaths among the *khalasis*, of which five were due to cholera on the journey to the field.

209. During the recess months the triangulation and traverse computations were completed. The fair mapping of the past season's work will be finished, with the exception of two incomplete sheets, before the party takes the field; 36 sheets have been submitted for publication during the year under report. There are no arrears of mapping in the party.

210. The total expenditure incurred on survey operations for the year ending 30th September 1905 amounts to ₹1,51,677 as compared with ₹1,39,510 for the previous year. The increase is chiefly due to the purchase of 2 new elephants at a cost of over ₹6,000.

211. The following table shows the outturn and cost-rates for the year under report and the two previous seasons:—

DESCRIPTION OF WORK.	AREA SURVEYED.			COST-RATE IN RUPEES PER SQUARE MILE.		
	1902-03.	1903-04.	1904-05.	1902-03.	1903-04.	1904-05.
Triangulation	1,161	610	800	3.2	7.4	7.7
Traverse	1,173 (a)	948 (a)	976 (a)	44.7 (b)	44.5 (b)	43.9 (b)
Topography 4"	623	671	680	136.6	135.7	140.8

(a) Linear miles of traverse survey.
 (b) Cost-rate per linear mile.

The cost-rates of triangulation and traversing are practically the same as for the previous season and may be considered fair average rates for thickly wooded and undulating country in Burma.

The cost-rate per square mile for 4-inch detail survey has risen by R7 per square mile. This increase is regrettable and is due to the failure to reach the anticipated outturn of detail survey by 40 square miles, owing to two of the detail camps being much delayed in reaching their ground through difficulties experienced in obtaining sufficient local carriage. This difficulty would not have arisen had two newly purchased Kheddah elephants arrived as arranged for, at the commencement of the season. This shows how small circumstances may seriously affect a season's outturn. When these elephants eventually reached the party they were unfit for work and both died within two months of their arrival.

The charge of 4 per cent. on the total expenditure of the party on account of instruments supplied was taken into account, for the first time since the party was attached to the Forest Survey Branch, in calculating the cost-rates, and this fact must also be taken into consideration in making a comparison with the cost-rates of previous years.

212. The programme for 1905-1906 is as follows:—

- (1) Triangulation and traverse survey to complete standard sheets 66, 67, 68, 69 and 70 with a view to these sheets being surveyed topographically on the 2-inch scale.
- (2) Topographical survey on the 4-inch scale in the Lower Chindwin, Yaw, Thayetmyo and Thaugyin forest divisions.

213. The Superintendent, Forest Surveys, inspected the party in the field in January and in recess in October 1905.

CADASTRAL AND TRAVERSE SURVEYS.

BENGAL.

214. The operations in Bengal remained under the supervision of Major R. T. Crichton, I.A., Superintendent, Provincial Surveys. During the year under report the 6 detachments have been formed into two parties and the surveys in Bengal are now carried out by three large field parties. The outturn of the season, which is again the largest accomplished as yet, is as follows:—

	Square miles.
Traversing	6,326
Cadastral survey	4,481
Record-writing	4,512
Topographical survey on 4-inch and smaller scales	572

NO. 4 PARTY.

Personnel.

Lieutenant L. C. Thuillier, Officiating Assistant Superintendent, 1st grade, in charge.

Traverse.

Mr. P. L. Causley, Extra Assistant Superintendent, 6th grade.

Mr. C. A. O'Donel, Extra Assistant Superintendent, 6th grade.

Mr. H. A. Hardless, Sub-Assistant Superintendent, 2nd grade.

1 Supervisor, 45 Traversers and 34 Computers.

Cadastral.

Mr. C. S. Kraal, Extra Assistant Superintendent, 3rd grade.

Mr. W. Skilling, Extra Assistant Superintendent, 4th grade.

Mr. J. C. Lears, Sub-Assistant Superintendent, 1st grade.

Mr. O. J. H. Hart, Sub-Assistant Superintendent, 1st grade.

Mr. G. W. Archer, Sub-Assistant Superintendent, 2nd grade.

Mr. T. F. Kitchen, Sub-Assistant Superintendent, 3rd grade.

4 Supervisors, 73 Inspectors, 834 *amins*, 1,262 *moharrirs*, chainmen, etc.

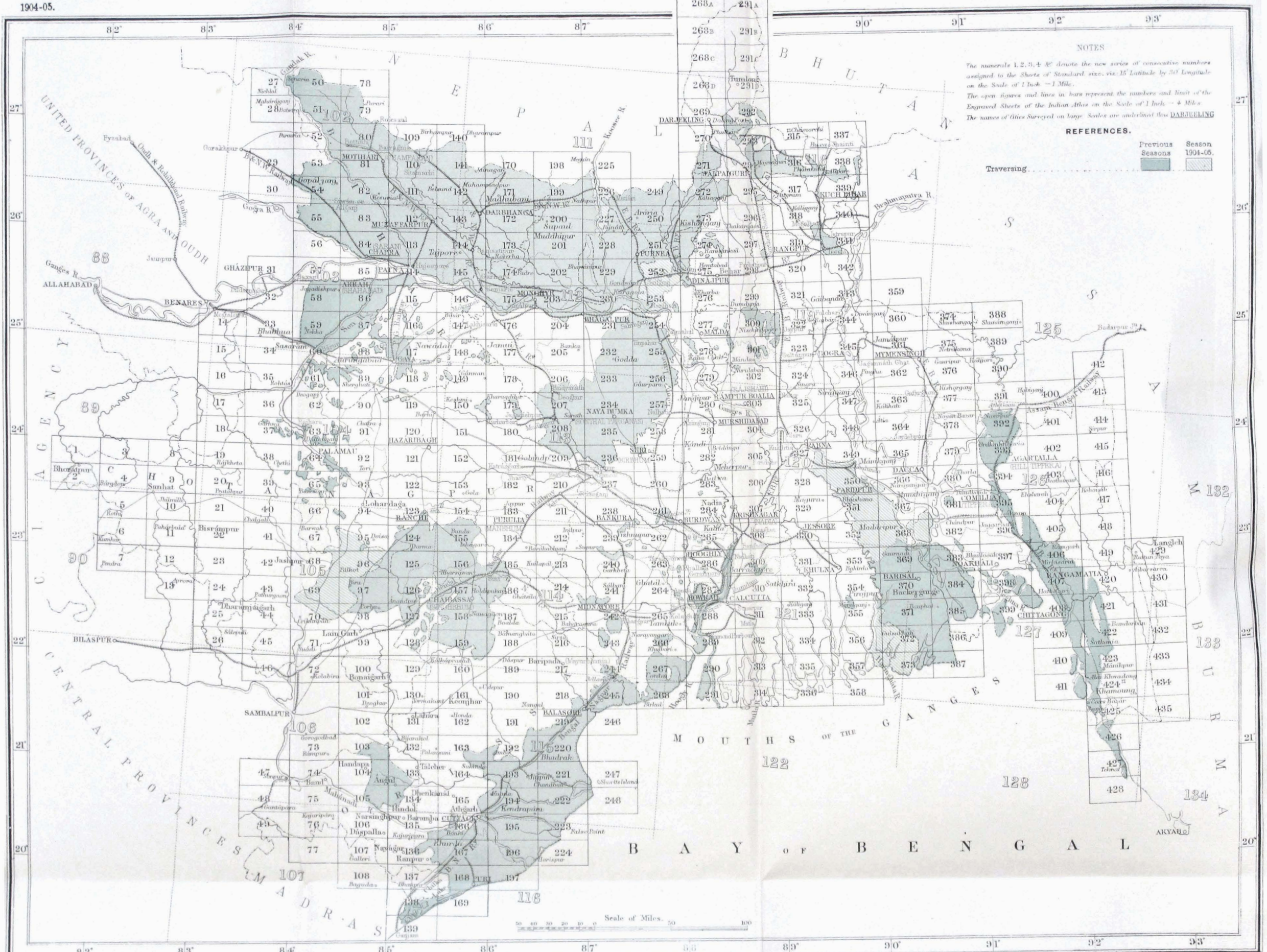
215. This party consisted of one traverse and two cadastral camps and was employed in the Bhágalpur and Purnea districts.

BENGAL.

INDEX TO TRAVERSE SURVEYS.

Nos. 4, 5, & 6 PARTIES.

1904-05.



NOTES

The numerals 1, 2, 3, 4 & denote the new series of consecutive numbers assigned to the Sheets of Standard size, viz. 15" Latitude by 30" Longitude on the Scale of 1 Inch = 1 Mile.
The open figures and lines in bars represent the numbers and limit of the Engraved Sheets of the Indian Atlas on the Scale of 1 Inch = 4 Miles.
The names of Cities Surveyed on large Scales are underlined thus DARJEELING

REFERENCES.

Previous Seasons	Season 1904-05.

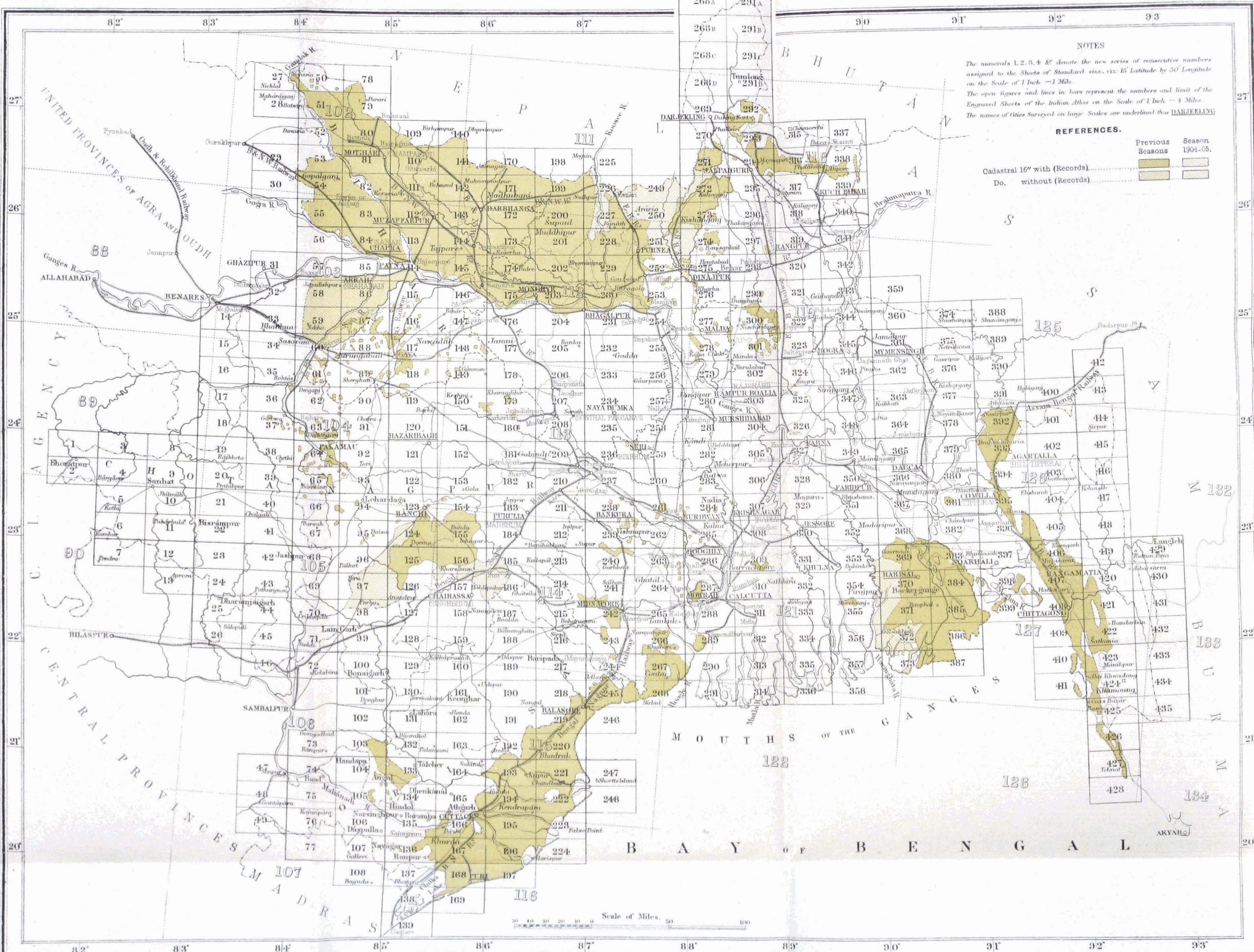
Traversing

BENGAL.

INDEX TO CADASTRAL SURVEYS.

1904-05.

Nos. 4, 5, & 6 PARTIES.



NOTES

The numerals 1, 2, 3, 4 & 5 denote the new series of consecutive numbers assigned to the Sheets of Standard size, viz. 15' Latitude by 30' Longitude on the Scale of 1 Inch = 1 Mile.
The open figures and lines in bars represent the numbers and limit of the Engraved Sheets of the Indian Atlas on the Scale of 1 Inch = 4 Miles.
The names of Cities Surveyed on large Scales are underlined thus DARJEELING.

REFERENCES.

	Previous Season	Season 1904-05.
Cadastral 15" with (Records)		
Do. without (Records)		

Scale of Miles. 0 10 20 30 40 50 60 70 80 90 100

The outturn for the season is as follows:—

District.	Nature of operations.	Area in square miles.	Cost-rate per square mile.
			R
Bhágálpur	Traversing for cadastral survey	1,250	31·7
	Traversing for topographical survey	130	6·5
	Cadastral survey	24	85·4
	Record-writing	24	28·5
	Topographical survey, 4 inches = 1 mile.	123	17·9
Purnea	Traversing for cadastral survey	468	47·8
	Traversing for topographical survey	234	4·5
	Cadastral survey	1,748	73·5
	Record-writing	1,748	35·6
	Topographical survey, 4 inches = 1 mile.	129	17·6

The cost-rate for traversing in Bhágálpur is very fair, the higher rate in Purnea being due to a smaller and detached programme. The rates for cadastral survey and record-writing in both districts are very good, especially considering the unhealthiness of the locality. The topographical surveys were confined to the Kosi river "diara" tract which has now been completed. The procedure adopted in this tract was described in paragraph 163 of last year's report.

216. The traversing has been suitably connected with the Great Trigonometrical survey and proves well. There were 40,241 theodolite stations which were marked by 5,395 stones at trijunctions and 30,344 cylinders and 4,502 pegs at other points. The pegs were principally used in the "diara" tracts where any attempt at preservation of marks is useless. Demarcation in the uplands was fairly good, and was not required in the "diara" except in the Government estates where it was conspicuous by its absence and caused a good deal of extra work at the traverse stage. The detail survey was checked by nearly 5 linear miles of test survey for each square mile of detail and over 27 per cent. of the record-writing has been checked by the Survey staff.

NO. 5 PARTY.

Personnel.

Captain F. C. Hirst, I.A., Officiating Assistant Superintendent, 1st grade, in charge.

Traverse.

Mr. T. W. Babonau, Extra Assistant Superintendent, 4th grade.

Mr. L. B. Fitzgibbon, Sub-Assistant Superintendent, 2nd grade.

1 Supervisor, 40 traversers and 22 computers.

Cadastral.

Mr. H. W. Biggie, Extra Assistant Superintendent, 5th grade.

Mr. C. S. Gasper, Extra Assistant Superintendent, 5th grade.

Mr. P. F. Delaney, Sub-Assistant Superintendent, 2nd grade.

Mr. A. B. Smart (Junior), Sub-Assistant Superintendent, 3rd grade.

4 Supervisors, 82 inspectors and 920 *aminis*.

217. This party also comprised one traverse and two cadastral camps and has accomplished the following outturn in Ranchi, Midnapore and Singhbhum districts.

District.	Nature of operations.	Area in square miles.	Cost-rate per square mile.
			R
Ranchi	Traversing	1,632	29.5
	Cadastral survey	909	51.5
	Record-writing	1,040	30.6
Midnapore	Cadastral survey	27	207.3
	Record-writing	149	104.1
Singhbhum	Cadastral survey	594	47.2
	Record-writing	594	32.6

The cost-rate for traversing is low, owing to large villages and large tracts of waste land, but is particularly satisfactory, as owing to the hilly nature of three-fourths of the area the subtense-bar had to be constantly used. The low rates for cadastral survey with records in Ranchi and Singhbhum are noticeable and are due principally to large fields and labour being readily supplied free. The average size of the field in Ranchi was 1.3 acres and in Singhbhum 1.1 acres. The Midnapore rates are exceptional as the work was entirely confined to completion of scattered arrears of previous season. This sort of work must prove costly.

218. The traversing has been connected with the Great Trigonometrical survey and proves well. In Ranchi there were 30,350 theodolite stations; trijunctions being marked by stones with dots cut in the centre and all other points either by stones with a "broad arrow" cut thereon or else the broad arrow was cut on the rocks "*in situ*." There are no Revenue survey or other old maps of Ranchi showing village boundaries, and as the demarcation was found wanting, the surveyors, with the help of the Deputy Commissioner's list of villages, surveyed the boundaries as pointed out.

219. In both Ranchi and Singhbhum the detail survey has been checked by nearly $3\frac{1}{2}$ linear miles of test survey to each square mile of detail and from 15 to 21 per cent. of the record-writing has been checked by the survey staff. The local establishments although now in their third year of employment only averaged 16 acres of cadastral survey and 23 numbers of record-writing a day. These outturns are very poor and would have seriously affected the cost-rates if labour had not been supplied free. The health of the establishments in all these districts was very indifferent, principally owing to malarial fever.

NO. 6 PARTY.

Personnel.

Mr. A. W. Smart, Extra Deputy Superintendent in charge.

Mr. N. Bedford, Extra Assistant Superintendent, 4th grade.

Mr. C. H. G. Johnson, Extra Assistant Superintendent, 5th grade.

Mr. E. G. Hardinge, Extra Assistant Superintendent, 6th grade.

Mr. O. E. C. Judd, Sub-Assistant Superintendent, 2nd grade.

Mr. P. Kenney, Sub-Assistant Superintendent, 2nd grade.

Mr. F. W. Marten, Sub-Assistant Superintendent, 2nd grade.

Mr. I. Newton, Sub-Assistant Superintendent, 3rd grade.

4 Supervisors, 62 traversers, 32 computers, 49 inspectors and 926 *amins*.

220. This party comprised one traverse and one cadastral camp and one camp employed on both traversing and topographical survey.

The areas accomplished are as follows :—

District.	Nature of operations.	Area in square miles.	Cost rate per square mile.
			R
Faridpur	Traversing	1,893	45·4
Backergunge	Traversing	27	43·4
	Cadastral survey	1,168	108·7
	Record-writing	950	36·7
Backergunge Sunderbans	Traversing	571	37·0
	Topographical survey	320	33·5

The rate for traversing in Faridpur is very fair considering that the southern half of the tract consists principally of large swamps intersected by streams and the northern half of thickly wooded uplands where heavy line-clearing was necessary. The rates for cadastral survey and record-writing for Backergunge are slightly higher than last season owing to much smaller fields. The average size of the field was 0·87 of an acre. The rates for the work in the Sunderbans are good considering the very difficult nature of the work.

221. In the traversing in Faridpur and Backergunge (excluding the Sunderbans) there were 45,167 theodolite stations which have been marked by 6,361 stones, 880 galvanized iron cylinders and 37,926 pegs. The cadastral survey has been checked by an average of over 4 linear miles of test survey to each square mile of detail and in the record-writing the entries against 22 per cent. of the plots have been checked. In the Sunderbans the area of 571 square miles comprises 251 square miles of more or less cleared lands which have been surveyed cadastrally and 320 square miles of dense forest and jungle cut up by innumerable streams and tidal creeks of which only a topographical survey was done. The usual procedure for marking of traverse stations had to be abandoned in the Sunderbans as owing to the spongy, water-logged nature of the soil, stones would have disappeared in a short time. The trijunction points have therefore been marked by 145 galvanized iron cylinders and 20 trunks of trees sawn off a little above ground level. Other salient points have been marked by 11 iron cylinders and 397 trunks of trees. At all the remaining 5,671 theodolite stations, wooden pegs 3 feet long and 4 inches in diameter have been driven into the ground. In addition to these marks, at all stations in the forest and jungle areas, cross sticks painted white were affixed to, or a white cross was painted on, an adjoining tree. Without these marks the identification of stations at the topographical stage would have been almost impossible. The density of the forest and jungle precluded any attempt at systematic line-clearing consequently a system of zigzag traversing was adopted of which successive stations were located on opposite banks of the creeks and streams and the distances measured by means of subtense-bars. This necessitated only small V shaped clearings at each station and has been a complete success as the traversing has proved very well.

222. There have been great difficulties to contend with in this survey. The establishment had to live in boats and as absolutely nothing was obtainable locally, all drinking water and supplies had to be sent out to them at regular intervals. Towards the end of the season the high winds and sudden storms which occur near the Bay of Bengal made boat work very dangerous. Notwithstanding all the precautions taken, the want of fresh water caused a great deal of sickness, specially skin diseases and sores from which fully 75 per cent. of the men suffered severely. Malarial fever and dysentery were prevalent also and lastly there was considerable danger to life owing to the country being infested with tigers. Two *khalasis* were killed by tigers and there were several narrow escapes. As a consequence the establishments absconded wholesale and very great difficulty was experienced in replacing them.

MISCELLANEOUS SURVEYS.

223. *Calcutta Municipality*.—The detachment under Mr. R. B. Smart, Extra Deputy Superintendent (retired) continued the operations in the added area of Calcutta and the adjoining Panchánnagrám Estate. The outturn of the year is as follows:—(a) Traverse of 2,090 acres of Dihí Panchánnagrám lying outside the municipal boundary, (b) detail survey of the foregoing area on the scale of 32 inches to the mile and (c) detail survey of 1,430 acres on the scale of 50 feet to the inch. The field work of this detachment is now practically finished but a lot of work still remains in the way of demarcation and reconciliation of municipal and revenue holdings and the area extraction which is difficult can only proceed as demarcation advances. Out of 393 fair sheets 133 have been completed in skeleton, *i.e.*, all details have been drawn with the exception of the boundaries of holdings which can only be entered as attestation progresses.

224. *Patna Division diara survey*.—With a view to the annual checking of accretion and diluvion in "diara" tracts the Board of Revenue ordered that the present position of the Ganges river be marked on maps of the latest surveys. This work was taken up by No. 4 Party, the procedure adopted being to run traverses along each bank of the river as close to the water's edge as feasible connecting them with trijunctions of the former survey and then to map the actual water's edge by offsets. A set of maps on the 16-inch scale was compiled showing the course of the river as previously surveyed in black and on these maps the present position of the river has been shown in red. The total length of the survey is 354 miles and the approximate area enclosed 55 square miles. Next season permanent marks will be embedded at selected points near the river and on high lying islands, and if a fair number of these marks are found remaining after the rainy season it should be possible to re-map the river as required without necessity for an expensive theodolite survey on each occasion.

225. *Relaying Jalpaiguri-Cooch Behar boundary*.—This work has been held over for several seasons as no officer was available to take it up. This season Mr. O'Donel was deputed for the purpose and it has now been done and a report with maps and data is being sent to the Deputy Commissioner of Jalpaiguri.

226. *Minor operations*.—The following minor operations have also been carried out during the season:—(a) relaying the Revenue Survey boundary of an estate in the Malda district which entailed the skeleton traversing of 53 square miles, (b) traversing for cadastral survey 2 villages, covering 6 square miles in Patna, (c) cadastral survey of one village in Ranchi and (d) demarcation of the Udaipur State boundary.

BENGAL DRAWING OFFICE.

227. During the year under report the Bengal Drawing Office has been moved from Free School Street to more commodious and suitable quarters at 166, Lower Circular Road. In addition to its original work of compilation of standard sheets this office has gradually undertaken a very heavy and varied programme and is now divided into 5 main sections.

(a) *Standard maps*.—During the year four 1-inch standard sheets, Nos. 143, 170, 199 and 200, comprising portions of Darbhanga, Monghyr and Bhá-galpur districts, have been completed and submitted to the Surveyor General's Office for publication. Seven sheets, Nos. 145, 146, 171, 172, 173, 174 and 175, are in hand, of which 3, Nos. 145, 146 and 171, are practically complete and will be submitted shortly.

(b) *District maps*.—During the year the district maps of Saran and Cuttack have been completed and submitted for publication. That of Puri has also been completed and will shortly be submitted. The map of Champaran is well advanced and that of Darbhanga is as far advanced as the state of the standard sheets permits. It has been decided that a map of Chittagong should be compiled and it is in hand but the incorporation of old material for the gaps left in the latest survey, which is necessary to complete the map, is proving troublesome.

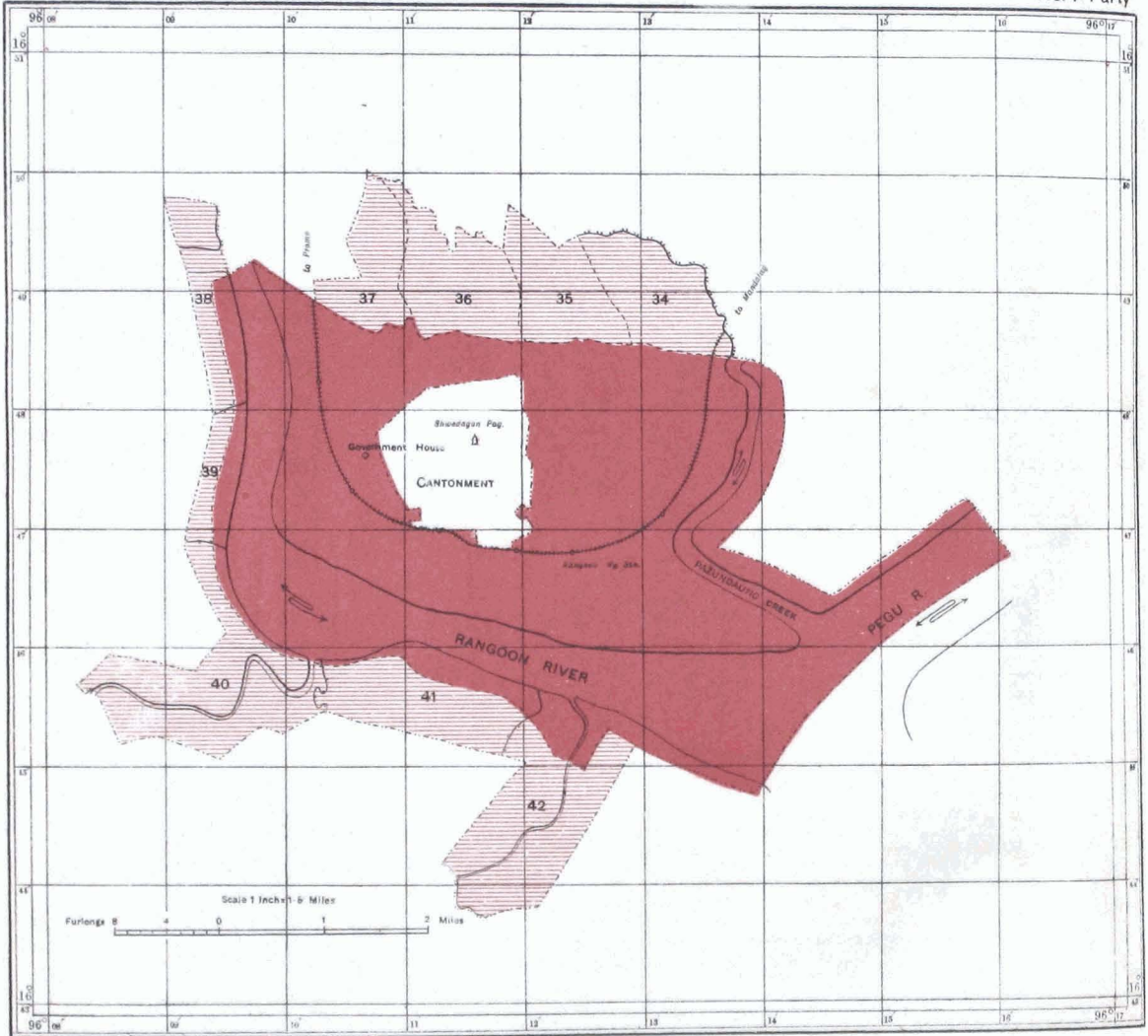
(c) *Traverse charts*.—The necessary computations for the compilation of these charts are now well advanced and it is hoped that 27 charts will be ready by 1st April 1906 and another 79 by October 1906.

BURMA

Index to the Survey of the Town of Rangoon

1904-05

No. 7 Party



No. 331, S. I. —Sept. 05 —75.

Photo. S. I. O., Calcutta

No. 331 R. S. I. —Oct. 05 —90.

Origin of Survey { Lat. N. 16-46-13.22
Long. E. 95-12-05.05

REFERENCES

- Surveyed during Seasons 1895-97
- Surveyed during Season 1904-05
- Municipal Boundary
- Block
- Block Number 42

Reg. No. 1030-S. 05.

(d) *Thana maps*.—These maps showing the serial numbering of villages and certain other details are compiled for the local Government and during the year the maps of 14 *thanas* have been published. Trijunction mark maps (required by the Settlement Department) of Gya and Shahabad have been completed and those of Patna and the Orissa districts are well advanced.

(e) *Reproduction of village maps*.—During the year 17,547 sheets have been traced, 12,354 have been examined, 280,822 copies have been printed and 239,082 despatched to Collectors and Settlement Officers. The programme for the next season is double that of the outturn just accomplished and everything points to a still larger and early increase, as copies of village maps are to be supplied to every "*parcha*" holder who is in possession of a plot. This frequently means the supply of 2,000 or more copies of a village map. In connection with this section a small "*badar*" establishment varying from 3 to 8 draftsmen has been maintained so as to deal with "*badars*" in the original sheets which become apparent when examining the traces.

(f) *Badar section*.—This section consisting of about 12 cadastral draftsmen and area estimators deals with "*badars*" received from the several Settlement officers and corrects the spelling of village names on original sheets and traverse tables in accordance with the *thana* lists supplied by the Settlement department.

(g) *Map record section*.—During the year 3,081 original sheets have been received for record from the field parties and 1,357 from the Surveyor General's office. The total number of original maps now lodged in the office is 81,592. The removal and re-erection of the large racks and of all these sheets to the new office has been a task of considerable difficulty but the opportunity has been taken to re-arrange all the maps by *thanas*. The paper traces which are prepared prior to reproduction by the Vandyke process are also kept in this section and a register is under preparation so that they will be readily traceable should further demands for copies arise.

228. Major Crichton inspected all the parties and camps several times during the field season and Nos. 4 and 6 Parties with all their camps during recess. He inspected the Bengal Drawing office constantly during the year and also the office of the Calcutta Suburbs survey.

UPPER AND LOWER BURMA.

No. 7 PARTY.

Personnel.

Lieut.-Colonel G. B. Hodgson, I.A., Superintendent, 1st grade, in charge until 2nd November 1904 and also from the 12th May to 5th July 1905.

Major C. W. H. Symonds, I.A., Deputy Superintendent, 1st grade, in charge from 26th November 1904 to 12th May 1905, and again from 12th August 1905.

Mr. J. S. Swiney, Extra Assistant Superintendent, 2nd grade.

Mr. O. D. Smart, Extra Assistant Superintendent, 4th grade, in charge from 3rd to 25th November 1904 and from 6th July to 11th August 1905.

Mr. C. Graham Lee, Extra Assistant Superintendent, 5th grade.

Babu Jagdamba Prasad, Extra Assistant Superintendent, 6th grade.

Babu A. C. Bose, Sub-Assistant Superintendent, 1st grade.

Mr. W. E. S. Swiney, Sub-Assistant Superintendent, 3rd grade.

17 Traversers, 14 computers, 17 draftsmen, 4 typers, 5 estimators, 9 inspectors and 89 field surveyors.

229. The cadastral survey of the Pakòkku district was continued and a large scale survey was carried out of an area of 9.3 square miles recently added to the Rangoon municipality. The programme was completed and the outturn of the season was as follows :—

LOCAL.	TRAVERSING.			DETAIL SURVEY.						
	Kwms.	Square miles.	Cost per square mile including demarcation.	Kwms.	Sheets.	Fields.	Acres.	Square miles.	Cost per square mile.	Size of field.
Pakòkku cadastral	355	69.4	58	462	766	(b) 190,946	(b) 412,800	(a) 605	} 114	{ 1.5
Pakòkku topographical	34	53	...	34	53	...	...	39.8		
Rangoon Town	...	9.3	2,064	...	107	22,071	5,952	9.3	3,887	0.26
TOTAL										

(a) Calculated on the cultivated area only.
 (b) Includes jungle.

230. *Pakókku District*.—Field work commenced on the 10th November 1904 and closed on the 2nd May 1905. The traversing was done under the supervision of Mr. J. S. Swiney. The Seikpyu township was completed and a small area in Pauk as well as 34 *kwin*s of Pakókku situated in the bed of the Irrawaddy. The country traversed was mostly undulating and covered with thin scrub jungle. Absence of water was severely felt in parts as owing to it the surveyors had at times to encamp at long distances from their work. The average number of traversers was 12 for $5\frac{1}{2}$ months and their average daily outturn amounted to 8 angles and 134 chains. The traversing was connected to 2 G. T. S. stations of the Manipur meridional series and 4 stations of minor triangulation of No. 10 Party which was also carried out during the season under report. Double chaining was employed throughout and amounted to a total of 1,705 linear miles. The theodolite was set up at 12,555 stations, of which 10,901 were new and were marked with the usual galvanised iron cylinders at an approximate cost of 93 annas per station. Observations for azimuth were made at 84 stations and vertical angles were observed at 3,101 stations and their heights computed. The origin of survey was the same as that of previous seasons.

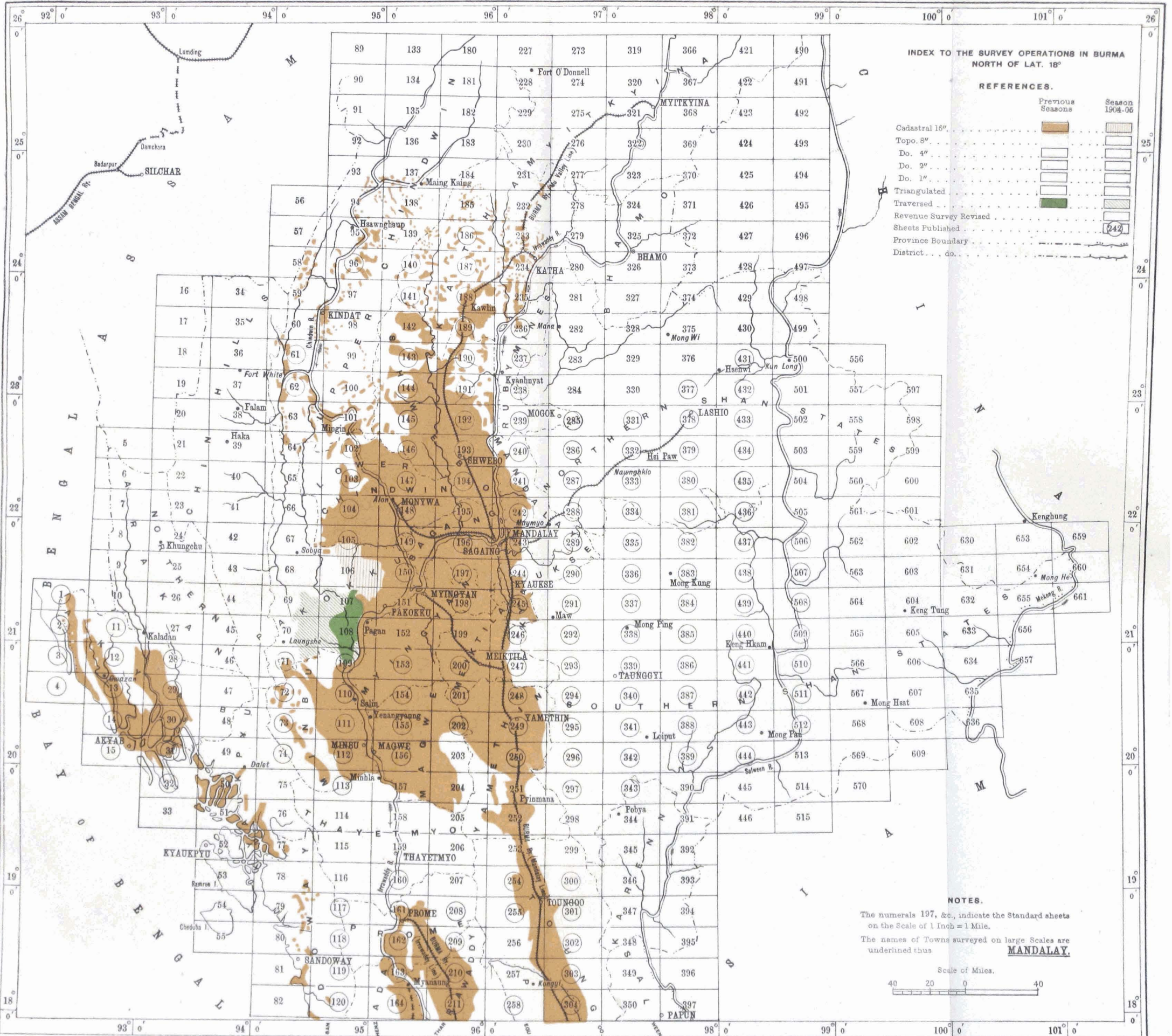
231. The cadastral survey was carried out under the supervision of Mr. Lee assisted by Babu Bose and Mr. W. E. S. Swiney. The average number of *amins* employed was 64 for 150 days with 6 Inspectors and the average daily outturn of each *amin* was 26 acres and 17 fields. The entire area surveyed cadastrally lay in the Myaing township. Only 387 square miles consisted of cultivated land which contained 164,637 fields, the average size of the field being 1.5 acre. The remaining 218 square miles consisted of jungle in which no details were surveyed. The work was checked by 371 linear miles of test lines run by Imperial and Provincial officers, and 263 linear miles of independent *partals* which give an average of 1.6 linear miles of test survey by superior officers, to each square mile of the area actually surveyed. The small area surveyed topographically was that mentioned above, lying in the bed of the Irrawaddy which is subject to periodical inundation so that the fields change from year to year. The survey was done on the 16-inch scale to enable both the 16-inch and 2-inch maps to be completed. Only the *kwin* boundaries, limits of cultivation and water channels were mapped and the village sites, which are occupied during the dry season. The original maps, 53 in number, will be handed over to the Deputy Commissioner and no copies of them will be printed.

232. The 2-inch fair mapping of the season's work was completed. It falls into sheets 105, 106, 107, 108, 150 and 151, of which the two latter were forwarded to head-quarters. That of the Shwebo district, which was reported in arrears last season, was completed with the exception of 3 sheets, which could not be drawn as the 16-inch maps had been sent to Calcutta for reproduction. The whole of the Shwebo 16-inch maps have now been printed and copies supplied to the Land Records Department. Of the current season's work, however, the 16-inch maps of only 144 *kwin*s out of 462 had been submitted for reproduction before the party resumed field work and no printed copies had up to that time been furnished to the local authorities.

233. A commencement has been made with the traverse charts of Burma and those of the following 23 standard sheets have been prepared, of which the first five have been sent to Calcutta for publication:—Sheet 149W and both sections of sheets 148, 196, 142, 143, 144, 145, 109, 152, 189, 190 and 191.

234. The cost-rates this season have returned to something like their normal figure and are considerably lower than those of last season when they were exceptional as was then explained. The rate for cadastral survey does not include the completion of the 16-inch maps which was somewhat in arrears at the close of the season. That of the traversing is 20 per cent lower than it has been during the last two seasons which is due to easier ground. All the rates include 4 per cent. for instruments.

235. *Rangoon Town*—Mr. Smart was in charge of this survey and was assisted by Babu Jagdamba Prasad. The area for survey formed a fringe round the old municipal limits which had been surveyed in 1895—97 and as it also extended to both sides of the river, it was spread over a large tract of country. On the northern side where the main town is situated the ground was undulating



INDEX TO THE SURVEY OPERATIONS IN BURMA
NORTH OF LAT. 18°

REFERENCES.

	Previous Seasons	Season 1904-05
Cadastral 16"	[Brown box]	[Light brown box]
Topo. 8"	[White box]	[White box]
Do. 4"	[White box]	[White box]
Do. 2"	[White box]	[White box]
Do. 1"	[White box]	[White box]
Triangulated	[White box]	[White box]
Traversed	[Green box]	[Green box]
Revenue Survey Revised	[White box]	[White box]
Sheets Published	[White box]	[White box]
Province Boundary	[Dashed line]	[Dashed line]
District do.	[Dashed line]	[Dashed line]

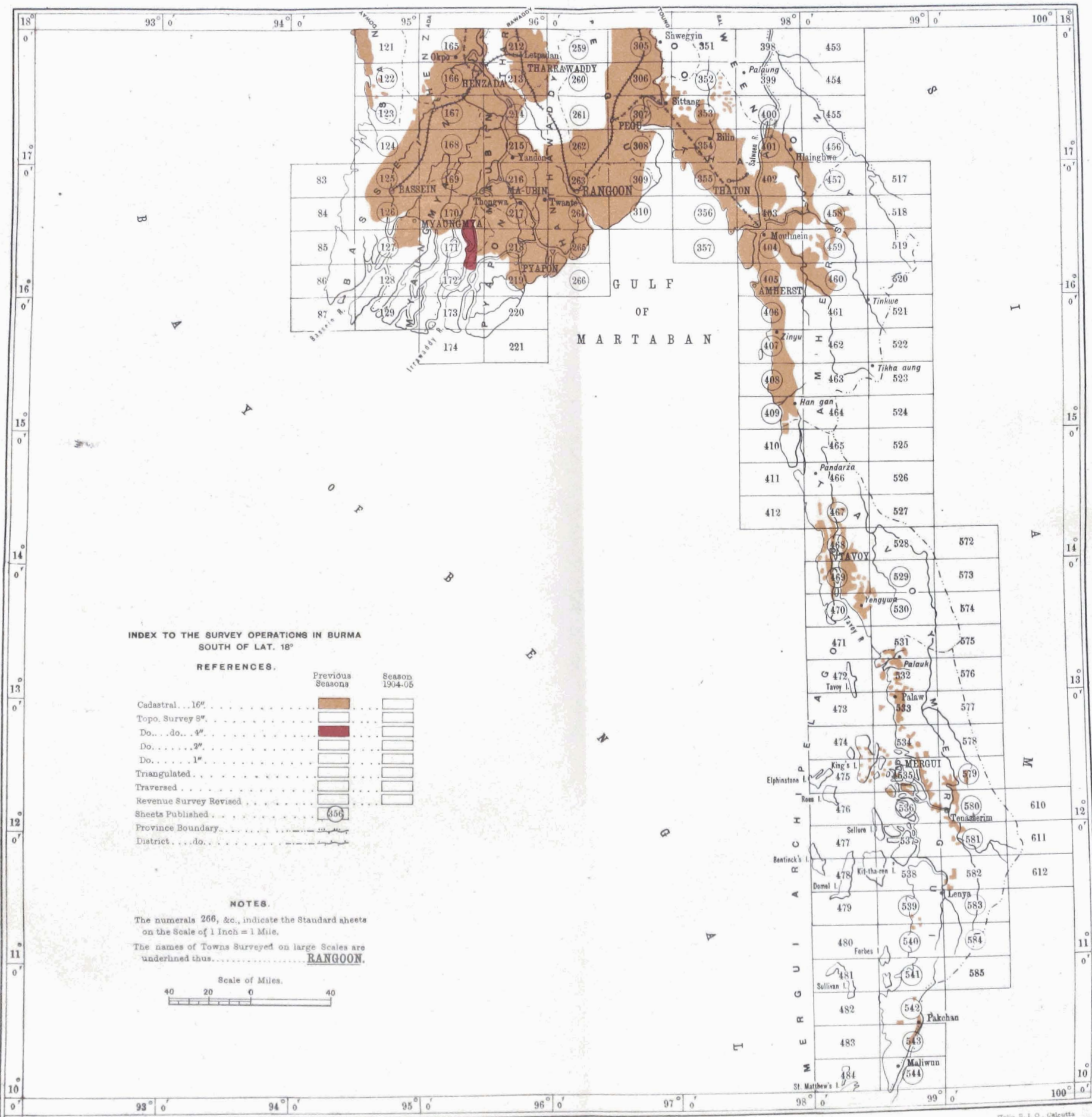
NOTES.

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

The names of Towns surveyed on large Scales are underlined thus MANDALAY.

Scale of Miles.

40 20 0 40



INDEX TO THE SURVEY OPERATIONS IN BURMA
SOUTH OF LAT. 18°

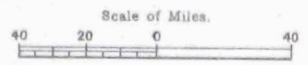
REFERENCES.

	Previous Seasons	Season 1904-05
Cadastral... 16"		
Topo. Survey 8"		
Do...do... 4"		
Do...do... 2"		
Do...do... 1"		
Triangulated		
Traversed		
Revenue Survey Revised		
Sheets Published		
Province Boundary		
District...do...		

NOTES.

The numerals 266, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

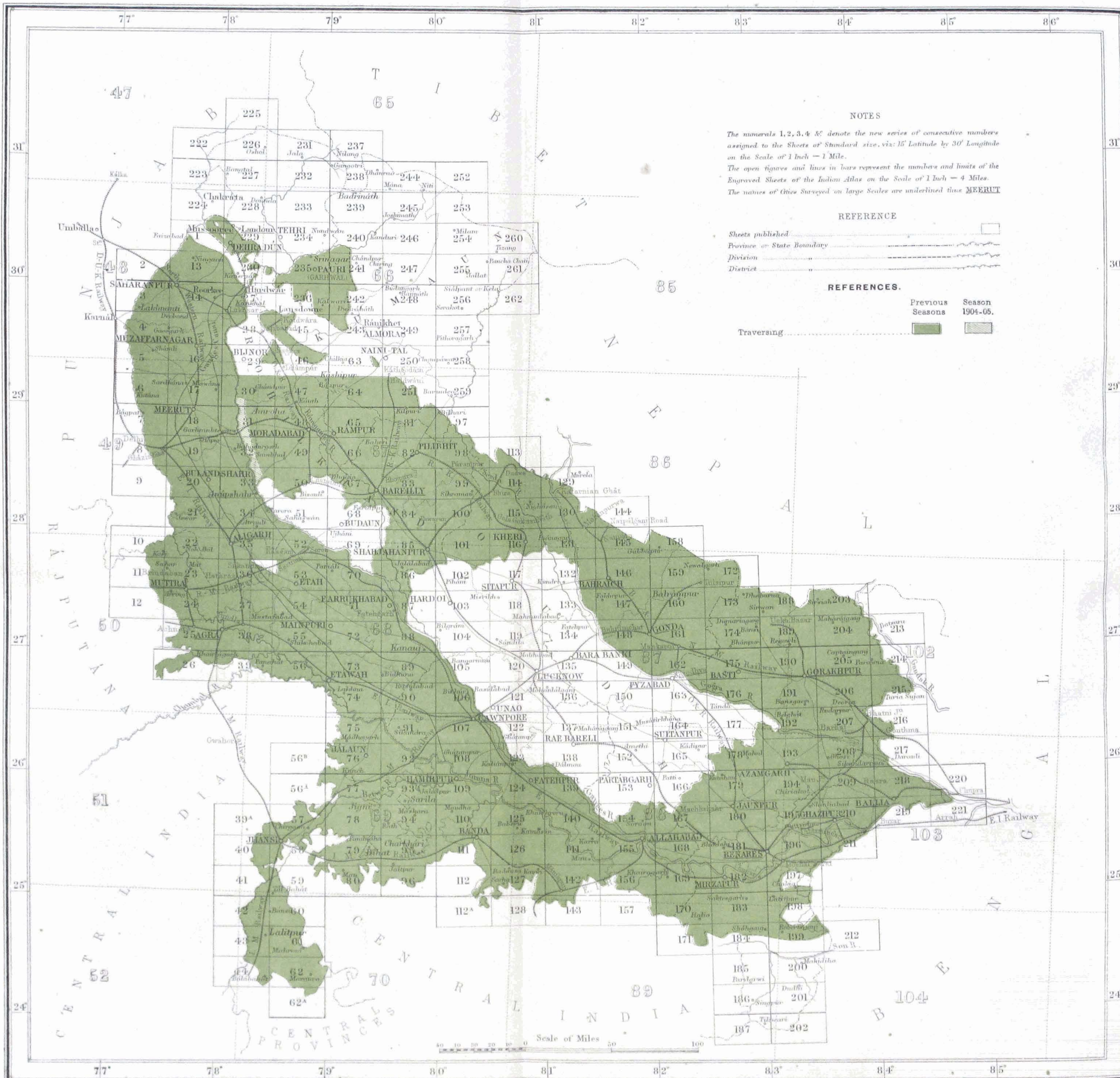
The names of Towns Surveyed on large Scales are underlined thus: RANGOON.



UNITED PROVINCES.

INDEX TO TRAVERSE SURVEY.

1904-05.



NOTES

The numerals 1, 2, 3, 4 & 5 denote the new series of consecutive numbers assigned to the Sheets of Standard size, viz: 15' Latitude by 30' Longitude on the Scale of 1 Inch = 1 Mile.

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

The names of Cities Surveyed on large Scales are underlined thus MEERUT

REFERENCE

Sheets published 
 Province or State Boundary 
 Division 
 District 

REFERENCES.

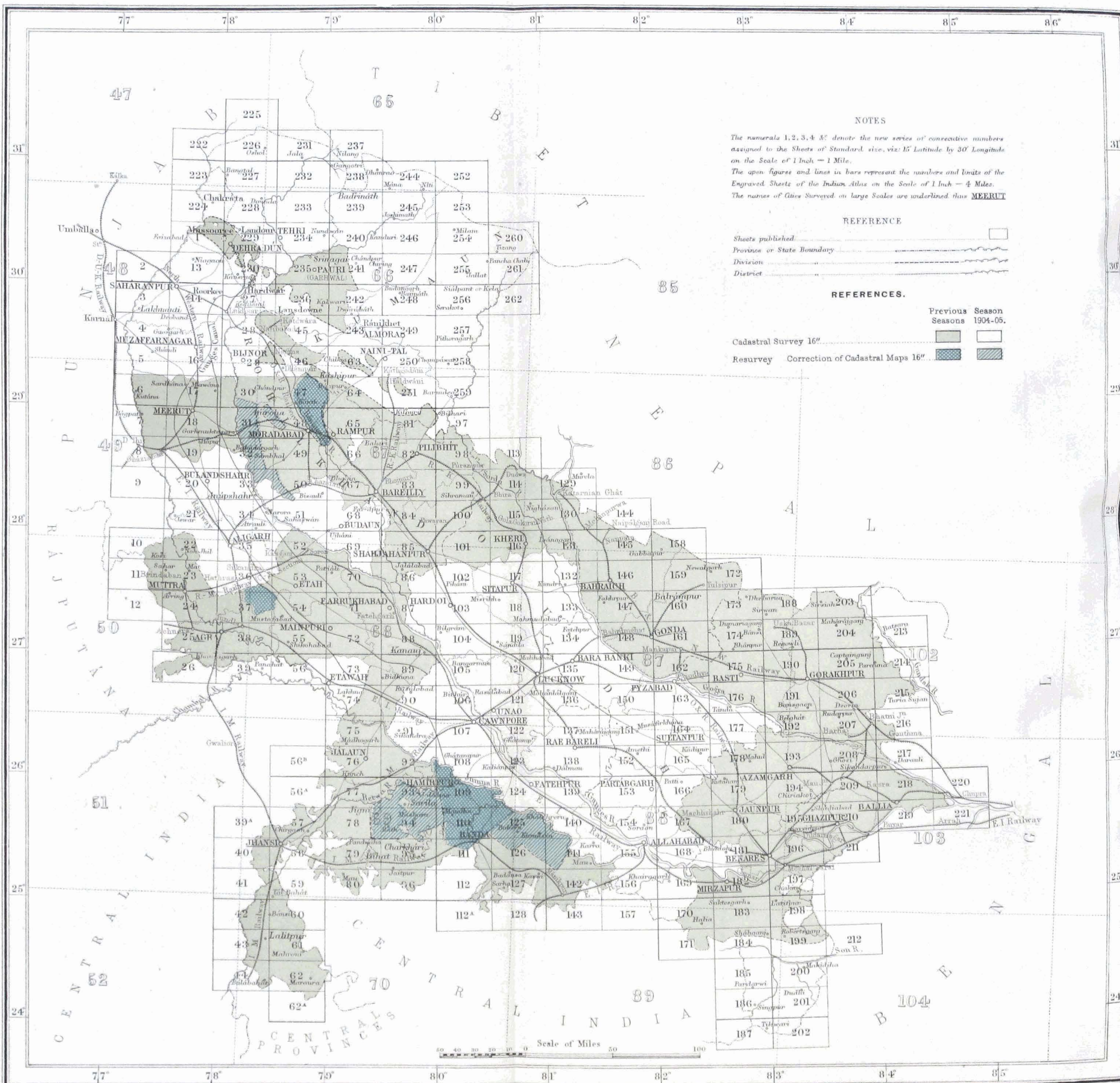
	Previous Seasons	Season 1904-05.
Traversing		

Scale of Miles

UNITED PROVINCES.

INDEX TO CADASTRAL SURVEYS.

1904-05.



NOTES

The numerals 1, 2, 3, 4 & 5 denote the new series of consecutive numbers assigned to the Sheets of Standard size, viz: 15' Latitude by 30' Longitude on the Scale of 1 Inch = 1 Mile.
The open figures and lines in bars represent the numbers and limits of the Engraved Sheets of the Indian Atlas on the Scale of 1 Inch = 4 Miles.
The names of Cities Surveyed in large Scales are underlined thus MEERUT

REFERENCE

Sheets published:
 Province or State Boundary:
 Division:
 District:

REFERENCES.

Previous Season:
 Seasons 1904-05:
 Cadastral Survey 16":
 Resurvey:
 Correction of Cadastral Maps 16":

and covered with houses, mostly surrounded by gardens and trees, but on the other side it consisted of open rice-fields with a few mills and villages here and there. The south side, however, was subject to periodical inundation which interfered very much with the work at times. The traversing occupied 10 surveyors for two months and the average outturn of the traverse surveyors per working day was 7 angles and 26 chains. The chaining amounted to 195.7 linear miles and the theodolite was set up at 3,459 stations which were all marked with galvanized iron cylinders. Vertical angles were recorded throughout by means of which the heights of 1,600 stations were determined and the work was checked by observations for azimuth at 22 stations. Three new trigonometrical stations were also fixed and marked with masonry platforms surmounted by pillars in the shape of cubes of 1 foot sides.

236. The detail survey was done on the scale of 100 feet to the inch by 3 inspectors and 27 *amins* in five months. It was carried out in the usual way, but owing to the broken nature of the ground in the northern portion and to avoid the necessity of unnecessarily chaining across private enclosures, survey by interpolation was resorted to in that portion and 2,859 plane-table fixings were made. Extra heights were determined with the clinometer at 6,625 points and where the nature of the ground required it, approximate contours at 5-foot vertical intervals, were inserted by means of these heights and those furnished by the traversing. The number of sheets is 107 and the printed maps will be produced by the Vandyke process from the field sheets themselves which will all be completed and forwarded to head-quarters before the party takes the field again.

237. The expenditure on this survey during the season is ₹ 65,900 and during October 1905 a further sum of ₹ 1,663 was expended in completing the drawing of the maps and the area statements, bringing the total cost of the survey to ₹ 67,563 exclusive of the cost of printing the maps, which it is estimated will come to about ₹ 640. Excluding this, the cost per acre is ₹ 11.4. The average size of the plot is 0.26 acre.

238. *Programme*.—Next season the traversing of the Pakòkku district will be completed and 900 square miles will be surveyed cadastrally, leaving one season's work to complete the cadastral survey of the district.

UNITED PROVINCES OF AGRA AND OUDH.

No. 8 PARTY.

239. Captain W. M. Coldstream, R.E., continued as Superintendent of Provincial Surveys to supervise the operations in these provinces throughout the year, and as before the party consisted of one traverse and three cadastral camps and one drawing office. The operations of the previous seasons were continued and the total outturn of the party for the season is—

Traversing for cadastral survey	323 square miles.
New cadastral survey with records	349 "
Revision of cadastral maps and records	1,822 "
Supplementary topographical survey, scale 2 inches = 1 mile	167 "
Road surveys	1,364 linear miles.

also certain minor surveys which are given in detail below. The cadastral surveys were carried out by the agency of *patwáris*.

240. *Traversing*.—The area traversed, 323 square miles, lies in the riverain tracts of Moradabad district

Personnel.

Mr. F. S. Bell, Extra Assistant Superintendent, 5th grade, in charge.

5 Traverse surveyors, 4 computers, 1 inspector, 7 *amins*, 7 road surveyors, 16 draftsmen, etc.

along the Ganges, where the main circuits had been measured during the previous season. The cost-rate, inclusive of ₹ 2.8 a share of head-quarter charges, is ₹ 26 per square mile.

The traversing was connected with five stations of the Great Trigonometrical Survey and the average linear error per mile is 4.6 feet. Azimuth observations were taken at 48 stations and the angular error is 3.2 seconds per angle. The preliminary demarcation was good.

241. A traverse was also run along the Allahabad-Rewah boundary in order to fix the sites of the boundary pillars and to provide a basis for the cadastral survey of a strip of ground along the boundary. The length of the traverse was 98 miles and the cost-rate ₹9·7 per linear mile. The work was difficult and rather expensive, as the line runs over a low range of hills for a considerable portion of its length. Azimuth observations were taken at 52 stations, the mean angular error being 2·6 seconds per angle.

242. The traverse camp also revised in the field the 64-inch maps of Cawnpore city and environs, covering an area of 8·4 square miles, brought up to date the cadastral maps of certain estates of an aggregate area of 1·7 square miles in Cawnpore for the Settlement Department, surveyed and mapped on the scale of 24 inches to the mile 1·6 square miles of the lands of the Hápur Remount Depôt, prepared general maps on the 16-inch scale of Fyzabad and Ajodhya towns from recent surveys, and surveyed on the 64-inch scale the boundaries of 1,364 linear miles of 1st class roads for the Public Works Department.

243. *Moradabad.*—The programme of cadastral survey and revision in this district was practically completed. Operations were commenced in October 1903, and have included the re-survey of 860 square miles

Personnel.

Mr. L. F. Berkeley, Extra Assistant Superintendent, 3rd grade, in charge.

Mr. J. H. Murphy, Extra Assistant Superintendent, 5th grade.
3 Head Inspectors, 17 inspectors, 240 *patwáris*, etc.

in *tahsils* Moradabad, Thákurdwára, Amroha, Hasanpur and Sambhal, and the revision of maps in the last three *tahsils*, covering an area of 406 square miles, of which 349 square miles of resurvey and 320 square miles of map revision were done this season. The cost-rate for the district is ₹37 for survey and revision and ₹22 for record writing. The district was traversed and cadastrally surveyed in the years 1871-76, but in the riverain tracts the old traverse stations had disappeared and fresh traversing was necessary. The cost-rates for the season are ₹40·4 for survey and revision of maps and ₹17·9 for record-writing. The average size of the fields is 0·8 acre. The maps were checked by an average of 4·4 linear miles of test survey per square mile, including 1·75 linear miles per square mile run by supervising officers and independently. Of the 185 *patwáris* trained, 43 failed to qualify, 29 were allowed to provide their heirs to do the work, and substitutes had to be provided for 14. In addition to the *patwáris*, 19 *kánungos*, 33 partition *amins* and candidates, and 26 students of the Agricultural College, Cawnpore, were trained in survey. At the request and expense of the municipality a survey on the 64-inch scale was made of the town of Moradabad, the civil lines being done on the 16-inch scale. The area surveyed on the larger scale is 1,055 acres, and on the smaller 1,702 acres, and the cost-rates are ₹1·9 and 9 annas per acre respectively. This includes the cost of the traversing and the printing of the large scale sheets and of a general map on the 16-inch scale, but does not include any charges for supervision, and no records or area statements were prepared.

Bánda.—Cadastral operations were commenced in October 1903, and will

Personnel.

Mr. F. B. Powell, Extra Assistant Superintendent, 5th grade, in charge.

Babu Nilmoni Chatterji, Extra Assistant Superintendent, 6th grade.
2 Head Inspectors, 15 inspectors, 207 *patwáris*, etc.

Karwi remain for revision during the next two years. The areas in which the maps have been revised and new annual records written during the year, are 362 square miles in *tahsil* Baberu, and 358 square miles in *tahsil* Kamásin, making a total of 720 square miles. The cost-rates are ₹26 per square mile for survey and ₹17 for record-writing. The average size of the fields is 1·0 acre nearly. Owing to the serious interruptions caused by the withdrawal of the *patwáris* from survey duty to estimate damage done by frost to crops, the whole of the village records for the year cannot be completed and made over to the Settlement officer for some months to come, but the arrears will not be so serious as to delay attestation. The traverse stations of the survey of 1874-1877 were permanently marked by stones which are in good preservation.

An average of 4·3 linear miles of test survey was applied per square mile, including 1·5 linear miles per square mile run by supervising officers and independently. Of 184 *patwáris* trained, 17 failed to qualify, 7 were allowed to provide their heirs to do the work, and substitutes had to be provided for the other 10. Mr. J. B. Smart, Deputy Collector, was attached to this camp and trained in all branches of the work, and 13 *kánungos* and 29 local men were trained in survey. A survey was made of the town of Bándá on the 64-inch scale at the cost of the municipality. The area surveyed is 902 acres, and the field work was completed at a cost of ₹1,203, which includes traversing but does not include any charges for supervision.

244. *Hamirpur*.—The revision of the cadastral maps was commenced in

Personnel.

Mr. P. C. Smart, Extra Assistant Superintendent, 3rd grade.
 Mr. C. S. Littlewood, Sub-Assistant Superintendent, 1st grade.
 2 Head inspectors, 9 inspectors, 253 *patwáris*, etc.

October 1903, and will be completed next season. Up to date *parganas* Hamirpur, Sumerpur, Maudha, Ráth,

Jálálpur and Maskara have been dealt with, and Mahoba *tahsil* remains for 1905-06. During the year the maps of *parganas* Ráth, Jálálpur and Maskara, comprising an area of 782 square miles, have been corrected, and new annual records written. The average size of the fields is 1·9 acre. The cost rates for the year are ₹30 per square mile for map correction and ₹20 for record writing. The *patwáris* were withdrawn from survey work for considerable periods at different times for work connected with damage to crops and for other purposes. Owing to these causes field work did not close till August, and although a sufficient number of records will be ready for attestation to begin in November or December 1905, the whole of the records cannot be completed till February 1906. The maps have been checked by an average of 4·5 linear miles of test survey per square mile, of which 1·7 linear miles per square mile were run by supervising officers or independently. The traverse stations of the last survey of 1874-79 were not permanently marked, and except those at trijunctions of village boundaries, very few have been found; this has enhanced the difficulty of the work and will render map maintenance in future very arduous. Out of 195 *patwáris*, 33 failed to qualify in survey, 19 of these were allowed to provide their heirs to do the work, and local substitutes were provided for 14. Thakur Lekhraj Singh, Deputy Collector, was attached to the section in February for training.

245. *Drawing Office*.—Fourteen standard sheets, No. 101, 102, 115, 116,

Personnel.

Mr. J. Kennedy, Extra Assistant Superintendent, 3rd grade, in charge.
 Mr. W. C. Price, late Extra Deputy Superintendent (retired), temporarily re-engaged.
 1 Surveyor, 2 probationer surveyors, 44 draftsmen, etc.

129, 130, 131, 132, 144, 145, 146, 53, 54, 55, have been compiled on the 2-inch scale for reduction to one-half by photography, and

twenty-one maps of the 2-inch topographical survey of Meerut of 1878 to 1882 have been revised from the maps of modern Cadastral surveys. Two district maps of Meerut and Pilibhit have been completed on the ½-inch scale for reduction to one-half, and submitted for publication, 16 traverse charts of sheets 69E, 70E, and both sections of 81, 82, 83, 84, 86, 99, and 100 were drawn and submitted, and 22 plane table sections were compiled on the 2-inch scale from the cadastral maps of Farrukhabad, Etáwah and Jálaun for supplementary survey by a topographical party.

246. Three plane-tables were employed on topographical survey on the 2-inch scale to supplement and fill in gaps in the cadastral surveys, and on the topographical survey of certain roads and railways in districts Meerut, Sitapur and Bahraich, and of the riverain areas along the Gogra in Bahraich, Kheri and Sitapur. Their total outturn was 167 square miles and 200 linear miles of railways and roads.

247. During the field season, the Superintendent inspected the cadastral field work and survey offices in Moradabad, Hamirpur and Bándá, conducted a class of 10 officers of the Indian Civil Service, checked the topographical work in Meerut and Bahraich, and inspected the office of the traverse section at Moradabad. During the recess he again inspected all four offices.

248. The cadastral map correction remaining to be done in Bándá and Hamirpur, and the miscellaneous work of the traverse section, will be transferred

in October to the direct supervision and control of the Land Records Department, and Captain Coldstream and 4 officers of the Provincial Service will be replaced at the disposal of the Surveyor General.

249. The Drawing Office will be retained for another year to continue the compilation of preliminary editions of standard sheets from cadastral maps and the preparation of plane-table sections for supplementary topographical survey.

ASSAM DETACHMENT.

Personnel.

Mr. T. Shaw, Extra Deputy Superintendent, 2nd grade, in charge.
Mr. F. P. Walsb, Extra Assistant Superintendent, from 17th January to 30th June 1905.
Mr. C. A. O'Donel, Extra Assistant Superintendent, up to 19th January 1905.
5 Traverse surveyors, 2 computers, 8 draftsmen.

250. During this season the work of this detachment was confined to traverse and boundary surveys and standard mapping.

The outturn of field work during the season is shown in the following statement:—

DISTRICT.	TRAVERSING FOR CADASTRAL SURVEY ON THE SCALE OF 16 INCHES = 1 MILE.		TRAVERSING AND BOUNDARY SURVEY OF TEA GRANTS.		Total square miles.	Linear miles.
	Number of villages.	Square miles.	Number of grants.	Square miles.		
Nowgong . . .	...	...	3	1'08	1'08	44'70
Sibságar . . .	...	...	7	7'40	7'40	34'84
Lakhimpur . . .	51	20'27	45	51'40	71'67	424'26
	51	20'27	55	59'88	80'15	503'80

In addition to the above, 28 linear miles of traversing were measured along the Dibru-Sadiya railway between Makum junction and Ledo coal mines station. The linear miles given in the above statement includes 153 miles of lines connecting grants and villages with one another and with previous seasons' surveys. Out of 4,061 stations at which the theodolite was set up, 50 were marked with stone prisms, 209 with masonry pillars and the rest with wooden pegs, and at 3,090 stations previously marked by wooden pegs *sémal* trees were planted five feet north of each station. As there are no regular village boundaries in Assam, the traversing for cadastral survey was confined to cultivated lands and village sites and any small blocks of intervening waste which could not conveniently be omitted.

251. As the work done by this detachment is of an exceptional nature, no useful purpose would be served by discussing the cost. During the year seven standard sheets were submitted for publication and nine district maps on the scale of 1-inch = 8 miles for the gazetteer were drawn. Mr. Shaw conducted two Survey school examinations for first class certificates at Gauháti and Jorhát and also examined 15 Pleaders in surveying and 13 *patwári* candidates.

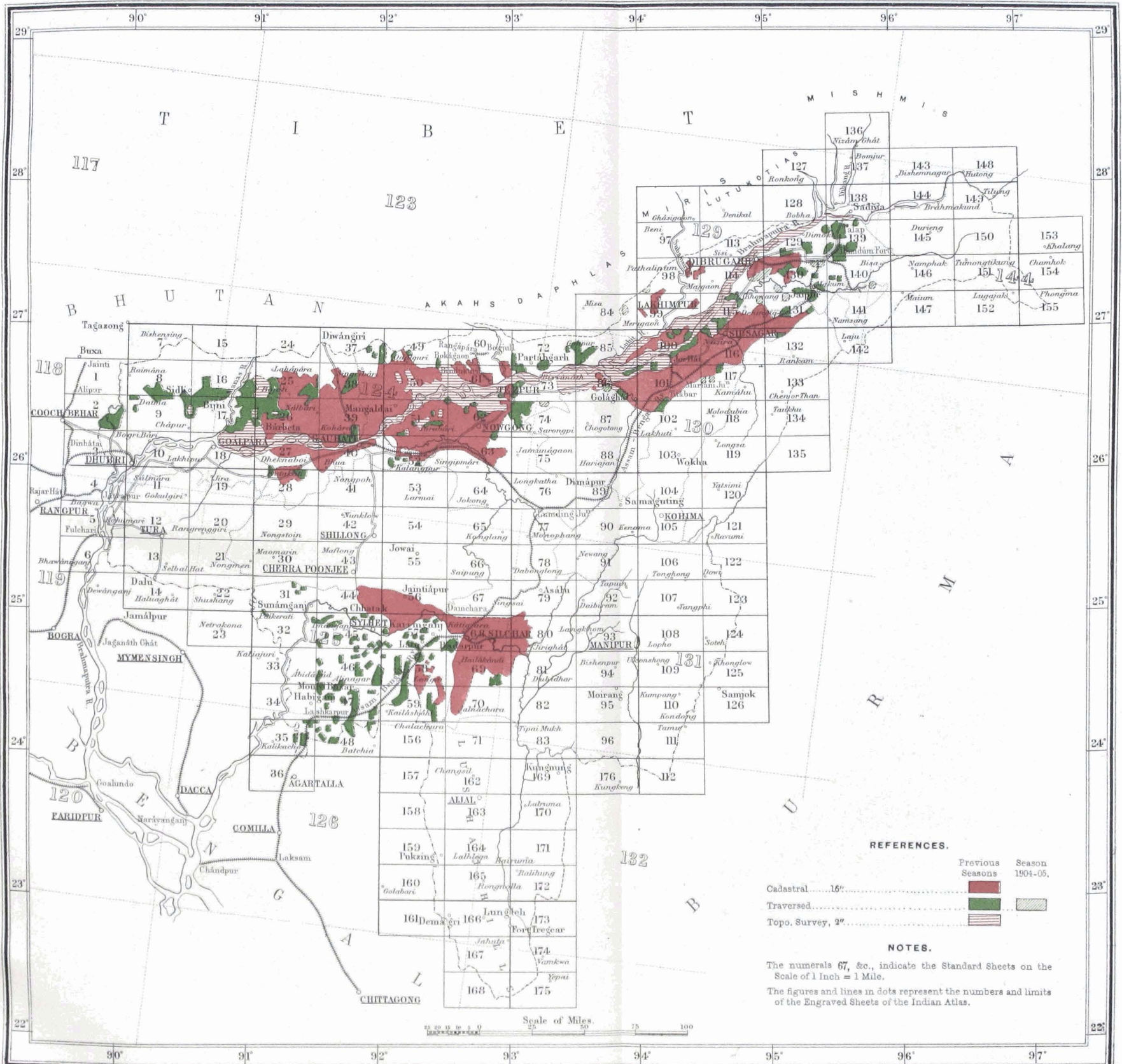
252. It is intended to close the drawing office from December 1905, when the whole of the material available from recent surveys for the correction of the standard sheets will have been utilized. The detachment will then cease to exist and the few traversers and computers remaining will be placed at the disposal of the local Government to continue traversing for cadastral and Tea grant purposes. Mr. Shaw will also remain in the province for the present to carry on the work of maintenance of land records until he can be replaced by an officer of the Provincial Civil Service whose appointment awaits the sanction of the Secretary of State.

ASSAM.

INDEX TO RECENT CADASTRAL, TRAVERSE, & TOPOGL. SURVEYS IN THE BRAHMAPUTRA & SURMA VALLEYS.

1904-05.

ASSAM DETACHMENT.



REFERENCES.

	Previous Seasons	Season 1904-05.
Cadastral, 16"		
Traversed, 16"		
Topo. Survey, 2"		

NOTES.

The numerals 67, &c., indicate the Standard Sheets on the Scale of 1 Inch = 1 Mile.
The figures and lines in dots represent the numbers and limits of the Engraved Sheets of the Indian Atlas.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

NO. 24 PARTY.

253. The party was under the charge of Captain H. H. Turner, R.E., throughout the year under review.

Personnel.

- Captain H. H. Turner, R.E., Deputy Superintendent, 2nd grade, in charge.
- Mr. D. J. Hunter, Sub-Assistant Superintendent, 1st grade.
- Mr. C. D. Simons, Sub-Assistant Superintendent, 2nd grade.
- 3 Recorders, 1 writer, 1 hospital assistant.

254. The programme of field work consisted of the commencement of a new series of triangulation in Baluchistan. As there was no principal series in the neighbourhood of Quetta on which to base the new series, the latter was started from a secondary base and a connection with

the Indian Principal Triangulation was left to a future date. The need of good triangulation in Baluchistan was so great that the above compromise had to be made.

255. The party took the field in the first week in October and, after a march of 87 miles to Kalát, the work of building stations was commenced. Owing to no stations being ready, observations could not be commenced till the 25th October. From that date observations were continued to the 7th March.

The recess quarters were reached on the 3rd April. After this date, however, further field work was carried out. The triangulation round Mussooree was revised in order to test whether there had been any permanent displacement of the hills due to the earthquake shock of April 4th. Observations were also taken from Banog H. S. to the snowpeaks for the investigation of the co-efficient of refraction to be used in calculating their heights.

256. During the recess the computations were completed, the seasons outturn of work being—

Principal Triangulation.

Number of stations newly fixed	8
Number of figures completed	2
Length of series completed in miles	130
Area of triangulation in square miles	2,464
Number of stations at which astronomical Azimuths were observed	1
Mean triangular error (9 triangles)	667

Secondary Triangulation.

Number of stations newly fixed	nil.
Number of figures completed	1
Length of series completed in miles	10
Area of triangulation in square miles	120
Mean triangulation error	1'47

257. The Superintendent, Trigonometrical Surveys, inspected the party on September 13th.

SCIENTIFIC OPERATIONS (GEODETIC).

ASTRONOMICAL LATITUDES.

NO. 22 PARTY.

258. Captain H. M. Cowie, R.E., accompanied the Tibet Frontier Mission to Lha-sa in the summer of 1904; on his return to No. 22 Party (Astronomical) in November he was employed for some weeks in computing the results of triangulation in Tibet and in drawing the fair sheets. The Astronomical party did not therefore take the field until December 1904. A programme was designed to

Personnel.

- Lieutenant-Colonel S. G. Burrard, R.E., F.R.S., Superintendent, in charge up to 13th November 1904, and again from 18th March 1905.
- Captain H. M. Cowie, R.E., Assistant Superintendent, 1st grade, in charge from 14th November 1904 to 17th March 1905.
- 1 Computer, 1 surveyor.

furnish certain results which were urgently required to supplement the existing

astronomical data of Lower Burma. During the field season Captain H. M. Cowie, R.E., observed for latitude at the four longitude stations of Lower Burma and for azimuth at Nagarkhána, a station near Chittagong. An azimuth had already been observed at Dattaung Taungzun and Kyaunggyi which were near the Akyab, Moulmein and Prome Longitude stations respectively.

TABLE OF RESULTS.

Latitudes.

Series.	Station.	Height above mean sea level.	Longitude.	Astronomical Latitude=A.	Geodetic Latitude=G.	Probable Error.	Deflection of the plumb-line=A-G.
		Feet.	° ' "	° ' "	° ' "	"	"
Burma Coast	Moulmein . . .	90	97-40	16 30 2'97	16 29 54'62	±0'113	+8'35
	Prome . . .	100	95-15	18 49 18'62	18 49 14'18	±0'101	+4'44
	Akyab . . .	20	92-56	20 8 14'87	20 8 12'86	±0'063	+2'01
	Nagarkhána . .	290	91-51	22 22 57'08	22 22 56'38	±0'059	+0'70

Azimuths.

Series.	Observing Station.	Astronomical Azimuth=A.	Geodetic Azimuth=G.	A-G.	Station observed.
		° ' "	° ' "	"	
Burma Coast	Dattaung . . .	171 27 28'29	171 27 31'93	-3'64	Bengara.
	Taungzun . . .	31 16 18'58	31 16 31'77	-13'19	Kaulah.
	Kyaunggyi . . .	109 26 42'1	109 26 48'1	-6'0	Prome.
	Nagarkhána . .	155 47 13'34	155 47 21'99	-8'65	Chandarnáth.

259. Latitude observations were also taken at Dehra Dún (Haig observatory) station, the result of which is exhibited in following table:—

TABLE.

Station.	Date.	Astronomical Latitude=A.	Geodetic Latitude=A.	Deflection of the plumb-line=A G.
Dehra Dún (old Survey Office) .	April 1852 . . .	30 19 19'56	30 19 57'07	-37'51
Dehra Dún (Base line East End)	November 1892 . .	30 16 37'26	30 17 7'35	-30'09
Dehra Dún (Haig observatory) .	December 1904 and March 1905.	30 18 51'90	30 19 28'73	-36'93

PENDULUMS.

NO. 23 PARTY.

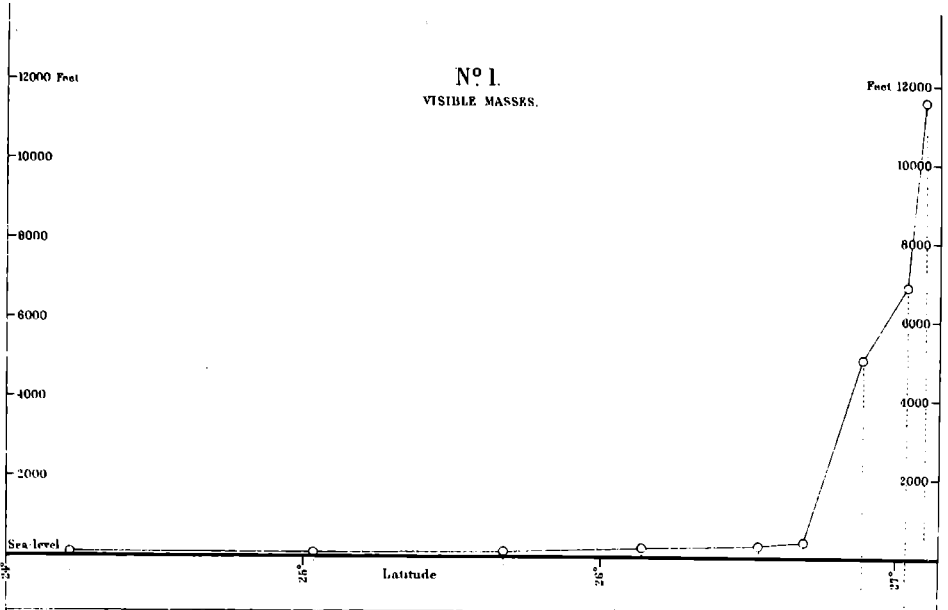
260. During the season 1904-05 the party was engaged in making pendulum observations at a number of stations situated on or near the meridian of Calcutta.

Personnel.
Major G. P. Lenox Conyngham, R.E., Superintendent, 2nd grade, in charge, Babu Hanuman Prasad, Sub-Assistant Superintendent, 1st grade, 2 surveyors and Computers.

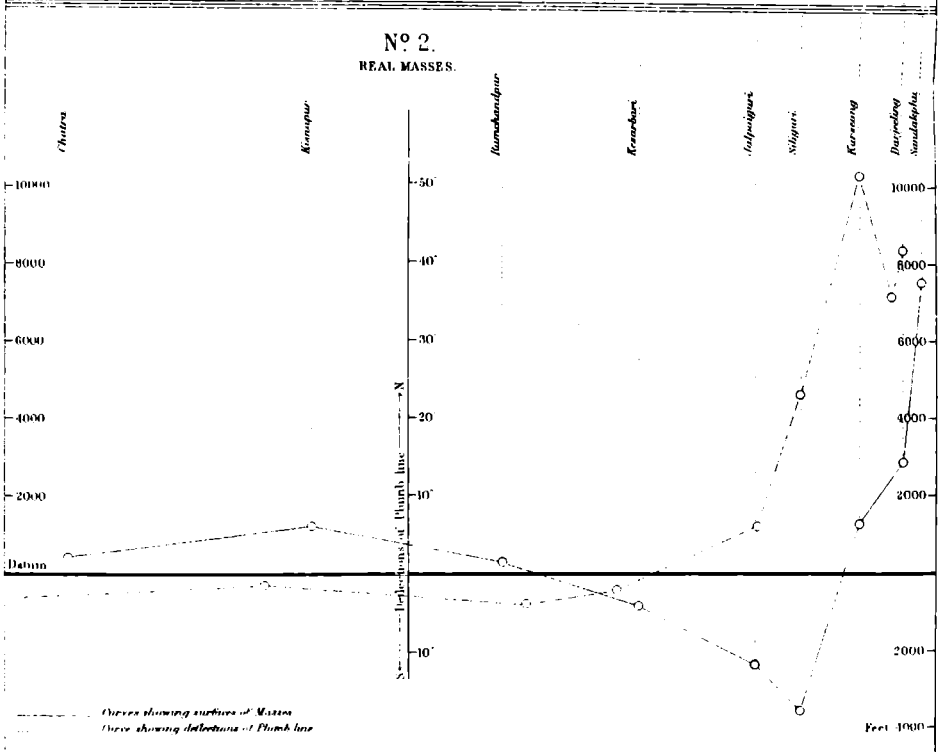
261. The new pendulum apparatus was used for the first time under field conditions. At the majority of the stations visited houses of more or less suitable character were available, but at four recourse had to be had to a tent. The variations of temperature which are unavoidable in a tent were a source of anxiety and Major Lenox Conyngham is of opinion that for the future where houses are not available, it will be desirable either to build a temporary hut or in some way to supplement the protection afforded by a tent.

DIAGRAMS
ILLUSTRATING THE RESULTS OF
PENDULUM OBSERVATIONS IN BENGAL.

N^o 1.
VISIBLE MASSES.



N^o 2.
REAL MASSES.



261. In the following table the results of the observations are given :—

STATION.	Latitude.	Height above s.a level.	Observed g .	g reduced to sea level = g_0 .	Theoretical value of g at sea level.	g_0 '' y_0 .
		Feet.				
Cuttack . . .	20 29 5	92	978·653	978·669	978·636	+ 0·033
Chatra . . .	24 12 40	64	'873	'884	'873	+ '011
Krishnapur . . .	25 2 26	113	'958	'965	'930	+ '035
Ramchandpur . . .	25 40 57	132	'972	'980	'975	+ '005
Kesarbari . . .	26 7 41	204	'955	'967	979·007	— '040
Jalpaiguri . . .	26 31 16	268	'924	'940	'035	— '095
Siliguri . . .	26 41 47	387	'850	'913	'048	— '135
Kurseong . . .	26 52 51	4,915	'628	'932	'062	— '130
Darjeeling . . .	27 2 47	6,966	'503	'931	'074	— '143
Sandakphu . . .	27 6 6	11,763	'193	'931	'078	— '147

The values of g are based on the value 979·065 at Dehra Dún, which in turn depends on the value 981·200 at Kew.

In reducing to sea level the three corrections, for height, intervening mass and inequality of surface, have all been applied. The calculation of the last which is called the orographical correction was a laborious piece of work. The methods elaborated by Captain Basevi and Colonel Herschel were followed, though some modifications tending to simplicity were introduced.

The pendulums seem to have suffered a very slight diminution in length during the field season, producing a change in the time of vibration of the mean pendulum of 0·0000013 sec. The effect of such a change on the deduced value of g is 0·005 c.m.

There is no evidence of the change being greater in one pendulum than in the others, and it is impossible to say whether it has taken place gradually or suddenly. Under these circumstances it has been thought best to use the mean of the two values of the time of vibration at Dehra Dún, the one determined before and the other after the tour, in deducing the value of g at the other stations.

The points of interest in the season's results are—

1. The considerable excess of g_0 '' over y_0 about latitude 25°.
2. The very large defect in g_0 '' at Siliguri at the foot of the Himalayas.
3. The fact that the deficiencies in g_0 '' at the Himalayan stations, though considerable, are very much less than that indicated by Captain Basevi's observations at Moré. His result could only be interpreted by supposing that the great apparent mass of the Himalayas was entirely compensated by deficiencies of matter in the underlying parts of the earth's crust, whereas the deficiency at Sandakphu corresponds to a compensation of only about one-third of the visible mass; that is to say, if the strata underlying Sandakphu were compressed until the height of that station was reduced from 11,766 to 7,586, they would then be of normal density, namely, 2·8.

When a section of the country traversed is drawn to show the real masses revealed by the pendulum, the deflections of the plumb line found by Captain Cowie in 1901-02 become intelligible, though without a greater number of pendulum stations it would not be possible to account for them completely.

262. The party was inspected by the Superintendent, Trigonometrical Surveys, in September 1905.

TIDAL AND LEVELLING OPERATIONS.

NO. 25 PARTY.

TIDAL OPERATIONS.

263. Major J. M. Burn, R.E., held charge of the Party from 2nd November 1904 to 10th July 1905,

Personnel.
 Major J. M. Burn, R.E., Deputy Superintendent, 1st grade.
 Mr. J. P. Barker, Extra Assistant Superintendent, 4th grade.
 Mr. H. G. Shaw, " " " " 5th " "
 Mr. E. H. Corridon, Sub-Assistant Superintendent, 1st grade.
 Munshi Syed Zille Hasnain, Sub-Assistant Superintendent, 1st grade.

when he took 1 month and 15 days' privilege leave; and from 25th August 1905 to 15th September 1905, on which

1 Surveyor, 19 computers, 2 native artificers and 4 tidal clerks.

date he proceeded on privilege leave combined with furlough on medical certificate.

Mr. J. P. Barker held charge from 1st October 1904 to 1st November 1904, from 11th July 1905 to 24th August 1905 and from 16th September to 30th September 1905.

264. Observations were taken by means of self-registering tide-gauges, during the year, at the stations given in the following list. The permanent stations are shown in italics :—

STATIONS.	Automatic or Personal observations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	REMARKS.
1 <i>Aden</i>	Automatic .	1879	Still working .	25	Property of Port Trust.
2 <i>Karáchi</i>	"	1881	"	24	
3 <i>Okha Point</i>	" {	1874 restarted 1904	} 1875	1	
4 <i>Bombay (Apollo Bandar)</i>	"	1878	still working .	27	
5 <i>Bombay (Prince's Dock)</i>	"	1888 1880	" 1890	17	
6 <i>Madras</i>	" {	restarted 1895	still working .	10 } 20	
7 <i>Kidderpore</i>	"	1881	"	24	
8 <i>Rangoon</i>	"	1880	"	25	
9 <i>Port Blair</i>	"	1880	"	25	

In addition to the above, readings to tide-poles were taken at Bhávnagar, Chittagong, Akyab and Moulmein.

265. All observatories, where there are tide-gauges, were inspected during the year. The registrations at these observatories have been satisfactory, excepting Okha, where there was a break in the record from 6th November to 26th December. The gauge has since worked well. Readings to tide-poles were taken under the direction of port officers.

266. The two following tables show the annual and decadal percentages of the predicted time and height, errors of high and low water at open coast and riverain stations :—

Percentage of errors in predicted times and heights at open coast stations from automatic registrations.

YEAR.	Number of Stations.	IN TIME.		IN HEIGHT.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{16}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1895	9	68	65	98	97	94	94
1896	9	71	70	97	97	97	93
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
Average of 10 years	9	73	69	95	95	95	94

Percentage of errors in predicted times and heights at riverain stations from automatic registrations.

YEAR.	Number of Stations.	IN TIME.		IN HEIGHT.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{16}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1895	2	59	55	74	47	94	84
1896	2	56	55	63	42	87	74
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
Average of 10 years	2	57	59	72	57	92	89

267. A reconnaissance of the Malay Peninsula near Kedah was made with the object of finding suitable sites for tidal observatories, but ended in failure. It has been found that the whole of the west coast is unfavourable for the establishment of observatories, and the scheme of carrying out tidal operations in the Peninsula has therefore had to be abandoned.

Preparations are being made for the reopening of a tidal observatory at Moulmein. It is now 19 years since this observatory was closed. The results derived from the observations which will now be obtained will serve as a check on the accuracy of the predictions and will be of benefit to both science and commerce.

Active measures will be taken to establish an observatory near Suakin. It is hoped that the observations will be productive of results which, in conjunction with those already obtained at Suez and Perim, will be of great help to the scientific investigations of the tides of the Red Sea.

SPIRIT LEVELLING OPERATIONS.

268. The Levelling Detachment was employed in Sind and in the Dehra District. In Sindh levels were taken between Sujáwal and Sukkur; in Dehra the short line from Dehra to Mussooree was revised.

The levelling in Dehra was done with the object of discovering any change in level which may have been caused by the earthquake of 4th April.

The total outturn of work was 318 miles.

The field season commenced on 21st October 1904 and closed on 15th June 1905.

Standard bench marks were erected at 19 towns in the United Provinces, one in Gwalior and one in Jhánsi.

A second levelling detachment has been organised and the detachments are designated Levelling Detachment No. 1 and Levelling Detachment No. 2.

During the coming field season detachment No. 1 will take levels across the Brahmaputra between Dhubri and Fakírganj and then connect the standard bench marks in the United Provinces with already existing bench marks. Detachment No. 2 will level from Sukkur to Shikárpur across the Indus and then from Lahore to Chach Base, connecting bench marks at three cantonment stations.

MAGNETIC.

NO. 26 PARTY.

269. During the year under report satisfactory progress has been made

Personnel.

Major H. A. D. Fraser, R.E., Deputy Superintendent, 1st grade, in charge up to 20th March 1905.

Captain R. H. Thomas, R.E., Officiating Assistant Superintendent, 1st grade, in charge from 21st March 1905.

Mr. E. C. J. Bond, Extra Assistant Superintendent, 6th grade, from 20th April 1905.

Mr. H. P. D. Morton, Sub-Assistant Superintendent, 1st grade.

Babu R. P. Ray, " " " 2nd " "

Mr. A. M. Talati, " " " " up to 8th May 1905.

Mr. E. A. Meyer, Sub-Assistant Superintendent, 2nd grade.

Babu N. R. Mazumdar, " " " " "

12 Observers, computers and recorders, 1 surveyor and 1 writer.

with the work of the magnetic survey: the five base stations are now in working order with the equipment originally contemplated: they cannot however be considered fully equipped until the vertical force instruments are installed: two of these have arrived in India while the remain-

ing two (excluding Colaba where a vertical force instrument is already in operation) are expected shortly.

270. The field season commenced on the 20th October and ended early in May when the party moved to recess quarters. Four field detachments were employed during the work season. The field observations were taken chiefly in Rajputana, the Central Provinces, Nizam's dominions, parts of Madras and the coast line from Mangalore to Cutch. Railways could be utilized but little, and the intervals between stations were mostly covered by marching. The total number of new stations was 206.

271. The two Imperial officers erected the self-recording instruments at Toungoo in December 1904, and in addition observed at 5 new and 4 old repeat stations and at the five base stations.

272. The total number of stations observed to date in four working seasons is 808 with 22 repeat stations: it is expected that the preliminary survey, including the extension of the work into the more easily accessible hill districts, will be completed in three more seasons with four field detachments. Most of the work, however, lies in difficult country, and progress will be distinctly slower than in former years.

273. Magnetometers behaved uniformly well in the season under review and the results from them were up to the standard laid down, but the dip circles in some instances gave considerable trouble in spite of their having been put in thorough working order at the beginning of the field season. Under ordinary observatory conditions, dip observations cannot be relied upon within ± 2 minutes, and in view of the approaching installation of the vertical force instruments, an earth inductor of the Schulze pattern has been ordered for Dehra Dún base station.

274. In 1903-04 the log π° K observations revealed marked changes; the two standard inertia bars were therefore remeasured at Kew in 1905. It was

found that both bars had lost weight, but the cause remains unexplained. The absolute moments of inertia of the bars (irrespective of the dimensions) were determined at Kew by Professor Watson's method.

The Magnetic Survey is indebted to Professor Watson for the gift of a new standard inertia bar. In order to detect in future any change in weight either in the bars or magnets, sanction has been asked to the purchase of a delicate balance; any change in the observed weight of a system will then indicate the desirability of redetermining its moment of inertia.

275. The party proceeded to recess quarters on the 7th May 1905 and the computation of the field work has been completed and abstracts of results made. Good progress has also been made with the tabulation and reduction of the base station results for 1904, which will be published in the next annual report.

276. The earthquake of the 4th April last was registered on the magnetographs at all the base stations, while at Dehra Dún the shock was sufficiently violent to throw the declination instrument out of adjustment, and even at Barrackpore the displacement was so great that the declination magnet adhered to the side of the box and it was necessary to introduce a bar magnet into the room to restore it to its normal position. The shortness of the time scale on the magnetograph traces (on which 1 hour is represented by 6 inches) precludes any very accurate measurement of the exact time of arrival of seismic waves; the indications are therefore of no great value as far as the investigation of the speed of such waves is concerned, and the results deduced from the various observatories can only be regarded as an approximation. There appears, however, to be sufficient evidence to show that even so close to the origin as 130 miles, magnetograms do not record preliminary tremors.

277. *Dehra Dún Observatory.*—The horizontal force instrument has given good results throughout the year, but the declination has required adjustment on two occasions, including that after the earthquake.

The vertical force pillars were erected in July last and the instrument itself in August. Experiments for the elimination of the temperature co-efficient are now in progress.

278. *Barrackpore Observatory.*—The instruments have worked satisfactorily throughout. The site is unhealthy and the observer who has suffered considerably from sickness is being transferred to Dehra Dún. The vertical force instrument for Barrackpore has arrived, and it is hoped opportunity will offer to erect it during the cold weather.

279. The observer at Kodaikánal resigned his appointment in April last, but through the good offices of the Director, Solar Physics Observatory, a suitable incumbent was obtained locally. The declination instrument again gave trouble through interference and it was opened up in December last. Nothing in the shape of fungoidal growth could be detected, but the instrument was taken to pieces, the parts thoroughly washed with perchloride of mercury and re-erected, since when the results have been satisfactory. It is noteworthy that the horizontal force magnetograph has not exhibited signs of this derangement.

280. *Toungoo Observatory.*—The instruments were installed in December last year, and several experiments carried out for determining the temperature co-efficient of the horizontal force system. These were not altogether satisfactory, and after the lapse of some weeks a solution was indicated in the rapid loss of moment evident in the horizontal force magnet. As it appeared probable that this was due to the manufacturers having omitted to "age" the magnet, the observatory was recently visited and the operation carried out. It is hoped that the magnetic moment is now stable and further experiments to determine the temperature co-efficient will be carried out next field season.

281. A beginning has been made with the investigation of the reduction formulæ for the field observations by Mr. J. Eccles, M.A., on lines suggested by Sir A. Rucker. In order to reduce the magnitude of the corrections for diurnal variation, observers will not work between 9 A. M. and 3 P. M. in future.

282. A table showing the approximate preliminary values (uncorrected) of the magnetic elements at the stations of observation of the field season 1904-05 is appended, together with a reference index map.

283. During the next field season operations will be carried on by four field detachments. Two detachments will work in Chota Nagpur, Orissa and the Agency tracts, one will work on the Eastern Bengal and Assam-Bengal Railways, while the fourth will be employed in filling up gaps left in previous seasons.

Abstract showing the approximate magnetic values at stations observed at
by No. 26 Party during season 1904-05.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ' "	° ' "	° '	° '	C.G.S.	
603	Shahabad	४	25 14 40	77 9 40	35 0	E 1 40	0°3530	
604	Barágaon	9	25 40 10	77 3 10	35 45	" 1 40	0°3515	
605	Birpur	10	26 7 30	77 8 20	36 30	" 2 5	0°3515	
606	Manakhoar	11	26 24 30	77 16 10	37 5	" 2 20	0°3560	
607	Gangapur	६	26 28 50	76 44 20	37 5	" 2 10	0°3485	
608	Jhalai	7	26 21 30	75 59 50	36 35	" 2 5	0°3510	
609	Málpura	8	26 17 0	75 22 10	36 40	" 1 50	0°3480	
610	Awan	9	25 48 0	75 36 20	35 55	" 1 55	0°3495	
611	Indargarh	10	25 43 50	76 11 0	35 50	" 1 45	0°3505	
612	Kotah	11	25 11 3b	75 51 40	35 10	" 1 45	0°3530	
613	Singoli	६	24 58 10	75 17 20	34 35	" 1 40	0°3540	
614	Rámpura	7	24 27 40	75 26 40	33 20	" 1 35	0°3570	
615	Jhalra Pátan	8	24 36 0	76 9 20	33 55	" 1 25	0°3550	
616	Kundio	9	24 2 0	75 53 30	32 25	" 1 40	0°3570	
617	Khilchipur	10	24 2 0	76 34 20	32 40	" 1 20	0°3600	
618	Naiakila	8	24 3 40	77 15 30	33 50	" 2 15	0°3475	
619	Thuria	४	22 40 10	76 41 20	30 0	" 0 20	0°3625	
620	Hat-Piplia	8	22 46 0	76 17 10	31 5	" 0 30	0°3550	
621	Bistan	9	21 41 50	75 40 10	27 10	" 1 5	0°3775	
622	Khal Ghat	10	22 8 50	75 27 10	34 0	" 2 35	0°3195	
623	Dhár	11	22 36 0	75 18 30	29 35	" 0 50	0°3670	
624	Chikalda	४	22 5 0	74 52 40	28 45	" 0 55	0°3635	
625	Sondwa	12	22 7 10	74 22 20	28 15	" 1 10	0°3620	
626	Artia	13	22 2 40	73 58 20	30 10	" 0 30	0°3650	
627	Jawhár	९	19 54 0	73 13 30	24 50	" 0 25	0°3680	
628	Girdon	10	20 5 20	73 25 50	26 5	" 0 55	0°3630	
629	Peint	11	20 15 20	73 29 10	25 30	" 0 45	0°3675	
630	Baphlun	12	20 32 50	73 29 30	25 45	" 1 15	0°3640	
631	Kanási	13	20 31 30	73 52 0	25 35	" 1 5	0°3655	
632	Jáykleda	14	20 47 40	74 12 10	26 25	" 0 55	0°3675	
633	Lawa	10	25 14 10	73 59 30	35 5	" 1 50	0°3595	
634	Bichabhera	५	24 16 20	73 22 50	33 5	" 1 20	0°3545	
635	Dhambolia	6	23 42 10	73 19 50	32 10	" 1 15	0°3555	
636	Debhári	7	23 15 20	73 30 10	31 5	" 1 15	0°3580	
637	Ghatahogam	8	23 35 30	73 53 50	31 45	" 1 25	0°3570	
638	Bánswára	9	23 33 10	74 25 50	31 45	" 1 40	0°3590	
639	Mánpur	10	23 59 50	74 14 40	32 45	" 2 0	0°3590	
640	Kánar	11	24 26 0	74 16 10	33 20	" 1 45	0°3540	
641	Silwáni	९	23 18 20	78 26 20	30 20	" 0 55	0°3 00	
642	Gourjhámar	10	23 31 30	78 56 0	31 45	" 1 5	0°3630	
643	Sháhgarh	7	24 19 10	79 7 20	33 5	" 1 40	0°3615	
644	Khargapur	8	24 48 50	79 8 50	34 55	" 1 35	0°3575	
645	Chhatarpur	9	24 55 50	79 35 10	34 45	" 1 40	0°3575	
646	Ajaigarh	10	24 54 10	80 15 30	34 25	" 1 25	0°3595	
647	Amáanganj	11	24 25 40	80 2 30	33 10	" 1 30	0°3625	
648	Manchar	4	23 51 10	79 58 20	32 40	" 1 25	0°3620	
649	Sanganner	16	19 34 20	74 13 30	23 55	W 0 10	0°3685	
650	Shevgaon	2	19 21 20	75 14 0	23 25	" 0 50	0°3710	
651	Shagud	7	19 22 0	75 42 40	23 25	" 0 20	0°3725	
652	Chousálla	5	18 42 50	75 41 40	21 45	" 0 35	0°3695	
653	Ter	6	18 19 40	76 9 10	21 5	" 0 45	0°3715	
654	Nominabad	7	18 44 0	76 23 30	22 10	" 0 30	0°3720	
655	Udgir	5	18 23 30	77 7 0	21 40	" 0 55	0°3750	
656	Aurád	6	18 15 0	77 24 30	21 40	W 0 15	0°3750	
657	Bidar	7	17 55 0	77 31 0	20 35	E 0 25	0°3770	
658	Rajasoor	8	17 48 30	77 2 30	20 15	" 0 25	0°3760	
659	Dallum	8	17 51 50	76 28 40	20 10	W 0 10	0°3705	
660	Miraigaon	9	18 44 0	75 1 20	22 0	E 0 40	0°3715	
661	Bijápur	3	16 50 0	75 41 20	18 15	" 0 10	0°3785	
662	Gabsavalgi	4	16 58 50	76 21 0	18 10	" 0 15	0°3760	
663	Shorápur	5	16 31 0	76 45 40	17 30	" 0 15	0°3785	
664	Mudgal	6	16 1 10	76 27 10	16 0	" 0 10	0°3765	
665	Gadag	7	15 25 10	75 38 10	15 25	" 0 15	0°3755	
666	Alúr	8	15 49 30	75 39 0	16 0	" 0 5	0°3780	
667	Alimatti	9	16 21 10	75 53 20	17 10	" 0 5	0°3760	
668	Korkop	10	16 1 10	75 6 0	16 20	" 0 10	0°3775	
669	Jamkhandi	11	16 30 50	75 17 10	17 15	W 0 20	0°3790	
670	Jath	10	17 2 40	75 12 0	18 40	E 0 5	0°3750	
671	Pandharpur	11	17 39 40	75 19 30	19 35	W 0 5	0°3770	
672	Náteputa	9	17 54 10	74 45 30	20 30	E 0 5	0°3720	
673	Kaledhon	10	17 26 0	74 37 40	19 45	" 0 20	0°3740	
674	Nundy Bayoor.	12	14 54 10	76 3 20	13 50	W 1 5	0°3710	
675	Tadgole	15	13 24 50	78 13 0	10 25	" 0 25	0°3820	
676	Kuvoy	17	12 5 40	75 11 30	8 50	E 1 35	0°3810	
677	Kasaragud	1	12 30 0	74 59 40	10 30	W 1 15	0°3820	
678	Mangalore	2	12 52 0	74 49 40	9 50	" 0 55	0°3760	
679	Udipi	2	13 20 40	74 44 20	10 40	" 0 5	0°3765	

Station of
Season
1903-04.

Abstract showing the approximate magnetic values at stations observed at
by No. 26 Party during season 1904-05—contd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ' "	° ' "	° ' "	° ' "	C.G.S.	
680	Coondapoor . . .	3	13 37 30	74 41 40	10 55	W 0 10	0'3795	
681	Bhatkal . . .	4	13 59 30	74 32 0	9 40	E 0 55	0'3750	
682	Kumta . . .	5	14 26 10	74 24 50	12 0	E 0 25	0'3890	
683	Kārwār . . .	6	14 47 30	74 7 20	13 40	W 0 10	0'3780	
684	Vengurla . . .	10	15 51 30	73 37 20	15 50	0 0	0'3765	
685	Devgad . . .	11	16 21 50	73 21 50	17 25	E 0 25	0'3690	
686	Ratnāgiri . . .	12	16 59 10	73 18 50	17 10	0 0 45	0'3775	
687	Dābhol . . .	11	17 35 20	73 10 0	19 55	0 0 30	0'3690	
688	Bānkot . . .	12	17 58 20	73 2 30	21 35	0 0 40	0'3670	
689	Revdaṅda . . .	1	18 32 20	72 57 0	22 20	0 0 55	0'3695	
690	Mahuva Bandar . . .	10	21 2 20	71 46 30	26 30	0 0 35	0'3650	
691	Jāfarabad . . .	4	20 51 50	71 22 10	26 45	0 1 20	0'3635	
692	Bālasore . . .	4	21 30 30	86 54 40	27 55	0 1 0	0'3750	
693	Bhadrak . . .	5	21 5 10	86 31 0	27 0	0 0 45	0'3780	
694	Jenapur . . .	1	20 51 30	86 4 10	26 45	0 0 55	0'3740	
695	Cuttack . . .	2	20 27 20	85 53 50	25 35	0 0 10	0'3770	
696	Puri . . .	3	19 48 40	85 50 10	24 25	0 0 40	0'3805	
697	Tapang . . .	4	20 3 20	85 34 50	25 5	0 0 45	0'3780	
698	Rambha . . .	5	19 32 0	85 6 0	23 55	0 0 30	0'3795	
699	Be r h a m p u r (Ganjām). . .	1	19 18 10	84 48 40	23 25	0 0 35	0'3795	
700	Palasa . . .	1	18 45 20	84 26 0	22 15	0 0 30	0'3805	
701	Chicacole Road . . .	2	18 24 30	83 54 20	21 30	0 0 30	0'3805	
702	Vizianagram . . .	3	18 6 40	83 24 0	21 55	0 0 0	0'3825	
703	Tuni . . .	1	17 21 30	82 32 10	19 15	0 0 15	0'3815	
704	Cocanada (Port) . . .	1	16 56 20	82 14 10	18 20	0 0 15	0'3805	
705	Rajahmundry . . .	2	17 0 40	81 46 20	18 40	0 0 20	0'3820	
706	Bhimadol . . .	2	16 48 40	81 15 30	18 0	0 0 10	0'3815	
707	Masulipatam . . .	3	16 11 30	81 7 40	17 0	0 0 15	0'3805	
708	Phirangipuram . . .	4	16 17 50	80 15 40	16 50	W 0 10	0'3840	
709	Gundlakamma . . .	5	15 59 10	79 38 20	16 15	0 0 0	0'3815	
710	Cumbum . . .	6	15 35 50	79 6 40	15 25	E 0 10	0'3780	
711	Diguvametta . . .	5	15 23 30	78 49 20	15 10	W 0 5	0'3800	
712	Nandyal . . .	6	15 28 20	78 28 0	15 30	0 0 5	0'3800	
713	Kurnool Road . . .	7	15 23 20	77 52 10	15 0	E 0 5	0'3800	
714	Tāndūr . . .	9	17 15 10	77 34 40	18 45	0 0 20	0'3780	
715	Gollaguda . . .	10	17 25 0	78 1 50	19 30	0 0 35	0'3760	
716	Kistnapur . . .	11	17 48 0	78 44 10	20 5	0 0 15	0'3790	
717	Thaviogpully . . .	5	18 16 40	79 6 30	21 0	0 0 45	0'3720	
718	Pedapali . . .	6	18 36 30	79 22 30	22 20	0 0 40	0'3730	
719	Asanada . . .	7	18 45 30	79 44 30	22 20	0 0 30	0'3760	
720	Kōttapalle . . .	8	18 22 0	79 4 10	21 0	0 0 30	0'3765	
721	Lankalagada . . .	9	18 41 0	80 7 10	22 0	0 0 30	0'3760	
722	Nāgāram . . .	10	18 20 50	80 25 40	21 15	0 0 40	0'3775	
723	Biarām . . .	11	18 3 10	80 44 20	20 40	0 0 35	0'3790	
724	Burgampol . . .	12	17 38 30	80 52 10	19 35	0 0 25	0'3805	
725	Damapet . . .	3	17 17 20	81 0 10	19 0	0 0 10	0'3805	
726	Podili . . .	7	15 37 10	79 36 20	15 20	W 0 5	0'3810	
727	Pamur . . .	8	15 5 20	79 24 40	14 25	0 0 5	0'3810	
728	Nandavaram . . .	9	14 40 30	79 28 50	13 15	0 0 0	0'3820	
729	Badvel . . .	10	14 44 0	79 3 50	13 30	W 0 10	0'3815	
730	Chyāgalamarri . . .	16	14 56 40	78 35 20	13 50	0 0 10	0'3815	
731	Kurnool City . . .	8	15 49 50	78 2 20	16 0	0 0 0	0'3785	
732	Kuta Kata . . .	9	16 23 30	77 56 0	17 25	0 0 0	0'3775	
733	Rājūmpett . . .	10	16 51 40	78 9 40	18 25	E 0 15	0'3780	
734	Shumshabad . . .	12	17 15 30	78 23 50	19 25	W 0 5	0'3745	
735	Nārāyanpur . . .	13	17 9 40	78 52 40	18 55	0 0 5	0'3760	
736	Devarakonda . . .	11	16 41 10	78 55 10	17 40	E 0 10	0'3785	
737	V é l é s v a r a m Ferry. . .	9	16 28 30	79 12 40	17 25	0 0 0	0'3785	
738	Komaravole . . .	10	16 6 10	79 20 0	17 15	W 0 25	0'3850	
739	Dāchépalle . . .	11	16 36 0	79 43 40	17 35	E 0 10	0'3795	
740	Tipparti . . .	13	17 0 40	79 24 50	18 25	0 0 5	0'3785	
741	Bālkonda . . .	14	18 51 30	78 19 40	22 30	0 0 40	0'3750	
742	Jagtiyāl . . .	15	18 47 30	78 54 40	22 15	W 0 40	0'3705	
743	Tāndūr . . .	1	19 9 0	79 26 40	23 5	E 0 20	0'3740	
744	Sokra . . .	2	19 27 40	79 4 10	23 50	0 0 10	0'3735	
745	Sirpur Tāndūr . . .	3	19 28 30	79 35 0	23 30	0 0 35	0'3740	
746	Chānda . . .	4	19 57 50	79 17 40	24 35	0 0 45	0'3735	
747	Danura . . .	2	19 46 50	78 45 10	25 10	0 0 50	0'3720	
748	Kūpti . . .	3	19 21 10	78 25 10	22 30	0 0 30	0'3730	
749	Dhānura . . .	4	19 19 10	78 8 30	23 45	0 1 10	0'3760	
750	Umarkhed . . .	5	19 36 10	77 41 20	24 15	0 0 35	0'3730	
751	Hingoli . . .	6	19 43 30	77 9 0	24 50	0 1 10	0'3675	
752	Bāsim . . .	7	20 6 50	77 8 20	25 35	0 2 0	0'3635	
753	Kāranja . . .	8	20 28 30	77 29 20	26 55	0 0 50	0'3595	
754	Goilkerā . . .	3	22 30 20	85 21 30	29 40	0 1 10	0'3715	
755	Rourkela . . .	1	22 13 40	84 51 30	29 15	0 0 55	0'3695	

Abstract showing the approximate magnetic values at stations observed at
by No. 26 Party during season 1904-05—concl'd.

Serial No.	Name of Station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	REMARKS.
			° ' "	° ' "	° '	° '	C. G. S.	
756	Bámra . . .	2	22 3 30	84 17 30	29 10	E 1 10	0'3700	
757	Kankla . . .	4	21 52 30	83 44 20	28 40	" 1 5	0'3720	
758	Kharsia . . .	3	21 59 40	83 6 20	28 50	" 1 5	0'3705	
759	Akaltara . . .	1	22 2 10	82 25 40	28 45	" 1 5	0'3705	
760	Belghana . . .	2	22 25 50	82 2 20	28 50	" 0 55	0'3650	
761	Khairi . . .	3	22 55 20	81 52 50	30 35	" 1 10	0'3660	
762	Shahdol . . .	1	23 17 0	81 21 50	31 5	" 1 10	0'3675	
763	Umaria . . .	12	23 31 10	80 49 10	31 30	" 1 15	0'3645	
764	Bhátápára . . .	4	21 44 0	81 56 30	28 15	" 1 55	0'3700	
765	Raipur . . .	5	21 15 50	81 38 20	27 35	" 1 0	0'3710	
766	Rájim . . .	1	20 58 30	81 52 10	27 0	" 0 55	0'3720	
767	Dhamtari . . .	2	20 42 40	81 32 40	26 15	" 1 50	0'3725	
768	Ráj-Nándgaon . . .	11	21 6 10	81 2 20	26 55	" 1 0	0'3725	
769	Sálekasa . . .	2	21 17 30	80 30 40	27 10	" 0 45	0'3775	
770	Bálaghát . . .	3	21 48 40	80 12 10	28 20	" 0 55	0'3700	
771	Nainpur . . .	4	22 25 40	80 5 40	29 40	" 1 0	0'3680	
772	Seoni . . .	5	22 4 10	79 32 50	28 55	" 1 0	0'3680	
773	Chhindwára . . .	5	22 3 40	78 57 30	27 55	" 1 5	0'3665	
774	Koka . . .	7	21 15 30	79 41 0	27 10	" 0 55	0'3700	
775	Kamptee . . .	8	21 12 30	79 12 40	27 15	" 1 0	0'3680	
776	Faunár . . .	9	20 46 50	78 42 40	26 0	" 0 25	0'3710	
777	Warora . . .	5	20 14 20	79 0 20	25 10	" 0 45	0'3700	
778	Dhámangaon . . .	10	20 46 50	78 8 40	25 40	" 1 40	0'3685	
779	Amráoti . . .	11	20 55 30	77 45 50	26 45	" 0 30	0'3655	
780	Yavlkhed . . .	12	20 42 50	77 4 30	26 5	" 0 35	0'3695	
781	Nándúra . . .	8	20 50 20	76 28 30	25 25	" 0 55	0'3725	
782	Choorée . . .	13	23 12 40	80 30 0	32 5	" 1 15	0'3635	
783	Kasaisonda . . .	14	23 4 40	80 51 0	...	W E 8 45	0'3520	
784	Kasaisonda (a) . . .	14	23 4 50	80 53 50	30 50	W E 1 50	0'3650	The first station was on rock markedly magnetic, the second was about ½ mile distant.
784	Dindori . . .	6	22 57 0	81 4 10	29 35	" 1 25	0'3670	
785	Madhopur . . .	7	22 45 40	81 25 20	30 15	" 1 5	0'3640	
786	Bemetara . . .	8	21 43 0	81 31 40	28 20	" 0 55	0'3700	
787	Kawarda . . .	9	22 0 20	81 13 40	28 55	" 1 15	0'3680	
788	Rajadhar . . .	10	22 14 0	81 2 40	29 10	" 1 10	0'3675	
789	Thonda . . .	9	22 27 50	80 38 30	29 45	" 0 55	0'3670	
790	Kakaria . . .	10	22 48 10	80 15 10	30 5	" 0 55	0'3670	
791	Lakhndón . . .	11	22 36 10	79 36 30	29 35	" 1 0	0'3670	
792	Deolapur . . .	6	21 35 10	79 22 20	27 50	" 0 55	0'3700	
793	Doonawa . . .	6	21 52 0	78 29 30	28 35	" 0 40	0'3675	
794	Betúl . . .	7	21 54 50	77 53 40	28 25	" 1 0	0'3665	
795	Palsia . . .	8	21 45 20	77 31 0	28 15	" 0 45	0'3540	
796	Rangubali . . .	9	21 42 40	77 8 20	27 30	" 0 55	0'3675	
797	Darni . . .	12	21 32 40	76 53 10	25 50	" 0 5	0'3785	
798	Jiri . . .	13	21 10 40	76 50 50	28 0	" 1 0	0'3705	
799	Anjangaon . . .	10	21 10 40	77 18 30	27 15	" 0 50	0'3715	
800	Brahmanwádá . . .	11	21 19 20	77 44 20	28 5	" 0 40	0'3680	
801	Loni . . .	12	21 23 0	78 12 10	27 35	" 0 55	0'3685	
802	Kátol . . .	13	21 16 0	78 35 50	27 35	" 1 5	0'3700	
803	Umrer . . .	6	20 51 0	79 20 0	27 0	" 1 20	0'3695	
804	Dokai-Surandee . . .	7	20 46 0	79 48 0	26 20	" 1 0	0'3715	
805	Palasgarh . . .	8	20 39 0	80 17 10	26 15	" 0 50	0'3715	
806	Kosemi . . .	9	20 23 40	80 34 10	25 35	" 0 55	0'3725	
807	Damkasa . . .	10	20 20 30	80 56 10	25 20	" 0 40	0'3735	
808	Kánker . . .	3	20 16 10	81 29 50	25 20	" 0 40	0'3750	

Repeat Stations.

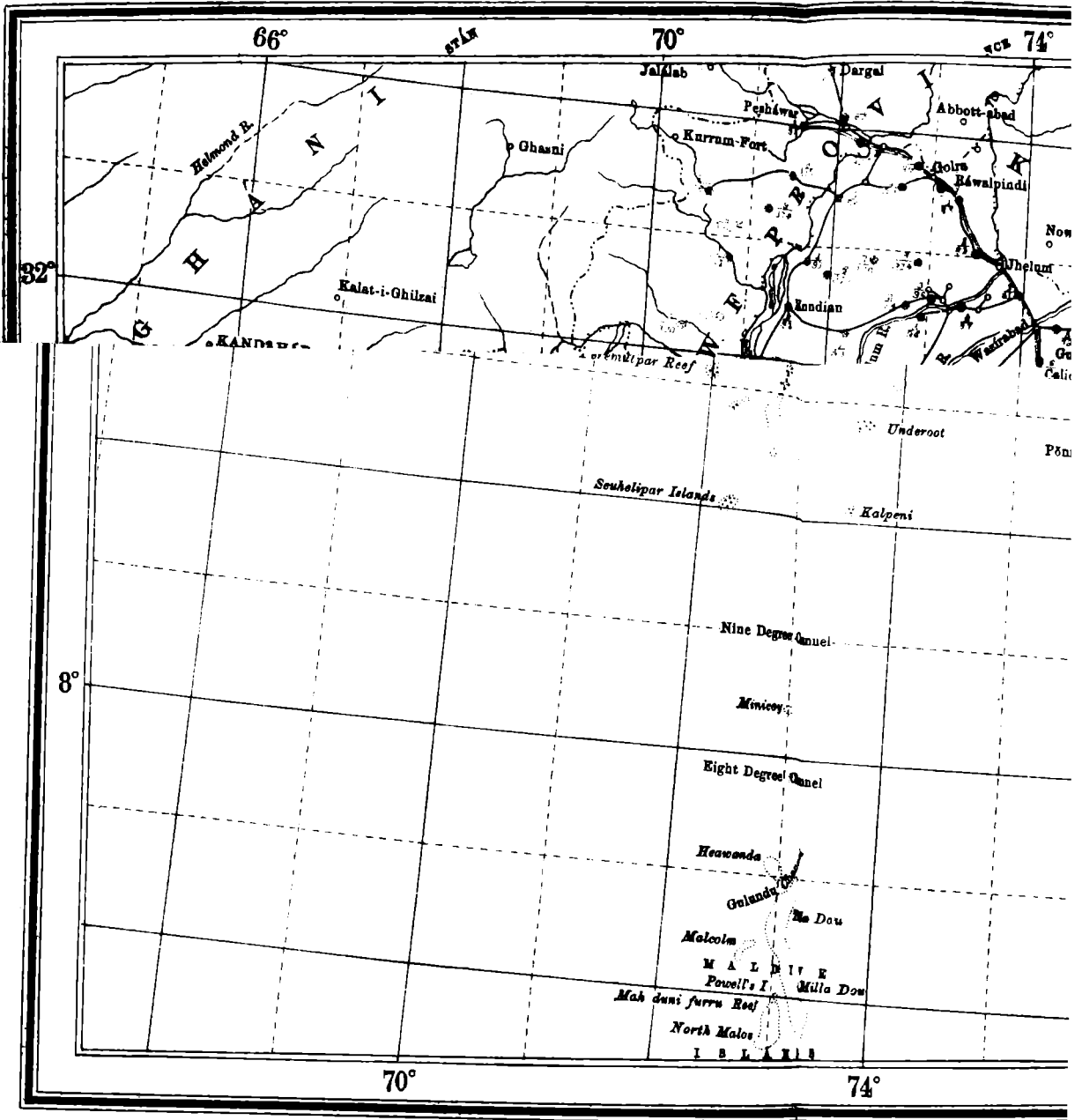
XVI	Bhusával . . .	...	21 2 46	75 47 18	26 40	E 1 0	0'3685	
XVII	Jubbulpore . . .	...	23 8 57	79 56 44	30 40	" 1 10	0'3650	
XVIII	Darjeeling . . .	...	26 59 49	88 16 39	38 10	" 1 50	0'3565	
XVIII	Tavoy . . .	...	14 4 50	98 12 30	12 25	" 0 45	0'3910	
XIX	Lashio . . .	...	22 56 47	97 44 40	31 15	" 1 0	0'3760	
XX	Akyab . . .	...	20 7 53	92 53 18	25 25	" 1 0	0'3820	
XXI	Sitchar or Cáchár . . .	...	24 49 43	92 47 21	34 35	" 1 25	0'3685	
XXII	Dibrugarh . . .	...	27 29 24	94 55 40	39 20	" 1 30	0'3580	
VII	Bangalore . . .	...	12 59 35	77 35 58	9 30	W 0 25	0'3815	

NOTE.—The above values of Dip, Declination and Horizontal Force are uncorrected for secular change, diurnal variation, instrumental differences, etc., and are to be considered as preliminary values only.

Where blanks occur, values have been already found during previous field seasons, or the observations have not been completed.

The Survey numbers refer to the published chart: thus No. 11 denotes No. 3 station in the dotted square, the spheric co-ordinates of whose centre are 26° North Latitude and 76° East Longitude.

All Longitudes are referable to that of Madras Observatory taken at the value, 80°-14'-47" East from Greenwich.



No. D. 78, S. I. 9-11-1905 600

Notes—The Longitudes are referable to the G Meridian, taking that of the Madras Ob as $8^{\circ} 14' 54''$ East.

TABULAR STATEMENTS.

field parties during the year 1904-05.

TRAVERSING.						DETAIL SURVEY.					RECORD-WRITING.			REMARKS.
Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.		
...	1,235	1,513	952	(b) Plane-table fixings. (c) Supplementary survey. (d) Triangulation computations not completed. (e) Includes 1053 square miles triangulated in 1903-04, but computed in 1904-05. (f) Includes 708 miles traversed in 1903-04, but computed in 1904-05.	
...	7,645	25,168	...	...	8,620	...	...	...	...	...	...	...
...	60	113	12	...	...	...	...	...
...	46	130	...	...	...	...	...	...
45	156	170	2	...	...	...	...	...
...		
...	...	256	5,294	5'5	57	234	170	147	...	...	...	...
...	...	284	5,028	2'4	3'0	267	185	156	...	...	...	...
...	2,939	...	...	...	...	...	...	...	...	...
...	...	23	126	...	...	75	77	...	...	...	...	...
...	597	113	311	...	...	...	...
...	134	37	225	...	...	...	...
...	...	29	738	0'09	...	135	185	244	...	...	...	...
...	254	139	212	...	...	...	...
...	227	101	169	...	...	...	...
...	203	171	4	...	...	...	...
...	...	976	16,135	3'99	2'82	277	171	150	...	...	...	...
...	108	171	57	...	...	...	...
...	92	171	107	...	...	...	...
...	1,235	3,081 (f)	...	...	3,817	...	...	...	...	...	...	...
55	2,719	137	655(b)	...	...	...	...	...
...	483	18	306	...	...	...	...	...
...	167	...	...	...	...	...	...	...
...	...	185	1,726	8'6	2'2	...	...	...	...	...	...	...
...	...	107	756	...	...	...	...	...	...	...	...	...
60	982(3)	...	...	...	...	...	...
...	2,787	13	770	...	...	...	...
...	2,426	...	664	...	...	...	...
...	1,509(4)	...	325	...	...	...	...
...	...	4,547	10,969	5	0'3	1,511(4)	9'5	227	...	...	...	...
65	...	4,839	...	...	...	12,584	...	...	...	...	...	...
...	...	53	...	...	...	2,078	4'8	39	...	...	...	...
...	425(c)	15'8(d)	38(c)	...	...	...	...
...	3,940	7	1,031	...	...	...	...
...	1,070	...	...	...	...	...	...
...	1,150	3	180	...	...	...	...
70	8,663	...	...	...	...	...	...
...	1,253	...	...	...	...	...	...
...	27,000	...	...	...	...	...	...
...	2,970	...	...	...	...	...	...
75	17,687	...	...	...	...	...	...
...	40,000	...	...	...	...	...	...
...		
79	7,645	31,628	...	...	...	21,588	...	...	...	...	...	...

Statement showing the cost-rates of work executed

Number of Party.	Nature and locale of field operations.	COST-RATE PER SQUARE MILE.											
		Tri-angulation.	Teavers-ing.	Detail survey and preparation of maps on scales of									
				1"	2"	4"	6"	8"	16"	48" & 12"	100'=1	64"	
	Topographical Surveys.	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	
1	Central Provinces . . . . .	...	...	...	18'4(b)	...	...	...	...	...	...	...
3	Upper Burma	24'9	...	...	23'9 (d)18'0	...	...	...	...	...	...	...
Bengal Surveys	Bhágálpur . . . . .	...	6'5	...	...	17'9	...	...	...	...	...	...
	Purnea . . . . .	...	4'5	...	...	17'6	...	...	...	...	...	...
	Backergunge . . . . .	...	3'0	...	...	33'5	...	...	...	...	...	...
10	Upper Burma	6'9	...	16'9	...	...	...	...	...	...	...	...
11	North-West Frontier	24'5	...	...	64'5	...	...	...	...	...	...	...
12	Sind	3'7	...	6'9	13'9	...	...	...	507'2(g)	...	...	...
15	North-West Frontier	{ 5'1 19'2 11'5 }	...	...	61'3	107'5	...	...	853'2	...	...	8190'5
18	Punjab . . . . .	...	3'9	...	11'6(b)	...	...	...	...	...	...	...
	Forest Surveys.												
9	Central Provinces (Básim Berar)	3'5	4'1(i)	...	...	...	...	...	...	...	...	...
	Bengal (Angul)	19'3	32'2(i)	...	...	76'7	...	...	...	...	...	...
	„ (Kodarma Estate) . . . . .	...	15'0(i)	...	...	...	...	...	...	...	...	...
	Assam (Sibságár, Gáo Hills, Nowgong, Darrang and Kám-rúp.)	5'2	26'6(i)	...	...	85'5	...	...	...	...	...	...
	Punjab . . . . .	...	...	...	...	24'6	...	...	...	...	...	...
	Burma (Katha, Mu, Mandalay, and Ruby Minas.)	8'6	19'9(i)	...	...	91'4	...	...	...	...	...	...
17	Bombay	11'7	13'2(i)	...	...	59'9	139'2	...	...	...	...	...
19	Madras	14'0	30'6(i)	...	...	123'3	...	...	...	...	...	...
20	Burma	7'7	43'9(i)	...	...	140'8	...	...	...	...	...	...
	Cadastral Surveys.												
4	Bhágálpur . . . . .	...	31'7	...	...	...	...	85'4	...	...	...	...
	Purnea . . . . .	...	47'8	...	...	...	...	73'5	...	...	...	...
5	Ranchi . . . . .	...	29'5	...	...	...	...	51'5	...	...	...	...
	Midnapore . . . . .	...	...	...	...	...	...	207'3	...	...	...	...
	Singhbhum . . . . .	...	...	...	...	...	...	47'2	...	...	...	...
6	Faridpur . . . . .	...	45'4	...	...	...	...	...	...	...	...	...
	Backergunge . . . . .	...	43'4	...	...	...	...	108'7	...	...	...	...
7	Pakkóku . . . . .	...	48'0	...	...	...	...	113'5	...	...	...	...
	Rangoon Town . . . . .	...	2064'3	...	...	...	...	...	...	3887	...	...
8	Moradabad . . . . .	...	23'8	...	...	...	...	40'4(n)	...	...	...	...
	Bánda . . . . .	...	...	...	...	...	...	25'6(h)	...	...	...	...
	Hamírpur . . . . .	...	...	...	...	...	...	29'8(h)	...	...	...	...
	Muttra City Survey . . . . .	...	...	...	...	...	...	...	...	...	1,855	...
	Brindaban City Survey . . . . .	...	...	...	...	...	...	...	...	...	1,576	...
	Moradabad „ „ . . . . .	...	...	...	...	...	...	36'3	...	...	1,200	...

by the field parties during the year 1904-05.

Cost-rate per acre, Cadastral Survey, including traversing, detail survey, and mapping.	COST-RATE PER SQUARE MILE.			Total cost inclusive of charges for instruments to Provincial Governments.	REMARKS.
	Stone embedding.	Records (Khanapuri).	Completion of vernacular records, assessment statistics, etc.		
R a. p.					
...	59,644(c)	
...	89,963	(b) Supplementary survey including preparation of field sections and fair mapping.
...	} (c)	(c) Includes R3,991 expended on traverse charts, district maps, and arrears of computations.
...		(d) Supplementary survey.
...		(e) On 12-inch scale.
...	106,311		(h) Includes R35,880 spent on riverain surveys for the Local Government, R35,471 on special surveys for military purposes and R18,375 on arrears of mapping.
...	97,527		(g) Cost included under head Cadastral Survey.
...	78,718	(i) Rate per linear mile.	
...	173,251	(j) Includes R1,524 cost of 4-inch boundary survey.
...	128,196(h)	(k) Includes 3,598 expended on arrears of mapping.
...		(l) Includes R700 publication charges and R6,000 purchase of elephants.
...	3,019	(m) Includes both map correction and survey based on new traversing.
...	20,979	(n) Includes R3,146 for bringing up records in Sagaing and Shwebo and also R3,318 for traverse charts of Burma.
...	2,156	(o) Expenditure met from Provincial budget or by municipality concerned.
...	30,759	(p) Map correction based on old traverse stations.
...		(f) Includes R12,670 expended on Trans-Frontier work.
...	6,453	
...	62,616	
...	77,568(k)	
...	107,642	
...	151,677(l)	
...	28'5	43,204	
...	35'6	214,226	
...	30'6	148,034	
...	104'1	21,111	
...	32'6	47,342	
...	85,983	
...	36'7	162,951	
...	1'0	...	...	131,057(m)	
...	65,539	
0 1 7(n)	2 2	...	...	51,460(o)	
0 0 6(p)	...	17'9	...	31,632(o)	
0 0 7(h)	...	17'5	...	38,787(o)	
2 14 5	...	19'8	...	5,305(o)	
2 7 5	1,844(o)	
...	2,931(o)	

Statement showing cost of Scientific Parties Survey of India for Survey Year 1904-05.

Number of Party.	Name of Party.	NATURE OF SCIENTIFIC WORK.								Total Cost of Party.	REMARKS.
		Astronomical determinations.	Principal Triangulation.	Determinations of Gravity.	Tidal observations.	Preparation of Tide Tables.	Leveling Operations.	Magnetic Observations.	Magnetic field work.		
22	Astronomical . . .	14,393	...	...	...	...	...	...	...	14,393	
23	Pendulum . . .	...	...	35,708	...	...	...	...	...	35,708	
24	Triangulation . . .	...	60,704	...	...	...	...	...	...	60,704	
25	Tidal and Levelling . . .	...	...	...	15,099	24,840	25,829	...	...	65,768	
26	Magnetic . . .	...	...	...	...	...	...	9,560	55,640	65,200	
	TOTAL . . .	14,393	60,704	35,708	15,099	24,840	25,829	9,560	55,640	241,773	

APPENDIX.

Report on Survey Operations with the Somaliland Field Force by Captain G. A. Beazeley, R.E.

Orders were received by Captain Beazeley to assemble a survey detachment for Somaliland at the end of December 1902. The party arrived at Obbia on 29th January 1904 and work was closed about the middle of June 1904.

Personnel.

Captain G. A. Beazeley, R.E., Deputy Superintendent, 2nd grade, in charge.

Captain C. G. W. Hunter, R.E. (joined as Assistant Survey Officer on 8th October 1903).

3 Surveyors, 40 *Khalasis* (10 of whom joined on 7th October 1903).

The work was heavily handicapped at the outset by lack of transport and facilities for extending the survey on either side of the line of communications, and with the exception of the

survey of the latter very little work could be turned out till Berbera was reached in July. The work with the Obbia column was carried out under very trying conditions as the marches were made in the heat of the day under a very powerful sun and water was often very limited. From September 1903 onwards, the party was employed to its utmost capacity except when delayed by the want of an escort when work had at times to be curtailed and even stopped, though a sufficiency of transport was always available. Had an assistant officer been available from the beginning, the whole of the work accomplished in British Somaliland with the exception of the country mapped during the Nogal and Northern Somaliland expeditions, could have been completed by the time Captain Beazeley arrived at Bohodle in May 1903, and this would have set the party free to survey fresh ground during the lull in the operations pending despatch of the force into the Nogal valley.

The different surveys carried out were as follows:—

- (1) Large scale survey of Obbia.
- (2) Obbia-Dibit triangulation and survey.
- (3) Route survey, Dibit-Galkayu.
- (4) Large scale survey of Galkayu.
- (5) Triangulation started at Galkayu.
- (6) Route survey Galkayu-Galadi.
- (7) Large scale survey of Galadi.
- (8) Route survey Galkayu-Bohodle.
- (9) Observations for latitude and longitude at Bohodle.
- (10) Route survey Burao-Upper Sheikh.
- (11) Triangulation Berbera-Eildab with branch to Lasdureh.
- (12) Large scale survey of Berbera.
- (13) Surveys on various scales between Berbera and Eildab based on points fixed by triangulation.
- (14) Reconnaissance surveys in the Nogal and north-eastern Somaliland.

Obbia Survey.—This was on the 12-inch scale, at the request of the Camp Commandant; to show the various camps, the landing place, water-supply, and native town, etc; it was carried out while preparations were made to push the survey on to Dibit.

Obbia-Dibit Survey.—A chain of triangulation 57 miles long and survey based on it was commenced on the 11th February and completed on the 25th. A persistent strong sea breeze and driving sand rendered work almost impossible at Obbia. The breeze continued through the night, and it always clouded over so that it was impossible to obtain more than an approximate latitude and azimuth. The longitude was obtained from the naval authorities. The area surveyed was 1,225 square miles, all on the $\frac{1}{4}$ -inch scale. The country was open and undulating with no marked features except sandhills and a maritime ridge of hills running parallel to the coast a few miles inland, rising to the west of Obbia to nearly 1,000 feet above sea level.

The route survey, Dibit-Galkayu, scale 1 inch = 1 mile—Was commenced on the 27th February 1903, and completed on the 3rd March, the distance being about 94 miles. The country was too flat to admit of triangulation and work was entirely carried out by plane-table traverse, distances being measured by the measuring wheel. The column marched in the middle of the day under a very powerful sun with a limited supply of water, and the march was a most trying one. The country was level with occasional patches of thick low thorn bush, but open otherwise, no hills except a few isolated knolls.

Galkayu Survey.—As the survey party were not allowed to leave Galkayu while the force was halted there, there was ample time to make a large scale survey of the post and its surroundings, and this was carried out on the 6-inch scale. A remarkable feature of the place was the Yamis chaem, a big bell-shaped water hole, with domed top that had partly fallen in, and vertical sides, the water being 160 feet below the level of the top. The

water was very deep towards the west and disappeared underground by a tunnel of unknown depth, quite inaccessible except by rope.

The Galkayu Triangulation.—Was started while halted at Galkayu but had to be abandoned owing to lack of transport, and other causes. A short base was measured, latitude and azimuth observed and 8 stations were observed from.

Route survey, Galkayu-Galadi.—This was commenced on the 26th March and completed on the 31st. The distance is 83 miles. The work was done on the 1-inch scale by plane-table traverse, except the last portion between Dudub and Galadi, where, as time was limited, the bush was thick and the open part was covered at night, the prismatic compass was used.

The thick high bush between Bera and Gondu rendered a plane-table traverse a most arduous task as no lagging behind was allowed. The country is level and devoid of any natural features. No theodolite could be taken but one was subsequently sent up before the party returned to Galkayu. As only one camel was allowed for everything including six days' rations, only five men could be taken. Halts were made during the heat of the day to rest the troops.

Galadi Survey.—In order to fully occupy the time spent at Galadi, Captain Beazeley carried out a survey of the 2,500 wells there on the 12-inch scale. These wells were for the most part crowded into a space of about half a square mile, the whole number lying within an area of about one square mile, thus showing what an important place Galadi was, and what a large population it must have supported. As a rule the wells held very little water which trickled through very slowly. A good many of them had been poisoned by corpses. All the depths were measured and recorded, none of them reached 70 feet in depth, the average being 16 feet. Most of the trees round the wells had been cut down and the white gypsum soil was very trying to the eyes. The place was surrounded by dense high bush. A 1-inch plane-table traverse was run to Yegallo, 5 miles to the north. The survey of Galadi could not be completed as all hands were required to assist in strengthening the defences of the place after the reverse at Gumburu, but 2,250 out of the 2,500 wells were cut in. The party left on 23rd April.

The Galkayu-Bohodle route survey.—Was executed on the $\frac{1}{2}$ -inch scale by prismatic compass traverse; time did not permit of a plane-table traverse being carried out, moreover the bush was too thick. Work commenced on the afternoon of 29th April, and was completed on the morning of 7th May. Captain Beazeley was put in charge of the small column. The distance traversed was about 147 miles. The country is level and mostly covered with dense bush except near Galkayu. The ground undulating near Badwein. A small hill was passed at Elbahai and a distinct ridge was passed at Damot. Two or three well-marked dry watercourses were passed on the march.

Operations at Bohodle.—While the party were halted at Bohodle between the 7th May and 24th June 1903, observations were carried out, when weather permitted, for latitude by circum-meridional observations to 16 pairs of N. and S. stars and the longitude was fixed by 3 sets of 20 telegraphic signals between Berbera and Bohodle, the naval authorities at the former post kindly assisting. Preparations were made to start a triangulation from Bohodle, and elevated stations to overlook the surrounding forest and bush were built, but the presence of bodies of the enemy put a stop to further progress, Captain Beazeley's squad having a narrow escape once. The party left for Berbera on 24th June 1903.

Route survey, Burao-Sheikh.—Major Craster, R.E., had made a route survey from Berbera-Bohodle and this was partly incorporated subsequently in the fair mapping of Somaliland, but a route survey by prismatic compass was carried out from Burao-Sheikh to enable Burao, which lies in the centre of a large plain south of the Golis range, to be cut in when running a triangulation down that way. The traverse was subsequently plotted on the $\frac{1}{2}$ -inch scale.

Berbera-Eildab Triangulation.—The party reached Berbera on 11th July 1903. After leaving Bohodle, and after refitting, the triangulation was first carried as far as Sheikh, then extended eastward to the Waggar mountains and a temporary base measured at Sheikh. A further extension eastward was then attempted but abandoned owing to lack of men, and the party proceeded south *via* Burao, and finally carried the triangulation as far as Kerrit where a small base was measured. The party then returned to Sheikh and arrived there 15th October. The party was then reorganized and strengthened by the addition of Captain Hunter and some *khalasis* and porter coolies, and the triangulation was extended from Kerrit to Eildab, when further triangulation was stopped by order of the General Officer Commanding. After the Nogal expedition, a base was measured at Berbera and the triangulation was extended eastwards from there to the hills surrounding Lasdureh. Further triangulation was then stopped owing to the breaking up of the Field Force in May and June 1904. The area of triangulation accomplished was 14,426 square miles and consisted of 75 stations and about 150 points.

Berbera Survey.—At the request of Major Craster, R.E., a large scale survey was made of Berbera for his railway reconnaissance, it was carried out on the 6-inch scale during September and October 1903.

Surveys between Berbera and Eildab based on the triangulation.—1,396 square miles of country round Sheikh were surveyed on the $\frac{1}{125,000}$ scale (approximately 1 inch to 2 miles); 4,218 square miles of country to the south and south-east of Berbera on the $\frac{1}{2}$ -inch scale; 1,253 square miles of country between Gololi and Eildab on the $\frac{1}{2}$ -inch scale.

More could not be accomplished owing to lack of *personnel* and sickness amongst the surveyors, and escorts could not always be supplied.

Reconnaissance surveys in the Nogal and north-east Somaliland.—An area of 6,109 square miles on the $\frac{1}{4}$ -inch scale was accomplished in the Nogal valley, based on plane-table traverse, and 6,135 square miles on the same scale and by the same method in north-east Somaliland. The work was most arduous and gave the party very little rest on the march and when halted. The work done in the Nogal valley was checked by astronomical latitudes but no theodolite or sextant could be spared for that carried out in north-east Somaliland.

The country traversed was utterly devoid of cultivation except a small patch round a mosque at Upper Sheikh, and no traces of any settled habitations were seen except at Burao, Upper Sheikh and the seaport towns. The entire population is *nomad* and wanders about in search of pasturage and water for their flocks.

The mountainous and hilly tracts of north and west Somaliland are suitable for a survey based on triangulation, but the rest is for the most part devoid of any marked features, except perhaps the maritime ranges on the east and south-east coasts, and traverses would have to be used to base the detail surveys on. Wells and water supplies are often at great distances apart.

Captain Hunter rendered invaluable service, he was a most zealous and indefatigable officer.

Sub-surveyors Mahomed Khan and Bhamba Ram worked very well and were most zealous, more especially the latter, who rendered great assistance at computations and in office to Captain Beazeley.

GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1904-05.

PREPARED UNDER THE DIRECTION OF
COLONEL F. B. LONGE, R.E.,
SURVEYOR GENERAL OF INDIA.



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