GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1900-1901.

PREPARED UNDER THE DIRECTION OF

COLONEL ST. G. C. GORE, R.E.,

SURVEYOR GENERAL OF INDIA.

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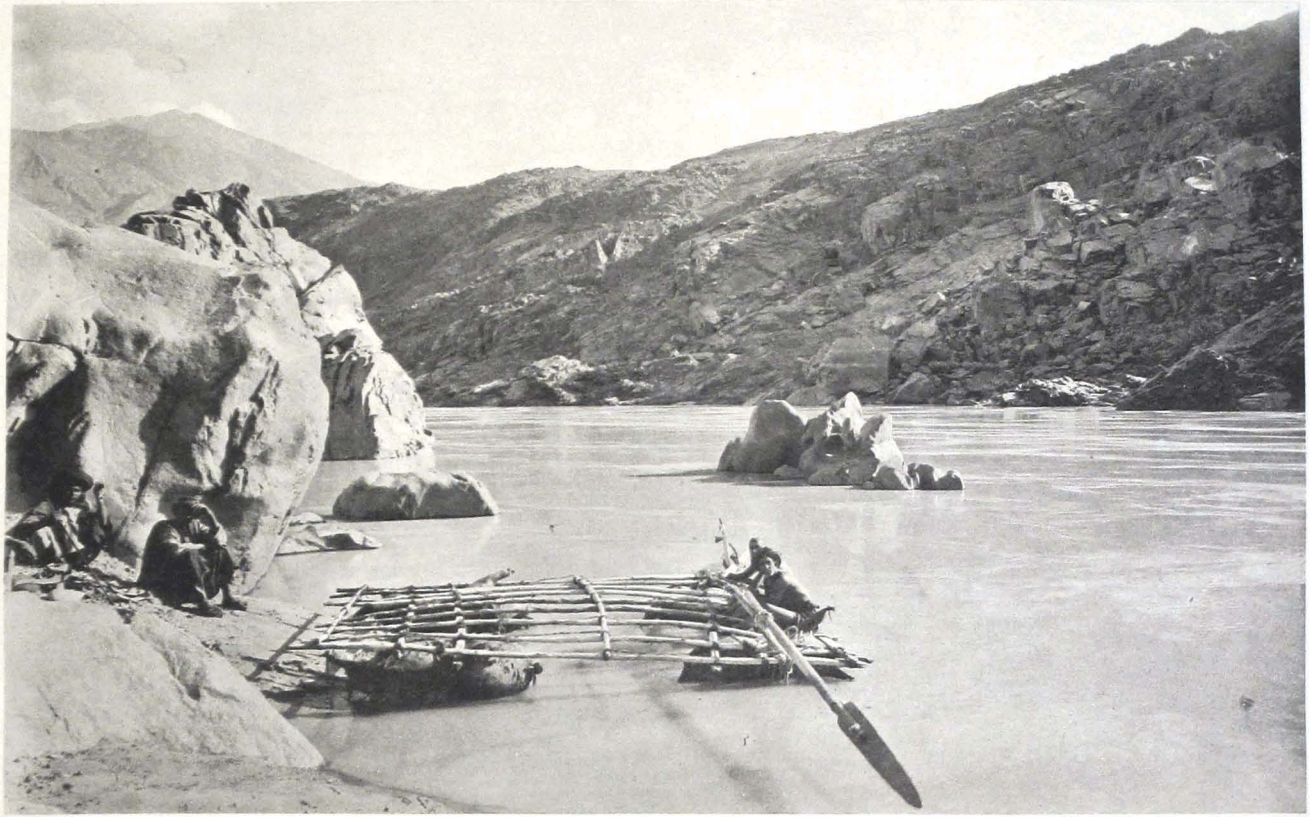

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1900-1901.

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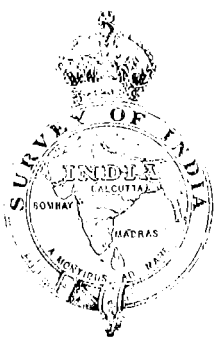

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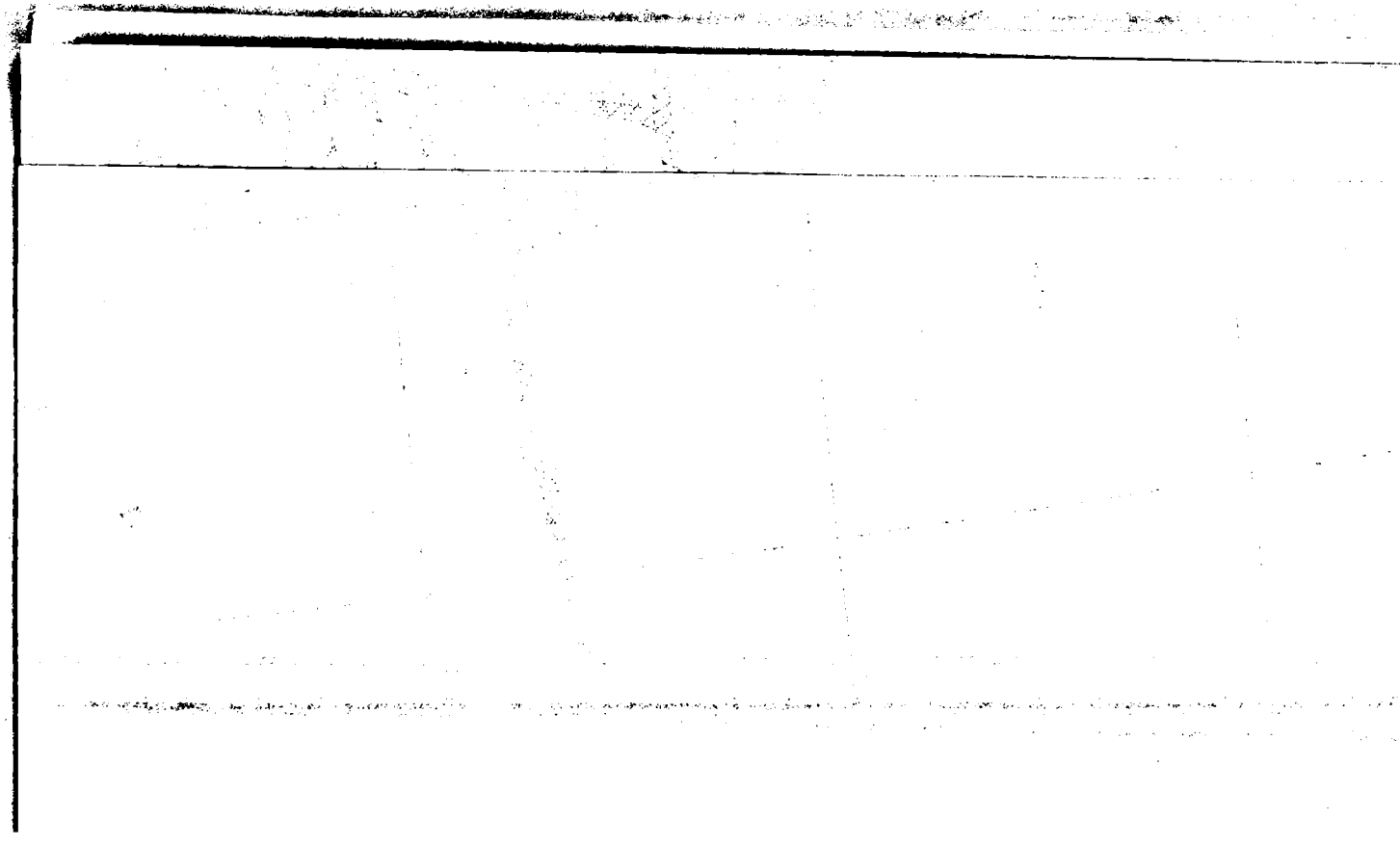


GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1900-1901.

PART I.

SUMMARY.

ADMINISTRATION.

Under the orders of the Government of India the present report, which deals with the operations of the Department for the survey year ending 30th September 1901, has been considerably curtailed and somewhat altered in form. Part III which hitherto dealt with the work of the several Head-Quarters offices is omitted, and the salient facts connected with these offices are incorporated in Part I. The number of Index maps illustrating the reports of the several parties is similarly reduced; a diagram indicates the progress of the forest surveys, and provincial index maps take the place of a large number of small indexes. The extracts from the narrative reports of the officers in charge of parties will no longer be printed as appendices to this report, but will be published separately in the "Professional Papers" of the Survey of India.

2. Colonel St. G. C. Gore, R.E., Surveyor-General, directed the general administration of the department and also superintended the Topographical Branch throughout the year.

Colonel J. R. Hobday, I.S.C., Deputy Surveyor-General, held charge of the Revenue Branch up to 30th March 1901, when he proceeded on leave and Major F. B. Longe, R.E., was appointed to officiate as Deputy Surveyor-General.

Major S. G. Burrard, R.E., superintended the Trigonometrical Branch throughout the year.

The office of Superintendent, Provincial Surveys, Bengal, was held by Major G. B. Hodgson, I.S.C., up to the 8th October 1900, and by Captain A. Mears, I.S.C., up to 5th November, when Captain R. T. Crichton, I.S.C., returned from leave and resumed charge from the following day.

The office of Superintendent of Provincial Surveys, North-Western Provinces and Oudh, was held by Mr. G. B. Scott up to 31st July 1901, when he retired and Captain W. M. Coldstream, R.E., succeeded him in the post.

The post of Superintendent, Forest Surveys, held for many years by Mr. W. H. Reynolds, was on his retirement on 30th September 1900 conferred on Major P. J. Gordon, I. S. C., who has carried on the administration throughout the year.

Inspection tours of the Administrative Officers.

3. The Surveyor-General proceeded on a tour of inspection to Burma on the 22nd February 1901, and after inspecting the operations of Nos. 3 and 10 Parties, and conferring with the Director of Land Records and Agriculture on the question of the maintenance of, and the information required to be shown on, the topographical maps, returned to Calcutta on the 21st March. On the 11th April he left for Simla, but on his way visited the Central Provinces Drawing Office at Jubbulpore and the Trigonometrical Branch Office at Dehra Dún, arriving at Simla on the 1st May. During his stay at Simla he visited the recess office of No. 18 Party, and settled preliminaries for its reorganization and amalgamation with the Punjab Traverse Detachment,

with a view to taking up survey operations in the plains of Punjab. He left Simla on the 30th July for Dehra Dún where he again visited the Trigonometrical Branch Office and the office of the Superintendent, Forest Surveys, Bengal Presidency. He also visited the magnetic observatory building which had just been completed. On the 5th August he proceeded to Mussooree where he inspected the recess office of No. 15 Party and the North-Western Frontier Drawing Office. He also visited there the offices of No. 4 Party and of the Punjab Traverse Detachment, and returned to Calcutta on the 14th August. On the 20th August he again left Calcutta and proceeded to Bangalore where he inspected the recess offices of Nos. 10, 11 and 21 Parties and visited the offices of Nos. 3, and 9 and 19 Parties; from there he proceeded to Kodaikánal Observatory, and thence to Poona where he inspected No. 17 Party. On the 16th September he left for Naini Tal, where he inspected the office of the Superintendent, Provincial Surveys, North-Western Provinces and Oudh, and also the Drawing Office attached thereto, and returned to Calcutta on the 26th September 1901.

4. Colonel Hobday inspected No. 4 Party and the Punjab Detachment at their recess quarters at Mussooree in October 1900. On November 17th he proceeded to Jubbulpore and inspected the Central Provinces Detachment, returning to Calcutta on the 20th idem. In January 1901 he inspected the Punjab Detachment in the field in the Montgomery district, and Nos. 2 and 8 Parties (North-Western Provinces and Oudh) at Sháhjahánpur, returning to Calcutta on the 5th February. On the 18th he went to Goalundo to confer with the Director of Land Records and the Superintendent, Provincial Surveys, Assam, on matters connected with the survey operations in that Province, returning the next day, and on the 22nd he accompanied the Surveyor General to Burma and inspected No. 7 Party at Mandalay and No. 3 Party at Toungoo and Prome. He returned to Calcutta on the 28th March, and proceeded on furlough out of India on the afternoon of the 30th idem, handing over charge to Major Longe, who accompanied the Surveyor-General to Jubbulpore on the 11th April to discuss with the officer in charge the future composition and work of the Central Province Detachment and inspected the office there. He returned to Calcutta on the 14th idem, and on the 29th he left for Azamgarh and there conferred with the Superintendents Provincial Surveys, North-Western Provinces and Oudh and Bengal, on the general arrangements as to superintendence and division of work between the administrative and executive officers in the two Provinces, with a view to modifying and reducing the heavy strain thrown on the shoulders of the Superintendent, Bengal Surveys, by the existing system. After visiting the office there he proceeded with the Superintendent, Provincial Surveys, North-Western Provinces and Oudh, to Mankapur, Balrámpur and Fatehgarh, visiting the various survey offices at those places. He returned to Calcutta on the 9th May and left for Assam on the 14th idem, inspected the office of No. 14 Party and the Assam Drawing Office at Shillong and the Assam Detachment at Tezpur. On the 3rd June he returned to Calcutta and left again on the 10th to arrange with the Surveyor-General the future programme of the survey parties under his charge and especially that of No. 18 Party, to which was to be added the Punjab Detachment, and that of No. 14 Party whose work in the Lushai hills it was decided to stop. Various circumstances detained him there till the 10th August, when he again returned to Calcutta. On the 23rd idem he left for Bangalore to inspect the recess offices of No. 3 and Nos. 9 and 19 parties, and to discuss with the Surveyor-General the future of the various survey parties then working in Burma. He returned to Calcutta on 16th September and left again on the 19th for Naini Tal to inspect the office of Nos. 2 and 8 Parties and the North-Western Provinces Drawing Office. Subsequently he proceeded to Mussooree and completed the final arrangements for the reorganisation of No. 14 Party, and for the amalgamation of No. 18 Party and the Punjab Detachment, and inspected the office No. 4 of Party at that place.

5. Major Burrard visited Mussooree in June 1901 and inspected No. 24 Party, and in July inspected Nos. 22 and 23 Parties. In August he inspected No. 18 Party at Simla. In September he inspected No. 26 (Magnetic) Party at Mussooree, and No. 25 Party (Tidal and Levelling) at Dehra Dún, and in October No. 12 Party (Sind) at Karáchi.

6. Major Gordon inspected the various detachments of the Forest Surveys in the field in the Central Provinces, Bengal, Jubbal and Tarhoch, and Hazára, and No. 20 Party in the field in Burma and also during recess at Dehra Dún.

FIELD PARTIES.

7. Field operations were carried on by one double and sixteen ordinary parties and three detachments; of these one was employed on trigonometrical, eight on topographical surveys, one double and one ordinary party on Forest surveys, two on cadastral surveys, three detachments on traverse surveys and four parties on scientific operations; the difference from the previous year being that a scientific party has been added to the list, and that the detachment employed on traverse operations in Bengal is not classed as a detachment, being reported upon under the head of cadastral surveys.

8. The operations of the Forest Survey Branch, which are under the administration of the Superintendent, Forest Surveys, are fully reported on in the Forest Survey Report, and are therefore only briefly mentioned here.

The surveys carried on by local agency in the North-Western Provinces and Oudh, which are under the general supervision of the Deputy Surveyor-General, have also been included in this report under the head of cadastral surveys.

9. In the following statement the whole of the operations are grouped according to the nature of the work on which the parties are employed.

Statement of Survey Operations and Parties.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey. (Inch = Mile)	Administrative Superintendent.
	Trigonometrical.				
24	India Triangulation	21	Captain H. H. Turner, R.E. Lieutenant H. Wood, R.E.	.....	Supdt., Trig.
	Topographical.				
3	Lower Burma	22	Mr. E. Litchfield	2=1 1=1	D. S. G., Rev.
10	Upper Burma	24	Captain F. W. Pirrie, I.S.C.	1=1	D. S. G., Topo.
11	Ditto	25	Mr. P. J. W. Doran	1=1	Ditto.
21	Ditto	26	Mr. C. F. Hamer „ A. J. James Lieutenant E. T. Rich, R.E. „ E. A. Tandy, R.E.	16=1 1=1	Ditto.
12	Sind	27	Mr. C. F. Erskine	2=1	Supdt., Trig.
14	Lushai Hills	28	Captain C. L. Robertson, R.E. Lieutenant C. P. Gunter, R.E.	1=1	D. S. G., Rev.
15	North-Western Frontier	29	Colonel R. A. Wahab, R.E. Captain G. A. Beazeley, R.E. Mr. E. A. Wainright	2=1 1=1 ½=1	D. S. G., Topo.
18	Himalayas, Punjab	30	Major W. J. Bythell, R.E.	4=1 2=1 1=1	Supdt., Trig.
	Forest.				
9 & 19	Madras Presidency	32	Mr. H. Todd	4=1	D. S. G., Rev.
17	Bombay Presidency	33	Mr. S. F. Norman	16=1 8=1 4=1	D. S. G., Topo.
20	Bengal Burma Central Provinces. Punjab	35	Forest Survey Branch	4=1	Supt., Forest Surveys.

Statement of Survey Operations and Parties—contd.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	Cadastral.				
2 & 8	North-Western Provinces and Oudh,	37	Mr. G. B. Scott Captain W. M. Coldstream, R.E.	Inch Mile 16=1	D. S. G., Rev.
4	Bengal	39	Major G. B. Hodgson, I.S.C. Captain A. Mears, I.S.C. „ R. T. Crichton, I.S.C.	16=1	Ditto.
7	Burma	46	Mr. E. G. Little „ J. Connor	16=1	Ditto.
	Traverse.				
	Assam	48	Mr. T. Shaw	.....	Ditto.
	Central Provinces	50	Mr. W. C. Price „ M. Gastaud „ R. C. D. Ewing	.....	Ditto.
	Punjab	52	Mr. R. B. Smart	.....	Ditto.
	Geodetic.				
22	India	55	Lieutenant H. M. Cowie, R.E.	.....	Supdt., Trig.
23	Ditto	56	Captain G. P. Lenox-Conyngham, R.E.	.....	Ditto.
	Tidal and Levelling.				
25	India	57	Captain H. L. Crosthwait, R.E. Mr. E. J. Connor	.....	Ditto.
	Magnetic.				
26	India	59	Captain H. A. D. Fraser, R.E.	.....	Ditto.

OUTTURN.

10. The total outturn of detail survey for the year amounts to 48,106 square miles, of which 17,000 are reconnaissance survey on the $\frac{1}{4}$-inch and smaller scales, and 31,106 square miles are rigorous surveys on various scales. To the total area may be added 17,000 square miles of reconnaissance survey on the $\frac{1}{3}$-inch scale surveyed by the officers and men of this and of the Intelligence Department attached to the China Field Force. A comparison with last year's outturn shows an increase of 1,688 square miles of rigorous survey, but a great decrease of reconnaissance work, mainly owing to there being no exploring parties at work on the North-East Frontier.

The total area triangulated, excluding 16,000 square miles by the survey detachment with the China Field Force, is 44,379 square miles.

The total area traversed for Cadastral Surveys is 6,997 square miles situated as follows—2,615 square miles in the North-Western Provinces, 3,611 in Bengal and 775 in Burma. This item is 1,147 square miles in excess of last year's outturn.

TRIGONOMETRICAL SURVEYS.

11. The Triangulation Party (No. 24) this year again worked in two sections, one of which carried on the minor meridional series, which had been commenced last year, and effected a satisfactory junction with the Mandalay Minor Longitudinal Series. The other section of the party commenced a new principal series which will run eastwards from the neighbourhood of Katha to the Salween, and then turn southwards along that river. Satisfactory progress was made by both sections.

TOPOGRAPHICAL SURVEYS.

12. The number of parties engaged on topographical surveys is the same as that of the previous year and the *locale* of their operations has been the same. Four of these, *viz.*, Nos. 3, 10, 11 and 21 continued to work in Burma, the three latter in Upper Burma and No. 3 in Lower Burma.

13. The work of No. 3 Party consists for the most part of surveying such portions of Lower Burma as have been untouched by the Cadastral Surveys. These latter have only taken up the survey of cultivated areas, so that many blanks remain on the standard sheets which must be filled up to render the sheets available as topographical maps.

The sheets taken up were for the most part in the Sandoway, Thayetmyo, Pegu and Toungoo districts. The outturn for the season was 1,130 square miles topographically surveyed on the 1-inch and 202 square miles on the 2-inch scale, and 600 square miles of triangulation in advance. The outturn is a comparatively poor one owing partly to the difficulties of the country but mainly to the extreme unhealthiness of the season. The country to be surveyed in the coming season is more promising, but it is a question for consideration how far such surveys are worth the cost. This point is being closely looked into.

14. The work of No. 10 Party is confined to the west of Longitude 96°30′ and consisted of 1-inch survey of parts of the Ruby Mines, Shwebo and Yamèthin districts, and of additions to and revision of the topographical maps compiled from the Cadastral surveys, such maps being quite useless for general purposes without such revision. The outturn of the season is 4,068 square miles of triangulation, 1,285 of original topographical survey and 2,023 square miles of revisionary survey. The cost-rates of the two latter are R26 and R22 per square mile respectively, showing that a complete resurvey would be only slightly more costly than revisionary work.

15. Nos. 11 and 21 Parties continued to survey the Shan States, the portions under survey being the country north and east of Lashio and that south-east of Lashio on the western side of the Salween river.

The aggregate area surveyed by the two parties was 6,686 square miles of triangulation and 4,265 square miles of topography on the 1-inch scale, an area considerably in excess of that of last year. Although a good deal of the country surveyed is rough and jungle clad, it supports a large population and considerable areas are under cultivation.

As the greater portion of the valuable and well-populated parts of the Shan States has now been surveyed, these two parties will be amalgamated and employed in completing such portions of the country on the 1-inch scale as may seem advisable, and in filling up and improving the $\frac{1}{4}$-inch maps of the outlying portions of Burma.

The result of the season's work in Burma is an addition to our topography of 8,905 square miles.

16. The survey of Sind on the 2-inch scale was continued by No. 12 Party in the northern part of the Province. An area of 2,553 square miles was topographically surveyed at a cost of R12 per square mile. In addition a large area was triangulated and traversed in advance.

17. No. 14 Party was again employed in surveying the Lushai Hills. Eight hundred and seventy square miles of detail survey were completed and 1,122 square miles of triangulation carried out. As the more important portion of the Lushai country has now been surveyed this party will be transferred to the North-Western Provinces for topographical purposes.

18. No. 15 Party as heretofore has been employed on various surveys for the Military Department chiefly in Sind, the Punjab and Kashmir. In Kashmir and adjacent countries although the work was very considerably interrupted by an abnormally stormy season, an area of 3,224 square miles was surveyed on the $\frac{1}{2}$-inch scale, and a carefully executed series of triangles covering an area of 5,000 square miles was carried in from the Kaghan valley as far as Gilghit. In Sind an area of 1,915 square miles was surveyed on the 1-inch scale.

To this party has been allotted the execution of the surveys of the various Military Cantonments which are required under the new Cantonment Act.

19. No. 18 Party, which has been for a considerable time surveying in the Kángra and Simla districts, has practically completed its original programme

during the year; 488 square miles were surveyed on the 1-inch, 951 on the 2-inch and 109 on the 4-inch scale. The Estate boundary survey of the Simla Municipality is being pushed on, and should be completed next season.

This party will in future be employed in the plains of the Punjab in compiling, testing and completing topographical maps from materials supplied by the Settlement maps. They will also undertake such special work, as Riverain Surveys, as may be required by the Punjab Government.

20. The total outturn for the year under the head of topographical surveys on various scales from 1-inch upwards amounted to 16,913 square miles against 14,547 square miles completed the previous year. The total is made up as follows:—

12,416	square	miles	surveyed	on	the	1-inch	scale.
4,388	"	"	"			2 "	"
109	"	"	"			4 "	"

FOREST SURVEYS.

21. The special surveys of Government Forests were, as in previous years, carried out by the Forest Surveys, Bengal Presidency, and by Topographical parties of the Survey Department. The general procedure differs widely.

22. In Bombay No. 17 Party, which is under the general professional superintendence of the Surveyor-General, is as regards its programme and the cost of operations entirely under the control of the Local Government. The Government of India has hitherto contributed a sum of R10,000 annually, in consideration of the topographical value of the survey of North Kánara, of which no reliable survey existed; as the survey of this district was completed during the year under report, this contribution will now cease.

23. In Madras the double Party, Nos. 9 and 19, is under the control of the Surveyor-General. In this Province one-third of the cost of the survey is paid out of Imperial funds.

24. In the Punjab No.18 Party, under the administration of the Superintendent, Trigonometrical Surveys, in addition to its regular topographical work, carries out the survey of forest lands in several districts.

25. The rest of the Forest Surveys in India are under the administrative charge of the Surperintendent, Forest Surveys, Bengal Presidency, under the orders of the Inspector-General of Forests and the administrative charge of the Surveyor-General. Revised orders for the adjustment of expenditure on these forest surveys have been issued by the Government of India, by which it is provided that the cost of all Forest Surveys, on a scale of not less than 4 inches to a mile, in the North-Western Provinces and Oudh, the Punjab, Central Provinces, and Burma, shall in future be uniformly distributed in the proportion of 30 per cent. to topographical surveys, in consideration of the topographical value of the work, and of 70 per cent. to Forests. The cost of surveys executed by Local Forest officers and of special surveys on a particularly large scale will, as heretofore, be borne by the Forest Department. The programme is arranged by the Surveyor-General and the Inspector-General of Forests.

26. In Bombay as in previous years the forests have been surveyed on three different scales according to their nature. Surveys were carried on in all three forest circles, the outturn on the various scales being as follows. On the 4-inch scale 410 square miles, on the 8-inch 255 square miles and on the 16-inch 11 square miles. The cost-rates were respectively R65, R107 and R113, comparing favourably with those of previous years. This party has suffered very severely from plague, a number of the best surveyors having died during the last few years, a loss which it is difficult to replace.

27. In Madras the double party, Nos. 9 and 19, continued work as before, surveys being carried on in the Kurnool, Cuddápah, South Canara and Coimbatore districts. The party suffered considerably in health but succeeded in mapping 1,378 square miles of forests at a cost-rate of R58 per square mile of detail survey.

28. In Burma No. 20 Party surveyed 873 square miles on the 4-inch and 5 square miles on the 2-inch scale, in Ataran, Rangoon, Pegu, Thayetmyo, Yamèthin and the Ruby Mines districts. The cost-rates of detail survey were practically the same as for last year, *viz.*—R97 per square mile. The rates for

traversing were considerably less and those for triangulation somewhat in excess of those of the previous season, the increase being solely due to loss of time caused by a necessary change in the programme during the field season.

29. In the Central Provinces 1,556 square miles of forest lands were surveyed by five detachments of the Forest Survey Branch, on the 4-inch scale at a cost-rate of R36, in Mandla, Damoh, and Chánda districts. The cost-rates of all classes of work, which may now be considered to have reached their minimum, are somewhat more favourable than for last year.

30. In Bengal the survey of the Singhbhum Reserved Forests on the 4-inch scale was continued by two detachments of the Forest Survey Branch. Three hundred and sixty-one square miles were surveyed at a cost-rate of R61 per square mile, about 25 per cent. less than for 1899-1900.

31. In the Punjab the survey of the Jubbal and Tarhoch State Forests was commenced, and 43 square miles were surveyed on the 4-inch scale.

In the Kángra and Hoshiárpur districts 50 square miles of forest were surveyed on the 4-inch scale and in the highlands of Kullu an area of 376 square miles of forest lands was mapped on the 1-inch scale.

32. The total outturn of Forest Surveys executed on various scales during the year amounts to 4,892 square miles, of which 2,838 square miles were surveyed by the Forest Survey Branch. The figures are as follows:—

	Square miles.
2-inch scale	5
4 „ „	4,621
8 „ „	255
16 „ „	11

CADASTRAL SURVEYS.

33. As in the preceding year, there was, during the year under report, one cadastral party in Burma under the direct administration of the Deputy Surveyor-General, while one was employed in Bengal and one in the North-West Provinces under his general professional superintendence, the programmes and cost of the operations being entirely under control of the Local Governments.

34. The main portion of the work of the Burma party lay in the Lower Chindwin district in Upper Burma. An area of 666 square miles was traversed and a cadastral survey of 808 square miles executed on the 16-inch scale. In Lower Burma the work consisted of the traverse of a number of isolated areas situated in dense jungle in the Sandoway district. An area of 105 square miles was completed.

35. In the North-West Provinces the establishment has been divided into three sections, traverse, cadastral, and drawing. The traverse section completed the traverse survey of districts Azamgarh, Farrukhabad, Mainpuri, Etáwah and Jálaun, and the scattered areas in Aligarh where cadastral survey is required. With the exception of a small area remaining in Etah this completes the programme of traverse survey at present required by the Local Government, and the bulk of the traverse party will now revert to Imperial work. The total area traversed was 2,575 square miles. The cadastral section completed the survey and *khasra*-writing in Gonda, Farrukhabad and the areas of Aligarh where such surveys were required. Operations were also carried on in Azamgarh, Mainpuri, Etah and Jálaun. The total area cadastrally surveyed was 3,944 square miles. During the year large scale surveys have been made of the towns of Cawnpore, Fyzabad, Ajodhya and Mainpuri. The scale adopted was that of 64 inches to the mile.

The drawing section is located at Naini Tal. Its cost is an Imperial charge and its employment is to construct topographical maps out of the material furnished by the cadastral surveys. The maps of two districts, Sháhjahánpur and Bareilly have been completed and those of Bahraich, Pilibhít and Kheri are in progress. It is somewhat doubtful whether these maps can be accepted as they are compiled or whether they will have to have their topographical detail revised and added to in the field before they are published. A close comparison which is about to be made between the maps of the Meerut district compiled from the cadastral surveys and those executed by the previous topographical survey of that district will throw light on this point.

36. In Bengal a considerable extension of cadastral surveys took place during the year. An area of 1,244 square miles was cadastrally surveyed on the 16 inch scale and the records written of 1,416 square miles in districts Monghyr, Patna, Darbhanga and Backergunge. The amount of traversing shows a very large increase on previous years, an area of no less than 3,695 square miles lying in districts Monghyr, Patna, Darbhanga, Purnea, Gaya, Backergunge, Singhbhum and Champáran. The sudden expansion of traverse work has heavily taxed the resources of the department.

The title of the Superintendent has been changed to that of Superintendent, Provincial Surveys, Bengal.

37. The total areas cadastrally surveyed during the season in the several provinces are as follows :—

	Square miles.
Burma	808
North-Western Provinces	3,944
Bengal	1,244

TRAVERSE SURVEYS.

38. In Assam the traverse detachment under the Superintendent, Provincial Surveys, traversed an area of 237 square miles, mainly of extension surveys of villages and of tea grants. A certain amount of boundary demarcation and survey was also carried on.

39. The Central Provinces Detachment was employed on traversing village boundaries and excised portions of Forest Reserves. The work was scattered through a number of districts, and an area of 845 square miles was traversed. The drawing section was occupied in compiling topographical maps from the cadastral sheets; the checking and correcting these sheets in the field is a work which will have to be carried out by this detachment.

40. The original programme of the Punjab Detachment was to run traverses over the Hazára district, but it was diverted to the Montgomery district and took up the work of traversing there, fixing the trijunctions of villages. In addition the commencement of a system of Riverain Traverse Surveys was made. These are being done with a view to determine the exact position of the Riverain boundaries which are now being fixed once for all throughout the Punjab. The total area traversed by the detachment was 2,670 square miles.

41. The total areas traversed during the year excluding those traversed by cadastral parties for their own surveys are as follows :—

	Square miles.
Assam	237
Central Provinces	845
Punjab	2,670

SPECIAL OPERATIONS.

42. No. 22 Party was employed during the year in determining astronomical latitudes on the Karáchi Longitudinal Series between the meridians of 67° E. and 72° E. Longitude. Observations were taken at eleven stations, the instrument used being Troughton and Simms' Zenith Telescope No. 1.

43. No. 23 Party was employed during the season on experimental work connected with the Jäderin Base line apparatus.

The experimental re-measurement of the Dehra Dún Base Line which took place last year showed the necessity of a very careful determination of the coefficients of expansion of the wires employed in the measurement. Apparatus was devised for the purpose and a very satisfactory determination was arrived at.

44. Tidal operations were carried on by No. 25 Party at thirteen stations throughout the year, seven of them being permanent. The observatory at Bushire was closed during the year, the observations there having been completed.

The Levelling operations were continued along the Eastern Bengal State Railway, the line crossing the Ganges river at Dámukdia Ghát and closing at Siliguri. Three different methods of carrying the levels across the Ganges were

employed as the river was far too wide to cross by the ordinary method of levelling. The agreement of the three methods was satisfactory. The outturn amounted to 211 miles of double levelling.

45. The Magnetic party which was formed in December 1900 was employed for the rest of the year in making preparations for the work. Base stations at which continuous magnetic records will be made are required at Bombay, Calcutta, Kodaikánal, Dehra Dún and Rangoon. At Bombay and Calcutta such observatories already exist, but unfortunately the introduction of Electric tramways in these two cities will vitiate their magnetic records and it has become necessary to arrange for other observatories which will be free from the effects of the electric current. It is hoped that these arrangements will be made in sufficient time to allow the field observations to be continued without break.

GEOGRAPHICAL SURVEYS AND RECONNAISSANCES.

46. Under this head are included surveys and reconnaissances which are executed on the $\frac{1}{2}$-inch or smaller scales. In Kashmir and neighbourhood an area of 3,224 square miles was surveyed on the $\frac{1}{2}$-inch scale, and on the N.-W. Frontier an area of approximately 20,000 square miles was mapped on the $\frac{1}{4}$-inch and $\frac{1}{8}$-inch scales.

A survey party, consisting of Major Renny Tailyour, R.E. (in charge), Munshi Ikbaluddin, K. S., and three surveyors, was sent with the China Field Force. Captain C. H. D. Ryder, R.E., being in China at the time was ordered to join the Field Force where he remained until the whole party returned in August 1901. Thanks to the energy of Major Renny-Tailyour and Captain Ryder, and the co-operation of the Intelligence Branch, the triangulation of 16,000 square miles of country was completed, and the large area of 17,000 square miles was mapped in detail on the $\frac{1}{2}$-inch scale. Major Renny-Tailyour has since been promoted to Brevet Lieutenant-Colonel.

HEAD QUARTERS OFFICES, CALCUTTA.

47. The general direction of these offices remained in the hands of Colonel St. G. C. Gore, R.E., Surveyor-General of India, throughout the year. The Revenue Branch Section was under Colonel J. R. Hobday, I. S. C., Deputy Surveyor-General, up to 30th March 1901, when he proceeded on leave and Major F. B. Longe, R.E., was appointed to officiate for him.

48. The other offices in Calcutta were, as usual, supervised by three Assistant Surveyor-Generals. The General and Topographical Branch Sections as well as the Mathematical Instrument Office were under Major Longe, R.E., up to 30th March, and thereafter under Major G. B. Hodgson, I.S.C. The Drawing, Engraving and Map Record and Issue offices were under the supervision of Major J. M. Fleming, I. S. C., throughout the year, while the Photo-Litho. Office was under Mr. T. A. Pope, up to 15th November 1900, when he proceeded on furlough and Mr. A. E. Spring succeeded him. Major Hodgson was on duty at Head-Quarters from 26th November 1900 to 30th March 1901.

49. In the *Correspondence Office* there has practically been no change in the procedure.

50. *Drawing Office.*—The Geographical Section has been engaged on the compilation of the various general maps, as well as the bringing up to date and adding to sheets when fresh material is available, and preparing for press and publishing these, as well as sheets received from the various field parties. Of the North-East and South-East Frontier Series seven sheets have been completed and published, while ten more are passing through press or in hand. Eight more sheets have been added to or brought up to date. Many of these sheets are in several sections, additions having been made from time to time, or more reliable work substituted for that already drawn. As this causes frequent mistakes, an attempt is now being made to join up all the latest material in single sheets. Several have been thus treated and the result should be a considerable saving in time in reproducing them when required. Of the North-western Frontier Series two sheets on the 1-inch and $\frac{1}{2}$-inch scales have been brought up to date.

Of the 1-inch standard sheets, five of the Burma maps have been under preparation, and of these three are either at, or almost ready for, press. Thirteen other sheets have been prepared for press and published, while additions to five more have been made. Of the standard sheets of the rest of India 45 have been in hand, and of these 25 have been published, the remainder being under publication or awaiting further material. Of the Madras Forest Survey on the 4-inch scale, 47 sheets have been dealt with, and of these 35 have been completed and published. Nineteen Provincial maps on various scales have been brought up to date. Of District maps on the $\frac{1}{4}$-inch scale, 25 have been added to in various ways. These maps, particularly in Assam and Bengal, are mostly compiled from old Atlas sheets, and often in a very unsatisfactory state. Several complaints have lately been received about them; one stated that a river shown on the map was 15 miles out of its true position, another that on one of these maps, along a road inserted from extra-departmental sources, the adjoining villages fell on the wrong sides of the road, while a third stated that owing to changes all over, the sheet supplied was utterly useless. Twenty-two of the Administration report maps on different scales have been in hand, and of these seven have been completed and published. Of the sheets of the Atlas of India 116 have had additions made to topographical features or names, while eight have had hills brush-shaded for the Engravers, and a considerable amount of brush-shading on other maps has also been done. The various Departmental General maps of India on various scales have all been in hand for revision, and most are now quite up to date, and will shortly be ready for issue, revised in railways and boundaries. Progress on the new 64-mile map has been suspended for the present owing to press of work, but a considerable amount of outline in one sheet has been engraved. It is now proposed to prepare this sheet by reduction from a new 32-mile map of India. The compilation of the duplicate 64-mile map of India has made satisfactory progress, while that of the new material for the outline of the new 32-mile Litho. map of India is practically finished. A new edition of the 48-mile railway map has been issued, but as the stones are very much worn out and the map somewhat out of date, a new edition is under preparation, and is well advanced. The 32-mile map of India showing railways with stations has at last been published, while that on the same scale showing railways and canals has been brought up to date in railways and boundaries, and will, it is hoped, shortly issue. It is intended to bring out a new engraved map of India on the 32-mile scale, and a good deal of revision of the existing map on the same scale as well as of fresh compilation has been accomplished. Of the new $\frac{1}{1,000,000}$ scale map of India and adjacent countries two sheets (Nos. 78 and 83) are approaching completion in outline, and another has been projected. It is now intended to engrave at once such sheets of this map as reliable material is available for, instead of bringing out a preliminary photo-zinco edition as was originally intended.

The maps of various cities and cantonments have been brought up to date or added to, and new maps of Maymyo on the 16-inch scale in 15 sheets and of Aijal in two sheets on the 24-inch scale have been sent to press, and the first published.

As usual there has been a very large amount of extra-departmental work.

A series of 23 maps of the various Provinces or Districts of India was prepared under instructions received from the Census Commissioner. Some of these had to be subsequently added to or modified at the request of the local officials, and two additional maps to supersede the one first supplied have been prepared for the Central Provinces. The Route map of the Punjab and Bengal Command has been most troublesome from various causes; but it is hoped that the latest proof submitted to the Military Authorities will be finally approved. Eight sample sheets (comprising Bihar and part of Bengal) of a proposed new postal Atlas of India on the 8-mile scale have been in hand, and proofs have been supplied to the postal authorities for approval. Other maps have been prepared for the Archæological and Botanical Surveys, and for the Foreign, Military, Forest, and Medical Departments.

The Section has been until the latter part of the year much handicapped by lack of supervising Establishment and at times work has been carried on under great difficulties. Owing to this, the much needed revision of the map catalogues has had to be delayed, though that of Madras is now ready for press.

Now that a sufficient staff is available, this work will be resumed and it is hoped completed before long. The Catalogues of Bengal, North-Western Provinces and Punjab are already well advanced.

51. In the Examining Section, which has been particularly handicapped from want of efficient supervision, 2,358 sheets of sorts have been dealt with, showing once more an increase of work done.

52. In the Revenue Section of the Drawing Office the maps of Calcutta on the 6-inch and 3-inch scales have been published. Neither being very satisfactory a commencement has been made of an engraved map on the larger scale, and a considerable amount of outline has already been made over to the Engravers.

Maps of Allahabad, Bareilly, Bhâgalpur, Cawnpore, Rangoon and Quetta have been in hand either for preparation or revision for republication.

The Peshâwar District Standard sheets, prepared from old Revenue maps, supplemented by revision work from the *Patwaris* Survey, have been published without the external boundaries, which, as taken from the professional Topographical Surveys, it has been found impossible to reconcile with the features on these sheets. An attempt will be made to enter these after a resurvey which is contemplated, and when completed a new edition will be brought out. One hundred and forty-seven standard sheets (37 being first editions) of the Punjab, North-Western Provinces, Assam, Bengal, Bombay, Central India, and Burma have been dealt with, and are either at press or republished. Several of the Burma sheets have been completed to margin from material supplied by the Director of Land Records. Thirty-seven of the Bengal and North-Western Provinces sheets which are out of print, have again, as no originals fit for reproduction are available, been prepared for press by touching up old litho. prints with white lead. These will have to serve as originals until something better can be provided; this procedure involves much labour, and the results are hardly fit for civilized use, and bring undeserved discredit on the Department, which is forced to issue them if the Public is to have any maps at all of these districts.

Several new index maps have been prepared and the existing ones revised and brought up to date. Two thousand and forty-seven pages of extracts from traverse data have been copied, checked, and supplied as required to Departmental or other Government Officials. A final examination has been made of the traverse records of Muzaffarpur and Shwebo and these have been now lodged in the Map Record and Issue Office.

Sixty traces, and copies of 336 original village plans have been supplied to district officials, while 900 applications from private parties for copies of original records have been received and disposed of during the year. On these applications 2,500 copies of map or traverse data were supplied, the Government fees realized amounting to R1,388.

Thirteen thousand, nine hundred and twenty-three maps for issue to the Public have been coloured and examined, and in addition 2,317 pairs of office copies have been either newly prepared or brought up to date and compared, making a total of 2,782 in all which have been thus scrutinized. The renumbering of all the existing Burma sheets rendered necessary by the recent change of number of the standard sheets has been taken up in this Section, and 8,986 printed sheets have been dealt with. Almost all the 1-inch standard sheets have been completed, but the majority of the 4-inch still remain to be done. This task has been a very laborious one; the new sheet numbers have been pasted over the existing ones, the numbers of adjoining sheets in the index table being altered by hand. Index maps giving the new numbers have been distributed as widely as possible, but still a considerable amount of misunderstanding and confusion results from the change, both in the office and amongst the outside public, and is inevitable for some time to come.

53. In the Cadastral Section the 252 sheets of the Tikâri Wards Estates remaining over from last year, with 34 sheets since received have been published. Of the Burma Survey 2,960 sheets remained over from last year, and during the year 6,531 sheets of districts Shwebo, Katha, Minbu, Yamèthin, Myingyan and Upper Chindwin in Upper Burma, and 1,343 sheets of districts Toungoo, Lower Burma, were received from the field party. Of this large total of 10,834 sheets, 4,897 have been published during the year, leaving a balance of 5,937 sheets in hand. Complaints have been received from the civil authorities regarding the slow rate at which these cadastral sheets are being delivered, but as at present

worked the outturn depends mainly on the number of zinc plates which can be prepared for the press. The printing has now been quickened and can deal with the maximum number of plates which can be got ready daily for the press. The only method of increasing the outturn is to utilize Vandyke's process for preparing the plates. Unfortunately the original cadastral sheets are unsuited for direct reproduction by this process as they are rendered opaque in many places by white paint obliterations and by notes pasted on them. It is hoped that arrangements can be made by which this office will be supplied with traces of the sheets which can be directly printed by Vandyke's process on to the zinc plates. If this is done a small temporary increase to the zinc printing establishment will enable the outturn to be almost doubled. Enquiries are also being made as to the possibility of so preparing the original cadastral sheets in future as to render them capable of being reproduced directly on to the zinc. The total number of maps passed for press in the Section was 5,207, of which, as above stated, 5,183 have been actually printed, 1,228 of these having been zincographed from transfer traces prepared in the Section. In addition a good deal of miscellaneous work has been done for Collectors, Settlement Officers, etc., while *Badar* corrections have been made in the field area statement of the Chakla Roshnabad Estate.

Twenty-five sheets of various districts have also been reprinted at the request of the Civil authorities to replace others lost or damaged.

Thirty-eight sheets of the Calcutta City Survey have been revised. Of these 12 have been examined and sent to press, and the remainder will be shortly taken in hand.

54. The outturn of work in the *Engraving Office* is practically the same as last year. Three new Quarter Atlas sheets have been completed and published, while new material has been added to 74 Quarter sheets which are in various stages of progress. One hundred and fifty-eight published quarter plates and 57 old full plates have had additions or corrections made to them, while 44 new quarter sheets have been projected or had borders cut.

The new 32-mile map of India which it is intended to bring out in 12 sheets has progressed. Sheet 9, containing however little detail, has been reprojected and is completed, while matrices of sheets 7 and 10 have been received, and are being corrected before duplicates are prepared. Sheet 8 is being reprojected in order to have new material engraved, as will also be done with sheets 1 and 12. The old 64-mile map with hills has been brought up to date as far as possible and published, and sheets 1 and 2 of the duplicate map have had entirely new material on the east and west frontiers engraved on them in outline, and a good deal of the lettering completed as well, and have also been brought up to date in railways and spelling of names.

A large piece of new outline has been cut on sheet 3 of the new map on the same scale, but it has been decided not to proceed further with this map at present. The maps of India on the scales of 1 inch=80, 128 (with hills and outline) and 256 miles are all in hand being altered largely to bring them up to date, and are approaching completion. A matrix of the route map of the Western Himalayas has been corrected and the engraving of the large amount of new material will be shortly commenced. The 16-mile Provincial map of Madras in 6 sheets has been practically finished in outline, but it has been decided to improve it by adding the entire detail in the Mysore State, and this will delay the publication for a little. The four sheets of the Punjab map on the same scale have all been in hand, particularly heavy additions as well as corrections having been made to sheets 1 and 3. These should be completed before long and the result will be a much enlarged and improved map. The maps of the Central Provinces, Central India Agency, Rájputána, Mysore and Gujarát on the 16-mile scale have all been attended to, while the map of the Punjab on the 32-mile scale has been in hand for names, and that of the Berars on the 8-mile scale has been brought up to date. Two new provincial and three new district maps for administration reports have been completed, while three and 27 respectively have been added to, and a similar map of Darjeeling has had the hills completed.

Considerable progess has been made with the outline of a new 6-inch map of Calcutta, while much other miscellaneous work has been done. Altogether 477 plates have been dealt with.

Twenty-three plates have had corrections filled in by electro-deposition which continues to give satistactory results. The copper-plate printing section pulled 25,917 impressions, the increase on last year's outturn being mainly due to the number of scales, etc., printed, and transfers of 30 Atlas sheets were pulled and sent to the Photo.-Litho. Office where the required copies were printed from stone. Until such time as additional space and presses are available, this is the only way in which the public demand for these Atlas sheets can be met, and the results are of course far inferior to those obtained direct from the copper-plate. Over 100 Atlas sheets are still out of print and a further supply must be obtained in this way to assist the copper-plate presses.

Two hundred and seventy plates have been steel-faced during the year.

55. In the *Photographic and Lithographic Office* the outturn of work during the year has been the largest on record. The number of departmental maps received for publication, excluding cadastral maps, amounted to 1,197 or 214 more than last year, while the total number of copies printed was 192,466, or 93,290 in excess of last year. The actual amount of map printing done for the Survey Department was thus nearly double that done last year. This satisfactory outturn is to be attributed in a great measure to the small increase made during the year to the number of zinc-correctors and compositors and to the three new zinc presses received, which have enabled the zinc-printing section to complete a large quantity of outstanding work, chiefly standard sheets. The arrears mentioned in paragraph 60 of last year's report no longer exist, and now that the establishment in this section is up to its proper strength they will not be allowed to accumulate again. As regards work done for other departments and officials there is also a very considerable increase, in spite of the fact that fewer demands have been made on the office for maps and diagrams to illustrate annual reports. The total number of extra-departmental subjects received was 2,112, or 578 more than last year, while the number of copies printed was 708,355, or an excess of 119,762 over last year. There was an enormous increase in the number of cadastral maps dealt with, which was rendered possible by the introduction of the new method of direct zincography, without negatives or transfers, described in last year's report. This process enabled the office to undertake the reproduction of a large number of Bengal Cadastral maps, and these have been disposed of at the rate of about 30 daily. But as the Cadastral printing staff was insufficient to deal with the printing of these, this work has been done, by special arrangement with the Bengal Government, as overtime. This arrangement is to cease in April 1902, when the Bengal Drawing Office will undertake the reproduction of their own Cadastral work, and consequently it is not to be expected that the very large outturn of this work shown by the Photo.-Litho. Office for the past year will occur again. The total number of cadastral maps received during the year was 13,142, or 8,200 more than last year. Of these 8,125 were Bengal maps reproduced by the new process, and printed as overtime work : the remainder were sheets of the Burma Cadastral Survey, and were photo-zincographed, or zincographed from tracings, in the usual manner. The total number of copies of complete villages printed was 252,995 as against 162,733 printed last year. Of these 85,590 were copies of Bengal sheets, of which, as a rule, only ten copies are printed.

The aggregate number of copies printed in the machines and presses, comprising both departmental and extra-departmental work, amounted to considerably over a million, the exact figures being 1,153,816 as against 850,502 last year. Even omitting the 85,590 copies of Bengal Cadastral maps printed out of office hours, this total represents an outturn considerably larger than any previously recorded.

56. In the Type-printing section the amount of work done also shows a large increase, though fewer separate pages or items, were set up. The total number of copies printed was 984,189, or 172,062 more than last year. This section moved into the new building erected for its accommodation in January 1901 and is now working under much more satisfactory conditions than formerly.

The Silver-printing Section also records an increase of work done. Of ordinary silver-prints, the demands for which vary a good deal, 2,119 were made, or 1,148 more than last year. Of cyanotype, or blue prints, which are supplied as

proofs to the Drawing Office before transferring work to zinc or stone, there were 2,866, or 474 more than last year.

57. The Heliogravure Section shows an all-round increase, especially in the number of photo-etched plates and prints made. The number of plates etched was 115, or nearly double the number turned out last year, while the number of prints made was 58,782, as against 56,570. These included the usual work for the Technical Art series, and for the Indian Museum, to illustrate the Zoology of R. I. M. S. *Investigator*, and also a large number of prints to illustrate various publications of the Geological Survey, and the Honourable Mr. Buckland's work on "Bengal under the Lieutenant-Governors."

58. The following maps may be mentioned as the most important on which the office was engaged during the year:—

The Railway and Canal map of India in six sheets, on the 32-mile scale, which is under preparation for the Government of India, Public Works Department, was practically completed, and proofs were supplied, which were approved and returned with press order in July 1901. The publication of this important map is, however, still deferred, as the Drawing Office have made numerous corrections to topographical details and boundaries. It is hoped that it will be published before the end of December 1901.

The old 32-mile map of India, with hills, which has been so constantly added to and corrected during the past 13 years that the stones are completely worn out, is to be superseded by a new and greatly improved map on the same scale, and this work has been in progress throughout the year. The hills are being drawn on stone in chalk, to be printed in brown, which will be a great improvement to the appearance and legibility of the map. At the close of the year only one of the six sheets, No. 2, was completed in all respects; the hills on sheet No. 5 were drawn, and the outline work on sheets Nos. 4 and 6 was in progress. The sheets are being put in hand as fast as material is supplied by the Drawing Office, but it is impossible at present to give any forecast of the probable date of publication.

The Railway map of India, on the 48-mile scale, with hills in grey, was again brought up to date and printed off. Of provincial maps, a map of Assam and a map of the North-Western Provinces and Oudh, each on the 32-mile scale, were printed, and a map of the Punjab and Kashmir, on the 16-mile scale, was taken in hand. Of plans of cities and cantonments may be mentioned a map of Maymyo, in two colours; and new editions of the various 3-inch maps of the City of Calcutta. Five hundred and thirty-two standard sheets of the Topographical and Revenue Surveys, on various scales, were dealt with during the year, either as reprints or new editions.

59. While on furlough during the year Mr. T. A. Pope, the Assistant Surveyor-General in charge, visited the Ordnance Survey Office at Southampton, and found that certain improvements had recently been introduced there in the methods of photo-zincographing large maps. These are not now put down on zinc by means of paper transfers, but are printed direct on the plates from reversed negatives, thereby preserving the sharpness of the original and greatly facilitating the proper registration of colour work. In order to introduce this method into the Calcutta Office a camera has been indented for, and is shortly expected, large enough to photograph a standard sheet in one negative. The difficulty hitherto experienced, whenever this method has been tried in the past, in obtaining proper contact between the zinc plate and the negative, is overcome by the use of a new form of pneumatic printing frame, which is also being procured. If no unforeseen difficulties arise, and none are likely to occur, this camera will completely revolutionise our present old-fashioned method of reproducing the larger publications of the department. All the coarseness due to the use of paper transfers will disappear, as will also the faulty registration which so frequently disfigures maps printed in colours, more especially in the case of standard sheets with hills printed in brown, due to the irregular expansion or shrinkage of the paper transfers at present employed. Some difficulty may be found in using the new method in the case of maps which have been drawn for reduction, in several sections, but these can probably be overcome; and the practice of drawing originals on an enlarged scale for reduction in the camera will, it is hoped, prove unnecessary in most cases, as the direct reproduction now aimed at should entirely preserve the sharpness of the original drawing.

The new camera has been built by Messrs. A. W. Penrose and Co. of London under Mr. Pope's personal supervision. It is fitted with a Zeiss lens of suitable powers, and a reversing prism working in front of the lens.

60. The process invented and patented by Sub-Conductor F. R. Vandyke, R.E., of the office, for the direct reproduction of drawings upon a zinc surface, without negatives or transfers, which was described in last year's Report, has been modified in some particulars and is now simpler than ever. A description of the changes introduced is being published amongst the Professional Papers of the Survey of India for this year. The process has been in daily use throughout the year, but has been almost entirely restricted to the reproduction of Bengal Cadastral maps. In April 1902, when this work ceases to be done in this office, the process will be more generally available. It is then proposed to utilise it for the reproduction of the regular Cadastral work of the department. The expensive, tedious and utterly unsuitable process by which these maps have been produced for many years past, involving as it does, the upkeep of a costly staff of photographers, is no longer necessary and should be abolished at the earliest possible moment. It will only be necessary to furnish this office with a tracing of each sheet, as has been done during the past year in the case of the Bengal sheets. Such tracings cost on an average about R1/- or R1/2/-each, including examination charges, and the charges incurred in this office for the preparation by the Vandyke process of the usual small number of copies would amount to about R2/. According to our present scale of charges for Cadastral maps, the same number of copies cost about R11/. In addition to the enormous saving that would thus be effected there are other advantages; the work turned out would be better and more legible; practically no corrections would be required on the zinc; and a very much larger quantity of work could be produced in a given time. Under the present system and with the existing establishment and photographic apparatus it is impossible to turn out more than 16 cadastral plates per diem by photo-zincography, and four or five by zincography from tracings in addition, and the work takes three days to complete. By the Vandyke process 30 or 40 plates, requiring no touching up by hand and ready for immediate printing, can be prepared daily with ease, and could be printed on the same day. Of course the printing of this number might entail some addition to the existing number of presses, but even this is not certain, as the plates are more easy to print than those prepared from transfers, of which the experience of the past year has given proof. Moreover the two presses now used for transferring and proving the cadastral sheets would no longer be required for this work and could be utilised for printing purposes.

The Government has purchased the right to use Sub-Conductor Vandyke's invention for a sum of R10,000. A specimen plate is attached to the end of this summary to give an idea of the quality of the results which the process is capable of producing.

61. In the *Map Record and Issue Office* the difficulty of keeping pace with the rapid accumulation of records is being more acutely felt every year.

The increasing number of original maps which continue to pour into this office, is choking up all available accommodation; under these circumstances the Curator has been driven to makeshift expedients which must eventually lead to confusion; many valuable records were being damaged by unsatisfactory storage, and others ran much danger of being eventually lost amongst unassorted heaps which were beginning to attain unmanageable dimensions.

Every effort is being made to remedy this state of affairs, and 2,000 new shelves have been provided as a first step towards establishing a more satisfactory system. Room was found for this addition by utilizing the space above the old racks and carrying them up to the roof; this region was formerly too dark to use, so a row of small clerestory windows had to be provided. Nearly all the 2-inch and 4-inch maps of the Punjab, Central Provinces, Burma, North-Western Provinces and Bombay are now satisfactorily stored, but this can only be regarded as a commencement, as it is impossible to carry out such changes otherwise than gradually with the available staff, without allowing current work to fall into confusion; even the work of clearing out maps to make space for the new racks, has hampered the office considerably, so that all hands have recently had to work overtime and on holidays almost continuously. The Assistant Surveyor-General in charge reports that they deserve all praise for the way they have faced the

situation, but men cannot be expected to maintain this high pressure indefinitely, and an increase of the staff to keep pace with the extra work will soon become inevitable. Very much more work of the same nature will be required before the arrangements for the proper storage of new maps, which continue to pour into the office, can be considered adequate or satisfactory.

62. About a quarter of a million of maps, having an aggregate cost of R275,881, was issued during the year, R10,105 being realised from private purchases.

The number of new maps received for publication was 8,038, of which 7,874 were cadastral sheets. Besides this over 6,000 original volumes, maps, etc., were issued from the office to other branches of the department and large number returned to store.

63. Great credit is due to Major Fleming, Assistant Surveyor-General in charge of this office, for the energy and ability he has shown in undertaking the very onerous work of rearranging and providing storage room for the maps which had accumulated far beyond the existing means of accommodation.

64. In the *Mathematical Instrument Office* the most important event of the year has been the preparation of a scheme to provide for the reorganization of the workshops on the principle of substituting a piece-work system for the present one of maintaining a fixed establishment of workmen on monthly wages. The sanction of Government was accorded to this proposal after the close of the year under report, and a change of this kind can only be introduced gradually; but it may be confidently expected that, under good management, a marked increase of economy and efficiency will result.

It is proposed to put an officer on special duty to supervise the inauguration of this system and to thoroughly overhaul the whole existing arrangements.

The office was originally started as an indispensible branch of the Survey Department, but is now extensively used by all the Civil and Military Departments of India; so that the outside work has become many times greater than that for the survey, although the latter has itself grown. In order to reap the full benefit of the elasticity which has been accorded to the workshops, it is most necessary that the whole organization should be somewhat remodelled with a due recognition of the nature of the work now required, so that the office may be able to deal promptly and efficiently with all demands made upon it, which has of late been a matter of increasing difficulty every year; it is hoped that these changes may be effected by reorganization rather than by increase of establishment. It will of course be impossible for the full benefits of the piece-work system, or even a large proportion of them, to become apparent during this transition period; but, by taking the main principles in hand at once as above proposed, it is likely that the eventual development will be more permanent and satisfactory.

65. The outturn does not differ very materially from that of the previous year, but the number of instruments dealt with has on the whole increased. The value of instruments issued and received, is, in each case, between two and a half and three lakhs of rupees, the issues being somewhat in excess of the receipts. Besides this, nearly six thousand instruments, or slightly more than last year, were put into repair for Public officers.

Over eight thousand repairable instruments were deposited in store; this is nearly twice as many as in the previous year; every effort is being made to reduce the large unwieldy stock of repairable instruments, and over 8,600 were made serviceable and issued, so that the net result for the year was a reduction of 411 in the number of instruments in the store.

With reference to this, it may be noted that the conversion and repair of old pattern Levels and Theodolites alluded to in paragraph 401 of last year's Report has steadily progressed, and during the year 165 Levels and 66 Theodolites were converted into serviceable instruments. This makes a total of 792 Levels and 365 Theodolites converted since the special establishment for this work was sanctioned, and all indents, except for special pattern Theodolites, have been complied with from this source; all indenting to England on this account has thus been avoided, but as the stock has run dangerously low, this will now have to be done to some extent, until it can be more rapidly replenished by the workshops. There is always a liability for unforeseen and urgent indents to

arrive, and any inability to comply promptly with them may cause serious and costly delay in the commencement of railway surveys or other such important undertakings.

The number of indents complied with was 1,499, showing an increase of about 4 per cent. on the previous year, and there has been some increase in the value of the workshops outturn, while on the other hand, the value of instruments indented for from England was £49,661, which is slightly less than last year, and the value of purchases in the local market also shows some decrease.

These figures are subject to very arbitrary fluctuations, but on the whole they show satisfactory efforts in the direction of economical working; without the freedom which the new system will afford no very great development in this respect could be expected.

BRANCH OFFICES.

66. The superintendence of the *Trigonometrical Branch Office*, Dehra Dún, was in the hands of Major S. G. Burrard, R.E., throughout the year. Mr. J. Eccles, M.A., held charge of the technical offices up to 20th February 1901, when he proceeded on leave after having made over charge of his duties to Mr. C. H. McA'Fee, who continued to be in charge to the end of the year.

67. Two Professional Papers, No. 3 "Method of Measuring Geodetic Bases by means of Colby's Compensated Bars," and No. 4 "Notes on the Calibration of Levels", were completed and issued; and the printing of the Tidal Volume, containing the details of the Tidal Observations taken during the period from 1873 to 1892 and a description of the methods of reduction, having been completed, it has been placed in the hands of the binders and will shortly be ready for publication. The Longitude Volume, containing the results of observations for re-determining the longitude of Madras from Greenwich, is being passed through the press. The compilation of the Levelling Volume, which is to contain the results of the levelling operations in India, has been begun.

A recalculation of the attraction of the Himalaya mountains upon the plumb-line has been made. The original calculation was made in 1854 by Archdeacon Pratt: the results of the two calculations give the following deflections of the plumb-line in the meridian :—

	1854	1901.
At Dehra Dún	...	72″2
„ Kaliána	27″853	36″2
„ Kaliánpur	11″968	18″4
„ Hámargída	6″909	10″0
„ Cape Comorin		3″4

The problem of Himalayan attraction has never yet been solved; Archdeacon Pratt's conclusion was that a deficiency of matter was underlying the Himalayas and compensating their attractive effects, and in his view this great mountain mass exercised no influence on our plumb-lines. In recent times, however, large deflections have been observed in Sub-Himalayan regions, and these cannot be explained by the Archdeacon's theories. The deflection of the plumb-line at Dehra Dún has been found by actual observation to be 38″ greater than the deflection at Kaliánpur. A calculation of the effects of the superincumbent Himalayan mass based on the theory of gravitation shows that the deflection at Dehra Dún should be 54″ greater than at Kaliánpur. The observations at Dehra Dún do not therefore support the theory of a complete or even considerable compensation. On the other hand if the Himalayan mountains are exercising the great attraction that may be inferred from the observations in Sub-Himalayan regions, it is difficult to understand how no effects are visible in the Gangetic and Central Indian Plains. A classification of all available data was made during the summer of 1901: the results have been considered and will shortly be published in a professional paper.

68. On page 13 of the Annual Report for 1899-1900 allusion was made to the measurement of the Dehra Dún Base-Line with the Jäderin apparatus. The observations could not be reduced until the coefficients of expansion of the wires had been re-determined: the re-determinations were made at Dehra Dún during the winter of 1900-01 by Captain Lenox-Conyngham and are described

in Part II of this Report. With their aid the measurements of the Dehra Dún Base-Line have been reduced and are as follows :—

With the Jäderin wires :—

		Miles.	Yards.	Feet.	Inches.
1st measurement .	39187·171 =	7	742	1	2·052
2nd ,,	39187·373 =	7	742	1	4·476

This gives a discrepancy of 0·202 feet, or 2·424 inches, which is equal to $\frac{1}{194,000}$th part of the length of the Base.

The mean of the above measurements is 39,187·272 feet, which is less than the very accurate determination made by Colonel Everest with Colby Compensation Bars in 1835 by 0·190 feet or $\frac{1}{206,000}$th part of the total length.

These results show that the apparatus will be probably fitted for use in Burma ; a discrepancy of $\frac{1}{206,000}$th part of the length is however comparatively large, and an improvement is hoped for : the number of times, that the measurement of a Base-Line will have to be repeated with the Jäderin apparatus cannot be decided until more experience has been gained.

General Walker measured the Cape Comorin Base-Line four times with the Colby apparatus of Compensation Bars, and obtained the following results :—

1st measurement	8912·5926 feet.
2nd ,, ...	8912·5856 ,,
3rd ,, ...	8912·5892 ,,
4th ,, ...	8912·5943 ,,
Mean . .	8912·5904 feet.

The respective discrepancies between the four individual measurements and the mean were :—

0·0022 *feet* or	0·026 *inches* or	$\frac{1}{4,050,000}$ *part of total length.*
0·0048	or 0·058	or $\frac{1}{1,860,000}$
0·0012	or 0·014	or $\frac{1}{7,430,000}$
0·0039	or 0 047	or $\frac{1}{2,390,000}$

Satisfactory as the first results with the Jäderin apparatus may be considered, their inferiority to those obtained with Colby's Bars is evident.

The advantages gained by the use of the Jäderin apparatus instead of the Compensation Bars are the rapidity with which the bases can be measured and the smallness of the party required to carry out the measurement. It has been found possible to measure with the Jäderin wires about 3,000 yards a day, whereas with the Compensation Bars the rate seldom exceeded 300 yards. A Jäderin Base-Line requires the presence of four Imperial and two Provincial officers, while a Base-Line measured with the Compensation Bars needs four Imperial and eight Provincial officers.

69. The Sub-Surveyor who accompanied the Archæological Research Party under Dr. Stein to Central Asia surveyed the country round Khotan and acquired valuable geographical information. His work and the exploration work of two other sub-surveyors who worked in the North-Eastern Frontier are being reduced.

70. The work in the Photo-Zincographic Section was heavier than usual. In addition to the reproduction of the maps of the Forest Department and standard maps, a heavy indent from the Quarter Master General is being worked out. Six hundred and eighty-three subjects were reproduced during the year, against 618 in the preceding year ; and the outturn shows a number of 63 721 pulls against 55,536. The actual number of copies of maps, etc., was 46,995 against 44,270, and their value ₹26,584 against ₹20,376.

71. The usual meteorological and magnetic observations and the solar photography were continued. In the appendix a chart will be found giving an interesting comparison of the mean monthly temperatures at Dehra of (1) the air in the shade, (2) the ground at a depth of 12·8 feet below the surface and (3) at a depth of 25·6 feet below the surface. It will be noticed that the summer temperature reaches a depth of 12·8 feet three to four months after the time of greatest temperature on the surface, the winter temperature only lagging two months. At a depth of 25·6 feet the extremes of temperature are reached four to five months after he surface extremes, ard the whole range is under 3°.

72. Three officers of the Imperial Service, Lieutenants A. A. McHarg, R.E., M. O'C. Tandy, R. E., and F. C. Hirst, I. S. C., went through a practical course of trigonometrical, topographical and astronomical work; and nine of the Provincial Service and 23 Sub-Surveyors were put through a course of topographical surveying and mapping.

73. The offices of the *Forest Surveys, Bengal Presidency*, at Dehra Dún, were employed, as usual, on correspondence and accounts, computations, area statements, mapping of field surveys, compilation of special maps and the upkeep of the records of the Forest Department. During the year 156 maps have been sent to press, 181 were in the press on the 30th September, and 319 are in different stages of progress. Four thousand, nine hundred eighty-four printed maps have been coloured and 2,702 mounted in book-form for Forest and other Civil officers.

74. *Local Drawing Offices.*—The system of locally compiling topographical maps on the 1-inch scale from old and miscellaneous material combined with the productions of the latest cadastral work, has gradually called into being several drawing offices whose work is carried on under the immediate superintendence of the survey officer in charge of the local cadastral party, and which are thus in a position to take advantage of all available local information. In so far as their work consists of topographical compilation it is charged to the Imperial revenues; and they also form a convenient centre to which special draftsmen can be attached when necessary to deal with miscellaneous cadastral work.

Of these the Bengal drawing office at Calcutta has this year been transferred from the charge of the head-quarter drawing office to that of the Superintendent, Provincial Surveys, Bengal; the outturn of work is detailed in the report on No. 4 Party in Part II.

The North-West Provinces drawing office under the Superintendent, Provincial Surveys, North-West Provinces and Oudh has carried on similar work in Naini Tal; details are given in the report of Nos. 2 and 8 Parties.

The Assam drawing office has been working on the same principle under the Superintendent, Provincial Surveys, Assam, and has been moved during the year to Shillong; its outturn is noted in the report on the Assam Detachment of which it forms a part.

75. Small drawing sections were maintained throughout the year by No. 17 Party and the Central Provinces Detachment, at Poona and Jubbulpore respectively. No. 18 Party had a section permanently employed at Simla on miscellaneous work; and in Bangalore the topograpical parties maintained an office with No. 21 Party to compile and bring up to date maps of Burma and the Eastern Frontier.

76. *The North-West Frontier drawing office*—under the superintendence of the officer in charge No. 15 Party—was employed as usual at Mussooree on transfrontier compilation, and a certain amount of miscellaneous work for the Intelligence Department. In addition to this a small amount of revision and correction of 1-inch Punjab maps was carried on, and a commencement has been made with three sheets of the new map of "India and adjacent countries" on the scale of one to a million.

ESTABLISHMENT.

77. The department has lost the services of two officers of the Imperial Service during the year.

Mr. G. B. Scott, Officiating Superintendent, 1st grade, and Superintendent, Provincial Surveys, North-Western Provinces and Oudh, retired from the service on the 31st July 1901. Mr. Scott joined the Revenue Branch of the Provincial service on 1st May 1863 and was promoted to the Imperial Service in November 1884. During his earlier service he was mainly conspicuous for his military services on and beyond the North-Western Frontier. From 1867 until the termination of the 2nd Afghán war, he was employed chiefly on trans-frontier and military survey operations, and for his gallantry and excellent services he was presented with a sword of honour and received two medals and several clasps. He was several times mentioned in despatches and his services were acknowledged by the Punjab Government, the Commander-in-Chief, the Viceroy and the Secretary

of State. He was recommended for a direct Commission as Captain in the Indian Staff Corps. Mr. Scott was attached to the Intelligence Branch of the Quarter Master General's Department on two occasions. From 1887 Mr. Scott held charge of important cadastral survey operations in Burma and in 1894 he was transferred to the North-Western Provinces to superintend the cadastral survey operations under the orders of the Local Government. He was in every way a most excellent officer and his able management of the large cadastral operations earned for him an extension of two years' service.

Captain H. J. Hare, R.E., Deputy Superintendent, 2nd grade, died on the 16th November 1900. He joined this department on 8th January 1897. During his short service, of nearly four years, he was mainly employed on Topographical Survey operations in Burma. During 1898-99 he served as Survey officer with the Burma-China Boundary Commission, and during the field season of 1899-1900 he carried on special survey work in the Irrawaddy Valley north of Myitkyina. His health had been far from good for some time past and he was granted privilege leave for a short change to Ceylon, where he died. Captain Hare was a very keen and promising officer and his loss will be much felt in the department.

78. In the Provincial service the department has lost the services of twelve officers during the year, *viz.*, by the retirement of Messrs. T. E. M. Claudius, W. C. Price, E. G. Little, H. Dowman, H. T. Hanby, C. D. Potter, J. A. Barker, G. D. Cusson, T. S. Marten, and C. W. Wilson, and by the deaths of Messrs. J. A. Higgs and W. H. D. Ewing.

SPECIMEN OF THE VANDYKE PROCESS.

This page has been entirely reproduced by the new Vandyke process, which is being generally brought into use for the reproduction of Cadastral Maps.

The original of this specimen having been drawn on thin Bank-post paper, the following is an estimate of the time and labour required for the whole process of reproduction:—

(1).—One man preparing the plate, half an hour.

(2).—Printing 500 copies in Machine Press, less than an hour.

For further particulars see para. 60, page 15, of this Report.

SURVEY OF INDIA OFFICES, CALCUTTA.

PART II.

THE OPERATIONS OF THE SEVERAL FIELD PARTIES.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 Party.

79. The party remained under the charge of Captain H. H. Turner, R.E., until 10th April 1901, when he proceeded on furlough, and handed over to Lieutenant H. E. Wood, R.E. The latter availed himself of three months' privilege leave from 27th June 1901, and the charge during his absence devolved on Mr. J. Bond.

80. The party left recess quarters at Mussooree on October 12th and reached Sagaing, Upper Burma, on November 1st.

Here the party separated, as in the previous year, into two sections: one under Captain Turner, with the head-quarters, travelled by rail to Katha, there to start a new principal series—"The Great Salween"—which is to proceed eastwards from the base Katha H. S.—Ubyetaung H. S., a side of one of the figures of the Mandalay Meridional Series; while the other, under Lieutenant Wood, went by steamer to Kalewa on the river Chindwin, to continue the Manipur Minor Meridional Series which had been commenced last year.

81. As no advance stations had been built for the new principal series, Captain Turner was delayed for some time at Katha, but he commenced observing on November 23rd, and, although much hindered by bad weather, completed the first figure, a tetragon, and observed six of the angles at two stations of the next. He also observed an astronomical azimuth at Simpitaung H. S. The country does not offer much difficulty for triangulation, but as the hills are densely clad with large tree jungle, the work of clearing the station sites is heavy.

Lieutenant Wood after a long journey by river and road began observing on November 20th. He was delayed during that month and December by the cloudy weather, thick mists blotting out the hills; but in January the weather improved, and work then proceeded rapidly.

The two final stations of the Mandalay Minor Longitudinal series (run last year) were connected to the Manipur series with satisfactory results, a mean difference of only 0″·02 in Latitude, 0″·03 in Longitude and 3″·6 in Azimuth being obtained between the values as computed by the two series. On February 22nd work was stopped by the smoke of the burning forests.

82. The party, with the exception of Mr. Hunter and a few men, reassembled at Rangoon and proceeded *viâ* Calcutta to recess quarters at Mussooree, where the office reopened on 27th March 1901.

Mr. Hunter remained for about six weeks in Burma exploring the following localities in order to discover sites for future base lines:—

(1) the Mansi district, about Latitude 24°·30′ and Longitude 95°·45′;
(2) Upper Chindwin district, in Latitude 24°·45′ and Longitude 95°·30′;
(3) the Meza Valley in Katha district;
(4) the Kyauksè district;
(5) the Sittang Valley in Toungoo.

The places which will probably prove suitable were found in the Kyauksè district and the Sittang Valley in the Toungoo district.

83. Captain Turner used Troughton and Simms' 12″ Theodolite No. 3, observing on 12 zeros with from 4 to 6 measures on each zero.

Lieutanant Wood worked with the sister instrument No. 2, and observed on 4 zeros with 4 to 6 measures each.

The season's outturn of work was as follows :—

Captain Turner's (Principal) Triangulation.

Number of stations newly fixed	3
Number of figures completed	1
Length of series completed, in miles	49
Area of triangulation, in square miles	1,730
Astronomical azimuths observed	1

Lieutenant Wood's (Minor) Triangulation.

Number of stations newly fixed	10
Number of figures completed	10
Length of series completed in miles	96
Area of triangulation, in square miles	1,850

Captain Turner's mean triangular error was o″·57.
Lieutenant Wood's " " o″·78.

84. The Superintendent, Trigonometrical Surveys, inspected the party in recess quarters at Mussooree on June 21st, 1901.

TOPOGRAPHICAL SURVEYS.

LOWER BURMA.

No. 3 Party.

85. Mr. E. Litchfield continued in charge of the party throughout the year.

86. The party left recess quarters at Bangalore on the 7th November 1900 and arrived at the head-quarters camp at Prome on the 16th. The field season was closed about the 20th May, and the office opened at Bangalore on the 3rd June 1901.

87. The party was divided into three camps. The head-quarters camp at Prome; camp No. I under Mr. Keating, in the Pegu district; and camp No. II, under Mr. George, in the Sandoway district. Mr. Donaghey was detached for the triangulation in Sheets 163 and 164 and Mr. Claudius for detail survey on the 1-inch scale in Sheet 159 in the Thayetmyo district. These two officers were under Mr. Litchfield's personal supervision.

88. The programme for the season, as modified, comprised :—

(*a*) The detail survey on the 1-inch scale of a strip of the Arakan Yomas, in the Sandoway district, situated between the crest of the Yomas on the east and Longitude 94° 30′ on the west; and of the unsurveyed areas in Sheets 118, 119, 120.

(*b*) The detail survey in the Thayetmyo district on the 1-inch scale of as much of Sheets 115 and 159 as possible.

(*c*) In the Pegu district the completion of the 2-inch survey of Sheets 259 and 260 and, if possible, of Sheets 261 and 262.

(*d*) Subsidiary triangulation in Standard Sheets 163 and 164 to assist the detail and revision survey of those sheets.

(*e*) Subsequently orders were received to complete the unsurveyed areas in Standard Sheets 253, 254, and 255 in the Toungoo district; and in March, on the completion of part of his triangulation, Mr. Donaghey, with Sub-Surveyor Mitchell, was sent to undertake the traversing required in those areas.

89. The outturn of the field season's work is as follows :—

	Sq. m.
Detail survey on the 1-inch scale	900
Revision " " " "	230
Detail " " 2-inch "	202
Triangulation	600
Traversing	74

The outturn compares unfavourably with that of the previous seasons, due primarily to an exceptionally unhealthy season, owing to which barely more than the equivalent of three and a half months' field work was obtained. It would seem advisable to alter the date of taking the field in these unhealthy localities.

BURMA SURVEY.

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

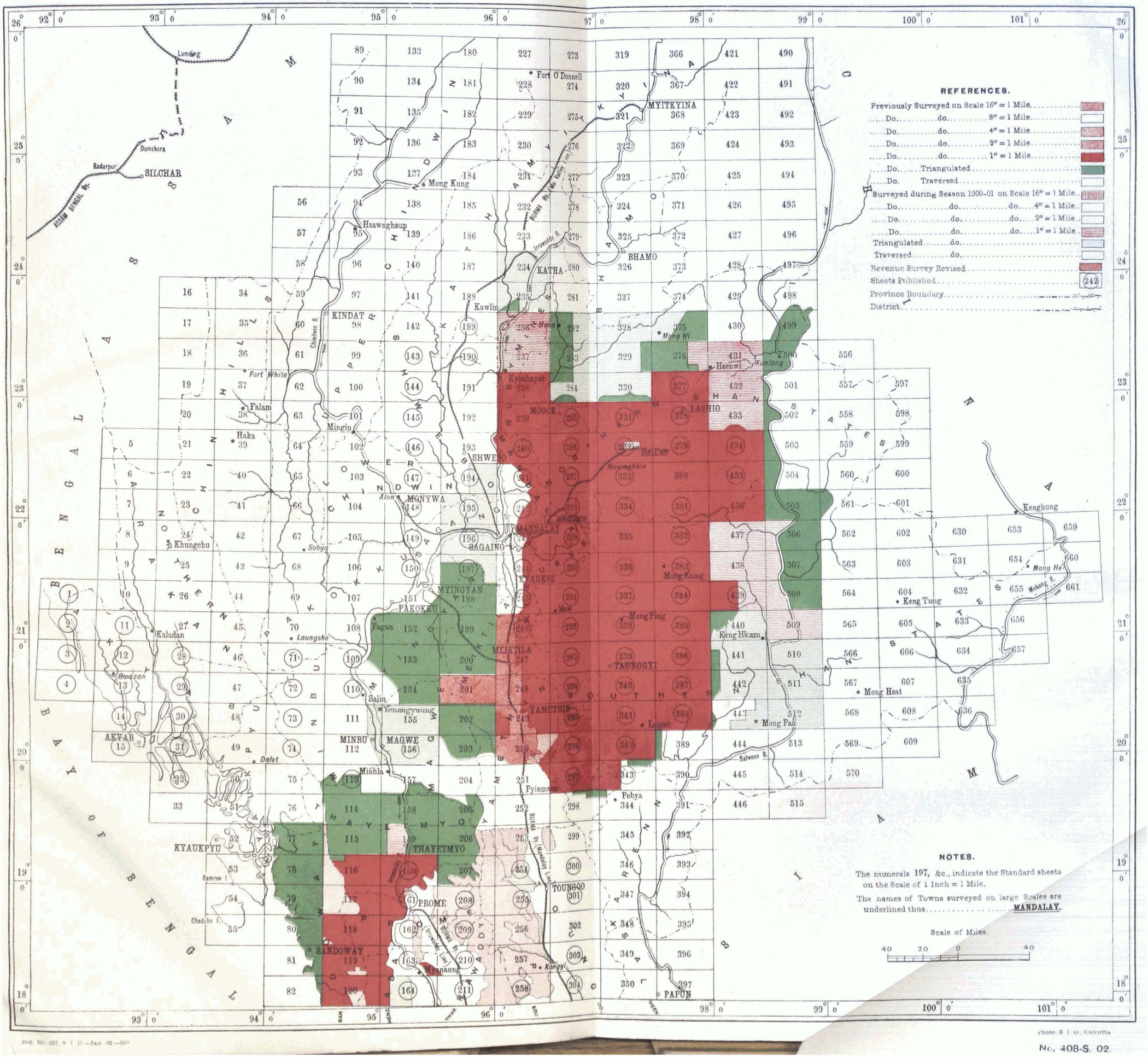


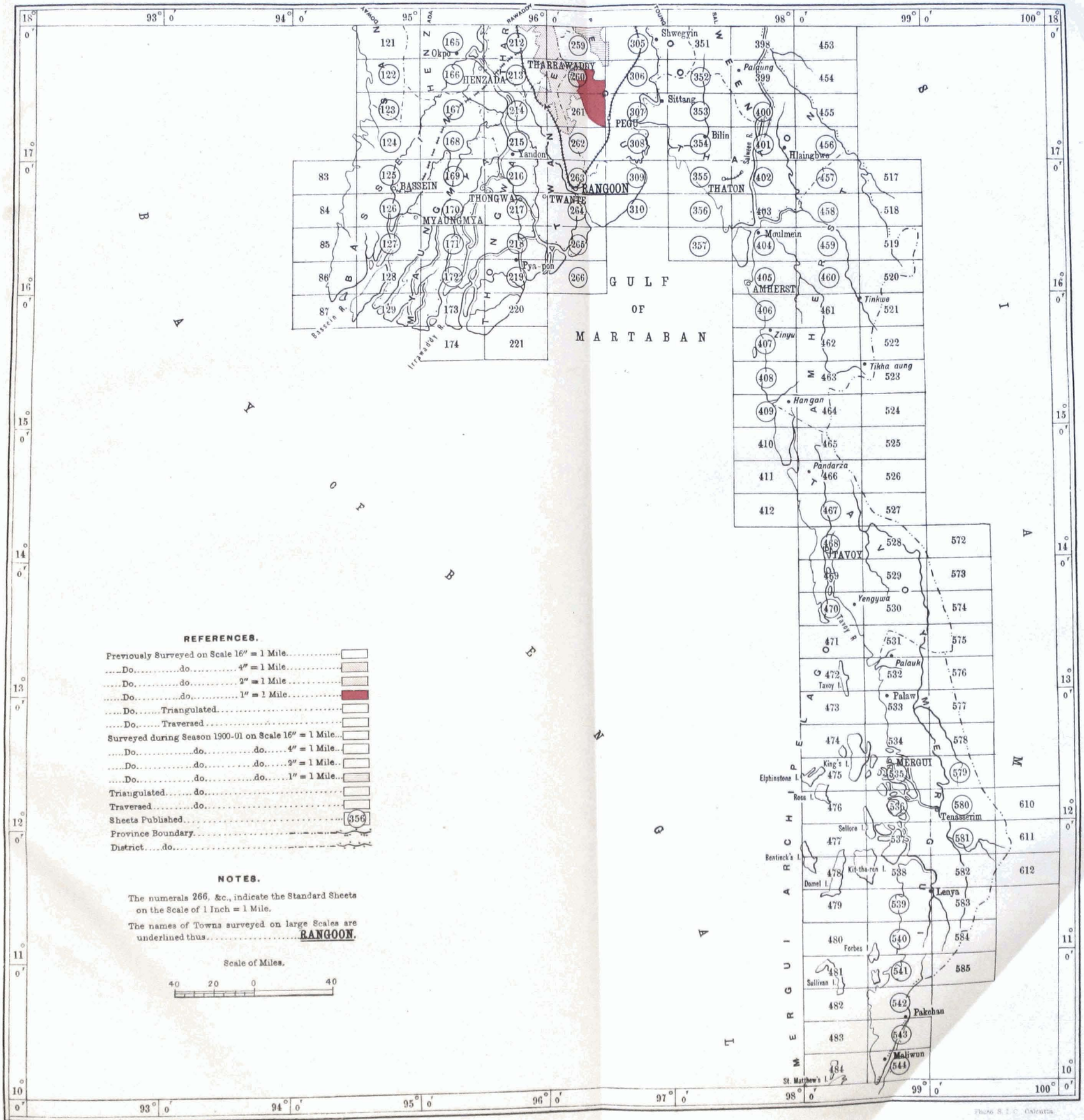
Photo S. I. O., Calcutta.

No. 408-S. 02.

Reg. No. 537, S. I. O.—Jan. 02.—350

BURMA SURVEY.

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



REFERENCES.

Previously Surveyed on Scale 16″ = 1 Mile.....
.....Do.....do.....4″ = 1 Mile.....
.....Do.....do.....2″ = 1 Mile.....
.....Do.....do.....1″ = 1 Mile.....
.....Do.....Triangulated.....
.....Do.....Traversed.....
Surveyed during Season 1900-01 on Scale 16″ = 1 Mile...
.....Do.....do.....do.....4″ = 1 Mile...
.....Do.....do.....do.....2″ = 1 Mile...
.....Do.....do.....do.....1″ = 1 Mile...
Triangulated.....do.....
Traversed.....do.....
Sheets Published..... (356)
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.

40 20 0 40

Photo S. I. C. Calcutta.
No. 409-S. 02.
Reg. No. 870. S. I. D.—Jan. 02—350.

and the local medical authorities will be consulted on this point. In such places the establishment becomes incapacitated and no more work is done in seven months than would be done in four under healthy conditions, while the expenditure continues making the cost-rates very high.

The total expenditure of the party is ₹89,889 and the cost-rates are as follows:—

Detail survey on the 1-inch scale	₹ 43	per square mile.
" " " 2-inch "	" 141	" "
Triangulation for 1-inch survey	" 12	" "
Traversing	" 68	" "

90. No fair comparison can be made between these figures and those of last year. The detail survey represents virtually about three and a half months' work against six months' expenditure. The 2-inch survey was based entirely on traversing executed some years ago; only a few of the stations were found, and if the survey had been delayed another year a re-traverse would have been necessary. All the features were chained, no interpolation being possible and progress was necessarily slow.

91. The party suffered severely from malarial fever throughout the field season, which has been the most unhealthy experienced since its formation. In Pegu not one man escaped fever during the first $3\frac{1}{2}$ months and for the remainder of the season all suffered more or less from its effects, and were unfit for hard work. In Sandoway things were no better; the daily average number of sick in the Toungup Hospital during January was 25; Mr. George, the Camp Officer, was seriously ill, and was found in an unconscious state by the Deputy Commissioner, who had him carried to the Toungup Hospital and telegraphed to Sandoway for the Civil Surgeon. Four men died, and many returned to their homes completely broken in health. Of the sub-surveyors recessing at Bangalore several are still ill and are undergoing treatment. Work cannot progress satisfactorily under such circumstances and in future measures will be adopted to avoid this danger as far as possible, and, by taking the field a month or so later when working in unhealthy tracts, it is hoped that some immunity may be secured.

The conditions for 1901-02 are more hopeful. The country to be surveyed in Thayetmyo and in Pegu is easier, more open and better populated; and the climate is drier and, it is hoped, healthier.

92. In the Sandoway district the country surveyed was similar to that previously described, but was confined to a strip near the crest of the Yomas, which was separated from the nearest villages by a belt of dense forest and undergrowth, about 25 miles in width, devoid of roads or paths. To keep down the expenditure the number of *khalasis* imported had been reduced; they were to be supplemented, when necessary, by local labour. But it was found that owing to the inaccessibility of the country to be traversed, and to the fact that it was harvest time, it was almost impossible in the early part of the season to obtain labour and as no other class of transport was available or practicable a considerable amount of trouble and much delay ensued.

The area surveyed in Pegu is in general character similar to that of last year; but it is uninhabited and wild. There is only one cart track, about five miles in length, entering it from Bawni, and the few paths which exist are generally confined to the beds of streams and the crests of spurs. There are no permanent villages, only a few temporary *Karen* camps.

As supplies were not obtainable locally either in the Pegu or Sandoway districts, these were imported from the nearest large towns and stored in depôts for distribution.

In both districts wild animals were numerous and were the cause of a good deal of nervousness on the part of the establishment. Again this year a *khalasi* was mauled by a bear in the Pegu district.

93. The 1-inch standard sheets are being drawn for publication in two colours. Eight sheets are in hand, of which seven will be completed within the next few months.

Ten 2-inch sections of Sheets 259, 260 and 261 are in hand; these are being drawn for reduction in one colour. Eight are complete as regards the new surveys executed by this party, the compilation of those portions of them surveyed by other parties is in hand.

Eight charts are in hand, complete as regards the work of this party, but awaiting the addition of that of other parties.

The computations will be completed before the party leaves for the field.

94. The programme for 1901-02 comprises—

(*a*) the triangulation for the topographical revision in the field of Sheet 262 and of the eastern halves of Sheets 253, 254 and 255 compiled from the cadastral map; and, if time permits, the extension of the previous season's triangulation into Sheets 113 157, and 204;

(*b*) the completion of the unsurveyed areas in Standard Sheets 115 159, 206, and 207, Thayetmyo district, on the 1-inch scale;

(*c*) the completion of the survey on the 2-inch scale of Sheets 253, 254, and 255 in Toungoo, and of Sheets 261 and 262 on the 1-inch scale in Pegu. The total area for survey being 620 square miles, while 1,730 square miles of topography obtained from the cadastral reductions has to be examined and supplemented, and it is doubtful whether this programme will be completed.

95. The party was inspected in the field by Colonel Hobday, Deputy Surveyor-General, at Toungoo, Thayetmyo and Prome in March, and again at Bangalore in September by Major Longe, Officiating Deputy Surveyor-General.

UPPER BURMA.

No. 10 Party.

96. Captain F. W. Pirrie, I.S.C., was in charge of the party throughout the year; Lieutenant Rich, R. E., who was attached as an assistant, being transferred to the charge of No. 21 Party during the season.

97. The survey operations were of the same nature as in the year 1899-1900, and consisted of 1-inch topographical surveys in the Ruby Mines, Shwebo, and Yamèthin districts of Upper Burma, as well as portions of the adjoining Shan States to the east; revision of topographical detail on 1-inch reductions from cadastral surveys was carried on in the Meiktila, Yamèthin and Magwe districts.

98. Water is always scarce in the Ruby Mines and adjoining districts after February, so this portion of the 1-inch survey had to be taken up and completed as early in the season as possible. Owing to the amount of forest and the intricate nature of the country, the work was not completed till the end of March, when great difficulty was found in obtaining water. It was carried out in a very satisfactory manner.

99. Owing to the difference in the amount of topographical detail shewn in the various revenue reductions, and the different methods of shewing the same kind of ground in adjoining districts, it was quite impossible to tell from looking at these maps what amount of resurvey would be necessary in order to make them useful to the general public. Again, as a rule, all indication of the hills has been entirely omitted; in only a few isolated cases was the word "hills" shewn on the revenue reductions where hills existed. This was particularly so in parts of the Yamèthin district where the hills were often high enough to prevent all local communications; if these were omitted in published maps, they would be practically valueless for any one finding his way through the country. The result was that the whole of the ground had to be carefully examined.

100. The officer in charge and his senior assistants thoroughly tested on the ground the work of the surveyors employed on both detail and revision surveys.

101. The outturn for the field season was as follows:—

	Square miles.
Triangulation	4,068
Detail survey on 1-inch scale	1,285
Revision survey	2,023

The cost-rates per square mile were as follows:—

	₹	a.	p.
Triangulation	4	15	0
Detail survey on 1-inch scale	26	4	0
Revision of topography in Revenue Surveys	22	5	0

102. Triangulation was carried on in parts of Magwe, Minbu, Sagaing, Mônywa, Shwebo and Katha districts, and embraced the remaining portions of Sheets 197 and 235, the whole of Sheets 156, 155, 196, 195, 234 and portions of 112, 111 and 194.

103. The new 1-inch detail survey completed during the field season comprises an area of 1,286 square miles in Sheets 236, 237, 250 and 296, chiefly in the Ruby Mines, but partly in Shwebo, Katha and Yamèthin districts.

104. The revision survey comprises an area of 2,023 square miles, and is made up of the western portions of Sheets 246, 247, 248 and 249 which had been partially revised in the previous season, the whole of Sheet 201 and the north-western portion of 250.

105. Owing to the hilly and more intricate nature of the country falling in the revision survey during this field season, a great deal more care and supervision was necessary in carrying out the work than was the case last year. The total area surveyed by the party is about the same as in the last field season, the detail survey being less, and the revision survey being more.

106. The health of the party during the field season was good, except in the months of November and December, when there was a good deal of malarial fever, especially in the Ruby Mines and Katha districts.

107. During the recess the greater portion of the computations have been completed and two triangulation charts were begun, but owing to insufficient data could not be completed. Standard Sheets 246, 247, 248, 249, 250, 201, 236, and 237 were completed. All available data for fair drawing standard Sheets 238, 239, 240, 243 and 244 were sent to the Drawing Office, Calcutta, but the editions of 243 and 244 can but be preliminary as the western halves have been accepted from the revenue reductions without subsequent revision in the field.

108. The programme for the next field season is as follows :—

The triangulation of standard Sheet 110 and the remaining portions of 254, 203, 112, 111, 109, 108 and 151. A secondary series will be run connecting the G. T. Mandalay Meridional series near Katha with the secondary G. T. Manipur Meridional series near Kindat for the future extension of topographical triangulation, and to provide stations and points for the forest survey traverses between those G. T. series. As a matter of secondary importance a connection will be made with No. 14 Party's triangulation west of Fort White, and other existing triangulation near Kindat. No new detail survey will be taken up. Revision survey of the topography in revenue reductions which comprise standard Sheets 202, 203, 156, 155, 154, 153 and 200, and if there is time towards the close of the field season the remaining revenue portions of 241 and 245.

109. The party was inspected by the Surveyor-General in the field in February and during recess in September. He was well pleased with the state of the party and especially with Captain Pirrie's conduct of the revision operations, a work which is new and somewhat experimental.

UPPER BURMA.

No. 11 Party.

110. The party remained under charge of Mr. P. J. Doran, Extra Assistant Superintendent, throughout the year. He had the assistance of 4 Provincial officers and 16 surveyors.

111. During the season under report the party continued the topography on the 1-inch scale in Sheets Nos. 437 to 439 and 506 to 509, embracing portions of the Northern and Southern Shan States. The country to the east of the Salween river falling in the Northern Shan States and its immediate vicinity, *viz.*, Sheets 506 to 508 was for political reasons forbidden ground, and this the party left unsurveyed.

The outturn for the field season was as follows :—

	Square miles.
Triangulation	3,311
Detail survey on the 1-inch scale .	2,472

The amount of work done, both triangulation and topography, is very satisfactory considering the nature of the country. The work was also a good

deal hampered by the heavy fogs which prevail in the neighbourhood of the Salween during a great portion of the year.

The surveyors were constantly visited and their work closely tested.

112. The country surveyed in detail, as well as the portions triangulated, consisted mostly of high hills and undulating low ground. The higher hills are covered with large trees and fairly free of undergrowth; on the low ground however, except when cultivated, the cover consists of a dense mass of shrub, elephant-grass, and bamboo jungle, and is especially thick on the river banks. Notwithstanding this there is a very considerable population in all the country west of the Salween, and a great deal of rice cultivation carried on, mainly on the *Jhoom* System. Far more rice is produced than required for local consumption and the balance is exported.

113. The party started from Bangalore for the field at the end of October 1900, and returned at the end of May 1901.

114. The triangulation fell a little short of the programme owing to the death of Surveyor J. Sebastian in the early part of the year. The party lost a very valuable hand when this officer, after but a few days' illness, was carried off by malarial fever.

Again the illness of Probationary Sub-Surveyor Sadik Hossein, at the best time of the year for observations, prevented the completion of the work. Mr. Gorman went to this sub-surveyor's help after finishing his own work, but he also fell ill and was disabled for further work of any kind for the rest of the season. Two of the menials died and the number ill with malarial fever during the season was greater than usual.

115. The recess work has been well brought up. The fair mapping of Sheets Nos. 436 to 439 and No. 509, also portion of Sheets Nos. 506 to 508 has been completed for publication in two colours. All the computations except the Latitudes and Longitudes of intersected points of two sheets have been finished. The charts alone remain to be done.

116. As the greater portion of the valuable and well populated parts of the Shan States has now been surveyed, it has been decided to amalgamate Nos. 11 and 21 parties, reducing the strength. A programme has been arranged by which such remaining portions of the country which, on account of their population or other reasons, are worth surveying on the 1-inch scale will be thus mapped. A considerable section of the party will be employed in surveying on the $\frac{1}{4}$-inch scale such portions of the country as still remain blank on our maps or which have hitherto been only very imperfectly reconnoitred.

In accordance with this the following programme has been arranged:—

On the 1-inch scale.—Sheets 440 to 442 and the ground falling to the west of the Salween river, of Sheets Nos. 510 to 512; the completion of the triangulation and detail survey of Sheet 443; and advance triangulation of 389, 444, and that portion of 512 which falls to the west of the Salween River.

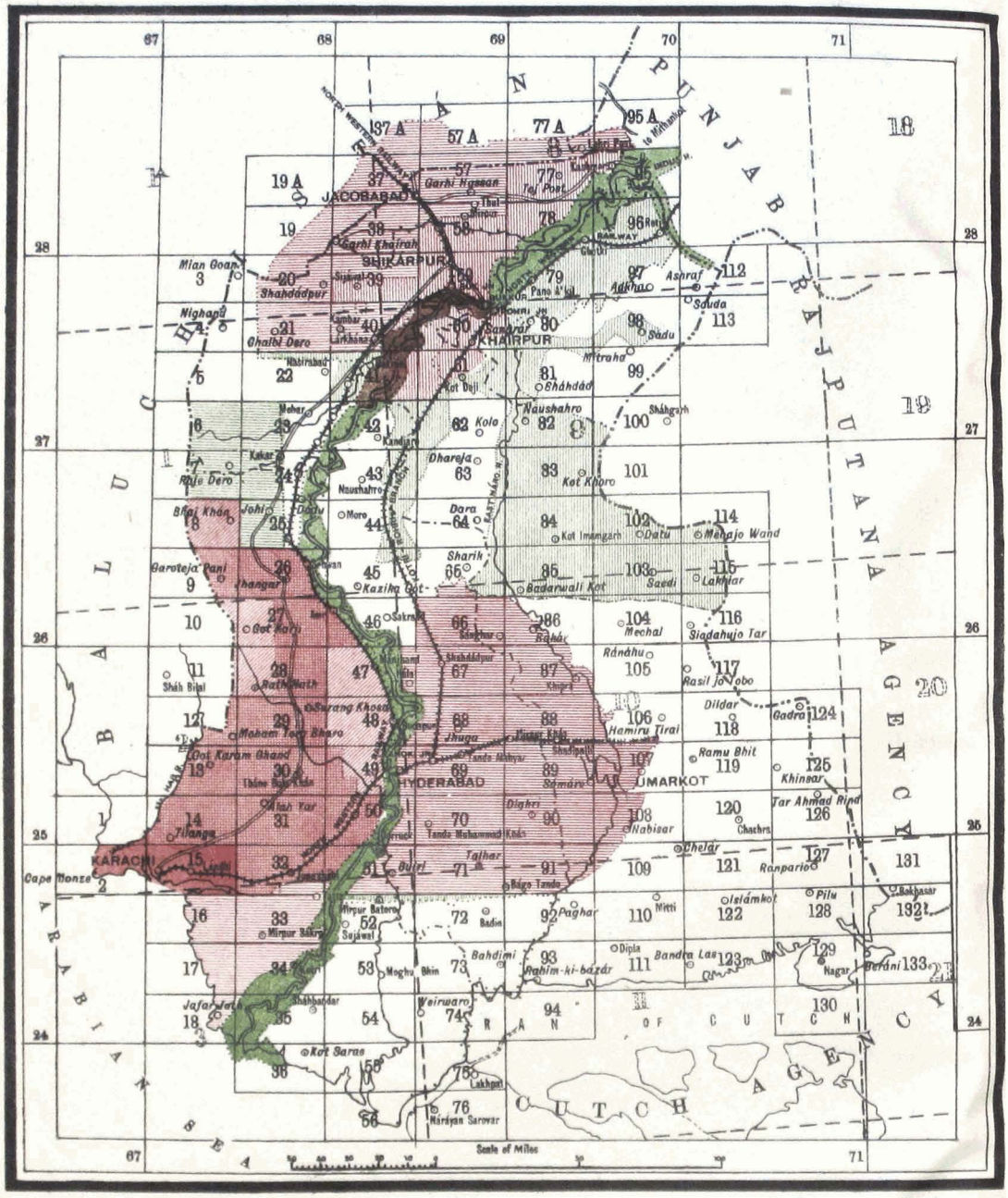
On the $\frac{1}{4}$-inch scale.—The detail survey of the country to the east of the Salween falling in Sheets 506, 507, 508, 510, 511 and 512; triangulation as much as can be done in Sheets 562 to 565 and 602 to 605.

117. The Surveyor-General inspected the party in September and was well satisfied with the state of its work.

UPPER BURMA.

No. 21 PARTY.

118. In the previous year the late Captain Hare, R.E., was in charge of the party, but fell ill just before the commencement of the field season. After a short interval, during which Mr. Hamer held charge, the party was handed over to Mr. A. J. James, who thus had to take over the duties at a most awkward time. Towards the end of the field season Mr. James' failing health necessitated the transfer of Lieutenant E. T. Rich, R.E., to the party. Lieutenant Rich held charge until late in June, when he himself fell ill and was invalided home. Lieutenant E. A. Tandy, R.E., was then transferred to the party, Mr. W. Stotesbury taking charge until his arrival. Lieutenant Tandy remained in charge until the end of the recess.



Regr. No. D. 488, S. I. D. - Sep. 1901 - 580

Photolithographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, November 1901.

REFERENCES.

NO. 226-S. 01.

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 12 Party

Do. ..... do. ..... 8" = 1 Mile ..... do.

Do. ..... do. ..... 4" = 1 Mile ..... do.

Do. 1900-1901 ..... 2" = 1 Mile ..... do.

Do. ..... do. ..... 1" = 1 Mile ..... do.

Triangulated and Traversed in advance ..... do.

Surveyed in previous Seasons Scale 1" = 1 Mile by No. 15 Party

Do. 1900-1901 ..... 1" = 1 Mile ..... do.

Triangulated in advance ..... do.

Indus Riverain Survey

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 Engraved sheets of the Indian Atlas.

Photogravure. Survey of India Offices, Calcutta, February 1902.

THE SIND DESERT.

Enlarged from a negative by Mr E.C.J. Bond.

119. The party which took the field under the officer in charge consisted of 1 extra assistant superintendent in charge of the 1-inch detail survey, 3 sub-assistant superintendents triangulating, 13 surveyors and sub-surveyors, 1 writer, 1 hospital assistant and 225 menials.

120. During the season the topographical survey, on the 1-inch scale of the Northern Shan States to the east and north of Lashio was resumed; and in addition the large scale survey of the town and environs of Hsi Paw on the Mandalay-Kunlong Railway was completed.

The total outturn of the party was as follows:—

Triangulation for 1-inch detail	. . .	3,375 square miles.
Detail survey on 1 „ scale	. . .	1,793 „ „
HsiPaw survey on 16 „ scale	. . .	4,885 acres.

In addition to this, a great deal of compilation of China, and Upper Burma maps has been carried out by the Bangalore Drawing Office. The country surveyed was all hilly, varying in elevation from 2,000 to 7,000 feet, thickly wooded and well populated; moving about was everywhere fairly easy owing to the several mule tracks and many footpaths which traverse the country.

121. The outturn inevitably suffered somewhat from all the changes in the charge of the party, and the cost-rates are accordingly somewhat higher than they should have been. They are as follows:—

Triangulation for 1-inch detail	. . .	Rs7·5 per square mile.
Detail survey on 1-inch scale	. . .	Rs21.4 „ „ „

The cost of the 16-inch survey was much enhanced by the employment of several assistants and others on the detail work for instructional purposes, and also by the accurate survey of an immense amount of detail which would not generally be attempted on this scale. This was done at the request of the local authorities for whom the map has been made, and the result is a most accurate and trustworthy but somewhat costly plan.

122. The party left recess quarters at the end of October 1900 and returned at the end of May. The general health was good and the season uneventful. The fair mapping and computation of the work done in the field will be completed by the end of recess. The three complete 1-inch sheets surveyed during the season and all the Hsi Paw sheets will be ready for publication this year, and the triangulation charts of the party are being brought up to date as quickly as possible.

123. As has been mentioned under the head of No. 11 Party, these two parties have been amalgamated and will in future work as one.

124. The party was inspected by the Surveyor-General in September.

SIND.

No. 12 Party.

125. The operations during the year under report were in continuation of those of the previous season. Mr. C. F. Erskine continued in charge of the party.

126. The following programme was completed:—

(*a*) Three series of secondary triangulation, two of which were 70 miles in length and one 40, and also a net-work covering the whole of the Khairpur State lying east of the Nára river.

(*b*) Village boundary traverse survey in portions of Sheets Nos. 41 and 60, together with an area of about 3,000 square miles in the Khairpur State, where the village boundaries are not demarcated.

(*c*) The detail survey on the 2-inch scale of portions of Sheets Nos. 39, 40, 41, 58, 59, 60, 61, 77, 78 and 95.

(*d*) The survey of the Karáchi cantonments on the 12-inch scale was also completed.

127. The recess office at Karáchi was closed on the 28th October 1900, and the party reassembled at Sukkur on the 3rd November, and each man was on his ground by the end of the second week in November.

128. The traversing in British territory consists, as in former years, of a village boundary survey with offsets, and in the Khairpur State, where the village

boundaries are undemarcated, of a series of main and sub-circuits divided into blocks by connecting lines. There were 7½ main circuits measured, 13 sub-circuits and 48 village circuits. The angular work was checked by observations for azimuth at 99 stations on main and sub-circuits, the average angular error per station being 49″. The linear measurements amounted to 2299 miles, and were checked by 75 connections with principal stations of the Eastern Sind Meridional Series, with stations of the Sehwán Series and those of the series run during the year under report.

The average correction per 1,000 links was 1·2 links. No permanent marks were laid down at traverse stations, but the marks erected by the Revenue authorities to demarcate village boundaries have been utilized, and the angles of village boundaries have been fixed by offsets; every fifth station has also been marked by an earthen pillar sufficiently large to be easily picked up by the detail surveyors.

In addition to the foregoing traverse operations, 74 bench marks laid down by the Railway Department were connected with the traversing; this involved observations at 176 stations, and 24 linear miles of chain measurement. The cost of the traverse survey amounts to R6·7 per square mile.

129. The area surveyed in detail on the 2-inch scale amounts to 2,553 square miles, giving 70 plane-table sections. The survey was carried out almost entirely by interpolation, and was based mainly on the traversing; it was tested from 416 *in situ* fixings, and was carried out under the direct supervision of the officer in charge. The cost of detail survey is R12 per square mile.

130. The survey of the Karáchi cantonments was completed early in the field season; the area surveyed has been fair drawn and the maps despatched to the Trigonometrical Office, Dehra Dún, for publication.

131. Field work closed early in April and the party returned to Karáchi for recess. During recess the fair mapping of the entire area surveyed in detail on the 2-inch scale was completed; the mapping was comprised of 28 quarter sections. They were drawn on the 2-inch scale for reduction and reproduction, and have all been despatched to the Trigonometrical Office, Dehra Dún, for publication.

The triangulation and traverse charts of Sheets Nos. 60, 77, 83, 84, 85, 95, 103, 114 and 115 have been drawn. All the charts with the lists of co-ordinates have been despatched to Dehra Dún.

132. Next season triangulation and traversing in advance will be taken up in Sheets Nos. 24, 25, 41, 42, 43, 44, 45, 46, 61, 62, 63, 64, 65, 81, 82, 99 and 100.

133. Detail survey will be carried on in Sheets Nos. 42, 61, 62, 63, 64, 82, 83, 84, 85, 102, 103, 114, 115 and 116.

134. The Party was inspected by the Superintendent, Trigonometrical Surveys.

LUSHAI HILLS, ASSAM.

No. 14 Party.

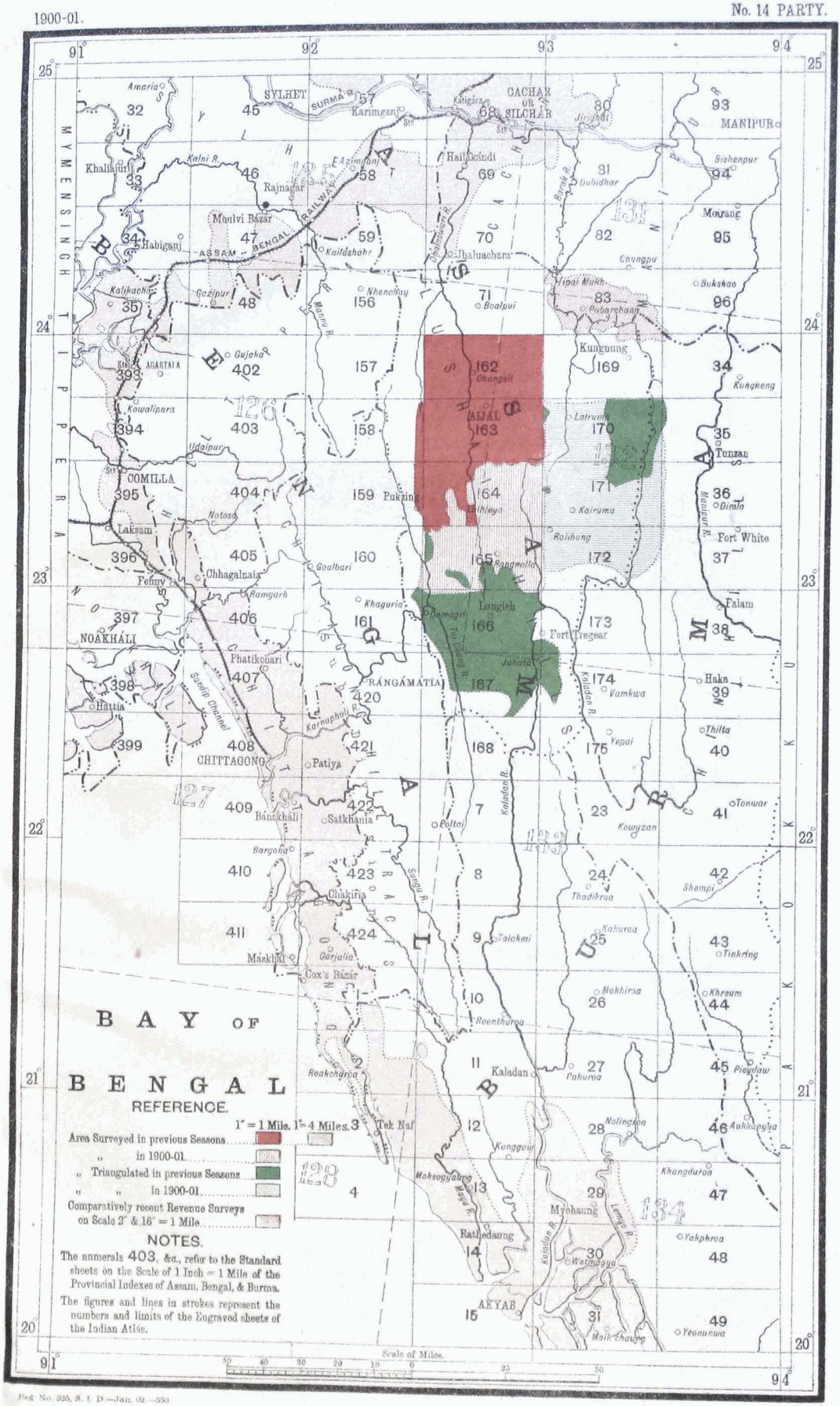
135. Captain C. L. Robertson, R.E., was in charge of the party till the 19th July 1901, on which date he made over to Lieutenant C. P. Gunter, R.E., who held charge till the break-up of the party in October 1901.

136. The party left Shillong on 23rd October 1900 and travelled to the field *viâ* Goalundo and Silchar. The party returned by the same route at the close of the field season on the 10th April, and the recess office was opened in Shillong on 20th May 1901.

137. The triangulation this season consisted of Tertiary Triangulation in Sheets 170, 171, and 172 and the extension of the First Class Secondary Series into Sheet 171. The computations of the tertiary work in Sheet 170 and of the First Class extension have proved well; those of work in Sheets 171 and 172 have not been completed. The Topographical survey on the 1-inch scale of Sheets 164 and 165 was completed with the exception of a few gaps in the latter which could not be surveyed for want of time and owing to the sickness of two sub-surveyors. Both sheets have been fair drawn and made ready for publication.

INDEX TO THE TOPOGL. SURVEY OF THE LUSHAI HILLS.

1900-01. No. 14 PARTY.



BAY OF BENGAL

REFERENCE.

1" = 1 Mile. 1" = 4 Miles.

Area Surveyed in previous Seasons

" in 1900-01

" Triangulated in previous Seasons

" " in 1900-01

Comparatively recent Revenue Surveys on Scale 2" & 16" = 1 Mile

NOTES.

The numerals 403, &c., refer to the Standard sheets on the Scale of 1 Inch = 1 Mile of the Provincial Indexes of Assam, Bengal, & Burma.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

Reg. No. 535, S. I. O.—Jan. 02.—550

Photo. S. I. O., Calcutta.

No. 401-S. 02.

138. The outturn for the season was as follows :—

	Square miles.
First class secondary triangulation—3 new stations fixed.	
Tertiary triangulation	1,122
Detail survey on 1-inch scale	870

139. The cost-rates were R28 per square mile for tertiary triangulation and R68 for detail survey.

140. The health of the party during the field season under report has not been good, and the returns show an increase of sickness compared with last year. Cholera broke out amongst the Khásia coolies entertained at Silchar, on the way to the field, and 20 deaths occurred from it, mostly on the march between Silchar and Aijal, besides 5 deaths from other causes. Every care was taken to safeguard the health of the men, and a hospital was built for them at the field head-quarters; the high rate of sickness is attributable to the general unhealthiness of the country in the valleys and to the poor physique of most of the imported coolies.

141. The country surveyed and the difficulties of survey are similar to those described in the report on the operations in 1898-99. In addition great difficulties were experienced in the low valleys in the south-east of Sheet 165. As in previous years, coolie transport alone was utilized; it consisted of 100 Gurkhas from the Darjeeling district, 150 Khásis from the Khási Hills, and local Lushais. The Lushais worked well and proved a great success, and in future years should be obtainable in sufficient numbers for the whole requirements of a party. Rations for the whole party, with the exception of local rice, had to be imported and distributed from head-quarters to the various detachments.

142. During the four years it has been employed in the Lushai Hills this party has completed over 2,000 square miles of detail survey on the 1-inch scale, and has triangulated nearly the same area in advance, besides carrying out some $\frac{1}{4}$-inch boundary work and making a complete survey of Aijal on the 24-inch scale.

143. As the survey of the more important portion of the Lushai country has now been completed, it has been determined to transfer this party to the North-Western Provinces to take up the topographical survey of certain districts, of which no maps are at present available.

144. The recess office of the party was inspected by Major F. B. Longe, R.E., Officiating Deputy Surveyor General at Shillong in May.

NORTH-WESTERN FRONTIER.

No. 15 Party.

145. Colonel R. A. Wahab, C.I.E., R.E., held charge of the party from the beginning of the year till the 17th April; when, having made over charge to Captain G. A. Beazeley, R.E., he proceeded on 7 months' leave to Europe. Captain Beazeley on leaving Mussooree for Kashmir on duty made over charge of the party to Mr. E. A. Wainright on the 9th May.

146. The several detachments left recess quarters about the end of October, the Kashmir detachment returning about that time and retaking the field early in May. The Sind party returned in April, and the Kashmir detachments are still in the field.

147. The party was divided into the following detachments :—one under Captain Beazeley, working in Kashmir, Chilás and neighbourhood, one in Sind under Mr. Freeman, and a section of draftsmen under Mr. Wainright, working up arrears of mapping, was left in Mussooree during the winter.

An Assistant and a computer have been sent on traverse work in connection with the settlement of the Hindubágh and Bori valleys, Balúchistán. Mr. Knight has been sent to supplement the triangulation of the Khojak Range of hills, and other members of the party were employed on special duties.

148. The programme submitted in last year's report has been carried out.

In Sind the following standard sheets were completed—8, 10, 11, 27, 28, 47, 48 and 49. No triangulation was extended in this district.

The Kashmir programme included the extension of ½-inch survey, a good deal of revision of previous year's survey, and the strengthening and extension of triangulation.

149. During recess a large amount of fair mapping has been got through, leaving now only one sheet of Sind untouched; while 6 charts of Balúchistán and Sind surveys have been compiled and drawn.

150. The total outturn of work of the party is as follows :—

	Sq. miles.
Triangulation for ½-inch survey	4,800
Detail survey ½-inch	3,324
" " 1-inch	1,915
" " 2-inch	440
" " 12-inch	32
Reconnaissance ¼-inch & ⅛-inch	17,000
Tringulation for do.	18,000

151. The programme for the ensuing season includes the detail 1-inch survey and triangulation in Sind; the continuation of the ½-inch survey and triangulation in Kashmir and Gilghit Agency during the hot weather; the Sind detachment will move up to Balúchistán in the spring for detail survey.

This party is also taking up the 12-inch surveys of military cantonments and the mapping of *bazars* which have been necessitated by the new Cantonment Act, and a commencement will be made with those at Cawnpore, Agra, Lucknow and Fatehgarh.

152. With the exception of one sub-surveyor, who died of pneumonia in Kashmir, there have been no casualties and the health of the party has been good.

153. The office of the party, at Mussooree, was personally inspected by the Surveyor-General in August.

HIMALAYAS, PUNJAB.

No. 18 Party.

154. Major W. J. Bythell, R.E., remained in charge of the party throughout the year, and Lieutenants A. A. McHarg, R.E., and M.O'C. Tandy, R.E., joined it in November, with a view to undergoing a course of instruction in plane-tabling.

155. The work of the party was similar to that of previous years, and the programme provided for the completion of the surveys of the allotted area. With this view the party was divided into two detachments, one for work on the 1-inch scale in the Kullu, and the other on the 2-inch scale in the Hoshiárpur district.

156. The Kullu detachment under Mr. Greiff consisted of Mr. Biggie and nine sub-surveyors; it left recess quarters on the 24th of August and was employed in Kullu until the beginning of December, and on the completion of its work there proceeded to the Hoshiárpur district *viâ* Mandi, and took up detail survey on the 2-inch scale. This detachment carried out its work in the face of considerable difficulties, resulting from continued bad weather, and the rugged nature, and high altitude (varying from 14,000 to 20,000) of the *locale* of its operations.

The Hoshiárpur detachment of 15 sub-surveyors under Mr. Robert left Simla on the 30th of November, and was employed on 2-inch detail survey throughout the field season. The area surveyed consisted chiefly of the outer Siwálik range, a mass of intricate and very broken ground, intersected in every direction by narrow ravines and *nalas* with steep and lofty sides.

The survey of the district was completed on dates varying from the 20th May to the 15th June when the party returned to recess quarters.

157. A Drawing Office of 15 draftsmen, to which four of the field surveyors were temporarily attached, remained in Simla throughout the field season to carry on the mapping work of the party.

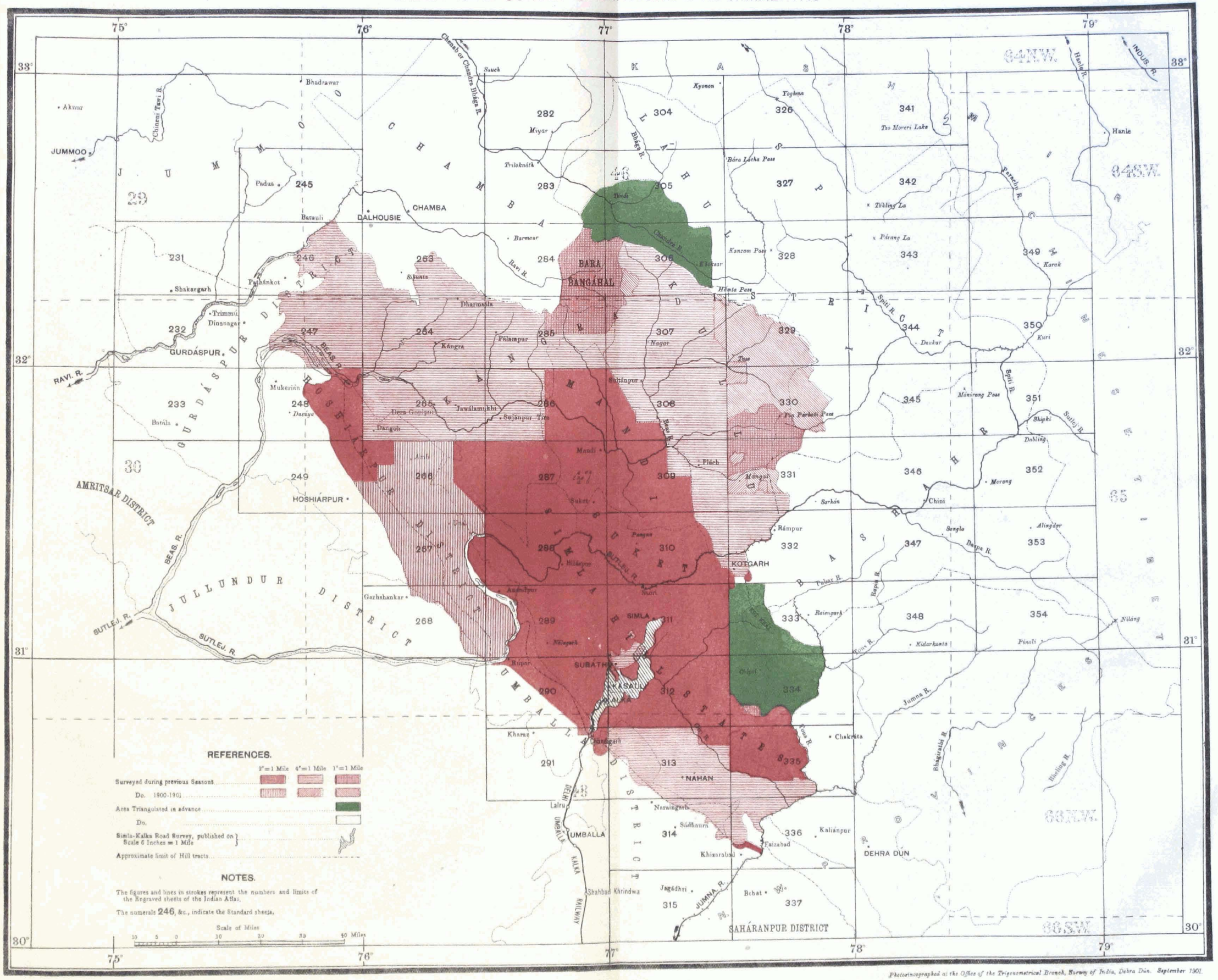
Mr. Parker was in charge up to the 15th November and on his proceeding on three months' privilege leave, Mr. Potter, who had received six months' extension of service, supervised the section until he retired from the service on the 16th February 1901.

PUNJAB SURVEY

1900-1901

INDEX TO THE SURVEY OPERATIONS IN THE HIMALAYAS

NO. 18 PARTY.



REFERENCES.

	2"=1 Mile	4"=1 Mile	1"=1 Mile
Surveyed during previous Seasons			
Do. 1900-1901			
Area Triangulated in advance			
Do.			
Simla-Kalka Road Survey, published on Scale 6 Inches = 1 Mile			
Approximate limit of Hill tracts			

NOTES.

The figures and lines in strokes represent the numbers and limits of the Engraved sheets of the Indian Atlas.

The numerals 246, &c., indicate the Standard sheets.

Scale of Miles

10 5 0 10 20 30 40 Miles

Photozincographed at the Offices of the Trigonometrical Branch, Survey of India, Dehra Dún. September 1901.

Regr. No. D. 559, S. I. D.-Aug. 1901-600

NO. 211-S. 01.

158. No new triangulation was carried out during the season under report, but Mr. Biggie was employed on supplementary work in Kullu, in Sheets Nos. 329 and 331, and also in the Hoshiárpur district in Sheet No. 267.

159. The outturn of the field season's work was as follows :—

	Square miles.
Detail survey on 1-inch scale in Kullu district . . .	487·5
" " " 2-inch " in Hoshiárpur and Kángra districts	950·7
" " " 4-inch " in Kullu district . . .	59·1

Of the total area surveyed on the 1-inch scale in Kullu 376·3 square miles were forest lands. In addition 49·8 square miles of forest on the 4-inch scale, and 0·25 square miles on the 8-inch scale, comprised in 65 blocks, were surveyed.

The cost-rate of each description of work per square mile is as follows :—

	R
Detail survey on 8-inch scale	78
" " " 4-inch "	
" " " 2-inch "	60
" " " 1-inch "	25

160. Considerable progress was made with the fair mapping; 25 sheets, of which 16 were on the 2-inch scale, were sent for publication during the year; 16 are in an advanced state at present; 29 proofs were examined, and 29 were coloured; whilst 25 traces of forest classification were prepared and sent for publication. In addition, a considerable amount of miscellaneous work, such as the preparation of traces of forest areas or boundaries, etc., was carried out by the section.

161. Sepoy Manna Singh completed his two years' course early in October 1900, and only one soldier surveyor, Lance Naik Zarin Shah, 6th Punjab Infantry, has been attached to the party during the year under report.

162. *Simla survey.*—During the winter months out-door work on the Simla survey was discontinued pending the completion of the demarcation of estate boundaries and fixing of boundary pillars, the setting up and plotting of traverses being continued in the office. Early in April work was re-started by four sub-surveyors, two more being sent from the Punjab Detachment in June to hasten the completion of the survey in compliance with the orders of the Punjab Government; during the rains four sub-surveyors were employed in plotting, while the remaining two took advantage of occasional breaks to do revision work. Since June two of No. 18 Party's sub-surveyors have been employed in plotting, and in July a second computer was attached from the Punjab Detachment.

The year's outturn consists of one main-traverse, eleven sub-traverses, and 135 estate boundaries, giving a total of 1,220 stations fixed.

The detail of 15 main-traverses and 33 sub-traverses has been plotted.

In addition to the above some further triangulation was found necessary in order to provide check points about a mile apart along the outer boundary and main traverses.

163. *Programme.*—As mentioned in last year's report, this party, having completed its original programme, will take up work in the plains of the Punjab, and its programme for next season is as follows :—

(1) The traversing of village boundaries in the Pákpattan *tahsil* of the Montgomery district, in continuation of the work carried on there last field season by the Punjab Traverse Detachment.

(2) The examination and correction in the field of the standard sheets on the 2-inch scale sheets compiled from the *patwaris'* maps which have been reduced from the 24-inch scale. This work will be carried out over an area of some 2,400 square miles in the Dipálpur *tahsil* of Montgomery and the Chunián *tahsil* of Lahore district. In the former case the reduced village plots have been fitted on to the traverses carried out by the Punjab Detachment, and in the latter the traverse stations of the old No. 1 Punjab Party have been plotted and used as the basis of the maps. In both cases the reduced plots from the *patwaris'* maps were found to fit in very well with the traverse stations.

(3) Riverain survey for fixing the boundary in the Sutlej river between the Ferozepore, Montgomery and Lahore districts, and further to the south-west in the same river between the Mooltan district and Baháwalpur State.

(4) Two sub-surveyors will complete on the 1-inch and 2-inch scales the topographical survey of the Native States of Jubbal and Tarhoch and endeavour to fill in all gaps in Sheets Nos. 333 and 334, which are not to be surveyed by the Forest Survey Department.

FOREST SURVEYS.

MADRAS PRESIDENCY.

NOS. 9 AND 19 PARTIES.

164. Mr Hugh Todd held charge of the parties throughout the season under report. On the completion of the recess duties, as far as practicable, the first camp or detachment left Bangalore for the field on the 26th October 1900, the three others leaving soon after; of these, three detachments, after a full six months field season returned to recess quarters between the 5th and 15th of May, whereas the fourth, in its endeavours to complete the work required in the Coimbatore district, did not return till the middle of June.

165. The parties were divided into four camps as follows:—

(1)	Mr. H. S. Wilson	with	18	surveyors and apprentices,	Kurnool district	(N. circle).
(2)	„ G. T. Hall	„	19	do.	Cuddapah „	(C. „).
(3)	„ G. D. Cusson	„	10	do.	S. Canara „	(S. „).
(4)	„ M. J. Sheehan	„	11	do.	Coimbatore „	(S. „).

(3) and (4) were formed from the double camp that had been employed during the two previous seasons in the Coimbatore district.

166. In the Nallamalais of the Kurnool district 300 square miles of triangulation were completed, in very difficult ground, consisting for the most part of densely forest clad plateaus. In the Cuddapah and South Canara districts 530 and 505 square miles respectively were completed. This class of work was carried out entirely by native agency, and the results by two out of the three men show a marked improvement on those of the previous season.

167. Theodolite traversing of forest reserve boundaries was carried on in the Kurnool, Cuddapah, and South Canara districts, and a total of 771 linear miles completed, more than double that of the previous season.

168. The area topographically surveyed on the 4-inch scale in the Kurnool, Cuddapah, South Canara and Coimbatore districts amounts to 1378 square miles, or about 78 square miles in excess of the original programme. Special precautions were taken to ensure accuracy, and prevent the surveyors from sacrificing it for quantity, and the work was submitted to a stricter scrutiny than usual, a proportion of the work in each district was examined by the officer in charge in the field, and his instructions to camp officers, to increase their test lines, were duly carried out. The importance of this was fully shown, as the work of several men, amounting in all to about 100 square miles, was rejected.

169. The country surveyed presented similar difficulties, from a surveyor's point of view, to that of previous seasons. In South Canara the evergreen undergrowth, interspersed with the wide spreading and formidable cane, in many places impenetrable, and overtopped by trees of unusual height covering the slopes of the Western Ghâts, contributed towards the difficulties of the surveyor and rendered work tedious and slow.

170. The health of the party was bad. On reaching his ground and before he had time to commence work, one surveyor was attacked by fever and died whilst on leave under medical treatment. He was a very capable hand and his death is a loss to the parties. The unusual rains in February rendered the Moyár valley, at the foot of the Nilgiris very unhealthy, and here three surveyors were almost completely incapacitated by fever. A most distressing catastrophe by fire occurred in the Nallamalais in Kurnool, by which a surveyor was severely burnt and incapacitated for some time, while five out of six of the

khalasis at work with him lost their lives. The officer in charge was attacked by cholera in the Nallamalais, but soon recovered. On the return of the parties to Bangalore there was an unexpected outburst of malarial fever, principally confined to natives, though some of the assistants also suffered for a time, and in some cases men had to be sent on leave for periods ranging from one to six months.

171. During the recess the triangulation and traverse computations were completed, as far as practicable. The fair mapping of the area topographically surveyed, comprising 57 sheets, exclusive of 7 sheets partially mapped last year, was carried out; which, considering the prevalence of sickness, reflects credit on all concerned.

172. In the Cuddapah district the incorrect demarcation of forest boundaries necessitating revision of a considerable area, practically involves the withholding of the season's work from publication.

Until the question of demarcation of the boundary between Mysore and South Canara is settled, the sheets of the South Canara forest reserves must also be held over.

173. The actual cost, including cost of instruments, for the survey year ending 31st August 1901 is R93,335 or R15,845 less than the year previous. The following table shows the comparative cost-rates and area surveyed for the last three years, but the cost-rates are somewhat misleading as they depend greatly on the pay of the senior officers, and, whereas last year two Imperial Officers were with the party as well as the present officer in charge, during the current year the pay of no Imperial Officer at all has been debited to it.

Description of work.	Area Surveyed.			Cost-rates per square mile.		
	1898-1899.	1899-1900.	1900-1901.	1898-1899.	1899-1900.	1900-1901.
Triangulation .	950	1,429	1,335	14	8	6
Traversing . .	598(*a*)	312(*a*)	771(*a*)	15	27(*b*)	8(*b*)
Topography .	1,350	1,524·8	1,378	76	58	58

(*a*) Linear miles. (*b*) Per linear mile.

174. The programme for the ensuing field season comprises continuation of triangulation, traversing of boundaries and topography, in the districts of Kurnool, Cuddapah and South Canara; a more thorough examination of the topography in North Coimbatore surveyed during season 1899-1900; where owing to the camp officer, responsible for the work, having been incapacitated by sickness, it has since been considered advisable to depute an officer to re-examine it before publication; the completion of about 6 square miles of topography remaining in North Coimbatore; the triangulation and traversing of the Godávari river, to furnish the preliminary data for 16-inch survey, and subsequently to commence triangulation of the Upper Godávari forest reserves; topography and traversing on the 4-inch scale of about 40 square miles of the Sivagiri forests, Tinnevelly district.

175. The parties were inspected by Major Longe, Officiating Deputy Surveyor-General, in September. The District Forest Officers of Kurnool, Cuddapah, South Canara and Coimbatore visited the office at Bangalore during recess to carry out the verification of the season's field work with the aid of the Government notifications.

BOMBAY PRESIDENCY.

No. 17 Party.

176. Mr. S. F. Norman held charge of the party throughout the year. Mr. P. R. Anderson joined since last report was submitted. Early in the year the party suffered a serious loss by the death from plague of Sub-Surveyor N. R. Patwardhan, whose services were extremely valuable as an efficient triangulator.

177. The various detachments left Poona for the field during the third week in November, and returned to recess quarters early in June, giving a full working season of six months.

178. The party was divided into three camps under Messrs. C. A. Norman, S. F. Norman and C. J. Veale, respectively, and continued the survey, on various scales, of the Forest areas in the Northern, Central and Southern Circles of the Bombay Presidency; these operations comprising:—

(1) *Northern Circle*—

(*a*) Supplementary triangulation in the Murbád *táluka* of the Thána district.

(*b*) Detail survey on 8-inch scale of the teak reserves in the Dáhánu *táluka*, Thána district.

(2) *Central Circle*—

(*a*) Supplementary triangulation in the Málegaon, Báglán and Peint *tálukas* of Násik district.

(*b*) Detail survey on 8-inch scale of the teak reserves in the Dindori and Kalvan *tálukas* of the Násik district.

(*c*) Supplementary triangulation in the Málsiras and Bársi *tálukas*, Sholápur district.

(*d*) Detail survey on the 4-inch, 8-inch and 16-inch scales in the Málsiras, Sángola, Sholápur, Mádha and Bársi *tálukas* of the Sholápur district. The 16-inch scale being confined to *Babul* Reserves below flood level, in accordance with recent orders of the Government of Bombay.

(3) *Southern Circle*—

(*a*) Supplementary triangulation and traversing in the Khánápur, Belgaum and Sampgaon *tálukas* of the Belgaum district.

(*b*) Detail survey on 4-inch scale of North Kánara District (Honávar *táluka*) and of part of the Khánápur *táluka* of the Belgaum district.

(*c*) Detail survey on 8-inch scale in the Mahád *táluka* of the Kolába district.

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

Description of survey.	Outturn.			Cost-rates		
	1898-99.	1899-1900.	1900-01.	1898-99.	1899-1900.	1900-01.
				₹	₹	₹
Triangulation (stations) . .	230	256	365	18·3	23·2	12·5
Traversing (linear miles) .	166	191	315	10·9	8·2	7·1
Topography 4-inch (sq. miles) .	429	379	409·7	53·2	64·1	65·4
„ 8 „ . .	254	236	254·8	136·6	139·5	106·7
„ 16 „ . .	55	55	10·8	122·9	134·1	113·0

The cost-rates are satisfactory and show a decrease, except in the case of the 4-inch detail survey, which is attributable to the scattered nature of the work on that scale.

180. The work was thoroughly examined and tested while in progress by the officer in charge and the camp officers.

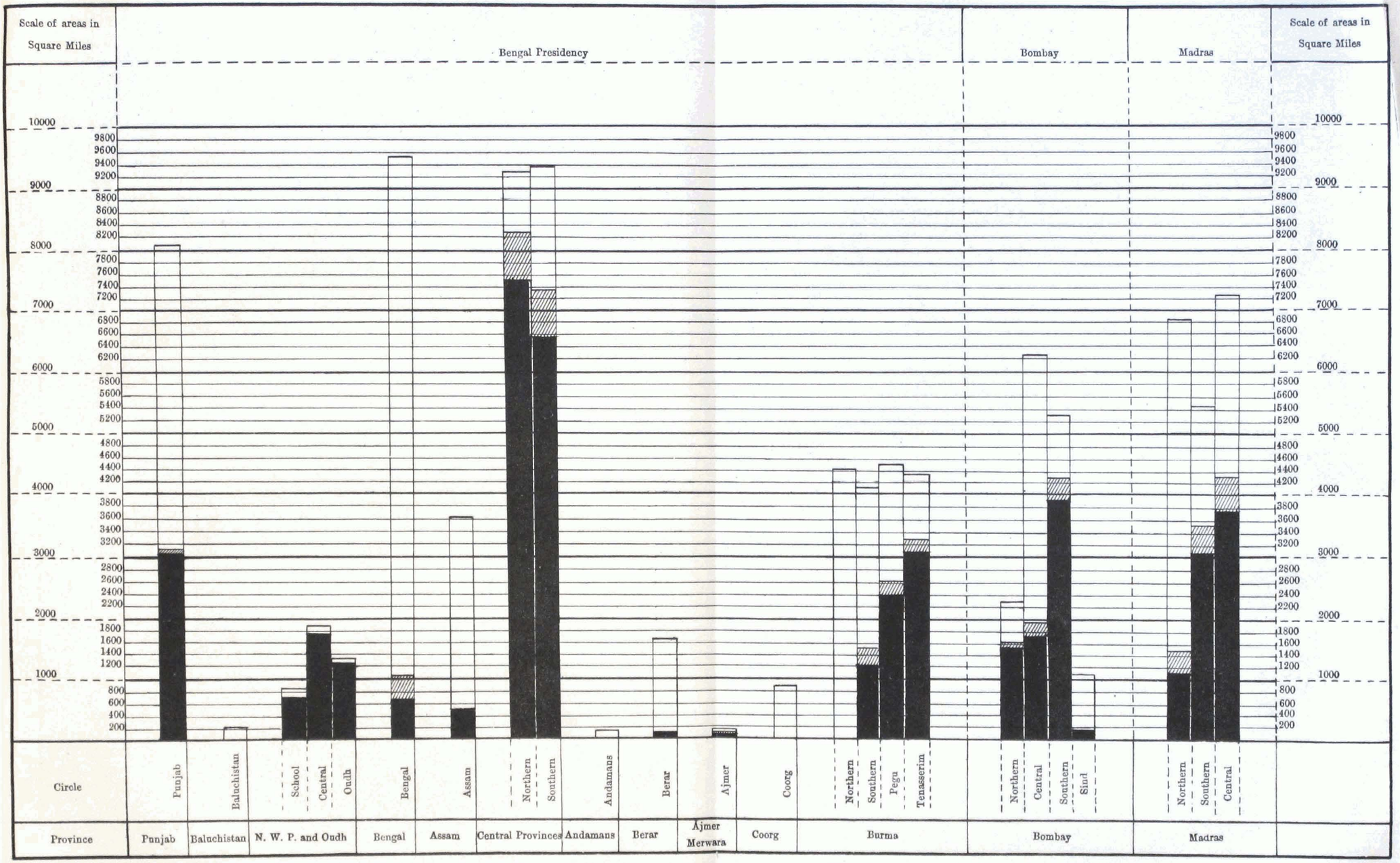
181. During the recess, most of the mapping of the past season's work has been completed.

A small Drawing Office was left in Poona during the field season to bring up the arrears of mapping, with Govind Gopal, a senior surveyor, in charge; this small detachment will have to be retained in future, as it is quite impossible for the recess staff to cope with the large amount of mapping which has yearly to be disposed of.

182. The programme for 1901-1902 is in continuation of that for the past season.

183. The party was inspected during September by the Surveyor-General.

DIAGRAM SHOWING PROGRESS OF FOREST SURVEYS ON 4" = 1 MILE AND ON LARGER SCALES UP TO 30th. SEPTEMBER 1901.



Note.—This diagram does not take into account any unclassed forests or C class forests in Berar.
The areas surveyed do not include boundary surveys.

Unsurveyed forest area.....

Surveyed during the year.....

Surveyed previously.....

Reg. No. 61, S. I. O.—Feb. 02.—550.

Photo. S. I. O., Calcutta.

No. 465-S. 02.

OPERATIONS OF THE FOREST SURVEY BRANCH.

184. Major P. J. Gordon, I.S.C., held administrative charge as Superintendent, Forest Surveys, Bengal Presidency, under orders of the Inspector General of Forests and the professional control of the Surveyor-General.

185. Revised orders for the adjustment of expenditure on Forest Surveys have been issued by the Government of India during the year; these provide that the cost of all Forest Surveys on a scale of not less than 4 inches to 1 mile, in Bengal, the North-West Provinces and Oudh, the Punjab, the Central Provinces, and Burma, shall in future be uniformly distributed in the proportion of 30 per cent. to topographical surveys in consideration of the topographical value of the work, and 70 per cent. to Forests. The cost of surveys executed by local Forest Officers and of special large scale surveys will, as heretofore, be borne by the Forest Department.

186. The following brief statement will indicate the nature of the year's operations, of which full details are being published separately in the annual Progress Report of the Superintendent, Forest Surveys, Bengal Presidency.

187. No. 20 Party, Survey of India, under the charge of Mr. T. E. M. Claudius, was divided into 6 detachments working in Burma; while the remainder of the Forest Surveys Branch consisted of 9 detachments working in the Central Provinces, Bengal, and the Punjab; the whole outturn being as follows:—

Province and Forest Division.	Outturn.				Number of Surveyors.
	4-inch Detail Survey.	Triangulation.	Traversing.	16-inch Boundary survey.	
Burma.	sq. m.	sq. m.	sq. m.	linear. m.	
Upper Chindwin	...	290	67	...	59
Ruby Mines	318	214	427	...	
Pyinmana	44	...	40	...	
Minbu	...	...	166	...	
Rangoon	9	...	...	...	
Pegu	124	...	130	...	
Thayetmyo	86	...	214	...	
West Salween	3	...	23	...	
Ataran	289	...	146	...	
South Tenasserim	...	30	25	...	
Central Provinces.					
Mandla	774	404	105	951	48
Damoh	6	...	...	...	1
Chánda	776	293	76	740	39
Bengal.					
Singhbhum	361	650	128	...	35
Punjab.					
Hazára	...	In progress	...	...	2
Jubbal and Tarhoch	43	...	...	...	5
Total	2,833	1,881	1,547	1,691	189

In addition to the above, one surveyor was deputed to Ajmer to work under the local Forest Officer, and three others to assist the Forest Officer of Kheri in Oudh; also a large amount of miscellaneous mapping and publication for various provinces was carried on at the head-quarters offices at Dehra Dún.

188. It may be noted that the small States of Jubbal and Tarhoch provided funds for a 4-inch detail survey of their forests, and it is hoped that other native

States having valuable forest reserves will avail themselves of the agency of the Forest Survey Branch to have accurate surveys made of their reserves, in order to ensure economic exploitation.

189. The Forest Surveys have generally in the past been able to make use of a certain amount of triangulation and traversing previously carried out by parties of the Survey of India, so that they have only a small staff capable of conducting this part of the work; it is feared that this want of triangulators may occasion some difficulty in the near future, now that the forest surveys are beginning to open up ground not previously surveyed, and it will be a few years before a sufficient number of men can be trained to these duties.

190. The accompanying diagram shows in a graphic manner the general progress of forest surveys throughout India. Of the balances unsurveyed, the survey of a large proportion of those shown in Bengal, Assam and Berar is not contemplated at present, and for the greater part of the balance in the Punjab boundary surveys only are required.

191. The strength of No. 20 Party has been greatly increased within the last two years, and its present total of some 60 surveyors is the maximum over which one officer can be expected to carry on even a general supervision; in spite of the efforts of the officer in charge, it became evident that the *locale* of operations was far too extended and scattered during the year under report.

In future arrangements will be made to confine the operations of this party as much as possible to the Chindwin and Lower Irrawaddy basins, and to employ separate forest survey detachments on the more scattered reserves of Burma. Mr. Claudius is now retiring after a service of 38 years in the Survey of India Department, and Captain Hume, R.E., succeeds him in charge of the party.

192. The programme sanctioned by the Inspector-General of Forests for the ensuing year is as follows:—

Burma.—In Upper Chindwin and Myittha Divisions, triangulation, traversing, and detail survey.

In Minbu Division, traversing and 4-inch detail survey to complete the Taungdwingyi block.

In Mandalay Division, traversing.

In the Ruby Mines Division, traversing and 4-inch detail survey.

In Ataran Division, a small amount of 4-inch detail survey to complete the *Ye* reserve.

Central Provinces.—In Mandla and Chánda Divisions, 4-inch detail and 16-inch boundary surveys, which will practically complete the surveys of the Northern and Southern Circles.

Bengal.—In Singhbhum Division to complete the 4-inch detail survey of reserved forests; other work in this division is contingent on the settlement being sanctioned.

In Hazáribágh Division, 4-inch detail survey of Koderma and adjoining protected forests, to show position of mica mines.

In Kurseong Division, a 4-inch boundary traverse will be undertaken if the settlement in the Singhbhum Division is not sanctioned.

North-West Provinces and Oudh.—In the Gorakhpur, Kheri and Pilibhít Divisions, a 4-inch boundary survey to complete all the surveys in these divisions.

Punjab.—In Jubbal and Tarhoch, 4-inch detail survey to complete the past year's work.

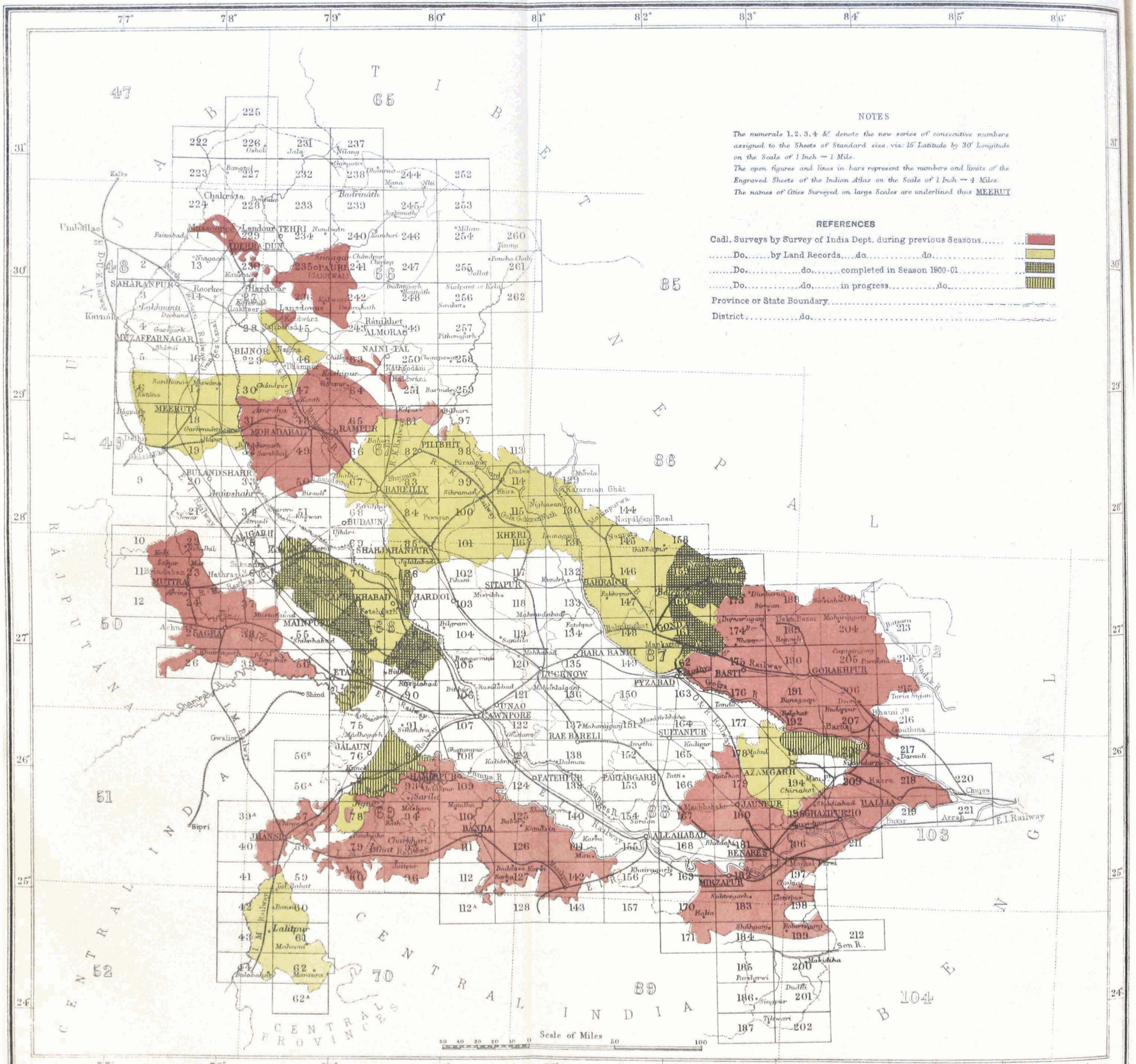
In Hazára Division, 4-inch boundary survey to complete existing maps.

Ajmer.—Four-inch detail survey under the local forest officer.

N. W. P. & OUDH SURVEY.

INDEX TO THE CADASTRAL SURVEY IN THE N. W. P. & OUDH.

1900-01.



Reg. No. 509, A. & P.—Oct. 01—850.

Engraved at the Survey of India Offices, Calcutta, 1901.

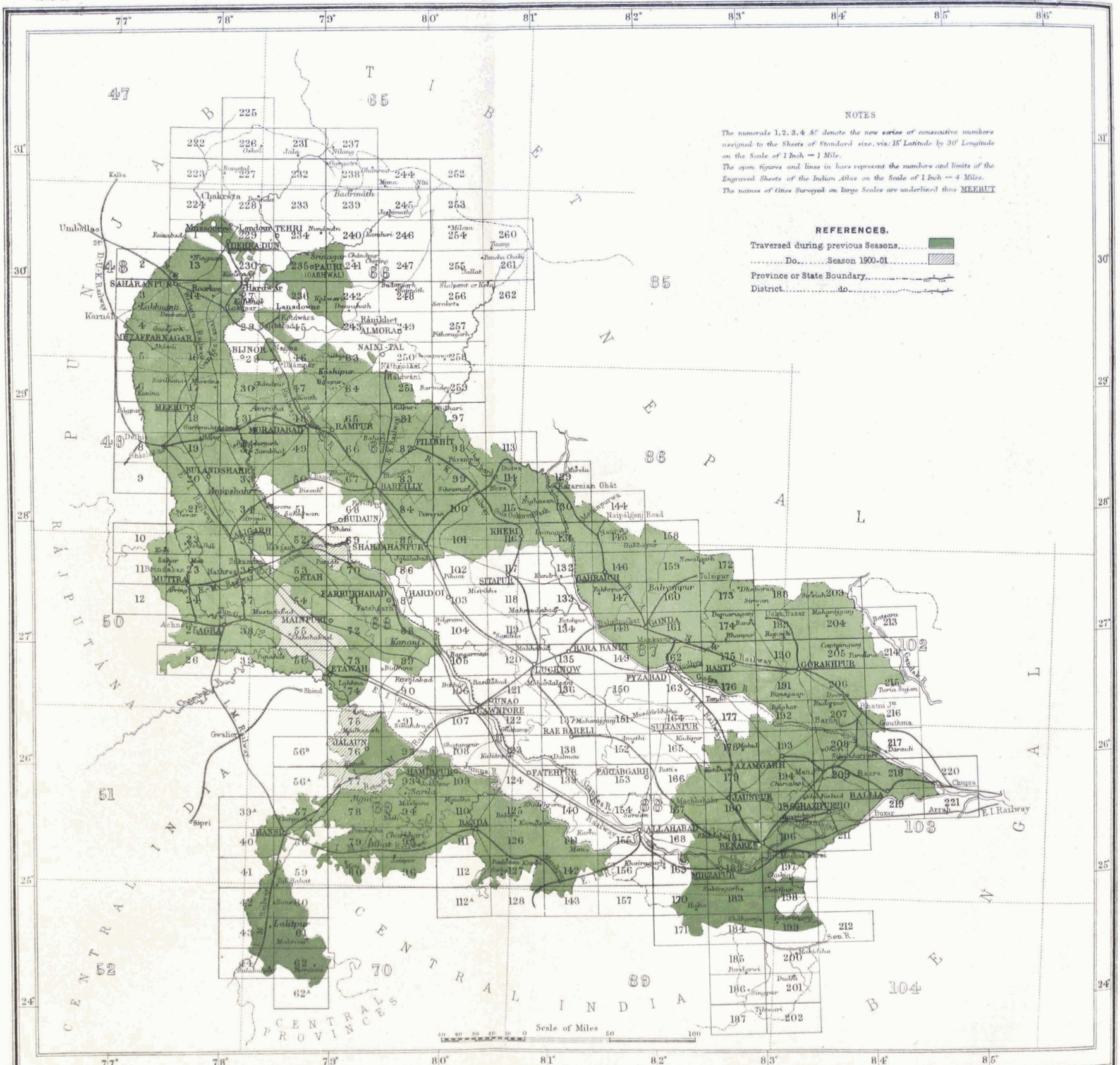
No. 594-S. 01.

Photo. S. I. O., Calcutta.

N. W. P. & OUDH SURVEY.

1900-01

INDEX TO THE TRAVERSE SURVEY IN THE N. W. P. & OUDH.



CADASTRAL SURVEYS.

NORTH-WESTERN PROVINCES AND OUDH.

NOS. 2 AND 8 PARTIES.

193. The Provincial surveys in the North-Western Provinces and Oudh remained under the charge of Mr. G. B. Scott up to the date of that officer's retirement on 31st July, when his successor, Captain W. M. Coldstream, R.E., took over charge.

194. The work has been carried out by three sections, namely, the Traverse, Drawing, and Cadastral Sections, the last consisting of seven cadastral parties and one detachment.

195. *Traverse Section.*—The Traverse Section completed the traverse survey of districts Azamgarh, Farrukhabad, Mainpuri, Etáwah, and Jálaun, and the scattered areas in Aligarh where cadastral survey is required, and continued the traverse of the Etah district.

With the exception of a small area remaining in Etah, the above completes the programme of traverse survey at present required for revenue purposes in these Provinces, and in consequence the Traverse Section will be withdrawn from provincial employment and attached to No. 14 Party for the traverse for topographical purposes of the Allahabad district, a small detachment being detained for the completion of the remaning work in Etah.

In order to obviate the necessity of further traverse, at a later date, in Allahabad, it has been decided to traverse that district on the village circuit system, which will provide a sufficient number of points for the revision of the village maps, or for a re-survey, should one be considered necessary, provided that the survey stations are carefully maintained, and this, it is hoped, will be secured by the regulations requiring each *patwari* to report annually on the condition of the survey stations in his circle.

196. The average number of survey stations laid down during the year was 15·4 per square mile; of these 10 per cent. were fixed on village-trijunctions previously marked by the district authorities, 35 per cent. were marked by roughly dressed stones, and the remaining 55 per cent. by baked clay cylinders embedded at the site.

The cost of survey marks of both descriptions laid down by the Traverse Section came to ₹3·3 per square mile.

197. The quality of the work was checked by comparison with the values of eight stations of the Great Trigonometrical Survey, the linear errors so disclosed being from 0·49 to 10·2 feet per mile. The angular accuracy of the traverses was ensured by one observation for azimuth to the sun or stars in an average of 32 angles; the angular errors so found varying from 1 minute in 10 angles on village circuits, to 1 minute in 27 angles on main circuits.

198. The total area traversed during the year under report was 2,615 square miles, and the total expenditure of the Traverse Section was ₹69,538 which gives a cost-rate of ₹27 per square mile, those of the three preceding years being ₹27, ₹29, and ₹26.

199. All computations have been completed, and plotted sheets of the area traversed have been made over to the cadastral parties, except those of Etáwah, where cadastral survey has been postponed for some years.

200. *Drawing Section.*—The drawing section is located at Naini Tal under Mr. J. Kennedy.

Of the six districts completely surveyed by the Provincial Surveys the map drawing of two, Sháhjahánpur and Bareilly, has been completed, except as regards the town and cantonments of Bareilly which are now under survey; the mapping of three districts Bahraich, Pilibhít, and Kheri is in progress; and that of Lalitpur sub-division in Jhánsi is completed.

The topographical maps of one district, Meerut, being comparatively modern, the preparation of new maps is postponed, pending a comparison of the existing maps with the new cadastral survey. As pointed out in last year's report, every effort is being made to include in the cadastral survey all topographical features on the ground.

The total cost of the Drawing Office for the year has been ₹10,651.

201. *The Cadastral Section.*—During the year, the survey and *khasra*-writing has been completed in Gonda, Farrukhabad, and in the scattered areas of Aligarh which were included in the programme.

One cadastral party has worked in each of the following districts: Azamgarh, Mainpuri, Farrukhabad, Etah, and Jálaun; two parties have worked in Gonda, and a detachment in Aligarh. The survey of Etáwah having been postponed by the Board of Revenue, the party working last year in that district was transferred to Jálaun.

The two Gonda parties having completed their programme are to come under reduction, and the Farrukhabad party is to be transferred to Jálaun to work as a second party in that district. The Aligarh detachment is to take up the revision of existing maps in the Jalesar *tahsil* of Etah, where the existing village maps are in comparatively good condition.

As a result of the reduction of the Gonda parties, two officers, Messrs. Bedford and Skilling, will revert to Imperial employment on the completion of the settlement records of Gonda in November, while Mr. Norman (Jr.) has already reverted.

202. The number of *patwaris* in the tracts under survey was 1,529, of whom 1,129 qualified as surveyors, 64 are yet to be examined, 185 deputed their heirs to do the survey, and substitutes were provided for 113 who failed to qualify.

In addition to the *patwaris* it was found necessary to employ *amins* for longer or shorter periods in the alluvial tracts of Azamgarh and Farrukhabad, and in the scattered areas of Aligarh. The *khasra*-writing was, however, done entirely by the *patwaris* or their heirs. The average outturn in survey varied from 4 acres to 26 acres, and in *khasra*-writing from 5 numbers to 45 numbers per man per diem.

203. All maps before being passed were checked by European officers or by *partallers* working directly under the Survey officers.

The average linear amount of check lines per square mile was 4·7 miles.

Twenty-one per cent of the *khasra* numbers were also checked.

204. The total area cadastrally surveyed during the year was 3,944 square miles, and the total expenditure in the survey parties has been R2,56,906, the cost-rate being R75 per square mile for survey and record-writing.

The cost-rates for next year are likely to be considerably higher owing to the fact that, as the work is drawing to a close, the areas for survey are small in several districts while the full office establishment is required to deal with the records of the past and coming seasons.

205. In addition to the regular programme of work for revenue purposes, town surveys on the 64-inch scale have been undertaken in Cawnpore, Fyzabad, Ajodhya, and Mainpuri, under the supervision of the district Survey officers.

The expenditure in connection with these surveys has been met by the Municipalities concerned. Surveys of Government roads in Mainpuri, Etáwah, Farrukhabad, and Jálaun have also been undertaken at the expense of the Public Works Department and of the Local Boards, under the supervision of the Traverse Section.

206. During the field season Mr. G. B. Scott inspected all the parties in the field, personally instructed a class of 15 young officers of the civil service in the rudiments of survey, and surveyed a portion of the Kheri-Bahraich boundary, and in the rainy season in company with the Deputy Superintendent inspected the offices of the cadastral parties in Aligarh, Etah, Farrukhabad, and Jálaun. Mr. Scott handed over charge of his duties to Captain Coldstream at Jálaun on the 30th of July on his retirement from Government service.

207. Captain Coldstream as Deputy Superintendent took over charge of the cadastral party working in Mainpuri in November, and remained at Mainpuri up to the 30th of June 1901, in order to gain a further insight into the methods of record and survey work in these provinces. In the rainy season Captain Coldstream inspected the offices of the parties in Aligarh, Etah, Fatehgarh, Jálaun, Gonda, and Azamgarh and checked the town surveys in Cawnpore and Fyzabad.

208. The field parties were visited and inspected by Col. Hobday, Deputy Surveyor-General, in January, and by Major Longe, officiating Deputy Surveyor General in April and May. Major Longe also inspected the Traverse and Drawing offices at Naini Tal in September.

BENGAL SURVEY.

INDEX TO THE CADASTRAL SURVEYS IN BENGAL.

1900-01.

No. 4 PARTY.

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 bare 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.

Cadastrally Surveyed with records during previous Seasons....

Do.....do....without records.....do.....

Do.....do....with records during Season 1900-01....

Records completed.....do.....

Province or State Boundary.....

District.....do.....

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

No 593-S. 01.

Engraved at the Survey of India Office, Calcutta.

Photo. S. I. O., Calcutta

Reg. No. 309, S. I. D.—Oct. 01.—500.

BENGAL SURVEY.

INDEX TO THE TRAVERSE SURVEY IN BENGAL.

1900-01.

No. 4 PARTY.

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 DARJEELING

REFERENCES.

Traversed during previous Seasons.....

Do. do. Season 1900-01.....

Province or State Boundary.....

District Boundary.....

Scale of Miles.

Engraved at the Survey of India Office, Calcutta.

Photo. S. I. O., Calcutta.

No. 596-S. 01.

Key. No. 309, S. I. D.—Oct. 01.—650.

BENGAL SURVEYS.

No. 4 Party.

209. The Cadastral Surveys in Bengal were continued under the superintendence of Captain Crichton, I.S.C.; Major Hodgson and Captain Mears each officiated as Superintendent for a few days until his return from furlough on the 6th November.

210. During the year the title of the office was changed to Superintendent, Provincial Surveys, Bengal.

211. The following table gives the outturn of work for the year in square miles :—

Division.	District and estate.	Traverse survey.	Cadastral survey.	Record-writing.	Topographical survey.
1	2	3	4	5	6
TEMPORARILY-SETTLED AND GOVERNMENT ESTATES.					
Major settlements.					
Bhágalpur . . .	Sonthal Parganas (Dáman-i-koh Government estate).	735(*a*)	...	...	...
PRIVATE ESTATES.					
Major settlements.					
Bhágalpur . . .	Monghyr	747	741	72[illegible]	26
Patna . . .	Patna	60	56	56	11
	Darbhanga . . .	64(*b*)	413	597(*c*)	...
Bhágalpur . . .	Purnea	728	...	...	...
Patna	Gaya (Maksúdpur estate) .	128	...	...	...
Dacca	Backergunge . . .	608	33	33	...
Chota Nágpur . .	Singhbhum (Poráhát, Kera, Chainpur, and Bandgaon Estates).	540	...	...	...
Miscellaneous.					
Patna . . .	Champáran . . .	84	...	...	84
	Darbhanga (Madhubani Municipality).	1	1	1	...
Rájsháhi . . .	Jalpáiguri (Baikuntpur estate boundary survey).	...(*d*)	...	...	...
	Total .	3,695	1,244	1,416	121

(*a*) Includes 166 square miles of jungle blocks and Paharia villages, also 2 square miles surveyed in the area returned as jungle blocks last season.
(*b*) Retraversing to relay stations of 1895 lost.
(*c*) The excess of record-writing over survey is on account of completion of the area surveyed only during previous season.
(*d*) Traversing of 97 linear miles for demarcation purposes.

In Monghyr, Patna and the Sonthal Parganas the areas traversed are respectively 147, 60 and 35 square miles in excess of the original programme. While in the two first named districts an excess of 191 and 56 square miles of cadastral work was also accomplished; in Darbhanga the area cadastrally surveyed also shows an excess of 31 square miles and in Backergunge 33 square miles over the anticipated area.

In Bhágalpur, Patna and Chota Nágpur the areas traversed are slightly less than was expected.

212. The following table showing the cost-rates per square mile of the various classes of work, and the explanatory notes have been abstracted from the published Annual Report on the survey operations in Bengal for 1900-1901 :—

District.	Cost-rate per square mile.			
	Traverse.	Cadastral.	Record-writing.	Topographical survey.
1	2	3	4	5
	₹	₹	₹	₹
Sonthal Parganas	55·4	...	...	...
Monghyr and Patna	29·4	70·9	58·2	16 0
Darbhanga	...	94·0	95·2	...
Purnea	38·4	...	...	...
Gaya-Maksúdpur estate	39·8	...	...	...
Backergunge	75·2	...	...	...
Singhbhum	55·9	...	...	...
Champáran	46·2	...	...	61·3

The cost-rate for traversing in the Sonthal Parganas, *viz.*, ₹55·4 per square mile, is high, but this is due to the very difficult nature of the country in the Dáman-i-koh and to the great amount of sickness amongst the establishment.

The traverse cost-rate of ₹29·4 per square mile for Monghyr and Patna is satisfactory, and is due to the large area accomplished by the North Bihar traverse section and the consequent low incidence of cost of control per square mile. The rate of ₹129·1 per square mile for cadastral survey and records in Monghyr and Patna is satisfactory, and compares well with the cost-rates of previous season's work in Bihar. The low rate is attributable to the large area accomplished, *viz.*, 797 square miles, and to the larger size of the average field, *viz.*, 0·59 of an acre. The cost-rate for topographical survey is also good. The work was very simple and amounted to practically only a boundary survey with few details.

213. The cost rate for Darbhanga of ₹189·2 per square mile for cadastral survey and records is high. The rate of ₹94 for cadastral survey, however, includes the bringing up to date of 186 square miles surveyed during the previous season but not *khanapuried*, and another reason for this high rate is the restricted programme, as only 413 square miles remained to complete the Darbhanga district. The high rate for record-writing, as compared with Monghyr work, is accounted for by the much smaller fields (only 0·35 of an acre) of Darbhanga. The outturn was also only 597 square miles as compared with the 785 of Monghyr and Patna. The cost-rate of ₹38·4 for traversing in Purnea is not excessive considering the unhealthiness of the tract surveyed. It should also be remembered that the cost of moving the camp and establishment to Purnea is included in this rate.

214. The rate of ₹39·8 for the Maksúdpur traversing is good considering the very scattered nature of the work and the difficulties experienced and time lost in locating the villages of the estate.

The rate of ₹75·2 for traverse work in Backergunge is very high. This is accounted for by the fact that this is a newly started survey, and therefore, the cost of tents, office furniture, camp equipment and their transit charges as well as transit charges of establishment and instruments, are included in the expenditure. Also a large number of cylinders for marking stations had been ordered in advance from Rániganj. Arrangements have been made for the supply of cylinders locally, and none of the foregoing charges will be recurring in future seasons' work, but we cannot expect the cost rates to be as low as in Bihar, because no local labour is available and all *khalasis* have to be imported and then paid at nearly double the Bihar rates of pay. The nature of the country makes the supply of boats to the surveyors necessary, and this is a heavy item of expenditure. The future cost-rate should be about ₹60 per square mile unless the programme is largely increased.

For the cadastral survey and record-writing in the Bamna Estate of the district, the cost-rates have not been computed, as this was an experimental survey carried out by a very large establishment for the small area, and the resulting cost-rates cannot be any guide for future work.

The cost-rate of R55·9 for Singhbhum traverse work is high. This is due to the difficult nature of the country, excessive sickness amongst the establishment and to the small programme. This section has a full programme in Singhbhum and Ránchi next season, and the rates will be lowered very considerably.

The cost-rates of R46·2 and R61·3 for traverse and topographical surveys in Champáran are reasonably fair considering the difficult nature of the country (which had to be closely contoured), the sickness amongst the establishment and the small programme.

215. The general procedure remained unaltered. The survey establishment carries out the Traverse and Cadastral surveys, and then, under the direct instructions and supervision of the Settlement Department, writes the records.

The entire field establishment, Inspectors and Amins, is retained throughout the year, each man during recess completing the records and statistical statements of the villages surveyed by him.

"DIÁRA" SURVEYS.

216. The experience of the past season has shown that the attempt to traverse villages in *Diára* tracts in accordance with the boundaries shewn on the old revenue survey maps should be abandoned.

The *Diára* survey of 1865 has in the minds of the inhabitants superseded the revenue survey, and in consequence the preliminary demarcation conforms generally to the *Diára* survey, and the Superintendent, Provincial Surveys, has therefore decided to traverse these tracts in accordance with the demarcation found on the ground, serving out to the line-clearers and traversers traces of the *Diára* survey instead of the old revenue survey, to enable them to work where the demarcation is found deficient. Subsequently the usual comparison will be made with the old revenue survey and all differences shewn.

Another difficulty which made itself severely felt was the uncertainty first of the *Diára* area, and secondly how much of that area should be Cadastrally and how much Topographically surveyed. To get over this it is intended to run traverses along the high banks of rivers immediately after the rainy season, these when computed and plotted will give an idea of the area to be dealt with, and within these limits can be allotted all Government and temporarily settled estates for cadastral survey, and the area for topographical survey can then be approximately estimated. There appears to be no reason why these preliminary traverses should not be run a year in advance of the actual survey, as they would be situated on ground beyond the limits of river action.

217. This year village sites in Bihar were surveyed on the 64-inch scale, each hut being separately and accurately surveyed, but as the hut is linked with its *sakin* or homestead land, and consequently only a *kitta* of the survey unit, it has been decided to abolish the survey of huts, except under certain stated conditions, and a considerable saving in expense is anticipated in consequence.

218. The increase in the Traverse programme from 1,379 square miles in 1899-1900 to 3,791 this year, severely strained the resources of the party. Every available traverse surveyor was given employment, and a number of new men were after a short course of instruction sent on field work. The result was that a considerable amount of revision had to be done, and the cadastral operations were several times in danger of coming to a stand-still owing to the traverse work not being available. To avoid this in future the Superintendent has, with the permission of the Board, started a traverse school at Dumka, and about 40 sub-surveyors with the proper proportion of *tindals* are undergoing a course of instruction there, and will if they prove suitable be eventually drafted into the various field parties next field season, the expenses being debited to the parties to whom the men are sent. It is hoped that this will lead to increased efficiency and an immediate reduction in cost-rates.

219. As regards traverse operations the people displayed extreme apathy except in Singhbhum, where help was readily afforded. In Darbhanga the attendance for the cadastral survey and record-writing was satisfactory, but in Monghyr there was much trouble. In Backergunge there was no active opposition, which may be considered satisfactory.

220. There was an unusual amount of sickness during the year. While in Darbhanga and Monghyr the health of the establishments was uniformly good, notwithstanding the prevalence of plague in the latter district; in Purnea, Singhbhum, Champáran, and the Sonthal Parganas, at times as many as 50 per cent. of the men were on the sick list with fever, and the work suffered much in consequence.

221. The Bihar and Singhbhum traverse sections recessed at Mussooree, while the Sonthal Parganas and Backergunge sections remained at the headquarters of their districts; the Darbhanga and Monghyr cadastral sections recessed at Bhágalpur and Dígha (Dinapore) respectively.

222. Seven junior officers of the Indian Civil Service underwent a short course of instruction in Traverse and Cadastral Surveying.

223. The season's work on the Nepál frontier was carefully compared with Colonel Tanner's survey of 1882-83, and with the old revenue survey maps. The surveys agree well, only one stone prism, No. 15, which had been washed away by the Kamla river, was found to have been re-embedded on safe ground, 373 feet west of its original position.

224. The Topographical Survey of the Patna *Diára* area on the 16-inch scale, covered 11 square miles. This area is almost all sand or water, the village sites were surveyed in blocks on the field plans. In Champáran the Topographical survey was based on the traverse stations and points fixed by plane-table intersections by an experienced topographical surveyor. The country was hilly, jungly and very thinly populated and fever was very prevalent.

The whole of the work in the Champáran district is now complete, and the compilation of the standard sheets is being carried on in the Bengal Drawing office.

SONTHAL PARGANAS.

225. The traverse survey detachment in this district was exclusively employed on the completion of the traverse work in the Government estate of Dáman-i-koh. The field season extended from the 18th October 1900 to the 2nd June 1901 and the outturn is 735 square miles, comprising 979 villages and 22 jungle blocks of an aggregate area of 166 square miles.

The preliminary demarcation was satisfactory. Seventeen thousand seven hundred and twenty-three new traverse stations were fixed and marked as follows:—1,969 by stones, 6,582 by clay cylinders and 9,172 by wooden pegs.

The country is hilly and difficult to work in, and the subtense bar method of ascertaining the direct horizontal distance between traverse stations had to be freely resorted to; this method though necessary is laborious, and takes a considerable time longer than chaining, which partly accounts for the lateness of the date on which the programme was completed; but a still greater cause of delay was the wholesale desertion of members of the establishment, chiefly owing to the unhealthiness of the district, and there were nine deaths amongst the men.

The records have been completed except that the co-ordinates of the main and sub-circuits have not been finally closed, pending an attempt which will be made next season to connect up with the Great Trigonometrical Survey on the other side of the Ganges. The angular and linear corrections, however, are well within the percentage allowed.

The magnetic variation as derived from 140 azimuth observations is 1°46′ east of the true meridian.

MONGHYR.

226. The operations consisted of the traversing of the Ganges *Diára* in *thanas* Tegra and Begusarai for immediate detail survey, and of an upland area in *thana* Gogri in advance for next season.

The outturn in the *Diára* tracts covers 198 villages aggregating 246 square miles, and in Gogri 255 villages or 501 square miles. The demarcation in the upland tracts of Gogri was on the whole very satisfactory. That of the *Diára* tract has already been remarked on.

Eleven thousand seven hundred ninty new stations were fixed and of these 726 were marked by stones, 7,892 by cylinders and the remainder 3,172 by pegs.

A line of permanent mark stones has been laid along the southern *high* bank of the Ganges at intervals of half a mile which should prove useful for relaying boundaries in *diára* tracts in the future.

The angular work proved good and the chaining on its own merits satisfactory, but a comparison of direct distances between three Great Trigonometrical Stations as derived from this survey and given by the Trigonometrical survey shows a discrepancy of 15 feet per mile which, though it will not interfere in any way with the value of the plots for cadastral work, is excessive.

MONGHYR.

(CADASTRAL SURVEY.)

227. The following table shows the outturn of cadastral survey and record-writing:—

THANA.	CADASTRAL SURVEY.			RECORD-WRITING.		
	Villages.	Fields.	Square miles.	Villages.	Fields.	Square miles.
1	2	3	4	5	6	7
Tegra	517	281,851	204	517	281,851	204
Begusarai	655	501,126	478	655	501,126	478
Monghyr (Diára tract)	5	7,225	34	5	7,225	34
Lakhisarai (Diára tract)	2	2,841	9	2	2,841	9
Surájgarh (Diára tract)	1	239	4	1	239	4
Gogri (Diára tract)	4	5,916	12	...	...	...
TOTAL	1,184	799,198	741	1,180	793,282	729

228. The cadastral survey is mapped on 1,722 sheets on the 16-inch scale, and for village site surveys on the 64-inch scale, for which there was insufficient room on the margins of the 16-inch sheets, 570 extra sheets have been prepared.

The detail survey was checked by 2,131 linear miles of *partals* run by the Survey officers, and independently, and by 2,134 linear miles of *partals* by Inspectors. This gives a total of 4,265 linear miles and an average of 5·75 linear miles of test survey to each square mile of detail survey. In addition the village sites were tested by resurveys of 435 portions and by 3,581 *partal* lines run through the main streets and alleys.

The demarcation throughout the area surveyed was found to be very imperfect, and in many cases the village boundaries appear to have been unknown to the landlords.

The record-writing, owing to the large number of petty landlords who had to be dealt with, has been very intricate. In the 1,180 villages of the season's outturn, there were 68,237 landlords, 6,011 *tauzis* and 9,831 *pattis*.

In a plot of land, area 0·57 of an acre, there are 1,582 shares. Thus each share represents 0·00036 of one acre. Another curious feature in the season's work occurs in the Government estate of Ramdiri, where the fields owned by many co-sharers vary from 25 links to 5 chains in width and are 1¾ miles in length.

229. In Patna a traverse survey of all lands lying between the southern boundary of Monghyr to the North of the Ganges and that part of the southern high bank of the river in the Patna district was completed, and comprised 22 villages in Barh and Mokameh *thanas* of an area of 60 square miles. Three-hundred and fifty-two stations were fixed and of these 48 were marked by stones in continuation of the line of permanent marks referred to in the details of the Monghyr traverse survey, the remaining stations being marked by ten pottery cylinders and 294 pegs.

Of these villages 18 were cadastrally surveyed and mapped on 71 sheets, and four with an area of 11 square miles were topographically surveyed on the 16-inch scale and mapped on 10 sheets.

DARBHANGA.

230. In Darbhanga the traversing had been completed in 1899 but as that of the area under survey was done in 1895-96 it was feared many of the theodolite stations would have disappeared. As a matter of fact, the theodolite was set up at 1,289 stations only, and this revision was confined to an area of 64 square miles in *thana* Madhubani and necessitated the rechaining of 177 linear miles.

CADASTRAL SURVEY.

231. The following table gives the outturn for the season.

THANA.	CADASTRAL SURVEY.			RECORD-WRITING.		
	Villages.	Fields.	Square miles.	Villages.	Fields.	Square miles.
1	2	3	4	5	6	7
Madhubani	297	534,506	279	297	534,506	279
Khajauli	67	234,068	134	196	551,768	319
TOTAL .	364	769,574	413	493	1,086,274	598

The excess of record-writing over cadastral survey in *thana* Khajauli refers to the area surveyed during the previous season, but of which the record-writing was postponed.

The survey is contained in 629 sheets on the 16-inch scale, and there are 550 additional sheets for the 64-inch scale village site surveys.

The average size of the field was only 0·35 of an acre. The independent *partals* amounted to 932 linear miles, and the Inspector's *partals* to 1,091 linear miles. The total gives an incidence of 4·9 linear miles of test survey to each square mile of detail. In addition to the foregoing, 695 blocks in the village site were resurveyed and 1,461 *partal* lines run through the streets and lanes. In the record-writing the entries against 18,377 fields were checked by the European Survey officers and 371,938 by the Inspectors. The total of 390,315 gives an average of 36 per cent. of the total number of plots.

The records of the entire season's work have been completed, with the exception of 43 villages, the records of which will be ready early in October.

PURNEA.

232. As the traverse surveyors in Monghyr and Patna districts completed their work, they were moved into Purnea and surveyed 854 villages covering an area of 728 square miles.

The origin of this survey is Lat. 25°-50′ and Long. 87°-40′. To check the work 109 azimuths were observed, and the resulting magnetic variation is 2°-04′ East. 12,584 new theodolite stations were fixed and these were marked by 1,743 stones, 10,716 cylinders and 125 pegs. All the computations have been satisfactorily proved and the plots handed over to the cadastral camp for next season's detail survey.

233. In the Gaya district the Maksúdpur estate was surveyed, but as the villages were much scattered no attempt was made to connect the various blocks and the survey will be of no use for the compilation of standard sheets.

BACKERGUNGE DISTRICT.

234. The origin adopted for the traverse survey is Lat. 22°-30′ and Long. 90°-30′.

235. All the surveyors were Bengalis but the *khalasis* were imported from Hazáribágh as they could not be obtained locally.

236. 19,431 traverse stations were fixed and marked, 1,250 by stones, 17,256 by cylinders and 909 by pegs, 16 were on old pillars. The magnetic variation derived from 82 azimuth observations is 1°-36′ east.

237. The country traversed is difficult, as though absolutely flat it is broken up by tidal rivers and narrow winding creeks. A certain amount of opposition was experienced at the commencement, but as precautions had been taken to employ local *amins* in place of the usual line-cutters the progress of the work was not materially affected.

238. The cadastral survey of the Bamna estate was made as a test of the special difficulties likely to be met with in the extended cadastral operations during the next field season. This test survey has proved most useful in showing when the Bihar system must be modified for the district, and as a training ground for *amins*.

The area surveyed was 33 square miles covering 44 villages and 34,588 fields.

SINGHBHUM.

239. The area traversed is 540 square miles enclosing 518 villages.

The origin of survey is the same as that of 1894-96, namely, Lat. 22°-30′ and Long. 86°-00′.

14,405 new stations were fixed, 919 trijunctions being marked by locally cut stones with a triangle and dot chiselled on the flat top. 10,000 clay cylinders were employed on other stations, and the supply of these having failed, stones with a broad arrow cut on them were used to complete the demarcation.

One hundred and thirty four observations for azimuth were taken and the resulting magnetic variation is 1°-42′ east.

Special precautions, such as running two chains and using the subtense bar, were taken to ensure accurate measurements in the hilly tracts.

MISCELLANEOUS SURVEYS.

240. In Champáran 84 square miles of the Rámnagar forest were traversed for the topographical survey of this area, required to enable the standard maps of the district to be completed. The topographical survey was also carried out, and also some demarcation work on the Bhabsa river.

241. In Darbhanga the Madhubani Municipality of 1,164 acres was surveyed, the true urban area of 490 acres on the 64-inch scale and the remainder on the 16-inch scale.

242. In Jalpáiguri the boundary between the Baikuntpur estate and the adjoining Government estate was relaid.

BENGAL DRAWING OFFICE.

243. The preparation of the standard maps of districts Orissa, Bihar and Chittagong was continued. In Orissa there are altogether 32 standard sheets; of these 6 have been published, 3 are under publication and the remainder 23 sheets have been drawn but cannot be published until the names have been corrected in accordance with the Settlement Department *thana* list. In consequence of the changes of spelling, a new edition of the six sheets already published is necessary. In Bihar there are 40 standard sheets; none have up to date been published, but 12 covering Muzaffarpur have been submitted for publication. Fresh editions of these sheets will also be required as the spelling is not in accordance with the Settlement *thana* lists, etc.

Of the Sáran and Champáran sheets, six and four respectively have been submitted for publication, the remainder are drawn, except three in Champáran in which this season's topographical survey has to be inserted, and three in Sáran in which the *diára* tract is still incomplete.

The 2-inch mapping of Darbhanga has been commenced and the Chittagong sheets are well in hand.

PROGRAMME FOR 1901-1902.

244. The following shows the *locale* of the operations for next year with the areas in square miles of the different classes of survey :—

District.	Traverse survey.	Cadastral with records.	Topographical.
Sonthal Parganas—Private estates	1,069	...	...
Monghyr	178	609	41
Patna—Government estates	55	...	...
Gaya—Deo Raj	1,00	...	...
Shahabad—Hathwa Raj estates	2	...	...
Purnea	...	710	...
Bhágalpur	1012	...	...
Singhbhum—Poráhát and Anandapur	260	...	...
Mánbhum—Nagarkiari estate	50	...	...
Ránchi	710	...	...
Backergunge	629	574	16
Kálimpong—Government estate	180	180	...
TOTAL	4,245	2,073	57

245. The officiating Deputy Surveyor-General inspected the Traverse Survey office at Mussooree during September, specially in connection with the changes in the method of computing the coordinates of village traverses, necessitated by the increasing use made of cadastral maps for the compilation of the standard sheets.

UPPER AND LOWER BURMA.

No. 7 Party.

246. Mr. E. G. Little directed operations till the 10th April when he retired on superannuation pension, and Mr. J. Connor assumed charge of the party.

247. The party was divided into five camps, the head-quarters and Lower Chindwin cadastral camp were in charge of the Executive Officer, and the Lower Chindwin traverse camp in charge of Mr. G. W. Jarbo ; Mr. Connor supervised the working of the drawing and arrears camp, while Mr. J. S. Swiney had charge of the traverse camp in Lower Burma.

248. The programme for the year in Upper Burma was to traverse 550 square miles, and cadastrally survey 800 square miles in the Lower Chindwin district. In Lower Burma it consisted of traversing 44 square miles in Sandoway district and 168 square miles in Kyaukpyu district, as estimated by the Land Records Department.

The areas actually traversed were in excess of the programme in the Lower Chindwin, this was done in order to complete the traverse work of the district ; in Lower Burma the areas surveyed were in defect of the programme owing to the villages demarcated for survey in Sandoway district being very widely scattered and surrounded by dense jungle ; this retarded the work to such an extent that the villages of that district alone could not all be traversed, and no work could be undertaken in the Kyaukpyu district. The area to be traversed in the Sandoway district turned out to be considerably in excess of that estimated for survey by the Land Records Department, and there are 5 square miles still left to be traversed.

249. The following statement gives particulars of the work done and the cost per square mile.

District.	Traversing.			Cadastral survey.				Scale.
	Villages.	Square miles.	Cost per square mile.	Villages.	Square miles.	Fields.	Cost per square mile.	
		(a)	₹				₹	
Lower Chindwin	*K'wins* 316 Blocks 33	666	63	502	808	4,02,110	111	16-inch.
Sandoway	97	105	373	...	...	...	...	...

(a) Includes 14 square miles of riv crarea.

BURMA SURVEY.

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

REFERENCES.

- Previously Surveyed on Scale 16″ = 1 Mile
- ....Do.....do.....8″ = 1 Mile
- ....Do.....do.....4″ = 1 Mile
- ....Do.....do.....2″ = 1 Mile
- ....Do.....do.....1″ = 1 Mile
- ....Do.....Triangulated
- ....Do.....Traversed
- Surveyed during Season 1900-01 on Scale 16″ = 1 Mile
- ....Do.....do.....do.....4″ = 1 Mile
- ....Do.....do.....do.....2″ = 1 Mile
- ....Do.....do.....do.....1″ = 1 Mile
- Triangulated.....do.....
- Traversed.....do.....
- Sheets Published.....(242)
- Province Boundary.....
- District.....

NOTES.

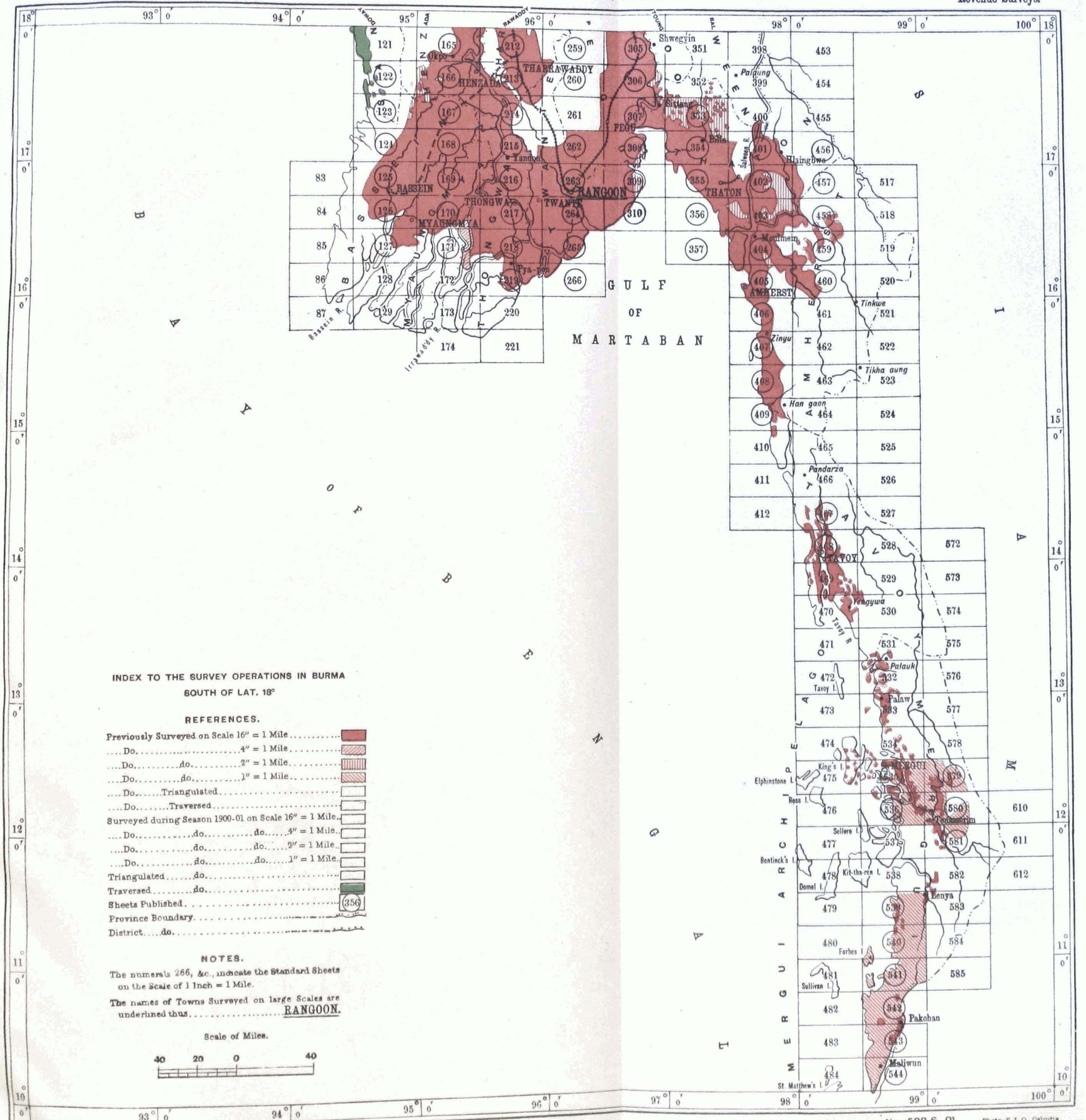
The numerals 197, &c., indicate the Standard sheets on the Scale of 1 Inch = 1 Mile.

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

Scale of Miles.

40 20 0 40

BURMA SURVEY.



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

REFERENCES.

- Previously Surveyed on Scale 16″ = 1 Mile
- ....Do. ..... 4″ = 1 Mile
- ....Do. ....do. ....2″ = 1 Mile
- ....Do. ....do. ....1″ = 1 Mile
- ....Do. ....Triangulated
- ....Do. ....Traversed
- Surveyed during Season 1900-01 on Scale 16″ = 1 Mile
- ....Do. ....do. ....do. ....4″ = 1 Mile
- ....Do. ....do. ....do. ....2″ = 1 Mile
- ....Do. ....do. ....do. ....1″ = 1 Mile
- Triangulated ....do.
- Traversed ....do.
- Sheets Published (356)
- 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.

40 20 0 40

The cost of the survey, both traverse and cadastral combined, in the Lower Chindwin district is about the same as that of the work done in the same district last season.

In Sandoway district the traverse work was exceptional, and the cost is in consequence quite out of proportion to the area. The bulk of this district was cadastrally surveyed under the supervision of the Land Records Department by local agency in 1890 to 1892, and the tracts made over to No. 7 Party for survey consisted of isolated *kwins* situated in dense jungle generally at great distances apart, which had not been surveyed by the Land Records Department.

250. The origins of survey adopted for the different districts are as follows: In Sandoway the origin is the same as used by the Land Records Survey Department, namely, Lat. 18° 30′, Long. 94° 30′, in the Lower Chindwin Lat. 22° 0′, Long. 95° 0′.

Connection to one station of the Trigonometrical survey was made, and 81 azimuths were observed in the Lower Chindwin district, while in Sandoway district connections to two stations of the Trigonometrical survey were made, and 68 azimuths were observed. The chains were tested weekly by the standards laid down in camps, and the sub-surveyors were inspected frequently in the field by the camp officers and their assistants. In Sandoway the traverse survey was connected with the work of the Land Records Department, whose survey marks were found in a fairly good state of preservation. In Lower Chindwin 12,589 theodolite stations were fixed during the season and in Sandoway 4,800 stations. Galvanized iron cylinders were embedded in the ground to permanently mark the stations.

251. The cadastral survey work in the Lower Chindwin district was mapped on 1,090 sheets on the 16-inch scale to check which 2,573·04 linear miles, or an average of 3·18 linear miles per square mile, of test lines were chained by assistants, independent *partallers* and inspectors. As a rule the work was found to be correct, but portions of some sheets had to be revised; this was done at the expense of the men who made the original surveys. The average size of fields in Lower Chindwin district, including jungle, is 1·29 acres.

252. Ten Burmans were trained as field surveyors during the season, and after they had become qualified they were employed on contract work in the same way as the other *amins*, with fair results.

253. The season's work has been completed, and traces of the 16-inch sheets and their area statements submitted to the local authorities.

In addition to the above the local authorities have been furnished with a second set of 16-inch traces of the work of previous seasons in Lower Chindwin district at the request of the Settlement Commissioner. The arrears camp and drawing office managed by Mr. Connor has been engaged on similar work to that stated in last year's report. The following statements show the progress that has been made during the year:—

Mapping of Standard Sheets—2-inch reductions.

Districts.	Sheets submitted for publication previous to 30th September 1900.	Sheets submitted for publication during 1900-1901.	Sheets remaining in hand.	Remarks.
Meiktila	24	...	...	
Upper Chindwin	...	64	...	
Shwebo and Ye-u	65	...	...	
Katha	...	53	...	
Yamèthin	(*a*) 36	...	...	(*a*) Includes 8 sheets recalled for correction of names and boundaries.
Myingyan	15	23	...	
Minbu	17	...	...	
Lower Chindwin	...	...	(*b*) 31	(*b*) Number of sheets in Lower Chindwin district not final, as the survey of the district has not been completed yet.
Magwe	20	27	...	
	(*a*) 177	167	(*b*) 31	

Cadastral Survey Mapping on the 16-inch scale.

Districts.	Sheets submitted for publication previous to 30th September 1900.	Sheets submitted for publication during 1900-1901.	Sheets remaining in hand.	Remarks.
Meiktila	1,486	...	...	
Upper Chindwin	...	893	...	
Shwebo and Ye-u	3,561	...	...	
Katha	1,635	...	...	
Yamèthin	300	1,156	(*c*) 951	(*c*) Includes 373 sheets sent to the Settlement Department for survey of extensions of cultivation, etc.
Myingyan	...	3,958	38	
Minbu	351	44	...	
Lower Chindwin	...	1,427	1,175	(*d*) These figures are liable to alteration until settlement operations have been completed.
Magwe	2,556	...	...	
	10,249	7,478	(*d*) 2,164	

254. The original 16-inch plans of 22 *kwins* of district Yamèthin have been sent to the Settlement Officer, at his request, for re-survey, as many alterations were needed and some omissions have been found in them; these are in addition to the plans referred to in last year's report.

255. The country dealt with in district Lower Chindwin was similar to that surveyed and described in last season's report. In Sandoway the dense mangrove jungle surrounding the *kwins* and through which the traverse lines had to be cut, proved a formidable obstacle to the survey and seriously retarded the progress of the work, thus raising the cost-rate to an abnormally high figure.

256. The health of the establishments in both Lower Chindwin and Sandoway districts was satisfactory on the whole; one temporary sub-surveyor, who contracted malarial fever in Sandoway district, died on his return to recess quarters at Mandalay. The field establishments on arriving from India were quarantined under the plague rules for 10 days, either at Rangoon, or on reaching their Field quarters.

257. The Upper Burma detachments left Mandalay for the field on 6th November 1900 and returned on the 30th May 1901.

The Lower Burma detachments left Mandalay on the 18th November 1900, and returned partly on the 4th June and partly on the 18th June 1901.

258. The drawing and arrears office of the party at Mandalay was inspected by the Surveyor-General accompanied by the Deputy Surveyor-General on the 29th February 1901.

259. The programme for season 1901-1902 is as follows:—

Traverse Survey	700 square miles in	Pakôkku	District.
,, ,,	5 ,, ,,	Sandoway	,,
,, ,,	168 ,, ,,	Kyaukpyu	,,
Cadastral Survey	(*a*)666 ,, ,,	Lower Chindwin	,,
,, ,,	105 ,, ,,	Sandoway	,,

(*a*) This includes 14 square miles of riverain survey.

TRAVERSE SURVEYS.

ASSAM PROVINCIAL SURVEYS (DETACHMENT).

260. This detachment continued its work under the superintendence of Mr. T. Shaw, Superintendent, Provincial Surveys, throughout the year.

261. The areas traversed were again very scattered, lying in both the Surma and Brahmaputra Valleys. The details are given below:—

District Sylhet.

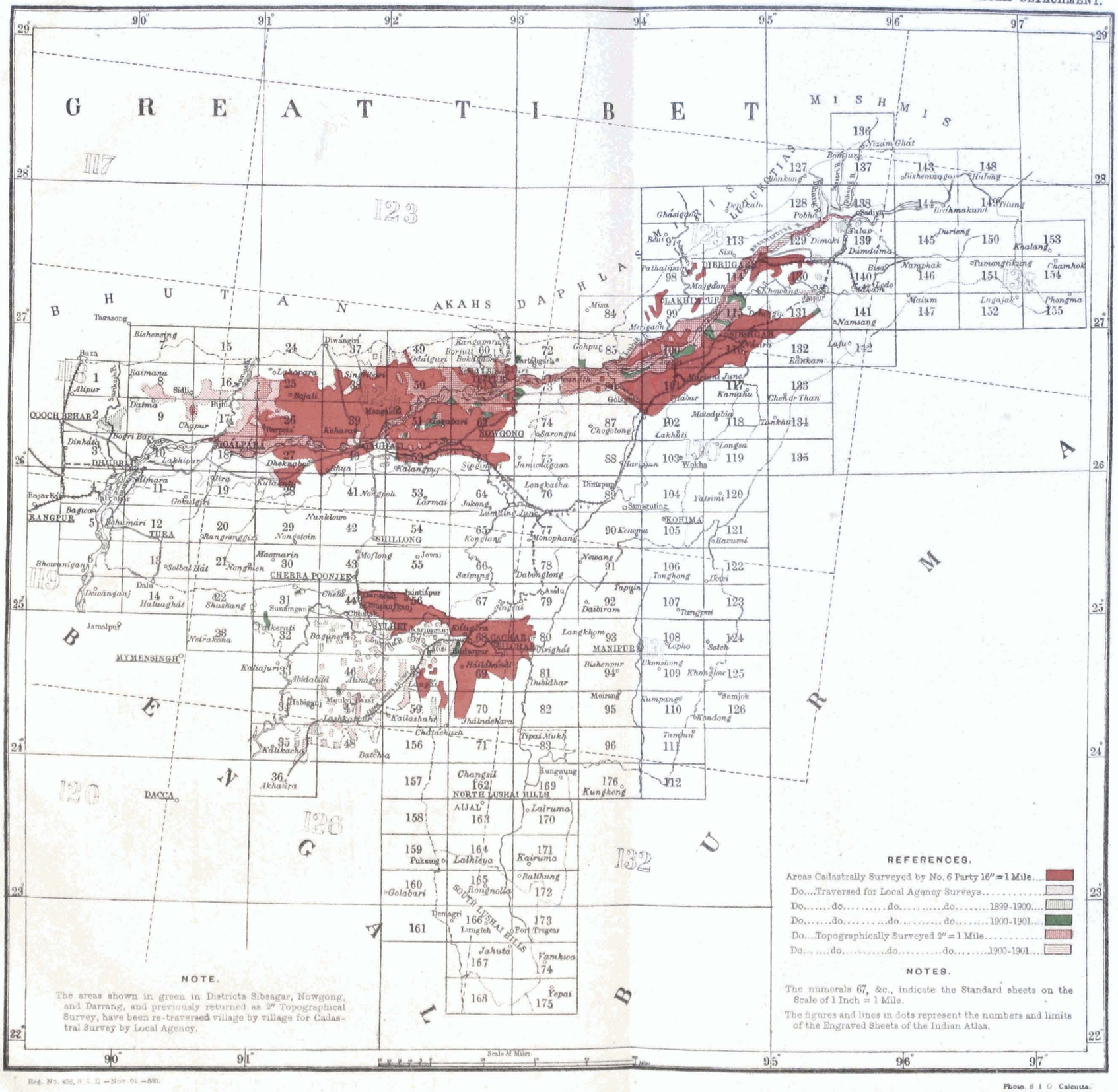
	Square miles.
(i) *Ilam* lands	11·9
(ii) Tea grant applications	2·9
(iii) Disforested areas	14·5
	Linear miles.
(iv) Sylhet and Tippera boundary	4·0

ASSAM SURVEY.

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

1900-01.

ASSAM DETACHMENT.



NOTE.

The areas shown in green in Districts Sibsagar, Nowgong, and Darrang, and previously returned as 2″ Topographical Survey, have been re-traversed village by village for Cadastral Survey by Local Agency.

REFERENCES.

Areas Cadastrally Surveyed by No. 6 Party 16″ = 1 Mile....

Do....Traversed for Local Agency Surveys....

Do.....do.....do.....do.....1899-1900....

Do.....do.....do.....do.....1900-1901....

Do....Topographically Surveyed 2″ = 1 Mile....

Do.....do.....do.....do.....1900-1901....

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.

Reg. No. 456, S. T. E.—Nov. 01.—500.

Photo. S. I. O. Calcutta.

No. 645-S. 01.

District Goálpára.

	Linear miles.
Boundary between Gáro Hills and *Pargana* Habrághát . .	16·7

District Nowgong.

	Square miles.
(i) Tea grants	52·2
(ii) Village extension survey	95·4

District Sibságar.

(i) Tea grants	46·4
(ii) Village extension survey	189·4

District Darrang.

(i) Village extension survey	22·0

District Lakhimpur.

Topographical survey of Brahmaputra River on 2-inch scale .	29·4

District Cachar.

Untraversed portion of the disforested tracts of Barák and Inner Line Reserves.	7·8

	Linear miles.
Boundary between the British villages and Cherra-Siemship .	4·2

262. The work in District Sylhet was really the completion of what was unfinished of last year's programme. As the *Ilam* lands and grants were very scattered, and the Settlement Officer was conducting the demarcation and line-clearing as best suited his operations, the services of one sub-surveyor were placed entirely at his disposal. The *Ilam* area to be traversed was very small indeed, and it was anticipated that the sub-surveyor would have completed this sufficiently early to admit of his services being utilized in the Brahmaputra Valley. This anticipation was not fulfilled, and towards the close of the season the Settlement Officer obtained permission from the Director of Land Records to employ an extra temporary sub-surveyor so that the traverse might be completed during the season. The extra sub-surveyor employed on the recommendation of the Settlement Officer did not prove a success, and his work had to be revised. There are no more *Ilam* lands to be traversed.

263. *Sub-circuits*—In Districts Nowgong and Sibságar the larger blocks of villages, which had already been cadastrally surveyed by local agency on a plane-table basis, were enclosed by sub-circuits and connected with the traverse stations of No. 6 Party where these could be found.

264. The following shews the outturn of traverse work in the different districts:—

District.	Linear miles of traverse.	Area in square miles.	No. of Azimuths observed.	Permanent marks connected.
Sylhet	...	81·4	28	181
Nowgong	...	29·8	38	85
Sibságar	...	109·8	79	193
Darrang	...	16·2	10	38
Goálpára	17·2	...	7	21
Khási and Jaintia Hills	4·5	...	2	11
TOTAL .	21·7	237·2	164	529

The comparatively large number of azimuths observed for the area traversed was due to the scattered nature of the work, each isolated block having at least one azimuth.

265. In Districts Sibságar, Nowgong and Darrang the magnetic meridian was found to be 1°-50′, in District Goálpara 1°-22′, and in Sylhet 1°-42′ east of the true meridian.

266. During the year boundary surveys, in consequence of disputes, were made in Districts Goálpára, Sylhet and the Khási and Jaintia Hills.

The work in District Goálpára was between *Pargana* Habrághát and the Gáro Hills, and the boundary was surveyed to define certain rights claimed by the Rani of Bijni.

The demarcation of four miles of the boundary between Sylhet and independent Hill Tippera was carried out by Mr. O'Donel. The survey in the Khási and Jaintia Hills was undertaken in order to put on record a boundary previously demarcated by the Deputy Commissioner. Through an unfortunate misunderstanding the exact boundary could not be pointed out to Mr. O'Donel at the time of his making his traverse survey, and the work will have to be revised during the coming year.

267. In the greater part of the season's work which fell in areas previously cadastrally surveyed by local agency, it was anticipated that the survey marks existed, and that the survey lines would have been cleared in advance of the sub-surveyors, and that delays on this account would be avoided. In practice, however, it was found that the boundaries ran through heavy jungle, that the survey marks had not been kept up in very many instances, and that the *Mandals* awaited the arrival of the surveyors at each village to assist them in locating the previous survey stations and in clearing the survey lines. Progress was in consequence very slow and the cost-rates high.

268. The cost-rates of traversing per square mile in the several Districts are as shown below:—

		R
Sylhet	Disforested area	19
	Ilam and grants	119
Nowgong		96
Sibságar		42
Darrang		81

The low rate for the disforested area in District Sylhet is due to the exclusion of Mr. O'Donel's pay and allowances which were debited to Provincial funds.

269. A small area of 38 square miles of the Brahmaputra River was surveyed topographically on the 2-inch scale.

270. The health of the party was fair on the whole and only two deaths took place among the menial establishment.

271. Skeleton plots on the 16-inch scale of 76 villages were supplied to the local authorities during the year.

272. Mr. Shaw examined the maps and records of the Land Records Department in Districts Nowgong, Sibságar, Lakhimpur and Kámrúp, and Mr. O'Donel in District Darrang.

273. A class for training local officers in practical field surveying was held at Jorhát for one month, and nine officers, three extra assistant commissioners and six sub-deputy collectors were instructed by Mr. Shaw, who also conducted examinations for first-class certificates at the Survey Schools at Gauháti, Jorhát and Dibrugarh.

274. The preparation of the 2-inch standard sheets of South Cachar was continued in the drawing office besides other miscellaneous work. This office was inspected by the officiating Deputy Surveyor-General in May, and he is of opinion that the whole question of continuing the present system of Provincial Surveys in Assam requires careful consideration.

CENTRAL PROVINCES.

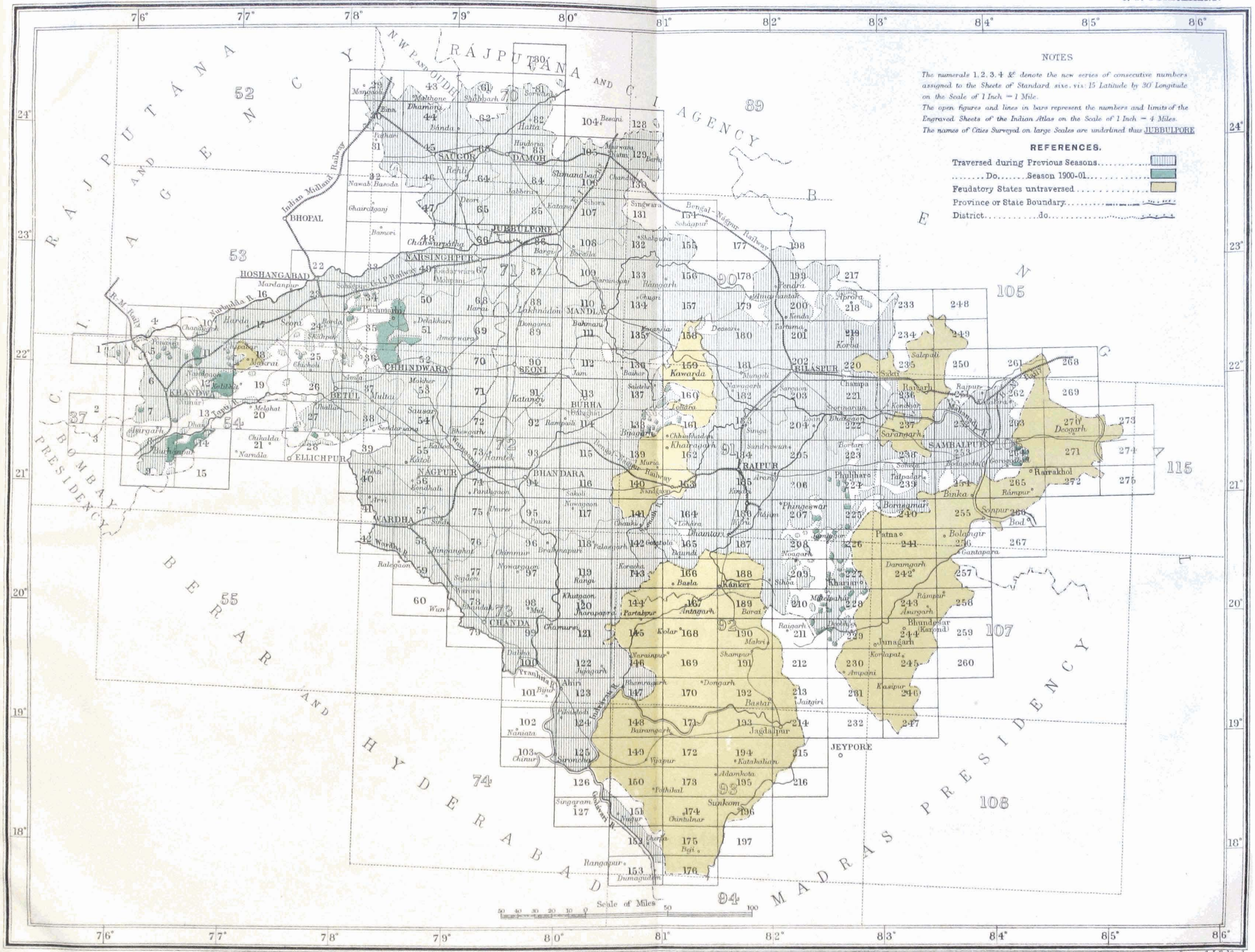
TRAVERSE DETACHMENT.

275. Mr. W. C. Price held charge of the party till his retirement on 22nd June, after which Mr. M. Gastaud held temporary charge till relieved by Mr. R. C. Ewing on 16th August. The operations of this season were confined to the traversing of detached villages in several districts in compliance with the requirements of the Commissioner of Settlements and Agriculture.

CENTRAL PROVINCES SURVEY.

INDEX TO THE TRAVERSE SURVEY IN THE CENTRAL PROVINCES.

1900-01. C. P. DETACHMENT.



Reg. No. 309, S. I. D.—Oct. 01.—550.

Engraved under the superintendence of J. Fulford.

No. 595-S. 01.

Photo. S. I. O., Calcutta.

276. A Drawing Office was attached to the Establishment for the compilation of the standard sheets, and a small revising staff of surveyors was added to check and correct in the field the maps compiled from the settlement surveys.

277. The traverse section was employed in surveying such areas as the Local Government directed, where plots were required by the *patwaris* for the completion by them of the detail survey on the 16-inch scale.

The following areas formed the programme for the season and were all completed:—

		Polygons.		Area sq. miles.
District	Raipur	88	„	134
„	Sambalpur	5	„	19
„	Chhindwára	80	„	248
„	Nimár	110 15*	„	305
„	Hoshangabad	40	„	135
„	Betúl	5	„	3
„	Bálághát	3	„	1
TOTAL .		346	„	845

* Scattered villages.

278. Of the traverse section, three sub-surveyors were employed in districts Raipur and Sambalpur and seven in districts Chhindwára, Nimár and Hoshangabad. The computers and head-quarters were encamped at Narsinghpur. The drawing section carried on its work in the office at Jubbulpore throughout the year.

(i) In Raipur the area traversed was situated in the *zamindaris*, the villages were very scattered, and much time was spent in going from one to another of the blocks and in searching for the excisions, the positions of which were only roughly known. Much inconvenience and delay was also caused owing to these not having been demarcated in advance.

(ii) Of the five jungle blocks in Sambalpur, one was a portion of Government Reserve Forest, the other four were portions of the district left unsurveyed by the preceding local Cadastral Survey. These blocks were all demarcated in advance.

(iii) In Chhindwára the demarcation was not done in advance but the boundaries were pointed out at time of survey. The *jagirdars* were not helpful and supplies had to be procured from Pachmarhi.

(iv) In Nimár, the demarcation of only 22 out of 110 blocks was done in advance, and a local peon had to be obtained from the *tahsildar* to assist in securing the attendance of the village headmen to point out the boundaries.

(v) In Hoshangabad there was no demarcation done in advance, but the *tahsildars* of Harda and Sohágpur appointed peons to assist, and the *jagirdars* in the Bariam Pagara *jagirs* and the Mahádeo blocks rendered very material assistance by doing the demarcation with their own men and supplying gratuitously auxiliary cooly labour.

(vi) In Betúl five excisions were traversed and connected with previous surveys; they were at long distances apart and much time was spent in marching between them.

(vii) In Bálághát three excisions were traversed. They had been demarcated and no difficulties were experienced.

279. The work consisted of traversing village boundaries and excised portions of Forest Reserves, which were necessarily scattered, on the principles in vogue in all revenue surveys. There were measured 3 main circuits, 8 sub-circuits, 346 village circuits and 429 sub-traverses.

The angular work (11,322 stations) was checked by 18 azimuth observations, the average angular error is 5″.

The linear measurements amount to 1,923 miles, the average error per 100 chains being 7 links.; four stations of the Jubbulpore Meridional series were connected with

280. The stones marking the stations of the previous surveys at the trijunctions and some others were found on the ground. This season's traverse stations were marked by embedding (about two feet under ground and six inches above) undressed stones marked at top with a circle and dot.

281. The area traversed is 845 square miles, at a cost of R23,825 or 28 per square mile.

282. The character of the country traversed was hilly and jungly, as it consisted of excised portions of original Forest Reserves, or jungle villages which having formerly had annual rentals of less than R15 were omitted by previous local cadastral surveys, but the rents of which now exceed that sum. The detached and scattered positions of the blocks necessitated much line clearing (the lines being generally carried over forest clad hills) in order that the necessary connections for determining their true positions might be made.

283. The party left recess quarters on 27th October 1900 and closed field operations on 15th June, when the establishment returned to Jubbulpore.

284. The computations have been completed, the 16-inch skeleton plots for issue to settlement officers with their numerical data have been supplied to Deputy Commissioners, *viz.*, 976 sheets of 346 villages.

285. The traverse work for the coming season will be 932 square miles, in districts Damoh, Mandla, Seoni, Hoshangabad, Sambalpur and Raipur.

286. The *drawing section* has completed the reduction by pantagraph of 2,529 villages contained in 4,635 cadastral 16-inch sheets of district Jubbulpore, and 1,294 villages, having 3,345 sheets in district Damoh, the details being transferred in blue to field sections measuring $7\frac{1}{2} \times 7\frac{1}{2}$ minutes in graticule: these reductions cover 84 field sections in Jubbulpore and 62 in Damoh, and will be given to field surveyors, whose duty it will be to verify, correct and supplement by careful examination in the field the topographical features transferred to them. During the coming field season a staff of qualified men will be appointed for this special work, and some members of the drawing office have been trained for it during recess. The cost of drawing office was R11,591.

287. The party was inspected on 19th November 1900 by Colonel Hobday, Deputy Surveyor-General, and on 13th April 1901 by Colonel Gore, R.E., Surveyor-General, and Major Longe, R.E., Officiating Deputy Surveyor-General.

PUNJAB.

PUNJAB DETACHMENT.

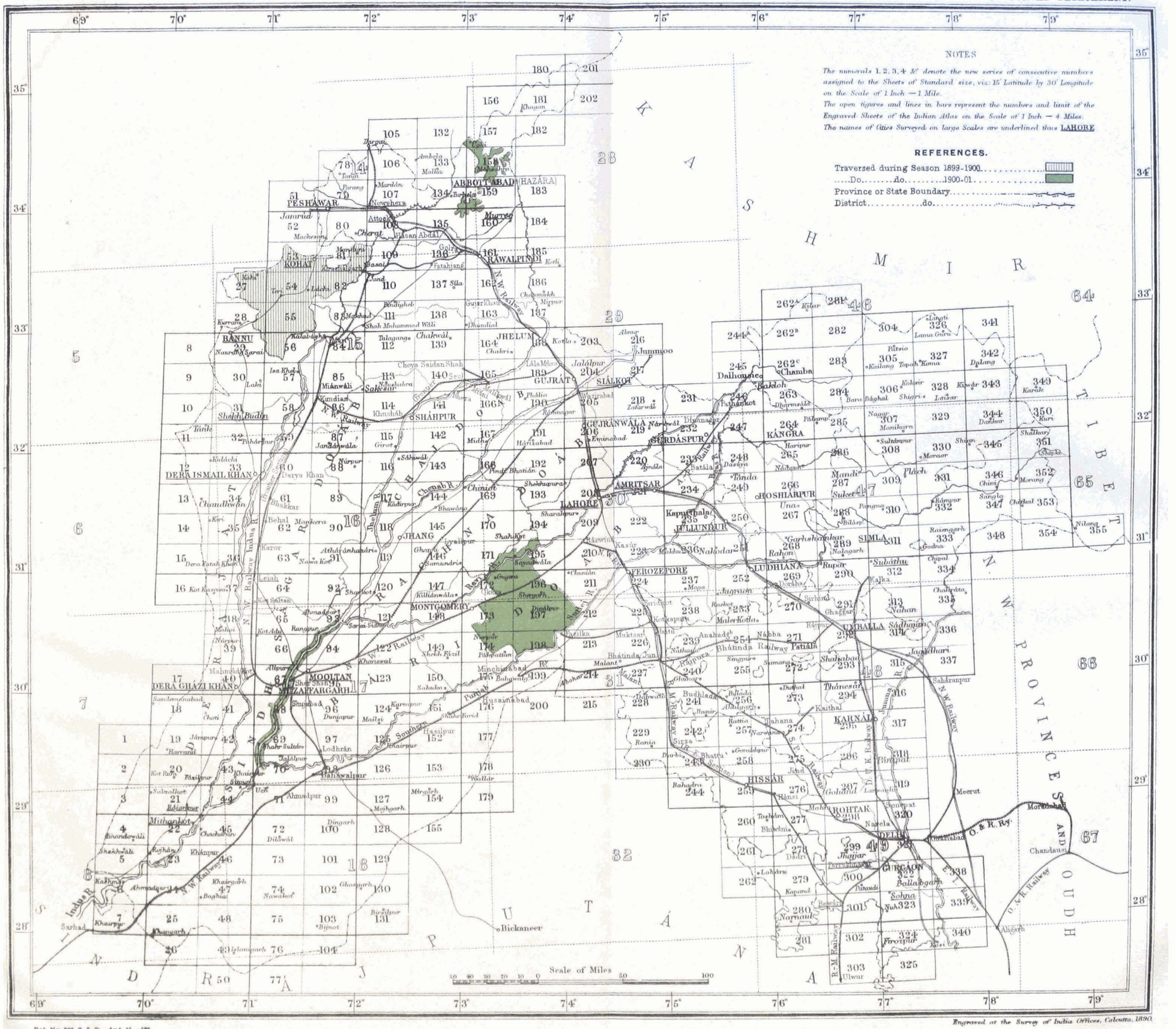
288. The detachment under the superintendence of Mr. R. B. Smart continued its traverse operations in the Punjab but it was strengthened by a Sub-Assistant Superintendent and six native surveyors and a special drawing office was started in connection with it for the preparation of standard sheets from the *patwari's* large scale village maps, using the traverses as a basis.

289. The original programme was to run traverses over the Hazára district similarly to the previous year's work in Kohát; and the work was actually commenced, but it was soon found inadvisable to continue it in that district, and on the recommendation of the Surveyor-General the Punjab Government agreed to the immediate transfer of the detachment to Montgomery. The Settlement Commissioner of the Punjab visited the detachment in the Agror valley and concluded that any further work there was unnecessary, as already our 2-inch and 4-inch maps showed the boundaries and our Topographical Survey had fixed all the trijunctions of the villages, and therefore, for Imperial purposes, further traversing was unnecessary. The Punjab Government having agreed to the transfer and the Government of India having sanctioned it, the party started on the 22nd December for Montgomery, and commenced work on the 9th January. Field work was closed on the 26th March, and the office reopened at Mussooree on the 8th April. The whole field season having lasted a little over six months.

290. On transfer to Montgomery the character of the work was somewhat changed. In addition to the ordinary duties of the party, which were to pick up by theodolite traverse the trijunctions of villages and ends of base lines, and to supply their direct distances apart to the settlement officers, a riverain survey of a portion of the Chenab was carried out for the following reasons.

PUNJAB SURVEY.

1900-01. **INDEX TO THE TRAVERSE SURVEY IN THE PUNJAB.** PUNJAB DETACHMENT.



Reg. No. 309, S. I. D.—Aug. 01.—500.

Engraved at the Survey of India Offices, Calcutta, 1890.

Photo. S. I. O., Calcutta.

No. 543-S. 01.

291. In the Punjab, as in so many other Provinces in India, the deep stream of the various rivers has hitherto been largely adopted as the boundary of villages, districts or of the Province. Owing to the constant changes of the river bed this has led to a never-ending series of disputes, so that the Punjab Government has determined as far as possible to fix once and for all each boundary independently of the ever-changing course of the rivers. In furtherance of this, a number of the internal riverain boundaries have been settled. Owing to their situation in the river beds no permanent demarcation can be made, so as soon as the settlement officers had laid down such a boundary, the *patwaris* of the villages on either bank, carried their village surveys, by means of their *square* system down into the river beds and entered the newly-determined boundary on their maps. As however, the temporary marks along such boundaries, are sure to be washed away, it becomes part of such a system to be prepared to relay the boundary accurately whenever the rivers change their course. It has been realized that it will not be possible for the *patwari*, with his cumbrous system of squares, to do this sufficiently quickly and accurately, and moreover there would be no certainty that the same boundary laid off from the village maps on either bank would coincide on the ground. The Punjab Government has therefore asked that the Survey Department should construct riverain maps showing the determined boundaries. There would be no difficulty in doing this were these boundaries marked, but the marks have disappeared, and, as above stated, the *patwaris* are not considered capable of relaying them. An attempt is therefore being made to utilize the boundaries as surveyed by the *patwaris* in the following manner;—

A careful traverse is being run along the high banks on either side of the rivers selected. All trijunction marks and the marked ends of the *patwaris* base lines in proximity to the traverse are picked up by the traverser, and cross connections at frequent intervals are made between the two traverses. Subsequently these are plotted on the 8-inch scale, and the *patwari's* maps, reduced to the same scale, are fitted on to the plots by means of their trijunctions and base line stations. The riverain boundary is then inserted from the *patwaris'* maps. If the latter are correct the common boundary plotted from the villages on either side, should agree. If it does so, or very nearly so, it will be accepted and a map prepared from these plots on the 8-inch scale.

No surveying will be done, as it is useless to map the everchanging stream, but such details as can be filled in from the settlement maps will be entered. These maps will subsequently be utilized by trained agency to relay disputed boundaries.

This experiment was during last season carried out on the Chenab river. The plots of the boundary from either side hardly ever agreed absolutely; although for the southern part of the boundary such agreement was fair, in the northern portion, a large discrepancy occurred. This seems to have been due as far as can be seen to the unaccountable missing of one of the 1,100 feet squares from one of the *patwari's* maps, though it appears to have been impossible to locate it.

In the coming year the experiment will be continued, and as some of the riverain boundaries are at present under settlement, every effort will be made to enter them while the marks are on the ground.

292. During the field season in the Hazára district 439 village trijunctions were fixed by the traversers, but the only compact block is one of 14 villages in the Agror valley covering an area formerly divided into 50 villages, as shewn by the survey of 1865-69. A comparison between the work of the year and that of 1865-69 shows that, except where the villages had since been amalgamated, the trijunctions are in the same positions.

In district Montgomery 1,607 trijunctions and 721 base lines were connected; of these only 1,365 trijunctions and 659 base lines were found to be demarcated, the remainder were marked by pegs by the surveyors as pointed out by the *patwaris* and villagers. This incomplete demarcation was in *Tahsils* Gugera, Dipálpur and Pákpattan and it was ascertained that that of *Tahsil* Montgomery was very incomplete, and it is much to be regretted that several of the trijunctions which were not demarcated were incorrectly pointed out by the village authorities on comparison with the reduced village maps.

The traversing of *Tahsil* Dipálpur was completed, and also that of Gugera with the exception of a small portion in the north adjoining Jhang, where the *patwaris* failed to attend and the settlement maps were not sufficiently accurate to admit of their being used for the preparation of the standard sheets; this area will consequently have to be topographically surveyed.

293. The following table gives the actual areas traversed :—

Names of tahsils.	No. of villages.	No. of square miles.	No. of Linear miles.
District Hazára.			
Mánsahra Abbottabad Haripur	179	317	721
TOTAL	179	317	721
District Montgomery.			
Gugera	244	851	761
Dipálpur	478	895	1,305
Pákpattan	127	255	408
TOTAL	849	2,001	2,474
Chenab Riverain area	182	352	392
TOTAL	182	352	392

294. In anticipation of the amalgamation of this detachment with No. 18 Party, 4945 settlement maps on the 24 and 16-inch scales were reduced to that of 2 inches to the mile and transferred to 51 plotted field sections. The details have been inked up in blue with the exception of the village boundaries which are accepted as correct and inked in black These sections will be inked up in the field after examination and from them the standard sheets will be drawn. Of the 849 villages which form the subject of the above mentioned 4945 maps, 814 were on the 24-inch scale and of these 26 cannot be utilised in the compilation of the standard sheets owing to faulty survey, and the majority of the remainder which were surveyed on the 16-inch scale have likewise to be rejected as they are exceedingly incorrect, being mere copies of plans made in previous settlements. In addition several *chaks* could not be fixed owing to their localities being unknown for the moment ; they will be located next field season. The following points were noticed and seem important enough to record :—

(1) There appear to be no recognised symbols or orders as to how roads, canals and water-courses should be shown on the settlement maps and consequently in one *halka* they are shewn one way and in another in some other way, making it almost impossible for the draftsmen to compile the field sections and necessitating very careful revision in the field.

(2) The spelling of the names of the villages on the maps and on the lists of villages to be traversed frequently do not agree, and this as well as the names of all the rivers, etc., will have to be carefully gone into during the revision in the field.

(3) *Thánás*, post offices, and other important buildings are not shown on the settlement maps, and consequently will have to be specially enquired about and fixed by survey during revision.

295. The village reductions have been transferred to 51 field sections, but of these only 36 will be sent into the field owing to it having been decided not to take up the revision survey of Gugera.

296. The angular work was checked by 159 azimuths, and 41 additional azimuths were observed at starting and closing stations of main and sub-circuits.

297. Fifteen principal stations of the Jogi Tila series running through the work were connected, and all the co-ordinates refer to the origin of survey. In addition 9 secondary or intersected points were used to check the traverses.

298. The cost of the party for the year is ₹51,660, giving an average cost-rate of ₹20 per square mile, but as the work was of three different types it may be well to note that that in Hazára cost ₹45, that in Montgomery ₹11 and the riverain work ₹23 per square mile. The cost per linear mile traversed in the above sections was ₹20, ₹9 and ₹20 respectively.

The cost of permanently marking stations of the riverain survey with stones came to ₹1-4-0 per square mile, and that of preparing the plane-table sections from the village maps came to about ₹3 per square mile. Six of the traverse sub-surveyors were temporarily attached to the survey training school, Dehra, during recess, for instruction in topographical surveying.

The detachment was inspected by Colonel Hobday, Deputy Surveyor-General, during the field season in January, and by the Surveyor-General in August while in recess.

GEODETIC.

ASTRONOMICAL LATITUDES.

No. 22 PARTY.

299. This party, under Lieutenant H. McC. Cowie, R.E., was employed during the season on latitude operations on that portion of the Karáchi Longitudinal Series lying between the meridians of 67° E. and 72° E. Long.

A chain of Astronomical Latitudes, determined at points along the parallel of 24°, and between the meridians of 67° and 87°, has thus been completed.

The observations were taken with Troughton and Simms' Zenith Telescope No. 1, fitted with two levels. Talcott's method of observation was employed. The results are given in the following table :—

TABLE GIVING THE FINAL VALUES FOR THE LATITUDES AND THE APPARENT DEFLECTION OF THE PLUMB LINE AT EACH STATION.

No.	Station.	Number of stars observed.	Astronomical Latitudes =O.	P. E.	Geodetic Latitudes =C.	Apparent deflection of plumb line =O—C.	P. E. of a result of unit-weight.
			° ′ ″	″	° ′ ″	″	″
1	Khankharia . .	92	24 36 58·17	±0·082	24 36 56·19	+1·98	±0·533
2	Didáwa . . .	116	24 51 17·32	±0·036	24 51 19·36	−2·04	±0·259
3	Virária . . .	95	24 56 32·76	±0·035	24 56 36·25	−3·49	±0·235
4	Lúnki . . .	69	24 58 18·74	±0·053	24 58 23·16	−4·42	±0·239
5	Rojhra . . .	113	24 57 26·08	±0·032	24 57 26·28	−0·20	±0·234
6	Chánga . . .	105	24 58 47·25	±0·036	24 58 47·00	+0·25	±0·252
7	Khori . . .	98	25 0 30·60	±0·032	25 0 31·53	−0·93	±0·221
8	Alamkhán .	101	24 49 30·50	±0·034	24 49 31·23	−0·73	±0·235
9	Károthol . . .	90	24 53 44·78	±0·028	24 53 46·69	−1·91	±0·185
10	Akbar . . .	45	30 53 38·52	±0·073	30 53 43·26	−4·74	±0·343
11	Ranjitghar . .	27	32 35 6·51	±0·053	32 35 12·10	−5·59	±0·186

300. The results of the season's work show that the geodetic values of latitude are almost always larger than the astronomical throughout the region traversed.

In the selection of stars for observations, two catalogues were used, the Greenwich Ten Year Catalogue for the epoch 1880.0 and the Catalogue of Fundamental Stars for 1900.0 by S. Newcomb, the latter being used in preference to the former, whenever possible. Many of the stars observed occurred in both catalogues; their places were accordingly computed from the data given in each, and the values of the colatitudes so obtained compared. The results of the investigation are given in Table VII in the Narrative Report; these will be published in a volume of the Professional Papers and show that the difference between the results obtained from the use of the two catalogues is constant.

301. The party was inspected by the Superintendent, Trigonometrical Surveys, in August.

EXPERIMENTAL BASE MEASUREMENTS.

No. 23 Party.

302. Capt. G. P. Lenox-Conyngham, R.E., continued in charge of the party, which was specially employed on experimental work throughout the year.

303. The experimental remeasurement of the Dehra Dún Base Line, which was made with the Jäderin apparatus in April 1900, showed that the wires supplied to the Indian Government had not the same co-efficient of expansion as those used by M. Jäderin and described in his pamphlet; an application to the Stockholm firm by whom the apparatus had been made, elicited the information that in place of steel an alloy of nickel and steel, having a very low expansion, had been employed. No values of the expansions of either of the wires, however, were given, and in the absence of these the lengths of the Base could not be computed from the measurements made, nor could any opinion as to the value of M. Jäderin's method be formed.

304. It was imperatively necessary to come to a conclusion as to the advisability of adopting the Jäderin apparatus for the measurement of the Base Lines which will be shortly required in Burma, and it was decided to assign to No. 23 Party the task of elaborating some means of measuring the expansions of the wires and of making the necessary determinations. The task proved a difficult one, but was successfully accomplished by Captain Lenox-Conyngham.

305. An account of the apparatus devised with details of the results obtained has been given in a Professional Paper of the Survey of India Department.

306. The final values of the co-efficients of expansion, as determined by Captain Lenox-Conyngham at Dehra Dún in the spring of 1901, were—

For hard drawn brass	0·0000109 *per* 1° Fahrenheit.
For the alloy of nickel and steel	0·0000002 ,, ,,

The observations gave no evidence of the necessity for a second term involving the square of the temperature in the expression for the expansion.

The values of the expansions given by M. Jäderin in the pamphlet are:—

For hard drawn brass	0·0000100 *per* 1° F.
For hard drawn steel	0·0000056 ,, ,, ,,

The agreement between the two values for the expansion of the brass wires is satisfactory; the great reduction of the expansion produced by the addition of nickel to the steel shows how valuable this alloy is for the construction of measuring instruments and standards of length.

307. The expansion of the nickel steel wire is so small that an error of 10° F. in the estimation of the temperature will only produce an error of $\frac{1}{5000000}$ of the length measured (that is to say of $\frac{1}{500}$ th of an inch in the case of these 80 feet wires), which is smaller than other errors to which the measurement of a Base Line is liable.

Thus the use of this metal removes the necessity for very accurate determinations of the temperature, which has always been a chief source of difficulty and uncertainty.

308. The above figures make the coefficient of the new alloy $\frac{1}{28}$th of that of steel. A report read before a conference of the International Geodetic Association at Stuttgart in 1898 stated that an alloy of 36 per cent. of nickel to 64 of steel had a coefficient of only $\frac{1}{50}$th of that of steel. We are unfortunately not aware of the composition of our wires, so that no inference can be drawn from the difference between the Stuttgart and Dehra Dún determinations.

309. The determinations of these coefficients occupied the party during the field season; in the recess season the recomputation of the experimental measurement of the Dehra Dún Base was taken up with the following results:—

	Feet.	Miles.	Yards.	Feet.	Inch.
1st measurement .	39,187·171 =	7	742	1	2·06
2nd ,, .	39,187·373 =	7	742	1	4·47

Discrepancy = 0·202 = $\frac{1}{196,000}$ of the length.

Mean of the two values 39,187·272 feet.
Length by measurement with the Colby Bars 39,187·462

Discrepancy = 0·190 = $\frac{1}{206,000}$ of the length.

310. These results are satisfactory, for there is good reason to believe that the experience gained will lead to such improvements in the procedure as will materially increase the accuracy of the work. The apparatus which was constructed for the determination of the expansions of the wires will be of great use when actual Base Lines come to be measured in Burma; the admirable behaviour of the wires, when subjected to close scrutiny under powerful microscopes, has created a confidence in their trustworthiness as measuring instruments which it was difficult for observers accustomed to the laborious refinements of the compensation bars to feel.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

311. Captain H. L. Crosthwait, R.E., continued in charge of the Party during the year, except for 15 days in October, when he was on privilege leave and Mr. E. J. Connor held charge.

Tidal Operations.

312. During the last 27 years tidal observations have been taken at 41 stations; of these the following were under observation at the commencement of the year:—

	Stations. (Those shown in italics are *permanent*.)	Date of commencement of operations.	No. of years observed.	Remarks.
1	Suez	1897	4	
2	Perim	1898	3	
3	*Aden*	1879	21	
4	Bushire	1892	8	Closed during year.
5	*Karáchi*	1881	20	
6	Porbandar	1898	3	"personal" observations were previously taken.
7	Port Albert Victor (Káthiàwádar)	1900	1	do. do.
8	*Bombay* (Apollo Bandar)	1878	23	
9	Bombay (Prince's Dock)	1888	13	
10	*Madras*	1895	6	previous observations from 1880 to 1890.
11	*Kidderpore*	1881	20	
12	*Rangoon*	1890	21	
13	*Port Blair*	1880	21	

313. During the year under review the station at Bushire was closed. An observatory will be opened at Bassein in Burma next field season.

314. The tidal observatories at work were all inspected during the year, either by Captain Crosthwait or Mr. Shaw.

315. All the tidal observatories have worked satisfactorily with the exception of Porbandar, where the registrations ceased from the 14th June, owing to the communication pipe being choked with sand driven in by the Monsoon. As this is the second year that this has occurred, steps will be taken at the next inspection to ascertain whether it is worth while continuing the observations.

316. The following tables give a summary of the percentage of errors in the predicted times and heights of high and low water for the last 10 years.

PERCENTAGE OF ERROR IN PREDICTED TIMES AND HEIGHTS AT OPEN COAST STATIONS FROM AUTOMATIC OBSERVATIONS.

Year.	No. of stations.	In time.		In height.			
		Within 15 minutes of Actuals.		Within 8 inches of Actuals.		Within $\frac{1}{10}$ of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1891	10	74	73	94	87	98	97
1892	8	75	74	91	85	98	98
1893	9	73	68	93	98	96	95
1894	10	65	62	95	92	97	95
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
Average of 10 years	9	71	63	93	93	96	95

PERCENTAGE OF ERROR IN PREDICTED TIMES AND HEIGHTS AT RIVERAIN STATIONS FROM AUTOMATIC OBSERVATIONS.

Year.	No. of stations.	In time.		In height.			
		Within 15 minutes of Actuals.		Within 8 inches of Actuals.		Within $\frac{1}{10}$ of mean range at Springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1891	3	64	58	66	66	92	92
1892	2	61	60	72	65	94	95
1893	2	57	57	68	50	89	84
1894	2	56	55	66	42	88	80
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
Average of 10 years	2	58	58	70	55	91	87

Spirit-Levelling Operations.

317. The levelling detachment worked again on the Eastern Bengal State Railway, commencing at Dámukdia Ghát, where the Ganges river was crossed, and thence along the railway line, closing at Siliguri.

Doubt had been thrown on the method hitherto adopted in the survey of India Department of carrying lines of levels across broad rivers: it had been urged that the level of the water on one side of a rapid river might be several inches and even feet higher than that on the other, and that consequently simultaneous readings of the height of the water on graduated poles, erected near the two banks, did not afford any clue to the real difference in level of the zeros of the two poles. There is a bend in the Ganges near Dámukdia, which made it a particularly unsuitable place for the employment of tide-poles. For these reasons it was decided to erect a bench mark on each bank near Dámukdia and to determine their difference of height by three different methods: the results were as follows:—

	feet.
(1) By means of vertical angles taken simultaneously by two observers with 24-inch theodolites: difference of height	2·139 ± 0·005
(2) By simultaneous observations to disc signals with standard levels: difference of height . . .	2·132 ± 0·016
(3) By simultaneous readings of the height of the water on graduated staves: difference of height . . .	2·211 ± 0·001

The results by the two first methods are affected by similar errors of refraction and their agreement may be fictitious; the tide-pole method differs from the mean of the other two by less than an inch, and the uncertainty of refraction renders the mean of the two first results not reliable to an inch.

The following conclusions may be drawn from the observations:—(i) that the method of crossing rivers by means of graduated tide-poles, even at bends which appear unfavourable, is not liable to appreciable error; (ii) that the method of vertical angles is superior to that of levelling.

318. The total rises and falls amounted to 1,954 feet, and the outturn of work to 211 miles of double levelling, in the course of which the instruments were set up at 2,558 stations and the heights of 26 embedded and 86 inscribed bench-marks, 1 railway bench-mark, and 1 station of the Great Trigonometrical Survey, were determined.

The detachment left Dehra Dún on the 26th October 1900 and closed work on the 27th April 1901.

319. During the next Field Season, the Sonákhoda Base Line will be connected, and levelling operations will be carried on from Párbatipur up the Brahmaputra River and thence towards Assam.

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

MAGNETIC.

No. 26 Party.

321. The work of this party commenced on the 12th December 1900, on which date Captain H. A. D. Fraser, R. E., arrived in Dehra Dún from England and took over charge of it. Before leaving England this officer had completed arrangements for the purchase of the necessary instruments, for which purpose he had been sent on deputation.

322. Under the general scheme for the Magnetic Survey of India, observations for declination, dip, and intensity are to be taken at points between 30 and 40 miles apart, distributed over the country; at certain stations, known as "repeat" stations, these observations will be repeated annually until the survey is completed. Base stations are to be established at Colaba, Kodaikánal, Dehra Dún, Madhupur and Rangoon; at these five places magnetic observatories will be built, and self-recording instruments installed.

323. It was intended to start field work in October 1901, and the interval was employed in training observers, computers and recorders.

324. It had been hoped that the self-recording instruments would have been installed at the Base Stations during the summer, but unforeseen delays have occurred in the construction of the observatories.

325. The new observatory at Rangoon has been completed, and it is hoped to set up the instruments there in the early part of 1902. The new observatory at Kodaikánal is still under construction, but it is hoped that it will be put in working order by next April. The new observatory at Dehra Dún was completed about the end of April, and the instruments were temporarily erected and worked for a few days in May. During last rains, however, certain defects in the building showed themselves, which prevented the permanent installation of the instruments till they could be remedied, and consequently the observatory is not yet in working order.

326. The comparison of the Kew and Colaba standard magnetometers has been completed, and the results will be published separately with the annual report of the party. They show that these standards are in close agreement with one another.

327. The field work for the ensuing field season will be confined to the area lying west of the line joining Dehra Dún and Bombay, and only three field parties are to be employed instead of five, though the latter strength will be attained in subsequent seasons. Two of these parties will work along railway lines, and the third will move in the Rájputána desert. Owing to lack of previous experience the first season's work must be regarded as to some extent experimental, though it is confidently expected that the results will prove sufficiently trustworthy to permit of their being accepted as part of the survey.

TABULAR STATEMENTS.

SUMMARY OF THE OUTTURN OF WORK OF THE FIELD PARTIES DURING THE YEAR 1900-01.

Summary of the outturn of work of the

Scale of Survey.	Number of Party.	Locale of Field Operations.		Triangulation.				1st Class.			Secondary.			Tertiary.		Spirit-Levelling Operations.		
				Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Intersected points.	Error per mile in feet.	Miles levelled over.	Permanent bench-marks connected.	Trigonometrical stations connected with.
Inches to a mile. 105·6	18	Himalayas . . .	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24	15	North-West Frontier .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	Provincial Surveys.	N.-W. Provinces, Azamgarh	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Gonda	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Farrukhabad.	5	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Mainpuri	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Etáwah .	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Etah .	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Aligarh .	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Jálaun	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Hamírpur	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Bengal Survey.	Bengal, Sonthal Parganas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Singhbhum .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Purnea .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Jalpáiguri .	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Backergunge .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Monghyr .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Gaya .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Patna .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Darbhanga .	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	7	Upper Burma, Lower Chindwin.	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Lower Burma, Sandoway	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	17	Bombay Forests .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	21	Hsi Paw Town and Environs (Northern Shan States).	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Punjab	25	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Detachment.	Central Provinces, Chhindwára Jagirs	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Hoshangabad	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Nimár .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Raipur .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Sambalpur.	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Bálághát	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ „ Betúl .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Provincial Surveys.	Assam, Sylhet . .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Goálpára .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Nowgong .	35	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Sibságar .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Darrang .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		„ Khási and Jaintia Hills.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12	12	Sind	40	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	15	North-West Frontier .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Total .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8	17	Bombay Forests .	...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Carried over .	44	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

Field Parties during the year 1900 01.

	TRAVERSING.				DETAIL SURVEY.					RECORD-WRITING.			Remarks.
	Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mille.	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.	
...	...	1,220	3·92	1·59	...	..	...	...	...	...	...	...	
...	...	...	...	...	0·8	...	...	...	...	...	...	...	
...	111	...	...	...	590	...	5,136	1,557	·34	472	1,236	845,172	
...	...	..	...	...	782	...	4,142	909	·37	784	909	1,514,031	
5	293	3,919	8	...	447	...	1,716	373	2·5	589	459	363,947	
...	616	11,918	8	7·5	447	...	2,637	453	·83	666	512	515,414	
...	461	7,613	6	...	55	...	101	56	1·1	25	27	13,035	
...	189	2,326	6	...	671	...	1,981	648	1·0	506	506	413,342	
...	180	2,988	2	...	147	...	2,301	51	2·86	147	51	77,914	
10	730	12,576	8·6	3·1	605	...	1,828	279	2·5	480	273	146,728	
...	35	584	6	...	...	...	...	...	...	...	...	...	
...	735	18,880	...	...	...	...	...	...	...	...	...	...	
...	542	16,109	...	...	...	...	...	...	...	...	...	...	
...	728	15,904	...	...	...	...	...	...	...	...	...	...	
15	...	397	...	...	...	...	...	...	...	...	...	...	
...	608	22,313	...	...	33	...	233	44 (a)	...	33	44	34,588	(a) Includes 13 villages=26 square miles of 16-inch topographical survey.
...	747	14,582	...	...	767 (a)	...	4,371	1,197	...	729	1,180	793,282	
...	128	4,107	...	...	...	...	...	... (b)	...	...	...	...	(b) Includes 4 villages=11 square miles of 16-inch topographical survey.
...	60	442	...	...	67 (b)	...	202	22	...	56	18	8,476	
20	65	1,733	...	...	414	...	2,026	365	...	598	494	1,093,631	
...	666 (c)	12,589	2·9	0·48	808	...	2,573	502	1·29	...	...	...	(c) Includes 14 square miles of river area.
...	105	6,035	4·6	1·8	...	...	...	...	...	...	...	...	
...	...	...	...	...	11	209	24	...	...	...	...	...	
...	...	...	...	...	8	...	12	...	...	...	...	...	
25	2,670	10,220	2·1	0·48	...	...	...	...	...	...	...	...	
...	248	3,249	·7	1·4	...	...	...	...	...	...	...	...	
...	135	1,323	·3	·9	...	...	...	...	...	...	...	...	
...	305	3,791	·4	·6	...	...	...	...	..	...	...	...	
...	134	2,644	·4	·6	...	...	...	...	...	...	...	...	
30	19	153	·1	1·0	...	...	...	...	...	...	...	...	
...	1	66	·1	·5	...	...	...	...	...	...	...	...	
...	3	96	·1	1·2	...	...	...	...	...	...	...	...	
...	81	1,968	...	0·2	...	...	...	...	...	...	...	...	
...	...	180	...	...	...	...	...	...	...	...	...	...	
35	30	496	...	...	...	...	...	...	...	...	...	...	
...	110	2,377	...	...	...	...	...	...	...	...	...	...	
...	10	451	...	...	...	...	...	...	...	...	...	...	
...	...	66	...	...	...	...	...	...	...	...	...	...	
...	10,749	...	...	...	6,052	...	...	...	...	5,085	...	...	
40	...	100	42	·2	3	11	96	...	...	...	...	...	
...	...	...	...	...	32	698	87	...	...	...	...	...	
...	...	...	...	...	35	...	...	...	...	...	...	...	
...	...	452	...	...	255	215	243	...	...	...	...	...	
44	...	...	...	...	6,342·8	...	...	...	...	5,085	...	...	

Summary of the outturn of work of the

Scale of Survey.	Number of Party.	Locale of Field Operations.		Triangulation.				1st Class.			Secondary.			Tertiary.		Spirit-Levelling Operations.		
				Instrument used. Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Stations fixed.	Triangular error in seconds.	Error per mile in feet.	Intersected points.	Error per mile in feet.	Miles levelled over.	Permanent bench-marks connected.	Trigonometrical stations connected with.
Inches to a mile.		Brought forward .	45	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	9 & 19	Madras Forests, Kurnool .	...	6 & 7	1,335	1·6	1·8	...	...	...	136	19·3	·6	676	1·7	...	...	...
		,, ,, Coimbatore	...															
		,, ,, Cuddapah	...															
		,, ,, South Canara.	...															
	17	Bombay Forests . .	50	6 & 7	381	1·3	1·3	...	...	...	251	15	·5	1,466	6	...	...	...
	18	Himalayas . . .	...	7	50	1·4	1·4	...	...	...	7	12	0·79	28	0·17	...	...	...
	Forest Branch.	Burma Forests .	...	6	534	20	20	...	...	...	9	9·5	0·7	4	0·4	...	...	...
		Central Provinces, Mandla and Damoh.	...	5	404	1·0	1·0	...	...	...	127	15	1·3	256	2·8	...	...	...
		,, ,, Seoni .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, Nimár .	55	6	65	2·7	2·7	...	...	...	6	10	0·7	17	0·7	...	...	...
		,, ,, Chánda	...	6	293	16·2	17·2	...	...	...	7	14	1·8	9	0·6	...	...	...
		Bengal, Singhbhum . .	...	6 & 7	650	6·8	8·1	...	...	...	35	16	0·5	55	1·3	..	...	...
		Punjab, Hazára . .	...	7	340	2·7	2·7	...	...	...	18	16	0·6	106	1·5	...	...	...
		,, Jubbal and Tarhoch States.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL .	60	...	4,052	...	...	...	...	...	...	...	...	...	...	...	...	...
2	3	Lower Burma . . .	...	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	12	Sind	...	7 & 8	3,729	11	11·3	...	...	...	86	6·4	0·2	203	0·34	...	...	...
	15	North-West Frontier .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		,, ,, ,, .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	Himalayas . . .	65	7	85	1·6	...	...	...	...	...	...	...	53	0·01	...	...	...
	Provincial Surveys.	Bengal, Champáran .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		Assam, Lakhimpur .	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Forest Branch.	Burma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL .	...	...	3,814	...	...	...	..	...	...	...	...	...	...	...	...	...
1	3	Lower Burma . . .	70	6	600	15	20	...	...	...	8	5	0·4	26	0·7	...	..	...
	10	Upper Burma . . .	...	6	4,068	6·3	6·5	...	...	...	50	7·2	0·10	394	0·33	...	...	...
	11	,, ,, . . .	...	6	3,311	5·2	6·4	...	...	...	47	10·4	0·22	611	0·47	...	...	...
	14	Lushai	...	6 & 7	1,904	111·7 1·4	111·7 1·4			5·6	0·11	39	17·8	0·25	649	...	...	...
	15	Sind	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	18	North-West Frontier .	75	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...
		Himalayas . . .	...	5	105	2·3	...	...	...	...	6	20	0·57	39	1·3	...	...	...
	21	Upper Burma . . .	...	6	3,375	7·5	7·5	...	...	...	30	14·2	0·31	458	0·56	...	...	...
		TOTAL .	...	...	13,363	...	...	...	...	...	...	...	...	...	...	...	...	...
½	15	Kashmir	...	...	4,800	...	...	...	...	...	...	..	...	...	...	...	...	...
		North-West Frontier .	80	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
		TOTAL .	...	...	4,800	...	...	...	...	...	...	...	...	...	...	...	...	...
¼ & ⅛	15	North-West Frontier .	...	...	18,350	...	...	...	...	...	...	...	...	...	...	...	...	...
	25	India	...	...	—	...	...	...	...	...	...	...	...	...	...	211	26	1
		GRAND TOTAL .	84	...	44,379	...	...	...	...	...	...	...	...	...	..	...	...	...

Field Parties during the year 1900-01—contd.

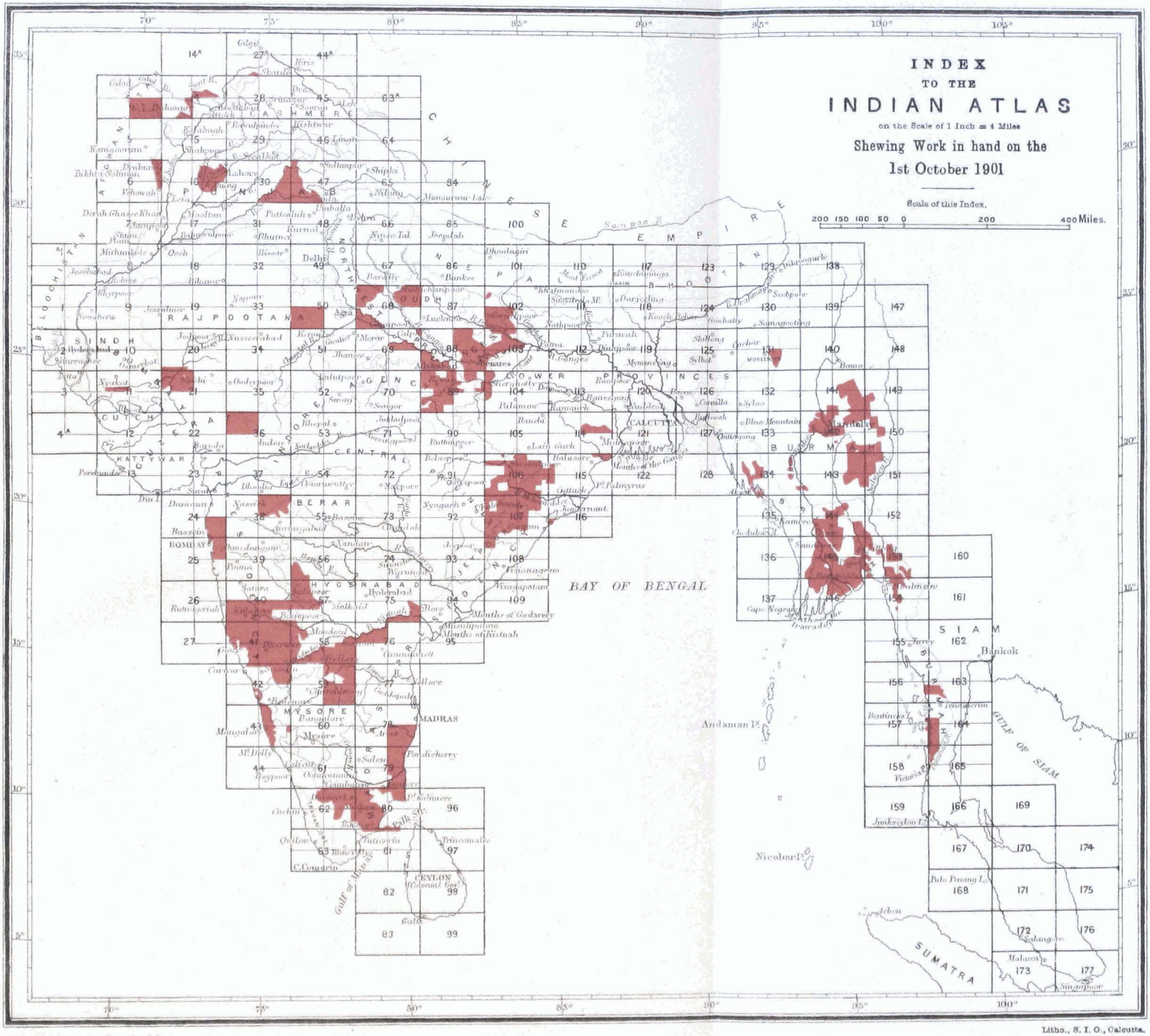
	TRAVERSING.				DETAIL SURVEY.					RECORD-WRITING.			REMARKS.
	Area in square miles.	Number of stations at which the theodolite was set up.	Angular error per station in seconds.	Linear error per mile.	Area in square miles.	Plane-table fixings per square mile.	Linear miles of test lines.	Villages.	Average size of fields.	Area in square miles.	Villages.	Fields.	
45	...	...	...	...	6342·8	...	...	...	...	5,085	...	...	
...	...	1,189	2·0	0·7	398	72	74	...	...	...	...	...	
...	...	...	...	...	232	43	24	...	...	...	...	...	
...	...	2,079	9·0	1·6	552	32	27	...	...	...	...	...	
...	...	3,822	8	2·5	196	86	...	...	...	...	...	...	
50	...	1,629	·07	·1	410	124	132	...	...	...	...	...	
...	...	...	...	...	109·	15	*in situ*	...	...	...	...	...	
...	1,238	...	...	...	873	134	304	...	...	...	...	...	
...	105	934	10	2·1	780	163	273	...	...	...	...	...	
...	...	350	4	2·7	...	...	...	...	...	...	...	...	
55	...	...	...	...	...	...	...	...	...	...	...	...	
...	76	806	7·5	3·5	776	115	1,095	...	...	...	...	...	
...	128	2,064	0·9	5·3	361	218	107	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
...	...	...	...	...	43	...	...	...	...	...	...	...	
60	...	...	...	...	4,730	...	...	...	...	...	...	...	
...	74	896	6	3	202	84	66	...	...	...	...	...	
...	...	6,199	49	1·2	2,553	23	1,320	...	...	...	...	...	
...	...	...	...	...	440	...	...	...	...	...	...	...	
...	...	...	...	...	120	...	...	...	...	...	...	...	
65	...	...	...	...	951	29	*in situ*	...	...	...	...	...	
...	84	684	...	...	84	...	57	...	...	...	...	...	
...	...	...	...	...	38	...	...	...	...	...	...	...	
...	...	...	...	...	5	62	*in situ*	...	...	...	...	...	
...	...	...	...	...	4,393	...	...	...	...	...	...	...	
70	...	...	...	...	900 230 (*d*)	9·9	*in situ*	...	...	...	...	...	
...	...	...	...	...	1,286 2,023 (*d*)	4·2 4·6(*d*)	403	...	...	...	...	...	(*d*) Revision survey.
...	...	...	...	...	2,472 (*e*)	95	295	...	...	...	...	...	(*e*) Includes 45·45 square miles of overlap.
...	...	...	...	...	870	2·3	*in situ*	...	...	...	...	...	
...	...	...	...	...	1,915	5·4	110	...	...	...	...	...	
75	...	...	...	...	440	...	...	...	...	...	...	...	
...	...	...	...	...	488	2	*in situ*	...	...	...	...	...	
...	...	...	...	...	1,793	5·3	*in situ*	...	...	...	...	...	
...	...	...	...	...	12,416	...	...	...	...	...	...	...	
...	...	...	...	...	2,124	3·2	77 & *in situ*	...	...	...	...	...	
80	...	...	...	...	1,100	...	...	...	...	...	...	...	
...	...	...	...	...	3,224	...	...	...	...	...	...	...	
...	...	...	...	...	17,000	...	...	...	...	...	...	...	
...	...	...	...	...	...	...	...	...	...	...	...	...	
84	...	...	...	...	48,105·8	...	...	...	...	5,085	...	...	

Statement showing the cost-rates of work executed by the

Number of Party.	Nature and locale of field operations.	Cost-rate per square mile.								
		Triangulation.	Traversing.	½″	1″	2″	4″	8″	12″	16″
		₹	₹	₹	₹	₹	₹	₹	₹	₹
	Topographical Surveys.									
3	Lower Burma	12·1	67·9	...	43·6	141·0	...	...	...	...
10	Upper Burma	4·9	...	...	26·2 / 22·3 (*p*)	...	...	...	...	...
11	Upper Burma	11·8	...	...	20·1	...	...	...	...	...
12	Sind	4·5	2″ = 6·7 / 12″ = 31·7	...	...	12·0 / 2·8 (*b*)	...	...	105 / 125 (*c*)	...
14	Lushai	27·9 (*q*) / 11·3 (*r*)	...	...	68·3	...	...	...	...	...
15	Kashmir	⅛″ = 1·5	...	7·1	...	...	...	...	...	...
	North-West Frontier	¼″ = 0·8	...	...	2·2	5·3	...	...	780·8	...
	Sind	...	...	...	11·0	...	...	...	...	...
18	Himalaya	45·1	...	...	25·3	60·1	78·3	...	...	...
21	Upper Burma	7·5	...	...	21·4	...	...	...	...	1,299·2
	Forest Surveys.									
9 & 19	Madras	8·8 (*s*)		...	...	...	58·0	...	...	...
17	Bombay	4″ = 8·4 / 8″ = 14·7	...	...	...	...	65·4	106·7	...	113·0
Forest Branch.	Burma	33·5	...	...	...	80·0	97·8	..	...	...
	Central Provinces	2·7	...	...	...	...	36·9	...	...	...
	Singhbhum	2·1	...	...	...	...	61·3	...	...	...
	Punjab-Jubbal and Tarhoch States	...	...	...	...	...	47·0	...	...	...
	Cadastral Surveys.									
Provincial Surveys.	North-Western Provinces	...	23·8	...	...	...	...	...	...	75
Bengal Surveys and Detachments.	North Bihar	...	31·8	...	...	...	...	...	...	81·8
	Sonthal Parganas	...	52·1	...	...	...	...	...	...	...
	Gaya	...	34·6	...	...	...	...	...	...	...
	Singhbhum	...	54·2	...	...	...	...	...	...	...
	Backergunge	...	60·2	...	...	...	...	...	...	228·8
7	Lower Chindwin, Upper Burma	...	56·3	...	...	...	...	...	...	111·0
	Sandoway, Lower Burma	...	363·8	...	...	...	...	...	...	...
	Traverse Surveys.									
Detachment.	Punjab	...	19·4	...	...	...	...	...	...	...
Do.	Central Provinces	...	27·1	...	...	...	...	...	...	...
Provincial Surveys.	Sylhet	...	118·8 (*t*) / 18·6 (*v*)	...	...	...	...	...	...	...
	Nowgong	...	95·8	...	...	...	...	...	...	...
	Sibságar	...	42·5	...	...	...	...	...	...	...
	Darrang	...	81·0	...	...	...	...	...	...	...
	Lakhimpur	...	...	...	...	3·8	...	...	...	...

several Field Parties during the year 1900-01.

	Cost-rate per acre.	Cost-rate per square mile.			Total cost, inclusive of charges for instruments to Provincial Governments.	Remarks.
	Cadastral survey, including traversing, detail survey, and mapping.	Stone embedding.	Records (*Khanapuri*).	Completion of Vernacular records, assessment statistics, etc.		
	Annas.	₹	₹	₹	₹	
..	...	...	...	...	89,889	
...	...	...	...	...	98,997 (*a*)	(*a*) Exclusive of ₹5,636 cost of Bangalore Drawing Office.
...	...	...	...	...	88,768	(*b*) Rate of mapping Khairpur Survey.
...	...	...	...	...	87,787	(*c*) Rate of mapping Karáchi Cantonment.
5	...	...	...	...	96,561	(*d*) Includes ₹8,019 expended on arrears of mapping.
...	...	...	...	...	1,21,090 (*d*)	(*e*) Includes ₹25,523 for arrears of mapping, ₹3,145 for instruction of soldier surveyors and pupils; ₹4,557 for Simla Survey and ₹3,207 for reduction and compilation of 2″ sheets from Patwari maps.
...	...	...	...	...		(*f*) Includes ₹68 expended on 1″ detail survey and ₹17,095 on miscellaneous compilation.
...	...	...	...	...		(*g*) Includes ₹69,930 cost of 1,237 linear miles of traversing.
						(*h*) Includes ₹1,508 cost of 181 linear miles of traversing; ₹3,678 cost of 1,091 miles of boundary survey and ₹868 cost of 829 miles of levelling.
...	...	...	...	...		(*i*) Includes ₹3,085 cost of 127 linear miles of traversing.
10	...	...	...	...	1,00,471 (*e*)	(*j*) Includes ₹15,287 cost of Bareilly mapping on 2″ scale.
...	...	...	...	...	93,200 (*f*)	(*k*) Includes ₹4,266, expended on Jalpáiguri-Baikuntpur boundary survey, ₹792 on Thana mapping and ₹4,747 on Orissa and Bihar Badars.
...	...	...	...	...	93,335	(*l*) Includes ₹569 expended on Mandalay Cantonment and ₹21,358 on completion of traverse and cadastral records of districts surveyed during seasons, 1892-1899.
...	...	...	...	...	62,350	(*m*) Includes ₹500 expended on revision survey in Pegu, and ₹7,911 on printing Rangoon Town maps.
...	...	...	...	...	1,73,433(*g*)	(*n*) Includes ₹11,591, cost of Jubbulpore and Damoh mapping.
15	...	...	...	...	65,221 (*h*)	(*o*) Includes ₹920 expended on Goálpára and Gáro Hills Boundary survey; ₹1,245 on standard mapping and ₹14,538 charge of Drawing Office.
...	...	...	...	...	26,547 (*i*)	(*p*) Rate of revision survey.
...	...	...	...	...	2,021	(*q*) Rate of tertiary triangulation.
...	...	3·2	...	...	3,41,732 (*j*)	(*r*) Rate of first-class secondary do.
...	2·84	1·9	74·1			(*s*) Rate of both triangulation and traversing.
20	...	3·3	...			(*t*) Ilam and grants.
...	...	5·6	...	...	4,52,947 (*k*)	(*u*) Disforested.
...	...	1·7	...			
...	7·22	15·0	220·2			
...	4·18	6·3	...	...	1,52,382 (*l*)	
25	...	9·2	...	...	47,572 (*m*)	
...	...	...	...	...	51,660	
...	...	1·1	...	...	35,416 (*n*)	
...	...	...	...	...		
...	...	...	...	...		
30	...	...	...	...	29,161 (*o*)	
...	...	...	...	...		
32	...	—	...	...		



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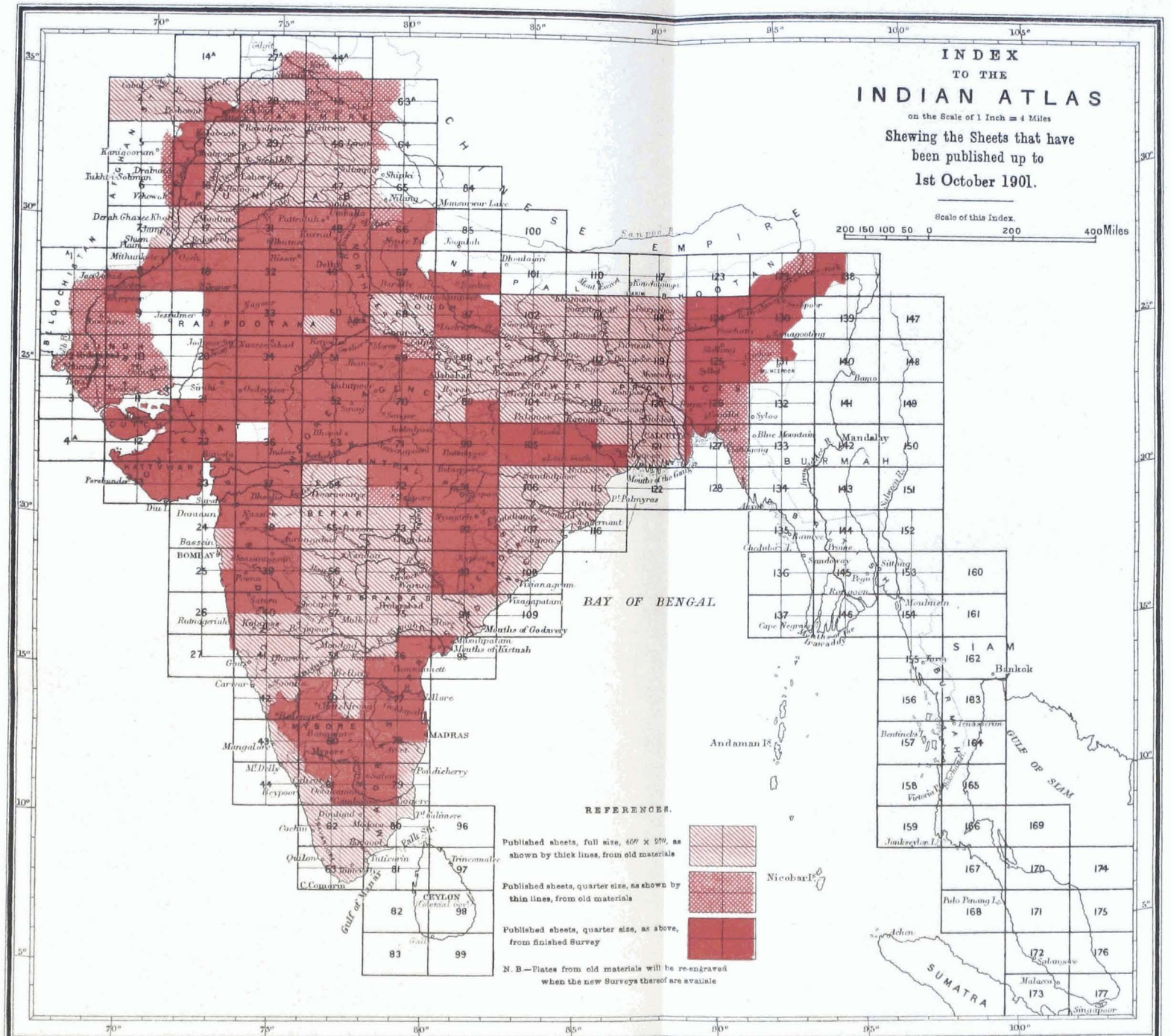
Litho., S. I. O., Calcutta.



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

APPENDIX.

Narrative report of MAJOR T. F. B. RENNY-TAILYOUR, *R.E., Superintendent 2nd grade, on the Survey Operations with the China Field Force, season 1900-1901.*

The survey party detailed for the China Field Force under Lieutenant-General Sir A. Gaselee, K.C.B., is given in the margin.

Major T. F. B. Renny-Tailyour, R.E.
Captain C. H. D. Ryder, R.E.
Munshi Ikbaluddin, K.S.
Surveyor Abdul Rahim, K.S.
Surveyor Natha Singh.
Sub-Surveyor Hazrat Ali.
1 Interpreter and 29 *Khalasis*.

At the time of deciding to send an expedition from India to China the outlook was so doubtful that it was considered advisable to delay the despatch of a Survey Party until it appeared certain that operations would actually take place. Consequently it was not until the 15th July 1900 that orders for the survey party were issued.

I left Bangalore for Calcutta with Munshi Ikbaluddin and the surveyors on the 20th July.

Captain Ryder received orders on his arrival at Shanghai to join the expedition and left there for the front on the 21st July.

The *khalasis*, who were supplied by No. 15 Party and came from the neighbourhood of Ráwalpindi, joined me at Calcutta. In addition to the ordinary equipment, which was supplied by the Dehra Dún office, I took two Perambulators. The tents for the party, as laid down in the Field Service Regulations, Intelligence and Surveys, were obtained from the Ordnance Department at Calcutta, and clothing, etc., from the Commissariat Department at Calcutta. On field service, surveyors, sub-surveyors and *khalasis* have relative rank as native officers, havildars and sepoys for the scale of allowance of tentage, baggage, rations, etc., but for clothing they are also allowed in addition such articles of the equipment authorized for followers as may be necessary, this is sanctioned in letter No. 248-W, dated 2nd May 1895, from the Military Department to the Surveyor-General of India.

The Survey Party was ordered to leave Calcutta on the 2nd August in the S. S. "*Rewa*" which had also a squadron of the 16th B. L. on board. The "*Rewa*" was a comfortable steamer but rolled badly, and we had a fairly rough passage, losing twenty horses and mules. We called at Hong Kong and Wei-Hai-Wei, and arrived early on the 24th August at the Taku anchorage, about ten miles from the shore, where an enormous number of warships and transports of all nationalities were collected. We were transhipped into a small steamer and landed the same evening at Sinho, the British depôt near Taku. Next day we proceeded by rail to Tientsin which presented an extraordinary sight; the streets were crowded with an endless variety of foreign troops, many of whom were passing through on their way to Peking. The bank of the Pei Ho (river) alongside the Foreign Concessions was covered with stores of all descriptions, and the river itself crowded with boats, the larger of which were being unloaded of stores brought up from Taku, while the smaller ones were loading up for Peking and the Posts *en route*.

On my arrival at Tientsin I wired for orders to the Chief of the Staff at Peking, suggesting that I should send a small detachment there for Captain Ryder, and start the survey work myself at Tientsin before moving on.

The telegraph line was not working properly, and it was some time before I received a reply ordering me to proceed to Peking and to survey the Pei Ho and the roads along its banks on my way. While awaiting this reply I had time to complete a triangulation in the neighbourhood of Tientsin and started Surveyor Natha Singh on a 1-inch survey of the town and the country round about. It was impossible to make an extensive triangulation here, owing to the flatness of the country.

Leaving Natha Singh with some *khalasis* and the heavy baggage at Tientsin, I started with the remainder of the party for Peking on the 9th September, surveying the river and roads as ordered. Our baggage was carried in boats as far as Tungchou, from which place Peking is about 14 miles distant by road. On the 17th September we arrived at Peking, where I met Captain Ryder who had joined at Tientsin from Shanghai in time to accompany the International Force which relieved the Peking Legations on the 14th of August; he had done a certain amount of surveying assisted by the Intelligence surveyors. After my arrival in Peking the field offices of the Intelligence and Survey were practically one, and the military surveyors worked so much under Captain Ryder and myself that it would be impossible to altogether separate the work done by the surveyors of the different branches.

As there were a large number of villages and most of the country to be surveyed was in the plains, I decided that the plane-tabling should be on the half inch scale. I started triangulation; measured a base; observed for latitude and azimuth; and in a short time had relatively fixed the principal hills within sight of Peking, as well as prominent points in the plains.

At first we were unable to move much out into the country, but the surveyors had plenty of work, making large scale plans inside the city, and compiling maps of the neighbourhood from surveys made by the Japanese prior to the disturbances.

Munshi Ikbaluddin started off on the 9th of October on a reconnaissance to the south-west; and on the 12th I set out with an International expedition under Lieutenant-General Sir A. Gaselee, K.C.B., for Pao-ting-fu; I took Abdul Rahim and Hazrat Ali with me, and there were also two military surveyors. A column was also sent from Tientsin to combine with us, and I arranged for Natha Singh to accompany it. Pao-ting-fu is situated about 100 miles to the south-west of Peking.

We were not opposed by the Chinese, and arrived at Pao-ting-fu on the 19th of October, the Tientsin column with Natha Singh arriving the following day. As the road was entirely in the plains and the weather generally hazy it was impossible to carry on a connected triangulation *en route*; I was, however, able to fix our position at several points, by observations to hills already fixed from Peking.

At Pao-ting-fu we were able to rescue several Europeans who had been very badly treated and had had several narrow escapes. A number of Europeans had been murdered here some months before, and an International Commission was appointed to enquire into the matter. Punishments were inflicted on the town, and the principal official and several others were beheaded.

During our halt at Pao-ting-fu I measured a base and did some triangulation; I also observed for azimuth and latitude, and by this means was able to connect on to the Peking series. Abdul Rahim accompanied a small column sent out to the west and did some useful mapping.

We started back from Pao-ting-fu on the 28th, leaving a garrison of French and German troops. It was arranged that the columns returning to Peking and Tientsin should split up and march back by several new roads, and, as a surveyor was sent with each party, we were enabled to get in a good deal of new country. The party I accompanied made a considerable detour to the east and arrived at Peking on the 6th of November.

Soon after my return permission was obtained to send Captain Wingate of the Intelligence and also a Survey detachment with a German column proceeding to Kalgan, about 120 miles to the north-west of Peking and on the outer Great Wall. This detachment consisted of Captain Ryder, Ikbaluddin and Hazrat Ali with one military surveyor, and started on the 12th of November. Owing to the long marches in pursuit of continually retreating Chinese troops no triangulation was possible, but a route traverse was kept up all the way. At Kalgan reliable information was obtained regarding the murder of Captain Watts-Jones, R.E., which had taken place some seven marches to the west, in the month of July. As the German column was returning by the same route, Captain Ryder decided to send Ikbaluddin back with it to fill in additional detail, while he with Captain Wingate returned by a new and more circuitous path through the hills, rejoining the Germans at Ch'ang-pi'ng-chou near the Ming Tombs about a week later, and from there making a small detour in the plains before returning to Peking on the 6th of December.

Surveyor Natha Singh came up to Peking from Tientsin on the 21st of November with the remainder of the *khalasis* and the heavy baggage.

Owing to the severe winter very little surveying was practicable for the next two or three months, and it was not until March that we again got the surveyors regularly out into the country. During these months we were fully employed compiling maps etc., principally with a view to the possibility of expeditions in the spring to the south and south-west. Great use was made of Chinese maps which in this part of China appear to be very fairly accurate in the plains, although the delineation of the hilly country is weird in the extreme. The translating of the names alone was a considerable undertaking.

Captain Ryder proceeded in March to Shan-hai-kuan, started a triangulation there and continued it to Tong-Shan, where he joined a column of about 200 men under Major Turner, Jodhpur Lancers, detailed as an escort for himself, Natha Singh and a military surveyor. In spite of hazy weather he managed to carry on and eventually connected his triangulation on to my Peking series.

A similar column under Colonel Phayre, 3rd Bo.C., with whom I sent Surveyor Abdul Rahim with Hazrat Ali and a military surveyor, working from Peking, met Major Turner's column at the Eastern Tombs, and between them a very large amount of country was surveyed up to the Great Wall.

Besides these columns, from March until the end of June we were able to obtain numerous small escorts, generally under an officer, which kept us very busy, and, with sometimes as many as ten military surveyors working in addition to the Survey Party, a large block of country was mapped in detail.

Surveying becomes quite impracticable in the plains in this part of China during the rains, which commence early in July, and as there was no prospect of being allowed to survey further afield, it was decided that the Survey Party should return to India about the middle of July.

Two draftsmen of the Intelligence arrived from Simla at the beginning of June. This additional help enabled us to reproduce, before our departure, preliminary maps for the use of the troops remaining behind.

The Survey Party left Peking on the 14th of July, and returned to India in the S. S. "*Sumatra*," arriving at Calcutta on the 2nd of August 1901.

Altogether the triangulation of 16,000 square miles of country was completed. As it was impossible for us to obtain our own longitude accurately we based our work on the Naval value of the Shan-hai-kuan lighthouse. The triangulation has been carefully computed at Bangalore, and the connection between the Shan-hai-kuan and Peking series

has proved very satisfactory, the Pao-ting-fu series also connecting well on to the Peking series.

There is thus a good continuous reconnaissance triangulation right round from Shan-hai-kuan to Pao-ting-fu.

The actual surveying in detail on the half-inch scale was carried on by means of plane-tabling, and a total area of 17,000 square miles was completed.

Owing to the hazy weather and the flat nature of the country it was impossible to use triangulated points for a great deal of the work, but, by means of accurate traverses by our own surveyors, the country was fairly well divided up, and thus a good check obtained of the work of the other surveyors. The Perambulators came in very useful for these traverses.

The military surveyors are of course not in the same class as the trained surveyors of the Survey Department, but their work, with a certain amount of adjustment, has generally fitted in wonderfully well; the final maps, drawn on the return of the Survey Party to Bangalore, and based on the triangulation and on the accurate work of our own surveyors, are very satisfactory and quite sufficient for all general purposes.

Without the intimate and cordial relations, which always existed on the expedition between the Intelligence Branch under Captain Norie and ourselves, it would have been quite impossible to have obtained anything like such good results; great assistance was also rendered by Doctor Gatrell, who was attached to the Head-Quarters as Interpreter, in the transliteration of the Chinese names, for which the official system (Wade's) was always adopted.

We had occasional communications with Captain Koenemann, the Officer in charge of the Survey Party with the German army. We gave them some assistance, and received in return a trace of a considerable area of country surveyed by them to the south of our own work. They did not attempt any triangulation, but their work, which was in the plains, appears to be very accurate; it was, I believe, done by officers and chained throughout.

On landing at Taku the country presents one dead level, but as Peking is approached ranges of hills appear to the west and north; these hills continue eastwards towards the sea, till at Shan-hai-kuan they are within three miles of the coast. The whole of the plain is well cultivated and studded with large and prosperous villages, except near the coast, where mud flats abound, relieved here and there by salt heaps, the collection of which forms a most important industry. The crops when full grown rise to 15 or 16 feet in height and absolutely prevent any extended view of the country being obtained.

The weather encountered was extremely annoying to a surveyor and at no season of the year was there a certainty of having two consecutive clear days. In the rains although the atmosphere is clearer clouds hang about the higher hills, in the cold weather there is an almost continuous haze, while the hot weather is no better. This haze is probably largely due to duststorms emanating from the bleak Manchurian plateau.

It is probable that there is a greater range of temperature in North China than in any other part of the world, the temperature in the shade varying from 100° (Fahr.) in the summer to below zero in the winter. In spite of this, the climate is not unhealthy, and good food is everywhere obtainable.

A plentiful supply of warm clothing was issued to the Force, and the good health of the party was in no small measure due to this precaution.

Captain Ryder is a very experienced surveyor and rendered me invaluable assistance throughout; his knowledge of the Chinese was extremely useful.

Munshi Ikbaluddin is very energetic and hard-working, and showed considerable tact in his dealing with military and other officers.

Surveyor Abdul Rahim is a very quick and experienced surveyor, he is most trustworthy and has a great knack of getting on with anyone whom he comes in contact.

Surveyor Natha Singh is a good and capable surveyor, and may always be relied on to bring in neat and accurate work.

Sub-Surveyor Hazrat Ali's knowledge of Chinese was most useful, he is very zealous and promises to turn out well.

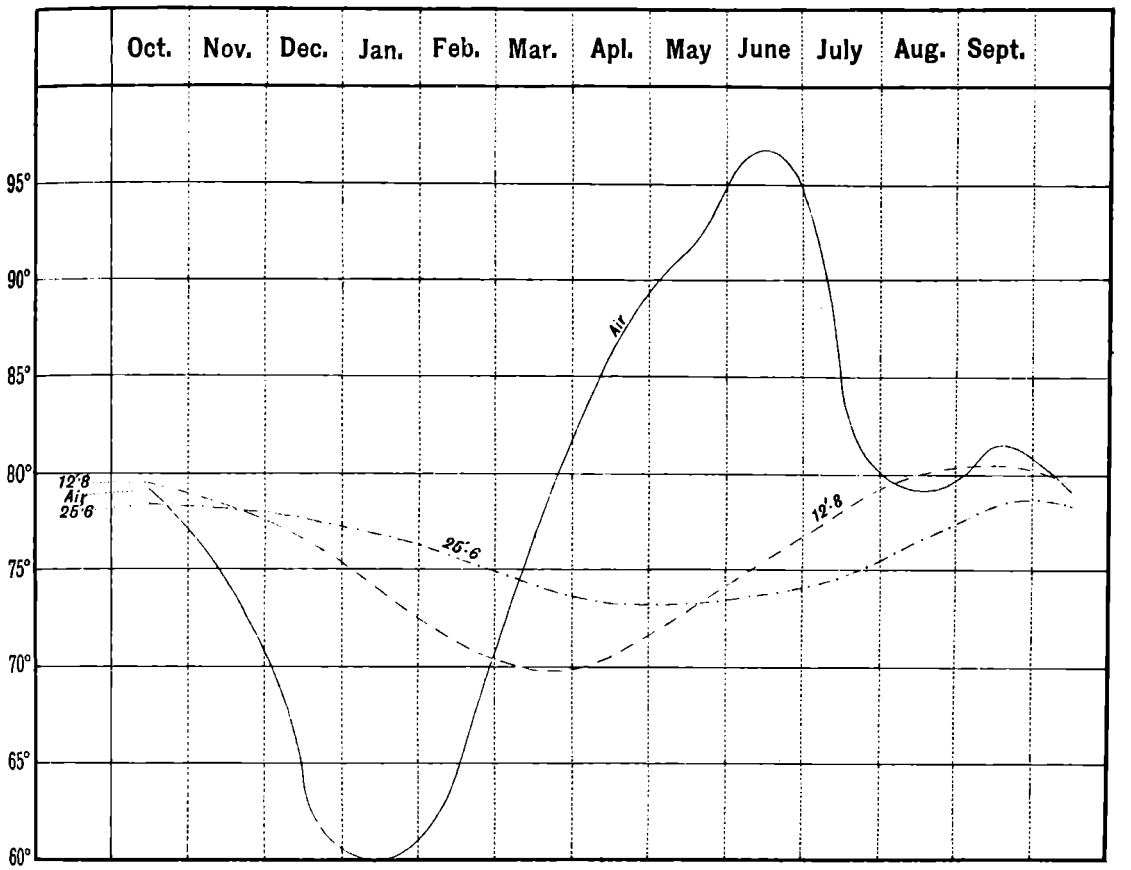
APPENDIX.

Mean monthly readings of earth thermometers taken at the Trigonometrical Branch Office, Dehra Dún.

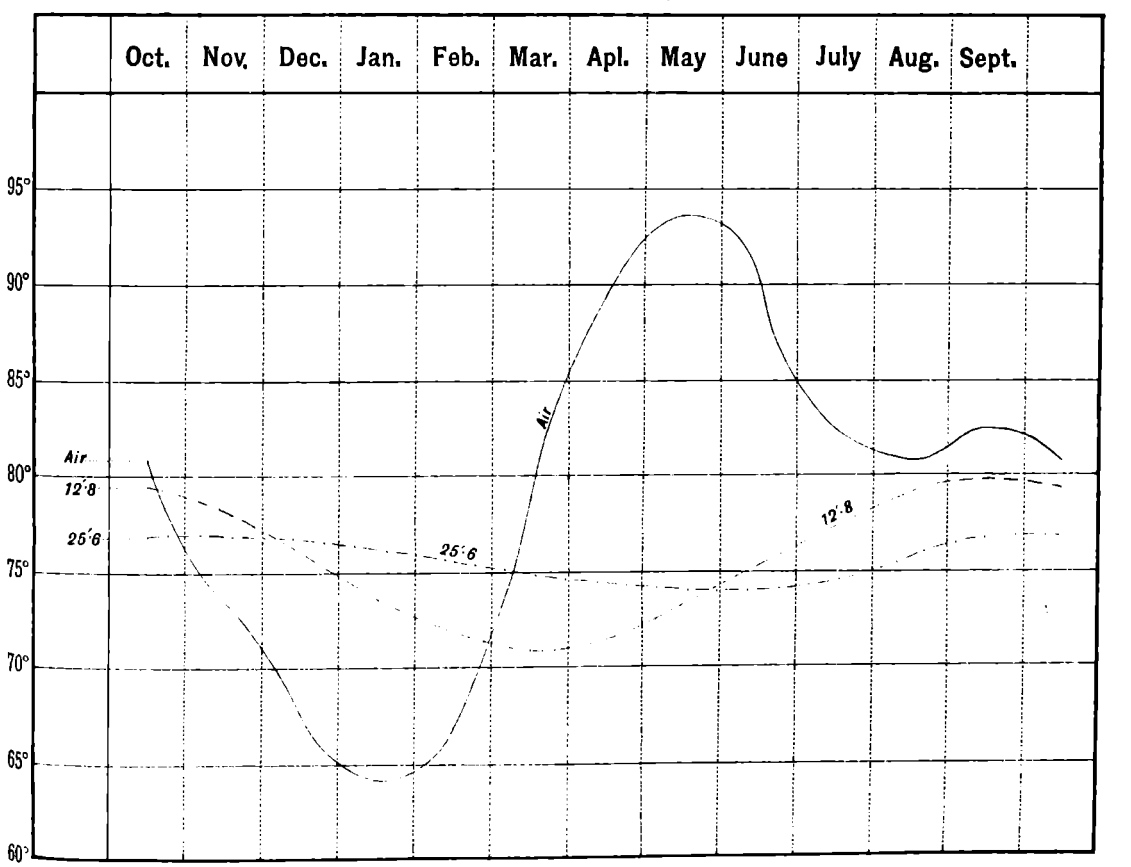
Depth in feet of thermometer bulbs below surface of ground.	Year.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.
25·6	1900-01	78·42	78·14	77·64	76·84	75·57	74·17	73·28	73·26	73·80	74·65	76·56	78·33
	Mean, 1881—1900	76·92	76·95	76·77	76·22	75·67	74·99	74·41	74·12	74·11	74·49	75·75	76·75
12·8	1900-01	79·60	78·31	76·61	73·92	71·22	69·92	70·52	72·83	75·42	78·05	80·04	80·54
	Mean, 1881—1900	79·43	78·17	76·06	73·55	71·81	70·88	71·43	73·21	75·32	77·36	79·20	79·72
6·4	1900-01	79·34	76·51	72·92	67·37	65·52	66·04	70·54	75·67	80·34	82·81	81·93	81·02
	Mean, 1881—1900	79·77	75·95	71·38	67·38	65·65	67·17	71·67	76·93	80·42	81·43	81·52	81·23
3·2	1900-01	77·52	73·20	66·44	60·41	61·04	65·57	75·27	82·53	87·45	86·39	82·33	81·57
	Mean, 1881—1900	78·39	71·96	65·80	62·01	61·44	66·90	75·66	82·35	84·93	83·40	82·22	81·74
1·1	1900-01	75·23	70·17	60·16	55·47	58·24	66·53	77·90	87·33	93·18	87·49	81·69	81·02
	Mean, 1881—1900	76·50	67·90	60·30	57·39	58·87	67·86	78·75	86·34	88·03	84·14	82·49	81·56
Thermometer in shade	1900-01	79·20	74·36	64·26	60·07	64·41	76·70	86·25	91·67	96·7	85·02	79·26	81·42
	Mean, 1881—1900	80·72	73·43	67·57	64·20	66·92	78·97	89·48	93·65	90·15	82·49	80·83	82·46

See para. 71 of this report which gives remarks on these figures and the diagram on the opposite page.

Curves of Mean Monthly Readings of Earth Thermometers taken at the
Trigonometrical Branch Office Dehra Dun.
for 1900-01
Depth of Earth Thermometers 12·8 feet and 25·6 feet.



Similar curves for the mean of the years 1881—1901.



Reg. No. 42, S. I. D.—Feb. 02—550.

Photo S. I. O. Calcutta

1902.

File No. 87 of 1902.

Serial No. 2.

GOVERNMENT OF INDIA.

DEPARTMENT OF REVENUE AND AGRICULTURE.

LAND-SURVEYS.

RESOLUTION.

No. 7-87—2.

Dated Simla, the 25th August 1902.

SUBJECT.

Reviews the General Report on the operations of the Survey of India Department for 1900-01.

G. C. Press, Simla.—No. 623 R. & A. D.—27-8-1902.—745.

DEPARTMENT OF REVENUE AND AGRICULTURE.

File No. 87 of 1902.
Serial No. 2.

Simla, the 25th August 1902.

No. 7-Land-Surveys.

Resolution by the Government of India, Department of Revenue and Agriculture.

READ—

The General Report on the operations of the Survey of India Department during the year 1900-01.

Field operations were carried on by one double and sixteen ordinary parties and three detachments; one party was employed on trigonometrical, and eight on topographical surveys; one double and one ordinary party on Forest Surveys, two on cadastral surveys, three detachments on traverse surveys and four parties on scientific operations. In addition to the above, traverse and cadastral surveys were continued in the United Provinces by local agency under the general superintendence of the Deputy Surveyor General. Special Surveys of Government Forests were also carried out by the Forest Survey Branch. The total outturn of detail survey during the year amounted to 65,106 square miles, which included reconnaissance surveys of 17,000 square miles on the $\frac{1}{4}$ inch and smaller scales; and 17,000 square miles on the $\frac{1}{2}$ inch scale which were surveyed in China. The area of detail survey effected was considerably less than in the previous year owing to the absence of reconnaissance work on the North East Frontier. The total area of rigorous surveys on all scales was 31,106 square miles; the total area triangulated, excluding 16,000 square miles completed by the survey detachment with the China Field Force, was 44,379 square miles; while the total area traversed for cadastral surveys was 6,997 square miles.

2. The Government of India have read with interest the account of the operations of the Survey Party under Major Renny-Tailyour, which accompanied the China Field Force, and succeeded, with the aid of the Intelligence Department, in mapping in detail the large area of 17,000 square miles. In Kashmir and on the North-West Frontier large areas were also surveyed; while the deputation of a Sub-Surveyor with Dr. Stein on his recent expedition added considerably to the geographical knowledge of Central Asia.

3. Of the eight parties engaged on topographical operations, four were employed in Burma, one on the Lushai Hills of Assam, and one in the Kangra and Simla districts. The Assam party will shortly be transferred to the United Provinces for topographical purposes, and the Simla party, which has practically completed its programme, will in future be employed in the plains of the Punjab in compiling topographical maps from materials supplied by the Settlement Maps. Nos. 11 and 12 parties, which have for some years been employed in the survey of the Shan States, will be amalgamated. These changes are in accordance with the policy of curtailing topographical operations in remote tracts, prescribed in the Resolution on the report for 1899-1900. Unless there are strong administrative or other reasons for the survey of the remote parts of Sandoway, Thayetmyo, Pegu and Toungoo, the Government of India are disposed to think that it will probably be better to discontinue these surveys. It is understood that the question is at present engaging the attention of the Surveyor General, and the Government of India will be glad to be favoured with a further report on the matter.

4. Cadastral survey operations were conducted in Bengal, the United Provinces and in Burma. In Bengal, a considerable extension of traverse and cadastral surveys took place during the year. The high cost of the cadastral survey in Darbhanga has again attracted the attention of the Government of India. The Government of Bengal have recently been addressed on this point and it is hoped that it will be found possible to effect substantial economies in the conduct of these operations. The Provincial Surveys in the United

Provinces were controlled with efficiency and economy under Mr. G. B. Scott, Superintendent, Survey of India, who has since retired, and whose long and valuable services in the Department His Excellency the Governor General in Council has much pleasure in acknowledging. It is hoped that the arrangements effected for the traverse survey in Allahabad will obviate the need for further traverses at a later date. The extent to which revisional survey has been found necessary in Burma, in order to render the cadastral maps available for topographical purposes, indicates the importance of including in cadastral survey all topographical features, and the Government of India are glad to observe that in the survey now in progress in the United Provinces this consideration is being borne in mind.

5. During the year Forest Surveys were carried out in Madras, Bombay, Burma, Bengal, the Central Provinces and the Punjab. The total outturn of these surveys on various scales amounted to 4,892 square miles, of which 2,838 square miles were surveyed by the Forest Survey Branch. In their review of the report for 1899-1900, the Government of India drew special attention to the need for economy in these surveys, and they now notice with satisfaction the decrease in the cost rates in Bombay. At the same time they have to express their regret at the losses from fever and plague sustained by both the Madras and Bombay Parties.

6. Turning to the scientific work undertaken by the Department during the year, a party was employed during the season in the determination of astronomical latitudes in the Karachi Longitudinal series; while a second party was employed with satisfactory results on experimental work connected with the Jäderin Base line apparatus. Tidal observations were continued as usual. Preparations for the commencement of the Magnetic Survey continued during the year, and arrangements have been made for the establishment of Base stations at Bombay, Kodaikanal, Dehra Dun, Calcutta and Rangoon, at which magnetic observatories will be built and self-recording instruments installed. At Bombay and Calcutta such observations have been recorded for many years. The recent introduction of electric Tramways in Calcutta, and their impending construction in Bombay, have rendered it necessary to arrange for the construction of new observatories at some distance from the two cities, at a distance beyond the effects of the electric current. Considerable progress was made in the preparation of the new series of professional survey papers, which will in future take the place of the technical papers appended to former reports.

7. At the head quarter offices much useful work has been accomplished in the revision and publication of maps, the out-turn of the Photo-Lithographic office being exceptionally large. The use of the Vandyke process to which reference was made last year has effected, as was anticipated, an enormous saving of time and expense in the reproduction of field maps. The Government of India notice with satisfaction the progress made in the Mathematical Instrument Office in the conversion and repair of the stock of old instruments.

8. His Excellency the Governor General in Council again desires to acknowledge the efficient manner in which the Department has worked under the able direction of Colonel Gore.

9. The report under review gives a concise and interesting account of the operations of the year. The instructions for its curtailment which were issued last year have effected a considerable improvement in its form and arrangement.

Ordered, that the above Resolution be forwarded to the Surveyor-General of India, the Inspector-General of Forests, the Local Governments and Administrations noted in the margin and to the Foreign, Military and Public Works Departments, and that it be published in the Supplement to the *Gazette of India*.

Madras.	Burma.
Bombay.	Central Provinces.
Bengal.	Assam.
United Provinces of Agra and Oudh.	Coorg.
Punjab.	Berar.
	N.-W. Frontier Province.

[True extract.]

J. O. MILLER,

Offg. Secretary to the Government of India.