GENERAL REPORT

ON THE

OPERATIONS

OF THE

Surbey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1905-06.

PREPARED UNDER THE DIRECTION OF

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

SURVEYOR GENERAL OF INDIA.

CALCUTTA:

OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.

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VIEW ON THE KABUL RIVER.

From a negative by Captain E. T. Rich, R.E.

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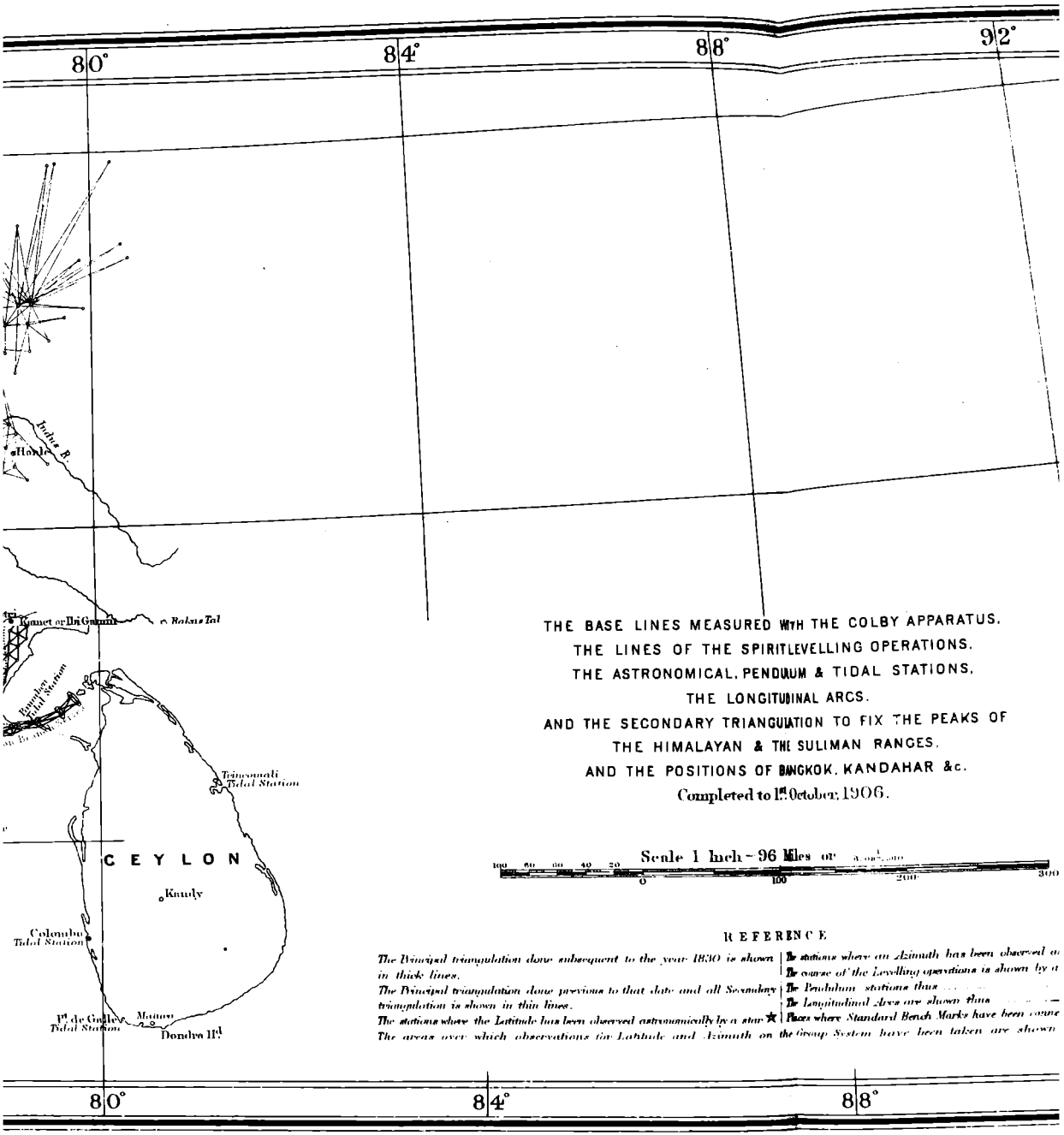


THE BASE LINES MEASURED WITH THE COLBY APPARATUS.
THE LINES OF THE SPIRITLEVELLING OPERATIONS.
THE ASTRONOMICAL, PENDULUM & TIDAL STATIONS.
THE LONGITUDINAL ARCS.
AND THE SECONDARY TRIANGULATION TO FIX THE PEAKS OF
THE HIMALAYAN & THE SULIMAN RANGES.
AND THE POSITIONS OF BANGKOK, KANDAHAR &c.
Completed to 1st October, 1906.

Scale 1 inch = 96 Miles or

100 60 50 40 20 0 100 200 300

REFERENCE

The Principal triangulation done subsequent to the year 1830 is shown in thick lines.
The Principal triangulation done previous to that date and all Secondary triangulation is shown in thin lines.
The stations where the Latitude has been observed astronomically by a star ★
The areas over which observations for Latitude and Azimuth on the Geog: System have been taken are shown
The stations where an Azimuth has been observed a
The course of the Levelling operations is shown by a
The Pendulum stations thus
The Longitudinal Arcs are shown thus
Places where Standard Bench Marks have been conne

ction of COLONEL H.R.THUILLIER, C.I.E., R.E., Surveyor-General of India.

October 1893.

TO ACCOMPANY SURVEYOR-GENERAL'S REPORT FOR 1905-1906.

GENERAL REPORT

ON THE

Operations of the Survey of India

DURING THE SURVEY YEAR

1905-1906.

PART I.

SUMMARY.

ADMINISTRATION.

1. This report deals with the operations of the Department for the survey year ending the 30th September 1906.

Colonel F.B. Longe, R.E., administered the Department throughout the year, while Lieutenant-Colonel G. B. Hodgson, I.A., held the position of Deputy Surveyor General, Lieutenant-Colonel S. G. Burrard, F.R.S., R.E., that of Superintendent, Trigonometrical Surveys, Major P. J. Gordon, I.A., that of Superintendent, Forest Surveys, and Major R. T. Crichton, I.A., that of Superintendent, Provincial Surveys, Bengal, for the same period.

Pending final reorganisation a new appointment called Superintendent, Frontier Surveys, was temporarily created. To fill this Major C. H. D. Ryder, D.S.O., R.E., was recalled from furlough and assumed charge on the 5th August 1906.

2. In the present report the new system of numbering the standard sheets on the scales of 1 mile and 4 miles to the inch has been generally followed and index maps of the form referred to in paras. 14 and 15 of last year's report are published in illustration of the text. Specimens of a degree sheet and a 1 inch sheet are also published.

3. Owing to the impossibility of obtaining the services of an officer with the requisite technical knowledge to reorganise the Photo-Lithographic offices this important duty could not be carried out. Mr. T. LeMesurier, the Superintendent of the Poona Photo-Lithographic office, was lent to the Government of India for the purpose, but on arrival in Calcutta he was in failing health and was forced to go to the General Hospital within a few days and gradually sinking he died there on the 6th February.

The Secretary of State for India has, however, now secured the services of Major W. C. Hedley, R.E., of the Ordnance Survey, for a period of two years, and he is expected to arrive in Calcutta in October 1906, and the reorganisation of these offices will therefore no longer be delayed.

4. The details of the reorganisation of the Department were under discussion throughout the year. Considerable progress has been made, and it is hoped that final orders will be issued during the coming survey year. Meanwhile surveys and mapping have been started on the lines recommended by the committee and a large number of maps should be published during next year.

Owing to the great difficulty in selecting symbols suitable for the whole of India and its adjacent countries, and to the changes in the type used for the lettering, necessitated by the new system of drawing all maps for reduction instead of reproduction, it cannot be expected that every map on any one scale will be exactly similar with regard to such details, but every endeavour is being made to

have them as nearly so as possible and such as are not in accordance with the latest orders will be published as preliminary editions and replaced as opportunity offers.

It must be remembered that each party prepares its own maps during the recess season by the agency of its field surveyors and that the parties are working in all parts of the country and under almost inconceivably different conditions, and while changes so material as the present are being introduced, it is not to be expected that all will interpret details in exactly the same way, the concentration of parties into groups under Superintendents will, however, greatly facilitate matters in future. The work on the whole has been very satisfactory and though the changes have thrown a great deal of troublesome and tedious work on the Headquarters Drawing and Photo-Lithographic offices good progress has been made.

During the coming year the Department will suffer considerably owing to the absence on furlough of many of its senior officers, but they can be better spared now while the details of reorganisation are being worked out than they could be later, and it will gain on their return by having their services available for a long period during which they will carry into effect the new arrangements and set them on a sound and permanent footing.

5. The tabular statements in Part II have been arranged in a somewhat different form to those of previous years and it is hoped that references will thereby be simplified.

Inspection Tours of Administrative Officers.

6. Colonel F. B. Longe, R.E., inspected the office of No. 1 party and the North-West Frontier drawing office in Mussooree early in October; he then, on October 12th, visited Dehra Dún, where in addition to inspecting the Forest Survey office and that of No. 20 party he discussed the future programme of the forest survey parties Nos. 9, 17, 19 and 20 and returned to Calcutta on October 20th. On the 5th February he again visited Dehra Dún and inspected the drawing offices of the North-West Frontier and No. 15 party and the reproducing section of the Great Trigonometrical Survey office; in consultation with the Superintendent, Trigonometrical Surveys, and the officer in charge of the Computing Office he also decided on the projections to be employed and other important details in connection with the future maps of the Department, returning to Calcutta on February 20th. On April 5th he left Calcutta and after visiting Bhim Tal and Naini Tal in order to investigate the suitability of the former place as a recess quarter for survey parties he arrived in Simla on the 15th April. On July 21st he left Simla on a tour of inspection, visiting in turn Calcutta (July 24th to 31st), Dehra Dún and Mussooree (from 2nd to the 14th) and returning to Simla on 15th August; in Calcutta he inspected the Drawing, Photo-Lithographic and Mathematical Instrument offices, at Dehra Dún, the Great Trigonometrical, Photo-Lithographic and Forest Survey offices, and at Mussooree the offices of Nos. 1, 12, 14 and 15 parties and the North-West Frontier drawing office. On his return to Simla he inspected the office of No. 18 party.

7. Lieutenant-Colonel G. B. Hodgson, I.A., Deputy Surveyor General, inspected the United Provinces drawing office at Naini Tal in October 1905 and again in September 1906; he inspected Nos. 1 and 2 parties in the Central Provinces during the field season and again during recess at Mussooree and Poona. In May 1906 he proceeded to Burma and inspected No. 7 party at Maymyo and No. 11 party at Taunggyi in the Southern Shan States, and in July he inspected Nos. 3 and 10 parties and the Burma drawing office at Bangalore. He visited the Bengal drawing office at Calcutta on many occasions.

8. Lieutenant-Colonel S. G. Burrard, F.R.S., R.E., Superintendent, Trigonometrical Surveys, inspected No. 25 party (Tidal and Levelling) in November at Dehra Dún and No. 23 party (Pendulums) in the field in March. In September he inspected Nos. 22, 23, 24, 25 and 26 parties at their recess quarters in Mussooree. He also inspected the Survey Training School from time to time during the year.

9. Major P. J. Gordon, I.A., Superintendent, Forest Surveys, inspected in the field the detachments of No. 9 party working in Assam and Burma. He

also inspected No. 20 party in the field in Burma and in recess at Dehra Dún, and No. 17 party at Poona and No. 19 party at Bangalore. He visited the Andamans in connection with the boundary surveys in the Northern Island which were being carried on under the officer in charge of forest working plans.

10. Major Ryder, D.S.O., R.E., Superintendent, Frontier Surveys, accompanied the Surveyor General to Mussooree on August 5th and thence to Simla on August 14th where the transfer to his charge of the parties in his circle was completed. While in Simla he inspected No. 18 party on 22nd August and returned to Mussooree on August 30th. While in Mussooree he constantly inspected the parties recessing there, namely, Nos. 12, 14 and 15 and the North-West Frontier drawing office.

DISTRIBUTION OF FIELD PARTIES.

11. Field operations were carried out by 22 parties and 4 detachments; of these 9 were employed on topographical surveys, 4 on forest surveys, 3 parties and 1 detachment on cadastral surveys, 1 party on both cadastral and topographical surveys, 3 detachments on cantonment surveys, 1 party on triangulation and 4 on scientific operations. In the following statement the whole of the operations are grouped according to the nature of the work on which the parties were employed:—

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	TOPOGRAPHICAL.			Inches. Miles.	
1	Central Provinces	17	Captain A. H. B. Hume, R.E.	2 = 1	D. S. G.
2	Berar	18	Captain H. Wood, R.E. Mr. C. F. Erskine	2 = 1	Ditto.
3	Lower Burma	19	Mr. E. F. Litchfield	1 = 1	Ditto.
10	Upper „	20	Captain A. A. McHarg, R.E.	1 = 1	Ditto.
11	Shan States	21	Lieutenant R. H. Phillimore, R.E.	1 = 1	Ditto.
12	North-West Frontier	22	Captain E. T. Rich, R.E. Mr. R. F. Warwick	2 = 1	S. G. and S. Frontier Surveys.
14	„ „	23	Captain H. L. Crosthwait, R.E. Lieutenant E. C. Baker, R.E.	2 = 1	Ditto.
15	„ „	24	Major C. L. Robertson, C.M.G., R.E.	2 = 1	Ditto.
18	Punjab „	25	Captain M. O'C. Tandy, R.E.	2 = 1	Ditto.
6	Eastern Bengal	36	Mr. A. W. Smart	4 = 1 2 = 1	S. P. S., Bengal.
	FORESTS.				
9	Eastern Bengal and Assam. United Provinces Central „ Punjab Burma North-West Frontier Province.	28	Major P. J. Gordon, I.A.	4 = 1 2 = 1	S. Forest Surveys.
17	Bombay Presidency	30	Mr. B. G. Gilbert-Cooper	8 = 1 4 = 1	Ditto.
19	Madras „	31	Mr. G. T. Hall	4 = 1 2 = 1	Ditto.
20	Burma	32	Captain A. Mears, I.A.	4 = 1 2 = 1	Ditto.

No. of Party.	Nature and *locale* of operations.	Page in this Report.	Executive Officers.	Scale of Survey.	Administrative Superintendent.
	CADASTRAL AND TRAVERSE.			Inches. Miles.	
4	Bihar	34	Captain F. C. Hirst, I.A.	16 = 1	S. P. S., Bengal.
5	Chota Nagpur	35	Captain F. C. Hirst, I.A. Captain L. C. Thuillier, I.A. Mr. T. W. Babonau	16 = 1	Ditto.
6	Eastern Bengal	36	Mr. A. W. Smart	16 = 1	Ditto.
Det.	Calcutta	38	Mr. R. B. Smart	105·6 = 1 32 = 1	Ditto.
7	Burma	39	Major C. W. H. Symonds, I.A. Mr. J. S. Swiney Mr. O. D. Smart	16 = 1	D. S. G.
Section No.	CANTONMENT SURVEYS.				
1	Northern Command	40	Mr. J. McHatton	16 = 1 64 = 1	D. S. G.
2	Western "	41	M. E. G. Little Mr. L. J. Pocock	16 = 1 64 = 2	Ditto.
3	Secunderabad Division	41	Mr. L. J. Pocock Mr. E. G. Little	12 = 1 48 = 1	Ditto.
	TRIANGULATION.				
24	India	42	Captain H. H. Turner, R.E. Mr J Eccles, M.A. Lieutenant C. M. Browne, D S.O., R.E. Major G. P. Lenox-Conyngham, R.E.	...	S. T. S.
	SCIENTIFIC.				
22	Azimuths	43	Lieutenant-Colonel S. G. Burrard, F.R.S., R.E.	...	S. T. S.
23	Pendulums	44	Major G. P. Lenox-Conyngham, R.E.	...	Ditto.
25	Tidal and Levelling	4	Mr. C. F. Erskine Mr. J. P. Barker	...	Ditto.
26	Magnetic	49	Captain R. H. Thomas, R.E.	...	Ditto.

RESULTS.

12. The total outturn of detail topographical and forest surveys on all scales is 23,312 square miles against 26,340 square miles of similar surveys during the previous year, no surveys on a smaller scale than 1 inch = 1 mile were carried out during the year; the total area triangulated or traversed for topographical or forest surveys is 27,134 against 19,265 square miles for the previous year. The decreased topographical outturn is mainly due to the transfer of Nos. 12 and 14 parties from Sind and the United Provinces to the North-West Frontier. These two parties which surveyed during 1904-05 2,787 and 2,426 square miles respectively were, owing to local circumstances and changes in personnel, only able to survey 753 and 737 square miles, respectively, during the year under report, which represents a decrease of 3,723 square miles. The total area of cadastral and special surveys was 2,982 square miles, and the area traversed was 6,464 square miles, as compared with 7,305 square miles of survey and 6,398 square miles of traversing for the previous year. The decrease in cadastral outturn is due to the transfer of the cadastral work in Bengal to the Settlement Department.

TOPOGRAPHICAL SURVEYS.

13. Towards the end of the year a new party was organised for topographical surveys near Quetta and at the commencement of the field season No. 14 party was moved from the United Provinces and No. 12 party from Sind to the North-West Frontier Province. With these exceptions surveys were generally in continuation of last year's work. No. 8 party, which had previously worked in the United Provinces, was broken up, the surveyors being drafted into other parties. No. 2 party continued to be largely a training party for young Provincial officers.

14. *North-West Frontier Province.*—Numbers 12, 14 and 15 parties continued their surveys on the scale of 2 inches = 1 mile. The work of all these parties was at times delayed from climatic or political causes, and in order to complete its programme No. 15 party had to remain out in the field until July, which proved a severe strain on all its members. Progress was also delayed through want of triangulation in advance of the detail survey.

The total areas of survey and triangulation were :—

	Square miles.
Survey 2 inch	2,948
Reconnaissance 2 inch	143
„ 1 inch	140
Triangulation	5,060

15. *Punjab.*—Number 18 party completed an area of 2,343 square miles on the 2-inch scale of supplementary survey in Multán, Muzaffargarh, Dera Gházi Khán districts and in Baháwalpur State; revision survey on the 2-inch scale of 330 square miles in the Muzaffargarh "Thal," and a re-survey on the 1-inch scale of 374 square miles in Baháwalpur State. District traverses for supplementary survey were carried out in Jhang, Lyallpur, Montgomery, and Shahpur districts and in Baháwalpur State and some special traverses in Kohat district.

The field work of all the riverain traverses of the Punjab was completed.

16. *Central Provinces.*—Number 1 party completed the re-survey of 1,320 square miles and the supplementary survey of 766 square miles on the 2-inch scale.

17. *Burma.*—Numbers 3, 10 and 11 parties continued surveys on the 1-inch scale and completed 9,248 square miles of which 2,096 square miles was supplementary survey, 140 square miles was supplementary survey of forests and the remainder new survey.

18. *Bengal.*—In the Sunderbans of the 24-Parganas, No. 6 party surveyed 456 square miles on the 4-inch scale and 594 square miles on the 2-inch scale. In conjunction with the cadastral surveys of Purnea and the Sonthal Parganas areas of 23 and 22 square miles were topographically surveyed on the 4-inch scale by No. 4 party.

19. *Berar.*—Number 2 party surveyed on the 2-inch scale 1,124 square miles.

20. *Eastern Bengal and Assam.*—Number 9 party, in addition to its forest survey operations, topographically surveyed on the 2-inch scale an area of 571 square miles in the Darrang district.

21. The total outturn of topographical surveys on the 4-inch, 2-inch and 1-inch scales is as follows :—

	Square miles.
North-West Frontier Province	3,231
Punjab	3,047
Central Provinces	2,086
Burma	9,248
Bengal	1,073
Berar	1,124
Eastern Bengal and Assam	571
TOTAL	20,380

FOREST SURVEYS.

22. The forest survey operations during the year were generally in continuation of those of the previous season.

In addition to the large scale forest surveys No. 9 party carried out 2-inch topographical surveys in Assam.

23. *Madras.*—In Madras No. 19 party carried out the 4-inch detail survey of the forests in Godavari, Ganjam, Chingleput, South Canara and North Malabar districts. The outturn of topography was 832 square miles at a cost of R104 per square mile.

The outturn compares favourably with that of last season when an area of 750 square miles was surveyed on the 4-inch scale at a cost of R123 per square mile.

The unhealthiness of the forest tracts, the scattered nature of the blocks, and the difficulties and delays experienced in obtaining local labour combined to prevent a greater increase in the outturn or reduction in cost-rates.

An area of 2,150 square miles was triangulated in Malabar preparatory to the 2-inch topographical survey in that district which will be commenced next season.

The traversing of the Mysore—South Canara boundary as demarcated by officers of the Madras government and Mysore State was continued.

It is proposed to discontinue 4-inch surveys of the forests in the Madras presidency with the exception of those in the Ganjam district which it is hoped will be completed next season.

Number 19 party will in future be employed on regular topographical surveys in the Madras presidency.

24. *Bombay.*—Number 17 party completed the survey of the forests in the Thana district on the 8-inch, and of those in the Satara district on the 4-inch scale. The 4-inch survey of the forests in Khandesh was continued and triangulation was completed in that district.

An area of 631 square miles was surveyed on the 4-inch scale, and 126 on the 8-inch at a cost of R87 and R173 per square mile, respectively. Owing to the difficult nature of the country and to the forest blocks being widely scattered the outturn was less and the cost-rates greater than in previous seasons. A sickly season also affected the outturn. As the cost of the publication of maps was taken into account for the first time for the purpose of calculating the cost-rates, it is difficult to arrive at a satisfactory comparison between the rates for the year and those of preceding years.

The government of Bombay having decided that the value of the remainder of the Khándesh forests does not justify the increased cost of a large scale survey, it has been decided, with certain unimportant exceptions, to employ No. 17 party in future on regular topographical surveys on the 2-inch scale.

25. *Burma.*—An area of 682 square miles was surveyed by No. 20 party in the Pakôkku and Thaungyin districts, and advance triangulation and traversing over an area of 1,622 square miles was also carried out for general topographical purposes in the former district.

The cost-rate of traversing was the lowest yet recorded, being only R43 per linear mile: the cost of triangulation was somewhat greater than for last year, chiefly owing to work having had to be suspended for two months on account of hazy weather. The general cost-rate of detail survey was R148 per square mile, or R7 more per square mile than for last season; this was due to the expensive nature of the work in Thaungyin where the rate was R154 per square mile. The cost-rate in the Chindwin where the bulk of the work lay was R142 per square mile or practically the same as for last season.

The policy of generally discontinuing large scale forest surveys having been adopted in Burma, No. 20 party will be employed next season chiefly on 2-inch topographical surveys in Pakôkku, while triangulation and traversing will be carried out in Assam to which province it is proposed to transfer the party.

26. Number 9 party, as formerly, was much scattered, being chiefly employed on 4-inch forest surveys in Burma, the North-West Frontier Province, the Punjab, the United Provinces and Eastern Bengal and Assam. In addition to forest surveys a detachment of the party also surveyed an area of 571 square miles on the 2-inch scale in the Darrang district, Eastern Bengal and Assam.

Full details regarding its outturn and cost-rates are given in Part II of this report as well as in the special annual report of the forest survey branch.

As no forest survey work will remain for No. 9 party after this year, it is proposed to transfer some of its members to other parties and to form a new party bearing the same number for work on the North-West Frontier.

27. The total outturn of the forest survey branch during the year amounted to 3,707 square miles of topography including 571 square miles on the 2-inch scale.

Sixty-nine thousand and twenty-three square miles of gazetted forests throughout India have now been surveyed on various scales for forest purposes.

CADASTRAL AND TRAVERSE SURVEYS.

28. One cadastral and one traverse party were employed in Bengal, and the Calcutta suburbs survey was continued under the control of the Superintendent, Bengal Surveys. One traverse party was employed in Eastern Bengal and one cadastral party in Burma. These operations were all in continuation of the previous season's work. In the United Provinces all operations connected with cadastral surveys were transferred to the control of the Land Records Department assisted by two officers of the Provincial service, five officers were thus released for work elsewhere. In Bengal the Settlement Department took over the control of the cadastral survey in Chota Nagpur and one officer of the Provincial service was attached thereto as a professional adviser. In Bihar the operations were carried out by the Survey of India as hitherto and this arrangement will continue for one season more, after which the whole of the cadastral surveys in Bengal will be done by the Settlement Department.

In Eastern Bengal, cadastral survey was suspended for the season and all such work will in future be done by the Settlement Department. In Assam the whole of the survey operations were transferred to the control of the Land Records Department, an officer of the Provincial service being deputed as a professional adviser.

29. The outturn of work done by the Survey of India in Bengal was the traversing of 4,433 square miles, the cadastral survey of 1,769 square miles, 45 square miles of topographical survey, and the record writing of 1,593 square miles. In the Calcutta suburbs only 267 acres were surveyed and 1,444 were traversed. The work of the season consisted mainly of the demarcation of holdings in areas previously surveyed and the completion of the maps of former seasons as they were received back after attestation. In Eastern Bengal 1,744 square miles were traversed for cadastral survey.

In Burma the outturn was 548 square miles of traversing and 1,170 square miles of cadastral survey, all in the Pakôkku district, the survey of which will be completed next season. In the Central Provinces, the boundaries of 43 detached villages, scattered over 4 districts were traversed for the Settlement Department by one of the topographical parties employed there. The chaining amounted to 213 linear miles.

30. Special large scale surveys based on traverses were carried out in 33 military cantonments and bazaars by 3 cantonment sections.

31. The total outturn of traversing and cadastral survey is as follows :—

Province.	Traversing square miles.	Cadastral survey square miles.
Bengal	4,433*	1,769
Eastern Bengal and Assam	1,744	...
Burma	548	1,170
Cantonment Surveys	69	43
TOTAL	6,794*	2,982

TRIGONOMETRICAL SURVEYS.

32. The programme of the triangulation party (No. 24) was to prolong the isolated Kalát Series eastwards and to connect it with the Great Indus Series. The work was successfully completed, and this important series of triangulation now stretches from the Indus through Northern Baluchistan, as far west as longitude 64° 30′. It will eventually reach Koh-i-Malik Siah the trijunction point of Baluchistán, Afghánistán and Persia.

An extension of the Kalát Series across Persia to the Euphrates would be a very valuable contribution to geodetic science, for the parallel of 30°, along which the series is trending, traverses a greater continuous length of land surface than any other parallel of latitude on the Earth.

* Includes 330 square miles of traversing for topographical surveys.

The future of geodesy lies in long arc measurements: the continent of America is to be measured from Baffin's Bay to Cape Horn: Sir David Gill's arc will extend from the Cape of Good Hope to Lapland: an Indo-Russian arc may possibly connect Cape Comorin and Nova Zembla and the present Kalát Series will form one section of the great arc of parallel which will embrace Asia and Africa and extend from Shanghai to Morocco.

SPECIAL OPERATIONS.

33. During this year systematic vertical observations of the Himalayan peaks of Kedarnath, Srikanta, Jaunli, Bandar Punch, and Nanda Devi from stations near Dehra Dún were commenced. During the recess season Mr. H. G. Shaw observed the peaks whenever they were visible; if this series of observations can be continued over five or six years, the varying effects of refraction and snow-fall will be deducible.

34. The pendulum operations were carried across the plains of the Punjab from Simla to Quetta. The results have proved that a zone of excessive density crosses the Punjab plains from north to south, underlying Montgomery, Ferozepore and Mian Mir. The existence of this zone had been inferred before from the peculiar direction in which gravity had been found to act at Amritsar and Multán: at both these places the plumb-line had been observed to be deflected away from visible mountains towards flat plains, and now the pendulum has shown that an excess of mass is lying hidden under the plains.

35. Tidal operations were continued by No. 25 party, observations being recorded at nine stations. The observatory at Okha in Cutch was closed during the year. The re-opening of the observatory at Moulmein was considered.

36. A second levelling detachment was formed at the commencement of the field season of 1905-06 and the two detachments have worked throughout the year. Twenty-one Standard Bench Marks were erected in large towns and levelled to. The programme of levels along the Indus in Sind was completed. A line of levels was commenced that will connect Lahore with Ráwalpindi and complete the Punjab levelling circuit.

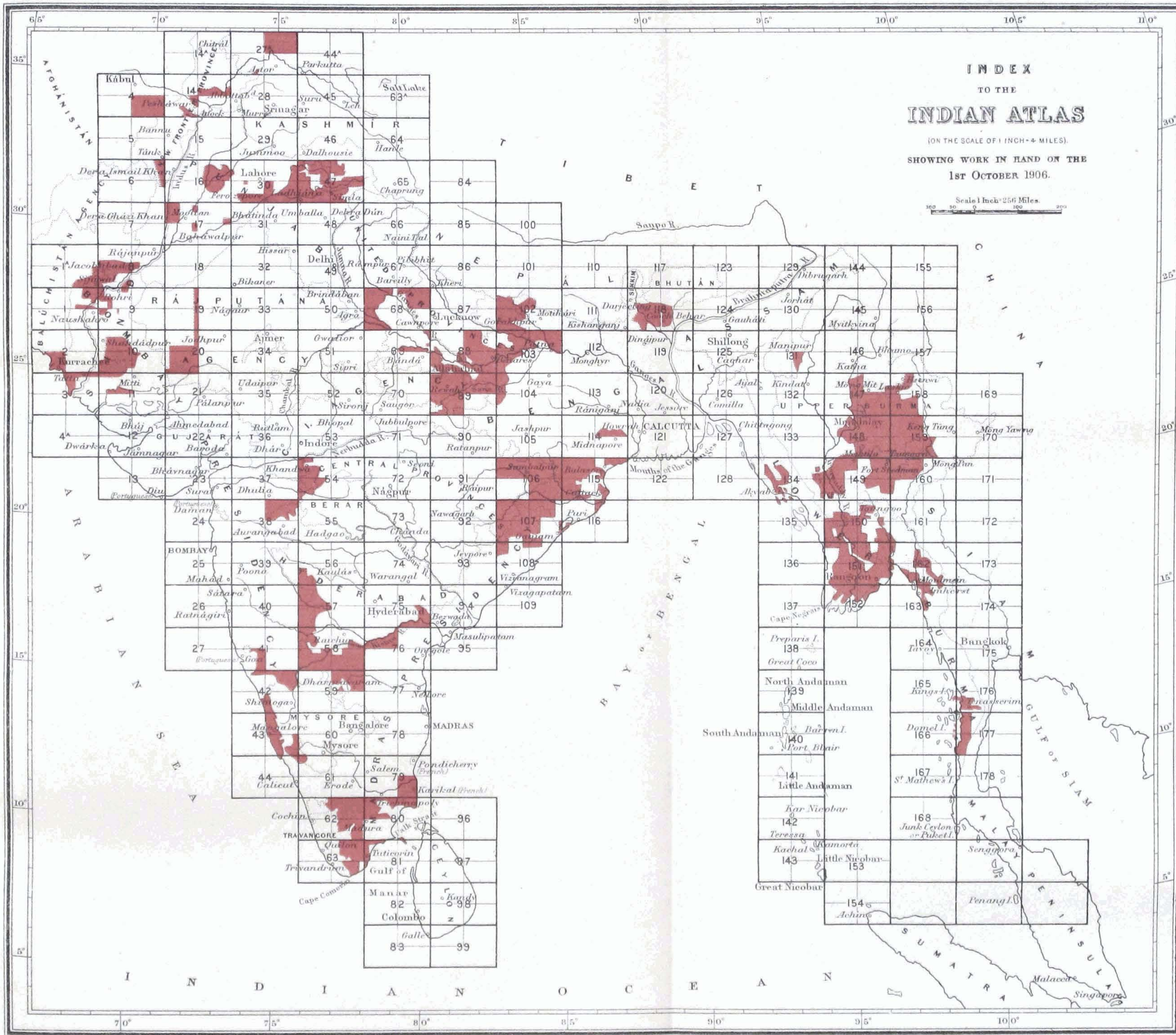
The bench marks east of the Brahmaputra had never been connected either with a tidal observatory or with any bench mark on the west of the river: thus though their differences of height had been well determined their actual heights were not known. During 1905-06 levelling operations were carried across the Brahmaputra at Dhubri and the two systems of levels on either side of the river were connected.

37. Four detachments of No. 25 party continued and extended the field work of the magnetic survey over different portions of the country. Very abnormal values of terrestrial magnetism have been found to exist in eight or nine different places in India, and more detailed surveys will be required. In one locality in the Rajputana desert the magnetic declination varies three degrees in 40 miles.

HEAD-QUARTERS OFFICES, CALCUTTA.

38. The general superintendence of these offices continued under Colonel F. B. Longe, R.E., Surveyor General. The Surveyor General's and the Mathematical Instrument offices were in charge of Brevet Lieutenant-Colonel T. F. B. Renny-Tailyour, R.E., throughout the year, except in June when Captain G. A. Beazeley, R.E., held charge; the Drawing, Engraving and Map Record and Issue offices were under Lieutenant-Colonel W. J. Bythell, R.E., till January and subsequently under Lieutenant-Colonel J. M. Fleming, I.A., and the Photo-Lithographic office under Lieutenant-Colonel J. M. Fleming, I.A., till January and afterwards under Lieutenant-Colonel W. J. Bythell, R.E.

39. *Drawing Office.*—The work done in this office during the year has been of a more or less unsatisfactory nature, owing to the changes necessitated by the recommendations of the late Survey Committee. Owing to alterations in dimensions and style and to change of symbols used on the departmental maps, most of the sheets sent in by the parties during the year have been submitted in a more or less irregular style, necessitating their revision in this office at the expense of its legitimate work. The details connected with the new sheets, as well as the symbols to be used upon them, could not be arrived at without the preparation of many preliminary specimens involving


INDEX
TO THE
INDIAN ATLAS
(ON THE SCALE OF 1 INCH = 4 MILES).
SHOWING WORK IN HAND ON THE
1st October 1906.
Scale 1 Inch = 256 Miles.
AFGHĀNISTĀN
BALŪCHISTĀN AGENCY
KASHMĪR
RĀJPUTĀNA AGENCY
CENTRAL PROVINCES
BERAR
HYDERABAD
MYSORE
MADRAS PRESIDENCY
BOMBAY
BENGAL
NEPĀL
BHUTĀN
ASSAM
TIBET
CHINA
UPPER BURMA
LOWER BURMA
SIAM
MALAY PENINSULA
SUMATRA
CEYLON
ARABIAN SEA
BAY of BENGAL
GULF of SIAM
INDIAN OCEAN
Kábul
Peshāwar
Lahore
Delhi
Agra
Lucknow
Allahabad
Patna
CALCUTTA
Bombay
Poona
Hyderabad
Madras
Bangalore
Mysore
Pondicherry
Colombo
Kandy
Galle
Rangoon
Mandalay
Moulmein
Bangkok
Penang I.
Malacca
Singapore
Achin
North Andaman
Middle Andaman
South Andaman
Port Blair
Little Andaman
Kar Nicobar
Little Nicobar
Great Nicobar

Engraved at the Survey of India Office, Calcutta.

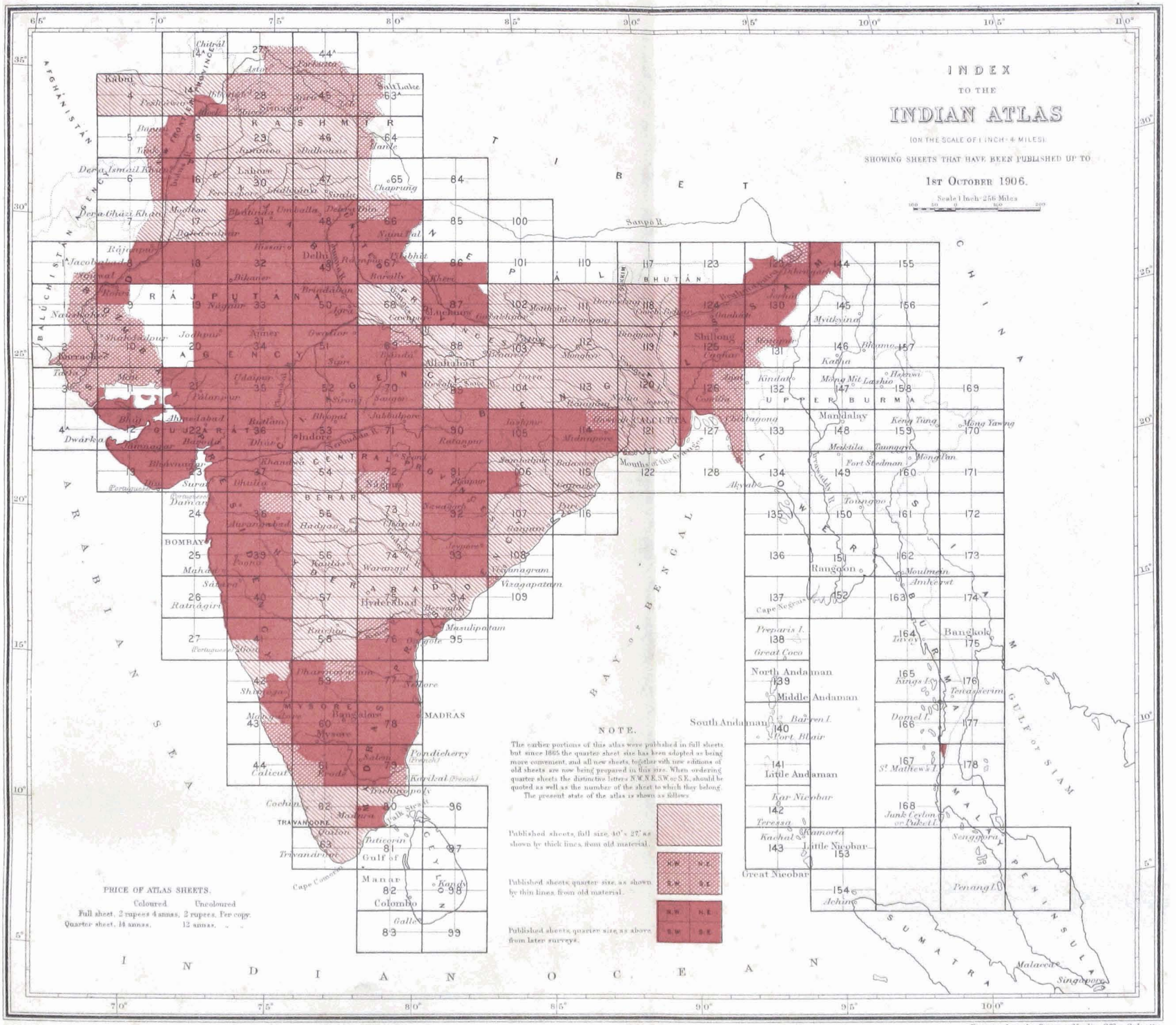
Published under the direction of MAJOR F. B. LONGE, R.E., Officiating Surveyor-General of India.

July, 1902.

No. 603, S. I.—Dec. 05.—500.

Nº 639-S. 1902.

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



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

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much labour, but it is hoped things are now approaching finality. A large number of sheets prepared for an important extra-departmental order had also to be entirely remodelled owing to difficulties in connection with printing, and but little new mapping has been undertaken.

40. Work on the old form of the Indian Atlas being suspended except as regards plates actually in hand, additional compilation was done for only 23 sheets. Additions to the details on 18 more were carried out in order to make them available for publication.

41. The publication of the general maps of India is still in abeyance. It was reported last year that owing to extensive internal administrative changes the issue of the new 32 and 64-mile maps of India could not be effected, and this year owing to constant references regarding the external boundaries of India, and the symbols by which they should be shown being still unsettled, the publication of these important maps is not yet effected. Thus owing to unavoidable circumstances the new 1-inch = 32 mile map which at its inception it was hoped would have been available in 3 years at most is, at the end of six years, still unpublished, and the department is at present in the curious position of not having any general map of India available for issue, the stock of old maps having been exhausted. The old plates and stones have been altered to meet new conditions, but as these have not been finally approved they cannot be printed from. A certain amount of work has been done on the plates and stones of the 32 and 64-mile maps, but no large amount of revision could be undertaken as the receipt of orders for publication was continually expected. Work on the 80, 96, 128, and 192-mile maps of India has proceeded steadily and the last three could be sent to press almost immediately after the receipt of orders regarding boundaries. The projection of the plates for the new engraved 32-mile map of India in 12 sheets on the recently revised secant conical projection has been commenced and several of the plates are ready for the detail engravers. The skeleton 64-mile District Map of India has been brought up to date and published during the year, but is of little use for general purposes. It has been decided to push on a photo-zincographic edition of the $\frac{1}{M}$ series of maps, and sheets 85 and 94 have been prepared on the old projection, thus completing the Burma sheets of the series. Similarly in order to provide a map of Eastern Bengal and Assam on this scale, sheet 79 has been taken in hand and is practically completed in outline as far as that province is concerned, while sheets 78, 83 and 84 have been brought up to date as regards recent internal territorial changes and are now among the maps set aside until orders as to external boundary symbols are received. New editions of the Provincial maps of Bengal, of Eastern Bengal and Assam in outline, and of the Central Provinces in outline and with hills, have been in hand; the first two have been completed and published, while the last only awaits the approval of the local Government as to boundaries, etc. The maps of the Punjab and the United Provinces on the scale of 1-inch = 32 miles have also been under revision and have been sent to press for proof prior to publication.

42. Forty-three District maps on scales of 1 inch=2 or 4 miles have been brought up to date or completed. Twenty have been published and the remainder are under publication, ten of these are new publications and one is a new edition.

43. Eight of the Burma degree sheets on the scale of 1 inch = 4 miles have been dealt with during the year. The hills for two of these sheets (Nos. 29 and 54) have been brush-shaded for photographic reproduction by an adaptation of the helio-zinco process. One of these (No. 29) has been reproduced with satisfactory results, though the cardboard on which the drawing was made was found, when the work was too far advanced to be rejected, to be of far from good quality. A drawing on better quality cardboard has been made of the hills of sheet 54 and will shortly be ready for press, and if the results are satisfactory it may be advisable to adopt this process for showing the hills on the engraved sheets when they are prepared, as the effect is good and by this process the hill plates could be prepared in about a quarter the time it would take to engrave them. Sheets Nos. 29, 31 and 67 have been completed and published, the remaining five are under publication in various stages and will shortly be available.

44. Six hundred and eighteen standard sheets have been dealt with during the year, the majority are as usual reprints and of these 225 have been

published. Thirty-five Administration Report maps on the scale of 1 inch = 8 miles were dealt with, all but one being reprints.

Of plans and maps of cities and cantonments 133 sheets have passed through the office, a large number being those of the Rangoon town survey. Nineteen sheets of the large scale Calcutta survey have been revised and published, while the 6-inch map has been partially revised, rearranged, and sent to press for proof; but such revision as can be made by this office must always be more or less unsatisfactory, and thorough professional revision is most desirable bearing in mind the great changes that are always occurring in the city.

45. The preparation of the new series of Index maps to illustrate the degree and standard sheets falling within each of the $\frac{1}{M}$ series has been steadily prosecuted during the last half of the year. Of these two, Nos. 34 and 84, have been completed and a limited number of copies published for departmental use, while 12 more are far advanced towards completion and should shortly be available. A large number of other index maps have also been dealt with for various purposes during the year.

46. Seventeen triangulation or traverse charts have been passed through the office, some necessitating a large amount of work. Owing to the press being unable to cope with the type work connected with these, a commencement has been made to insert the letterpress by hand, and it is hoped some more may shortly be got ready for publication in this way.

47. As usual a large amount of work has been performed for other departments, Military, Foreign, Public Works, Postal, etc. The Postal maps of the various circles continue to form a very heavy piece of work; those of the Central and United Provinces have been published during the year, while those of Bombay, Madras, and Eastern Bengal are well in hand, the first having reached the proof stage, but as numerous alterations were made when the map was in that stage it had to be reproduced a second time. A very troublesome piece of work, namely, the preparation of the Agency maps of Central India, is gradually being completed in spite of the constant corrections and additions made on the proofs. Manœuvre maps for the various commands form a never-ending source of work, and it would be well if officers requiring these could look more ahead, as it is impossible to satisfy all applicants at once, and the maps of the various areas affected are generally wanted at the same time of the year and urgently. A series of maps for the various Provincial Gazetteers has also been under preparation as opportunity offered, and will continue for some time to come to tax our drawing power.

48. The Examining Section of the office has passed 1,884 sheets and has besides provided a large amount of geographical information to various officials and performed much other miscellaneous work. This section is not strong enough to cope with the work demanded of it.

49. A total of 1,803 pages of traverse data have been copied and examined by the Computing Section for local or district officers, as usual the majority of the demands being from Burma. There has besides been the usual miscellaneous compilation work. The number of applications received from private individuals for copies of old records, etc., was 1,035, in response to which 1,566 authenticated copies were issued and for these the Government fees paid over to the Account Section amounted to R940-4-0.

50. Twenty-nine thousand two hundred and ninety-five coloured copies of maps were examined and passed for stock or issue. Six hundred and eight sheets were coloured for the office records, and 3,960 were corrected and certified to after correction.

51. *Engraving Office.*—Owing to the recommendation of the late Survey Committee that the compilation of the sheets of the Atlas of India should be discontinued, the engravers have mostly been employed on the new pattern index maps and degree sheets, as well as on the general maps of India and miscellaneous work.

Atlas sheets No. 41 N-W, 60 S-W, 80 S-W, and 106 S-W, have been published during the year. Corrections have been made on ninety others, in order that they may be available for printing when required.

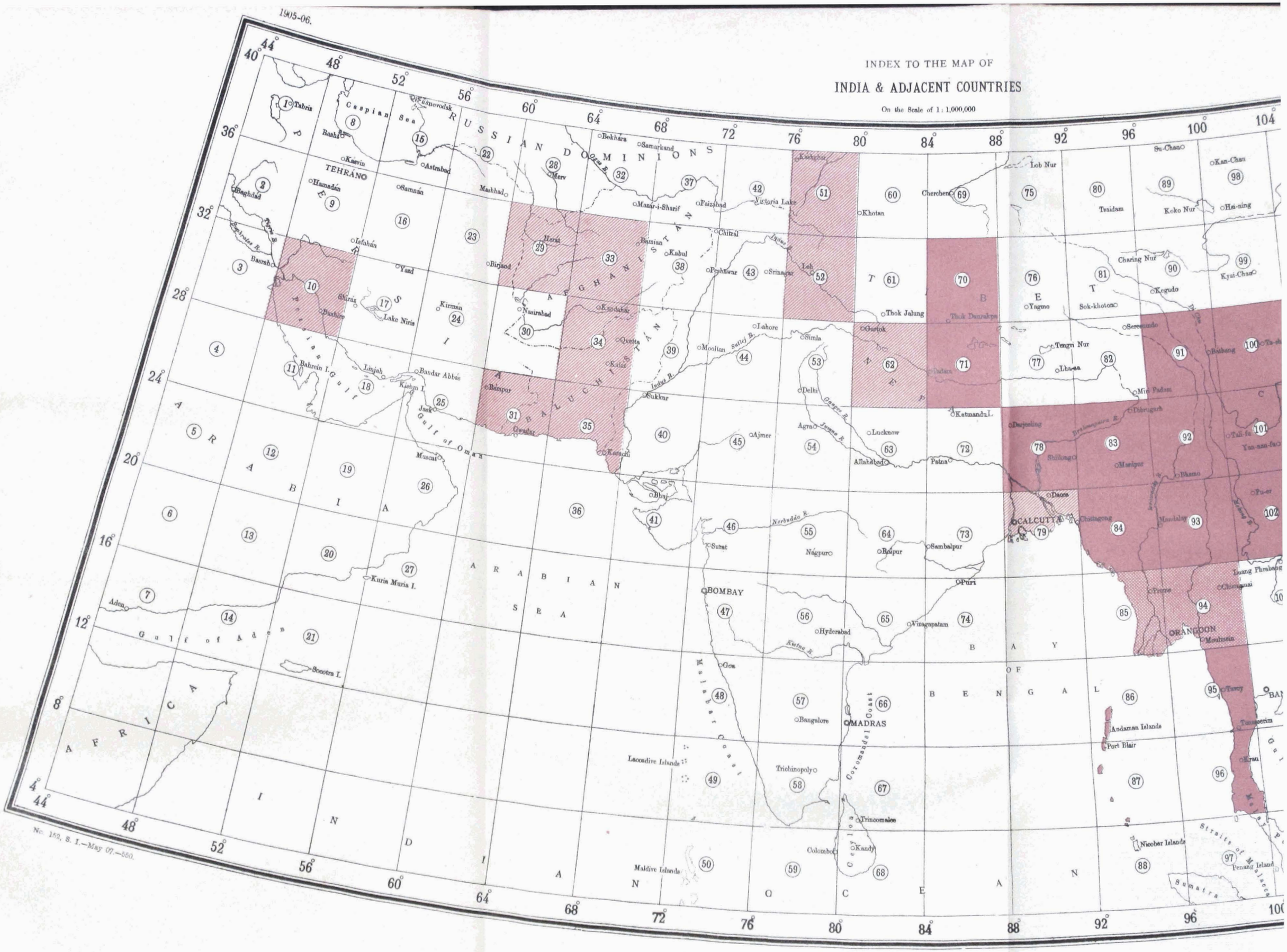
Five more quarter atlas sheets, Nos. 20 S-W, 89 N-E and N-W, 106 N-E, and 107 N-W, still remain to be completed for publication. A few more plates also require to have corrections finished off.

1905-06.

INDEX TO THE MAP OF

INDIA & ADJACENT COUNTRIES

On the Scale of 1: 1,000,000



Published under the direction of Colonel F. B. Longe, R.E., *Surveyor General of India, August 1907.*

Scale of Miles

100 50 0 100 200 300 400

NOTE.

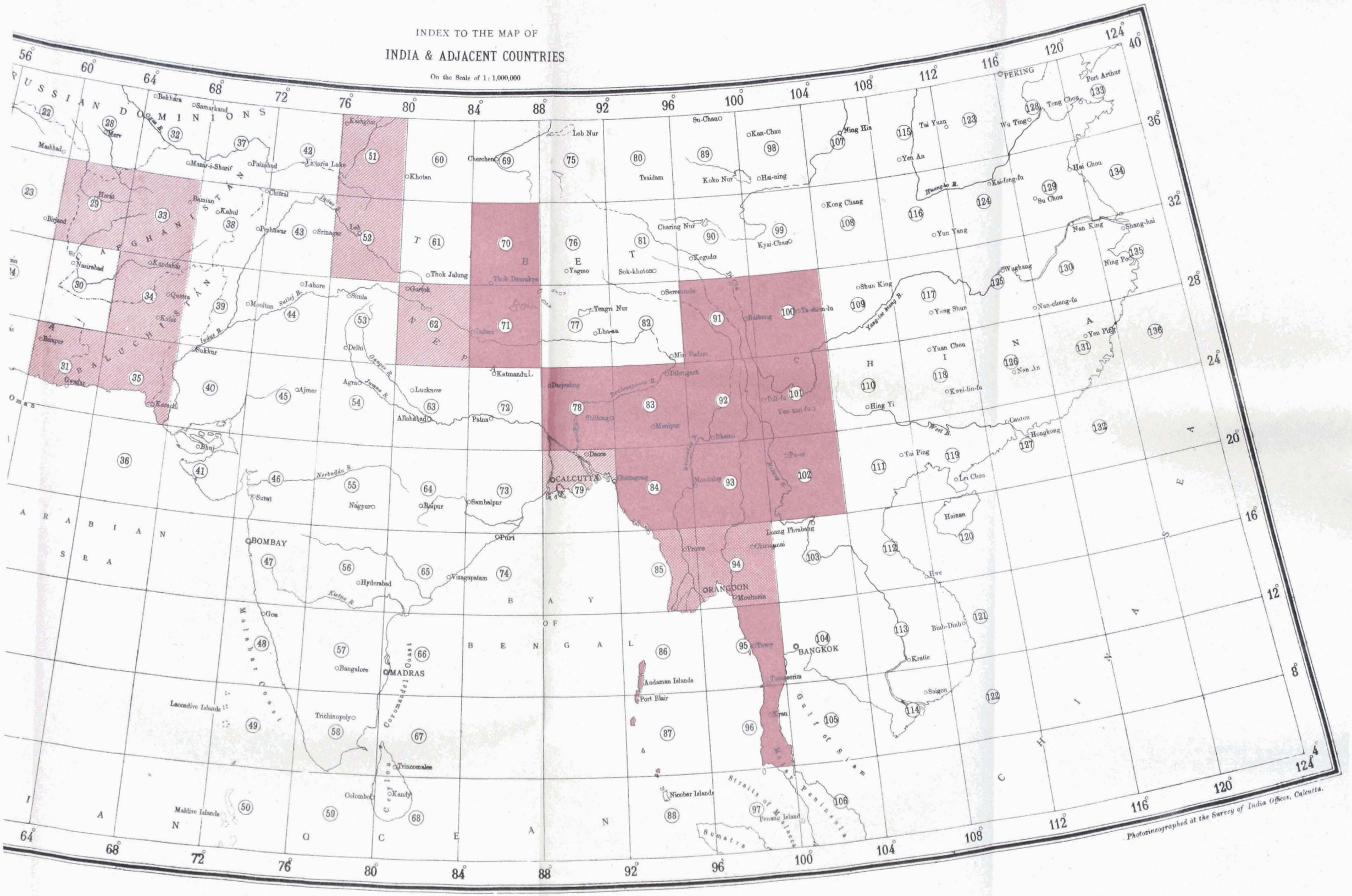
The Longitudes of the MAP OF INDIA AND ADJACENT COUNTRIES are referrible to the Greenwich Meridian, taking that of Madras Observatory as 80° 14′ 54″ East, the most recent Geodetic value.

No. 152, S. I.—May 07.—550.

INDEX TO THE MAP OF

INDIA & ADJACENT COUNTRIES

On the Scale of 1 : 1,000,000



Published under the direction of Colonel F. B. Longe, R.E., *Surveyor General of India, August 1907.*

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100 50 0 100 200 300 400

NOTE.

The Longitudes of the MAP OF INDIA AND ADJACENT COUNTRIES are referrible to the Greenwich Meridian, taking that of Madras Observatory as 80° 14′ 54″ East, the most recent

REFERENCES

Sheets Published

" Under publication

" In hand

Photozincographed at the Survey of India Offices, Calcutta.

Reg. No. 242-S. 07.

On the completion of the above no more work will be done on the plates of the old Atlas of India.

Six of the new degree sheets which are to take the place of the atlas sheets have been projected. An experimental sheet has been commenced on three plates, but the work had to be suspended until material was available for the additional longitudinal strip of 2′ 27″, due to the adoption of the latest value of the longitude of Madras for our maps. This material only came to hand late in the year, when work was at once resumed. It is proposed to complete this sheet as early as possible, and after all details on it have been approved of, work on other sheets, for many of which it is hoped complete material will shortly be available, will form the main work of this section.

A sample standard sheet of the new pattern has also been in hand during the year. This has been engraved on four plates for reproduction in colours. The engraving of the detail has been practically completed. There has been considerable delay over this sheet as the hill work was found on completion to have been cut too deep, and required considerable toning down, while some lettering also required alteration.

The sheet has been further delayed owing to the characteristic symbols to appear on each sheet not having been finally approved. Orders on this point have however now been passed and the plates will be completed as early as possible.

It is yet uncertain if more of the standard sheets are to be engraved.

A new 32-mile map of India in 12 sheets will be shortly commenced, and the projection of the plates is well in hand.

Work on the duplicate 64-mile map of India, which has been brought up to date as far as possible and in particular on the North-West and North-East Frontiers, has been carried on throughout the year. The plates are now practically ready for printing, but orders are awaited regarding the external boundary symbols. As soon as an edition has been printed off, it is intended to alter the meridian lines, adopting the meridian of 80° as the central one, so that each quadrilateral formed by the intersection of the meridional lines with the latitude parallels will embrace the area of one of the sheets of the India and adjacent countries series. It is intended at the same time to insert a finer symbol for the railway lines than exists at present, revise boundary symbols, etc., and in many ways bring the map more up to date. One plate has already had a matrix taken and certain corrections have been carried out. A considerable amount of work has also been done on the engraved plates of the 96, 128 and 192-miles=1 inch maps of India.

During the year work has been carried out on the 1-inch=16 mile maps of Bengal, Bombay (new), Gujarát, Madras (new) and Punjab. These plates have been for long in hand and are being completed for publications.

Nine plates for the new index maps to the standard and degree sheets falling in each $\frac{1}{M}$ sheet have been prepared, and dry prints have been supplied to the Drawing Office for the entry of the detail required. These index maps will in the first instance be prepared by helio-zincography, but eventually they will probably be engraved. Thirty-nine District maps, four Weather Charts, three of the plates of the Calcutta maps, thirteen scale plates, and twenty other miscellaneous plates have been worked upon. Four new forms in English and Urdu for commissions in the native army have had to be engraved, as it was found impossible to make the required alterations on the old plates. These will occupy the engravers for some months to come. Eighteen photogravure plates have had titles cut on them, while a photogravure map in two large plates of the Goa territory on the scale of 2 inches=1 mile has required much retouching to prepare it for printing. The Copper-plate Printing Section pulled 45,143 impressions, an increase on last year's total of 1,693 pulls.

In the Steel-facing Section 355 plates were dealt with, and 46 plates were corrected from the surface and filled in by electro-deposition.

During the month of April, a serious theft of copper-plates, sixteen in number, took place in the office. Apart from the value of the copper stolen, the loss is luckily small, as most of the plates had been either just commenced or contained small areas of country only. The most serious losses are Atlas Sheet No. 51 N-W, and two plates of the old so-called Lottery Map of Calcutta. The first will shortly be replaced by an etching on copper from an impression obtained from a print by

the Vandyke process. No clue to the perpetrators of the theft has been discovered, though the police have made enquiries in all likely quarters and offered a reward. The almirahs which were formerly constructed, more for the object of preserving the plates from disarrangement than for safety, have been strengthened, and precautions are daily taken to see that all plates are locked up before the office is closed.

52. *Photographic and Lithographic Office.*—The total number of prints of maps, plans, diagrams, etc., for the Survey of India and for other departments shows an increase of 20,265 over that of the previous year. The total number of copies printed being 932,614 as against 912,349 in 1904-05.

There was a slight falling-off in the number of cadastral maps printed, the figures being 45,490 as against 58,875.

There has been a decided improvement in the class of originals sent in by outside departments for reproduction and this has enabled more extra-departmental work to be undertaken.

53. The following were the more important departmental publications of the year:—

Three hundred and six standard sheets of which 68 were in black and brown. The total number of copies printed from these sheets was 76,221.

Forty-two District maps of which 10,410 copies were printed.

A map of India on the scale of 1 inch=64 miles.

A new sketch map of Bengal, 1 inch=32 miles.

A map of Eastern Bengal and Assam, 1 inch=32 miles.

A map of Eastern Bengal and Assam in five colours, 1 inch=12 miles.

A map of the Madras Presidency, 1 inch=32 miles.

A map of the United Provinces in two colours, 1 inch=16 miles and a map of the Bombay Presidency, 1 inch=32 miles.

Forty sheets of the Calcutta survey were corrected and 200 copies of each printed.

Twenty-two sheets of the Delhi Hissar Revenue survey, of each of which 150 copies were printed.

A map of the Aden survey, Steamer Point cantonment, and a cantonment plan of Ahmedabad.

The new 32-mile map of India with hills in brown has been worked on during the year, further corrections to several of the sheets having been received.

54. The principal extra-departmental items included 60 maps of various kinds for the Foreign Department.

Eleven maps, etc., including the 80-mile map of India showing railway systems in nine colours of which 2,150 copies were printed, and a diagram in seven colours showing capital outlay, gross earnings, etc., of which 1,900 copies were printed for the Railway Board.

Nineteen plans and diagrams and one map in four colours were prepared and printed for the Sanitary Commissioner to the Government of India.

Five thousand seven hundred and eighty copies of 4 maps in colours involving 40,460 runs were printed for the Linguistic Survey, and 247,160 copies of various charts were printed for the Meteorological Reporter to the Government of India.

55. The outturn of the Type Section (1,816,405 prints) is less than last year. The work of the Heliogravure Section has decreased considerably.

Last year it was reported that Mr. Turner had met with considerable success in reproducing a brush shaded hill drawing. These experiments have been continued by Mr. Taylor, who has devised a new method for reproducing a brush drawing and printing direct on to zinc without the necessity for any hand-work. The results are shown in the map attached to this report and may be considered very satisfactory, and it is hoped to make extensive use of this process in future.

The office continues to suffer severely from the lack of high class printers, and it will be absolutely necessary to obtain a better class of printers if the new standard sheets in four colours are to be satisfactorily dealt with.

56. *Map Record and Issue Office.*—Issues during the year amounted to 110,068 sheets of an aggregate value of R1,23,016, which is an increase on last year's totals of 14,704 sheets and of R14,596. Out of this total R18,210 was realized from sales to private individuals.

The number of new maps received on publication was 104, whilst 990 new editions and reprints were received from press for issue. The number of original,

maps, volumes of computations, etc., issued from store to other departments or branches of the office was 4,915 of which 4,755 were received back again.

The transfer of the original cadastral sheets from this office to the various head-quarters of local Governments or districts was completed during the year.

The work of revising the catalogues has again been resumed, and those of the United Provinces and the Punjab are approaching completion, and it is hoped will shortly be ready for issue.

No more forest maps have been transferred to Dehra Dún, as rack accommodation for them is not yet available there.

The work of overhauling and re-registering the fair maps, computation volumes, etc., has been steadily carried on throughout the year, and a fair amount of progress made, but much still remains to be done. The topographical record room has been re-arranged and made much more accessible; while a wall with an iron door has been built entirely closing in the room in which the fair maps of the department are stored, and it is hoped they are now more secure against fire than they were previously. It would, however, be far more satisfactory could all our valuable records be placed in a detached building suitably constructed where they could be better protected from the ravages of vermin and insects, and be still more safe from fire.

57. *Mathematical Instrument Office.*—During the year under report, *i.e.*, from 1st April 1905 to 31st March 1906, there has been a considerable increase in the demands made on this office. For the last three years the value of instruments, etc., issued was R3,64,646, R3,54,005 and R4,22,179, respectively; the value of repairs to instruments received for that purpose and returned in a serviceable condition was R37,449, R40,069 and R41,818 and the value of instruments received from government officers as "no longer required" was R74,066, R85,994 and R76,096.

The book value of the stock of instruments, etc., in the serviceable store at the end of each of the last three years was R3,85,145, R3,92,653, and R4,53,251. In order that this office may be prepared to meet without delay all reasonable demands and in view of the long time that usually elapses after an indent is despatched to the Director General of Stores, before the receipt of the instruments indented for, it is impossible to keep these values low.

The book value of the stock of instruments, etc., in the repairable store at the end of each of the last three years was R1,64,474, R1,46,734 and R1,19,907. Instruments for which there was a demand were not left in the repairable store for any length of time, but were sent to the workshop for repairs and transferred to the serviceable store for issue.

The "profit and loss statement" for the workshop is satisfactory. The number of men and boys employed at the end of each of the last three years was 320, 352 and 421, and the value of the total work done in the workshop during each of these years was R1,50,567. R1,58,958 and R2,01,083. The continued increase in these figures is satisfactory, but, unless the office is removed elsewhere, a limit will soon be reached, for the buildings are already overcrowded and there is very little space available for extensions.

The value of instruments, etc., manufactured in the workshop for the serviceable store during each of the last three years also shows a steady increase, being R57,095, R64,188, and R82,638, respectively. A considerable profit accrues to Government on account of these manufactures, as the instruments, etc., are turned out at a lower price than they can be purchased at and there is no occasion to keep up a large stock of them in the serviceable store. The value of instruments, etc., purchased locally for the serviceable store during each of the last three years was R11,641, R14,405 and R17,810.

The value of instruments, material, etc., obtained from England through the Director General of Stores during each of the last three years was R1,46,509, R1,91,113, and R2,87,740. These amounts are naturally increasing owing to the rise in the values of the issues and in the value of the work done in the workshops.

58. Mr. T. R. Theakston, Mathematical Instrument Maker, died while on leave in Europe, and his post was filled by the confirmation in the office of Mr. T. A. Ferrier who was officiating for him during his absence. Mr. Theakston was a most zealous hardworking officer, and the great increase in outturn and improvement in workmanship is in a great measure due to his energy and initiative.

BRANCH OFFICES, DEHRA DŪN.

59. *Trigonometrical Surveys.*—The superintendence of the Trigonometrical Branch was under Lieutenant-Colonel S. G. Burrard, F.R.S., R.E., during the year. Lieutenant C. M. Browne, D.S.O., R.E., was in charge of the Technical offices up to 27th November 1905, when Mr. J. Eccles, M.A., on return from leave, relieved him, and held the charge for the rest of the year.

Lieutenant F. F. Hunter, I.A., joined on the 27th April 1906, on special duty.

Lieutenants L. G. Crosthwait, I.A., V. R. Cotter, I.A., and K. W. Pye, R.E., who joined on the 13th and 30th October 1905, and 17th March 1906, respectively, were put through a course of trigonometrical, topographical and astronomical work. Fifteen Sub-Assistant Superintendents were also put through a course of training during the year and one Sub-Assistant Superintendent and six surveyors prepared for exploration work.

60. The following computations were carried out in the Computing Office :—

(*a*) Various pieces of snow peak triangulation in Kumaun and Garhwal between longitudes 79°-0′ to 80°-30′, have been finished with the exception of the heights, as have also Colonel Tanner's Someshwar Series and the Darjeeling revisional survey.

(*b*) The Dehra Dún and Jaunsar Báwar triangulations are nearly ready for press. The above are all for incorporation in the synoptical volume of the North-East Longitudinal Series.

(*c*) Snow peak triangulations in Western, Eastern and Central Nepal, the Sikkim triangulation peaks observed from the Western border of Sikkim, and the heights of Colonel Waugh's Himalayan peaks with modified co-efficients are now in hand for incorporation in the same volume.

(*d*) Besides the above, computations for investigating the co-efficient of refraction and the deflection of plumb-line were also made.

(*e*) Computations on account of change of origin of the rectangular co-ordinates of the triangulations of Dehra Dún and Deoban and for the projection of a map of Persia were made for the Drawing Section.

(*f*) A number of miscellaneous heights were computed to supply data.

(*g*) The Pendulum results supplied by No. 23 party for the Geodetic Conference were checked.

The printing of the fourth edition of the Auxiliary Tables was completed and the books are being distributed. A pamphlet containing the record of rainfall, etc., at Dehra Dún for the past 36 years was issued. The printing of Volume XVIII of the Great Trigonometrical Survey of India containing Astronomical Latitudes was commenced and is nearly finished.

During the year fifty-two officers were supplied with data from records in this office.

The comparison and examination of press proofs were carried on and the care of the records, library and printed papers as well as the meteorological observations were continued as usual.

The necessary professional aid in connection with the protection of stations was rendered by the Computing Office to the office of the Superintendent, Trigonometrical Surveys. Six hundred and seventy-five stations were repaired at a cost of R3,651-15-9 by the district officers. Out of 333 districts from which the reports are annually due only one failed to make a return.

61. In the Drawing Office the following maps were drawn either totally or partly and sent to press :—

(1) Three Tibet maps, scale 2 miles=1 inch; and one, scale 100 yards=1 inch.

(2) Nine Sind level sheets.

(3) Three North-East Frontier sheets on scale 8 miles=1 inch.
One North-East Frontier sheet 4 miles=1 inch.
One North Frontier sheet on scale 8 miles=1 inch.

(4) One Sikkim map on scale 4 miles =1 inch.
One Bhutan map on scale 8 miles=1 inch for the Bengal Government.

(5) Five standard sheets of the United Provinces.
(6) One Punjab sheet on scale $\frac{1}{8}$ mile=1 inch, which involved the drawing of four sheets on the scale of $\frac{1}{4}$ mile=1 inch, and half a Punjab standard sheet.
(7) Six triangulation charts.
(8) One sheet of the Map of India and Adjacent Countries.
(9) A number of diagrams to illustrate a book on Himalayan geography.

While the following are nearly ready for press :—
(1) One standard sheet of the United Provinces.
(2) Eleven Sind level sheets.
(3) One North-East Frontier sheet, scale 16 miles=1 inch.

And the following are still in hand :—
(1) Three sheets of the Map of India and Adjacent Countries.
(2) Index Route Map of the Western Himalayas.
(3) Map of Persia, scale 40 miles=1 inch.
(4) One standard sheet of the United Provinces.
(5) Three level sheets in Sind and one in the Punjab.
(6) A special map for the Foreign Department prepared under the direction of Lieut. F. F. Hunter, I.A.

Headings, footnotes including symbols and area statements, were completed on 224 maps which were also sent to press.

Two thousand seven hundred and sixty maps were coloured.

Nine hundred and eighty-three maps and diagrams were photographed against 1,099 during 1904-05, and 108,064 pulls taken against 85,066 in the same period.

Photographs of the sun were taken on 300 days.

62. *Forest Surveys.*—The offices of this branch were under the superintendence of Major P. J. Gordon, I.A., Superintendent of Forest Surveys, throughout the year, and in addition to the ordinary routine work were employed on the upkeep of the map records of the Forest department, and on the compilation of special working plan, and other maps sanctioned by the Inspector General of Forests.

During the year 248 maps were published at Dehra Dún and Calcutta and 138 at the Government Photo-Zincographic Office at Poona.

Eleven thousand six hundred and twenty-nine printed maps were issued, of which 8,304 were coloured and 2,642 mounted in book form.

There was a considerable demand for forest maps by the public interested in the mining and timber trades, as well as by officers of the railway and canal departments, and a sum of R858 was realized during the year by their sale.

Good progress has been made in providing racks for storing maps and it is hoped that accommodation will soon be available for storing the remaining forest maps now in the Calcutta Office.

LOCAL DRAWING OFFICES.

63. *North-West Frontier Drawing Office.*—The principal work of this office during the year has been the preparation of small scale maps of the North-West Trans-frontier series. Of the fourteen sheets of this series on the scale of 1-inch=4 miles on which the office has been employed during the year, 13 have been sent to press, six sheets on the same scale of the South-West Asia series have also been sent for publication, and one of the Northern Trans-frontier series. The six sheets of the map of "India and the Adjacent Countries" are almost ready for publication.

Personnel.

Captain F. W. Pirrie, I.A., Deputy Superintendent, 2nd grade, in charge till 15th October.
Major C. L. Robertson, C.M.G., R.E., Deputy Superintendent, 1st grade, in charge from 16th to 20th October.
Mr. R. R. Dickinson, Extra Assistant Superintendent, 1st grade, in charge after 20th October.
Mr. W. S. Cornelius.
Mr. F. E. Warde, Sub-Assistant Superintendent, 1st grade.
Mr. H. Sindon, draftsmen.
19 draftsmen, etc.

The miscellaneous work has included the reduction and plotting of portions of Dr. Sven Hedin's routes from Tehran to Seistan, the preparation of duplicate computations for No. 15 Party and the colouring, examination, and correction of a large number of maps on various scales.

The total cost of the office during the year has been R24,960.

This office will be absorbed in the office of the Superintendent, Frontier Surveys, during next year and its work will be continued there on similar lines to those reported above.

64. *Burma Drawing Office.*—This office is located at Bangalore and is employed mainly on the compilation of degree sheet maps, but much miscellaneous work in connection with Burma surveys is also done. Mr. W. Stotesbury (late of the Survey of India) held charge until the 11th June 1906, when he was relieved by Mr. T. Shaw, Extra Deputy Superintendent, 1st grade, who was transferred from Assam. The subordinate establishment consisted of 19 draftsmen of whom 10 were transferred temporarily to field parties during the recess season to assist in standard mapping. Sheets 85N, 93H and 93K were completed and sent to Calcutta for publication and sheets 84P, 85N and 93K were published. The following sheets of which the survey has been completed are in hand:—84L, 85M, 93L and 94A. The drawing of sheets 85O, 93P and 94C has also been commenced, but the survey of these sheets has not been completed yet. The drawing of sheet 94B, the whole of which has been surveyed, will be taken up next season. Nine standard maps of No. 10 Party of season 1904-05 were completed in this office, four standard sheets which had been published in the old form were redrawn in the new form, and all were forwarded for publication. The degree sheet mapping will be continued next season and the arrears of No. 3 Party's 1-inch mapping will be handed over to this office for completion.

65. *United Provinces Drawing Office.*—This office was formerly attached to No. 8 Party which was broken up as mentioned at paragraph 248 of last season's report. Mr. J. Kennedy, Extra Assistant Superintendent, 2nd grade, continued in charge and was assisted by Mr. W. C. Price, late Survey of India, who was temporarily re-employed to push on the standard mapping which is being compiled from the cadastral surveys of the province. Mr. Price resigned in April 1906 and Mr. F. S. Bell, Extra Assistant Superintendent, 4th grade, was attached to the office till the end of the season, when he was transferred to a topographical party. The subordinate establishment consisted of 35 draftsmen, 3 typers and 2 computers. Fifteen standard sheets were completed, seven were forwarded to Calcutta for publication and 11 were published during the season; nine other sheets are in hand. Eleven traverse charts were completed and four were forwarded for publication but none have yet been published.

ESTABLISHMENT.

66. During the year the department has lost the services of Major H. A. D. Fraser, R.E., who is now employed under the Kashmir Durbar.

The following military officers were appointed to the department during the year:—Lieutenants L. G. Crosthwait, I.A., H. J. Couchman, R.E., O. H. B. Trenchard, R.E., S. W. S. Hamilton, R.E., V. R. Cotter, I.A., and K. W. Pye, R.E.

67. In the Provincial service seven officers have retired—Messrs. R. F. Warwick, J. S. Swiney, W. Robert, A. W. Smart, C. P. Torrens, F. E. Warde, and Munshi Ikbaluddin, K.S.; three have resigned—Messrs. P. Samuels, F. C. Glass and Babu H. N. Mukharji; and two have died—Messrs. C. S. Gasper and G. W. Archer. Sixteen (probationary) appointments to the Provincial service have been made during the year.

68. The Gold Medal of the Paris Geographical Society has been awarded to Major C. H. D. Ryder, D.S.O., R.E., for his valuable additions to the geography of Tibet and of the sources of the Brahmaputra.

In recognition of their services, while employed with the Seistan Arbitration Commission, the Government of India has been pleased to sanction a special personal allowance of R200 per mensem to Mr. G. P. Tate, and rewards of R500 to Surveyors Kadir Sharif, Gopal Singh, R.B., and of R300 to Surveyor Jamal-ud-din.

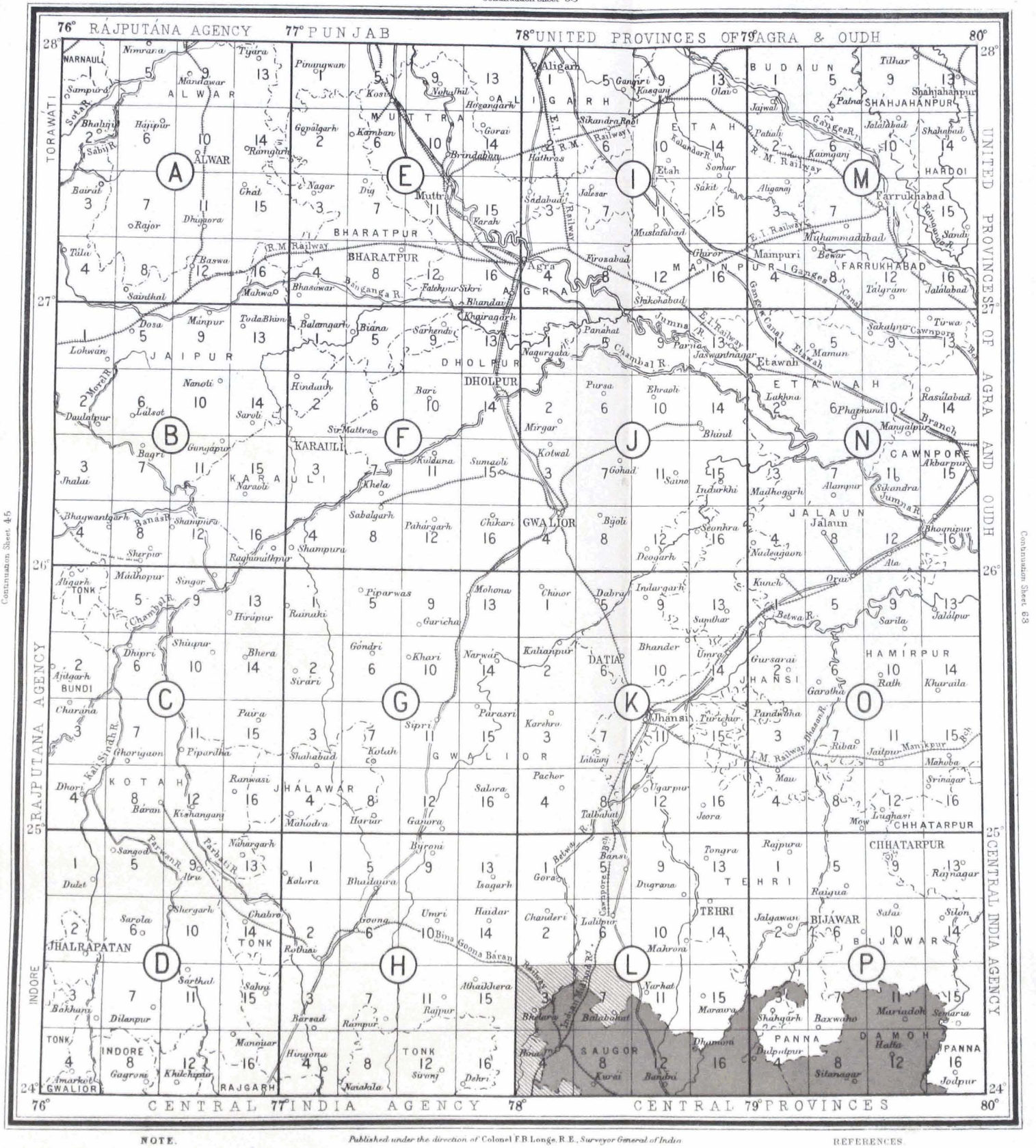
SHEET N° 54.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.

Continuation Sheet 53



NOTE.

The number in the heading is that of the Sheet of the India and Adjacent Countries Series on the Scale of 1000000.

The letters denote the Degree Sheets on the Scale of 1 Inch = 4 Miles contained within the above, while the small figures denote the numbers of the 1 Inch Sheets contained in each Degree Sheet.

When ordering a sheet on the 1000000 Scale, only the number given in the heading should be used, e.g. N°93. In the case of a Degree Sheet, the number in the heading and the Degree Sheet letter must be given, e.g. 93A. For a 1 Inch Sheet, the number in the heading the Degree Sheet letter and the 1 Inch Sheet number must be quoted, e.g. 93 $\frac{A}{2}$.

Published under the direction of Colonel F.B.Longe, R.E., *Surveyor General of India.*

1907

Scale 1 Inch = 28 Miles.

Miles 10 0 10 20 30 40 50 Miles

INDEX TO ADJOINING SHEETS.

44	53	62
45	54	63
46	55	64

REFERENCES.

1. Degree Sheets published on the $\frac{1}{4}$ Inch Scale
2. Sheets published in new style on the 1 Inch Scale
3. " " old
4. Triangulated in advance
5. During year under report
6. Surveyed
7. Previously surveyed but not published

Sheets under 3 only approximately conform to limits shown on Index.

No. 140, S. I.—May 07.—550.

Reg. No. 271-S. 07.

Hello. S. I. O., Calcutta.

PART II.

THE OPERATIONS OF FIELD PARTIES.

TOPOGRAPHICAL SURVEYS.

CENTRAL PROVINCES, UNITED PROVINCES, AND CENTRAL INDIA AGENCY.

No. 1 PARTY.

69. The party was mainly occupied this season in completing standard sheets of which the Central Provinces portion only had been surveyed in recent years, and the greater part of the area surveyed consisted of territory of the States of the Central India Agency of which a topographical survey had been done on the 1-inch scale between 1854 and 1872 This was re-surveyed on the 2-inch scale, while the work in the Central and United Provinces consisted of supplementary topographical survey, also on the 2-inch scale, of ground surveyed cadastrally many years ago by local agency and traversed by the Survey of India. An attempt is being made to carry out the present survey with the aid of the triangulation and traversing of the old surveys, which have not proved altogether adequate. Some of the trigonometrical stations cannot be found, heights are wanting in others, even in the work of the Great Trigonometrical Survey; intersected points cannot now be identified, discrepancies exist in the various former surveys topographical, forest and cadastral; traverse stations and trijunction mar... have disappeared and finally the old survey of Central India having been done on the 1-inch scale, the triangulation is not sufficient for the larger scale now employed. A considerable amount of triangulation and traversing has consequently to be done now, and this season 60 linear miles of simple traversing was done and 550 square miles of triangulation with observations at 19 stations whereby 10 new stations were fixed.

Personnel.

Captain A. H. B. Hume, R.E., Deputy Superintendent, 2nd grade, in charge.
Mr. W. Skilling, Extra Assistant Superintendent, 4th grade.
Mr. F. P. Walsh, do. do. 5th „
Mr. W. J. Newland, do. do. 6th „
Mr. B. M. Berill, Sub-Assistant Superintendent, 1st grade.
Mr. R. E. Saubolle, do. do. 2nd „
Mr. F. C. Glass, do. do. 2nd „
55 Surveyors.

70. Field work commenced on the 21st October 1905 and closed in the early part of May 1906 during which time the health of the party generally was good. In the sheets lying to the north the country was mostly flat and open with occasional rocky hills covered with thin jungle, while to the south, especially in the Bhopal State, it was hilly and forest clad. The valley of the Nerbudda river, a portion of which again came under supplementary survey this season, was described in last year's report. The outturn of detail survey was 2,086 square miles scattered over 16 standard sheets. This is a very small outturn for so many surveyors, but many of these were new or partially trained men who had been drafted into the party for further training from the parties employed on the north-west frontier where the training of surveyors is out of the question, and 7 were native soldiers also under training. The average outturn *per* man was 0·38 square miles *per* working day; the average number of plane-table fixings *per* square mile was 28 and of clinometer heights 4·2.

71. Several large forest reserves in the Central Provinces, that had been surveyed some seasons back by the Forest Survey, fell into this season's work, but owing to insufficiency of trigonometrically fixed points, it was found impossible to carry out the necessary examination of the maps to bring them up to date and into accordance with the new work and this will be done next season, when the necessary data will be obtained by traversing. This however prevents the completion of several sheets at present. The cost-rate of the detail survey was R25·3, but this does not include the work done in connection with the

reduction of the cadastral maps nor the fair mapping, both of which include areas not surveyed this season. The cost of the former operation was ₹7·4 *per* square mile and that of the latter ₹12·9.

72. The traversing of village boundaries for the Settlement Department was continued and 43 villages were traversed in Nimar, Balaghat and Saugor districts involving 213 linear miles of chaining.

73. As it has now been ordered that all standard sheets are to be surveyed up to graticule limits many of the maps of former seasons cannot be published, the survey having been confined to the Central Provinces, and again this year it has not been possible, as explained at paragraph 71, to despatch all the season's maps for publication. The drawing of all that was surveyed was however completed and four sheets in the new form and one in the old were sent to Calcutta. Seven sheets were published during the season. The Surveyor General inspected the party during the recess and the Deputy Surveyor General during both the field and recess seasons.

74. Next season the unfinished sheets of this season's programme will be completed, the area being 690 square miles including the forest areas, and an endeavour will be made to complete the following 15 standard sheets $54\frac{L}{11,\ 15,\ 16}$, $54\frac{P}{3,\ 4,\ 7,\ 8,\ 11,\ 12,\ 15,\ 16}$, $64\frac{A}{1,\ 5,\ 13}$, containing an unsurveyed area of 1,557 squar miles. All of these sheets were partially surveyed a few seasons ago. The personnel of the party however still remains the same and there is so much miscellaneous work in connection with the work of former seasons to be done that it is doubtful if this programme, small as it is, will be completed.

CENTRAL PROVINCES AND BERAR.

No. 2 PARTY.

75. The instruction of newly appointed officers of the Imperial and Provincial services was continued in this party, and the topographical survey of Berar on the scale of 2 inches to the mile was carried on in continuation of last season's operations. Field work commenced on the 16th October 1905 and closed on the 8th May 1906.

Personnel.

Mr. C. F. Erskine, Officiating Superintendent, 2nd grade, in charge, till 27th December 1905.
Captain H. Wood, R.E., Officiating Deputy Superintendent, 2nd grade, in charge, from 28th December 1905.
Lieutenant H. S. Couchman, R.E., Assistant Superintendent, 2nd grade, from 30th January 1906 to 21st September 1906.
Lieutenant S. W. S. Hamilton, R.E., Assistant Superintendent, 2nd grade, from 14th January 1906.
Mr. C. J. Veale, Extra Assistant Superintendent, 6th grade.
18 Junior provincial officers.
5 Soldier surveyors.

The minor series of triangulation begun last season was continued for a length of about 50 miles and closed on the Khanpisura Meridional series of the G. T. Survey. The network triangulation done during the season covered 1,850 square miles and the average number of square miles to each point trigonometrically fixed is 2·9.

76. The detail survey of four sheets was completed together with a strip of country $2\frac{1}{2}$ miles wide along the eastern margin of sheet $55\frac{L}{8}$, necessitated by the correction recently applied to the longitudes in India, the area surveyed being 1,124 square miles. Most of sheet $55\frac{K}{5}$ consists of the Wardha district of the Central Provinces, but the rest of the area surveyed this season falls into Berar. It comprised the valleys of the Wardha and Purna rivers and consisted of undulating plains with low bare hills here and there. The outturn given above does not include an area of 33 square miles of reserved forests of the Central Provinces which had been previously surveyed on the 4-inch scale and was not re-surveyed. All the forests met with in Berar not already surveyed by the Forest Survey Branch were mapped on the 2-inch scale. The average monthly outturn of plane-tabling *per* man was 9·3 square miles and the average *per* working day 0·5. The average number of plane-table fixings *per* square mile was 23·9 and of clinometer heights 6·1.

77. The mapping of the arrears left over from the preceding season and that of 3 sheets of the present season's work was completed and submitted for publication. The mapping of the fourth sheet was very nearly completed, as were the whole of the computations of the triangulation, although the recess

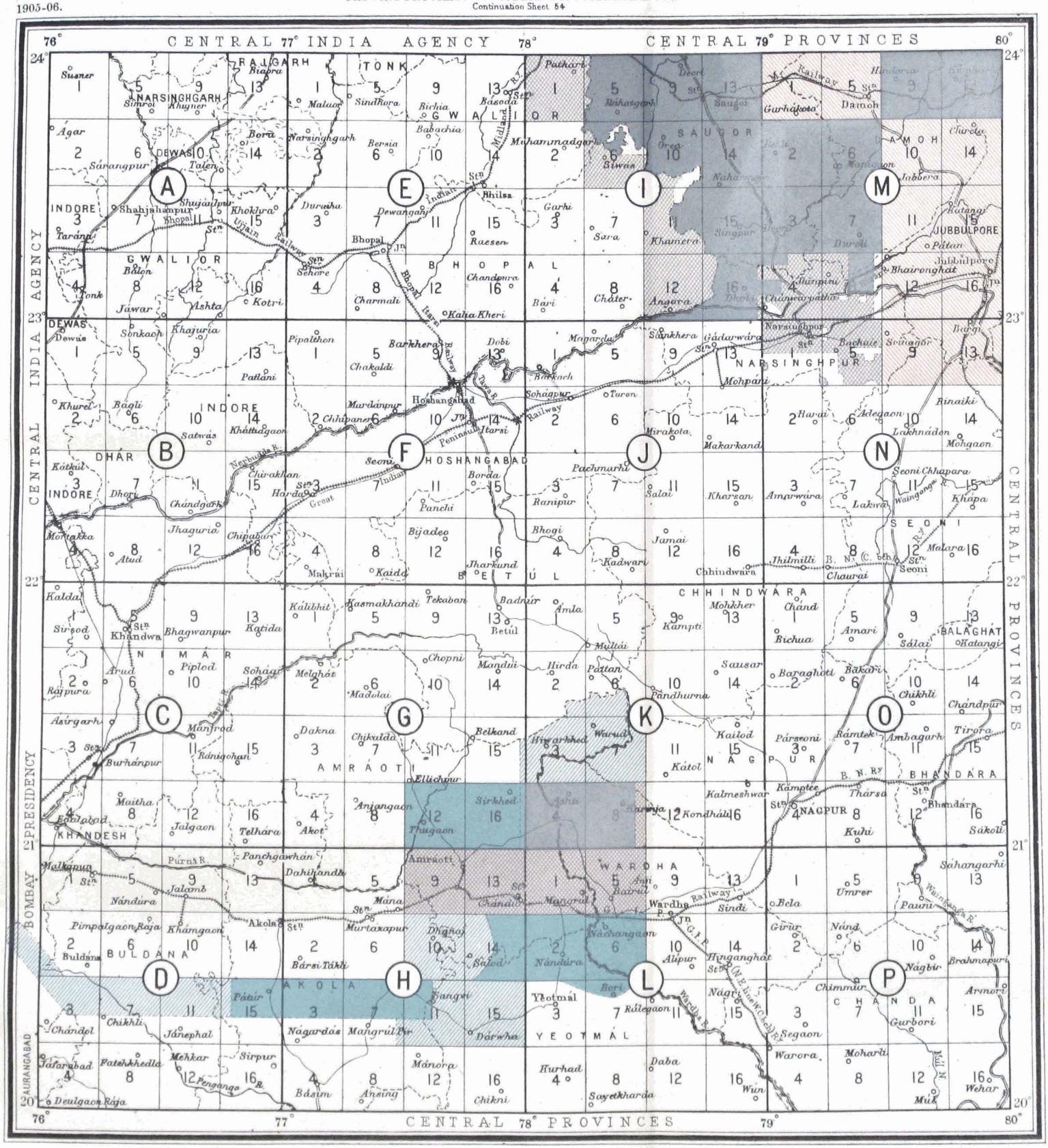
SHEET N° 55.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.

Continuation Sheet 54



Continuation Sheet 46

NOTE.

1. The number in the heading is that of the Sheet of the India and Adjacent Countries Series on the Scale of 1/1,000,000.
2. The letters denote the Degree Sheets on the Scale of 1 Inch = 1/2 Miles contained within the above, while the small figures denote the numbers of the 1 Inch Sheets contained in each Degree Sheet.
3. When ordering a sheet on the 1/1,000,000 Scale, only the number given in the heading should be used, *e.g.* N°93. In the case of a Degree Sheet, the number in the heading and the Degree Sheet letter must be given, *e.g.* 93A. For a 1 Inch Sheet, the number in the heading the Degree Sheet letter and the 1 Inch Sheet number must be quoted, *e.g.* 93 $\frac{2}{3}$.

Published under the direction of Colonel F.B. Longe, R.E., *Surveyor General of India.*

1907.

Scale 1 Inch = 28 Miles.

Miles 10 0 10 20 30 40 50 Miles

INDEX TO ADJOINING SHEETS.

45	54	63
46	55	64
47	56	65

REFERENCES

1. Degree Sheets published on the 1/2 Inch Scale
2. Sheets published in new style on the 1 Inch Scale
3. ——— old
4. Triangulated in advance
5. ——— during year under report
6. Surveyed
7. Previously surveyed but not published

Sheets under 3 only approximately conform to limits shown on Index.

No. 147, S. I.—May 07.—350

Reg. No. 241-S. 07.

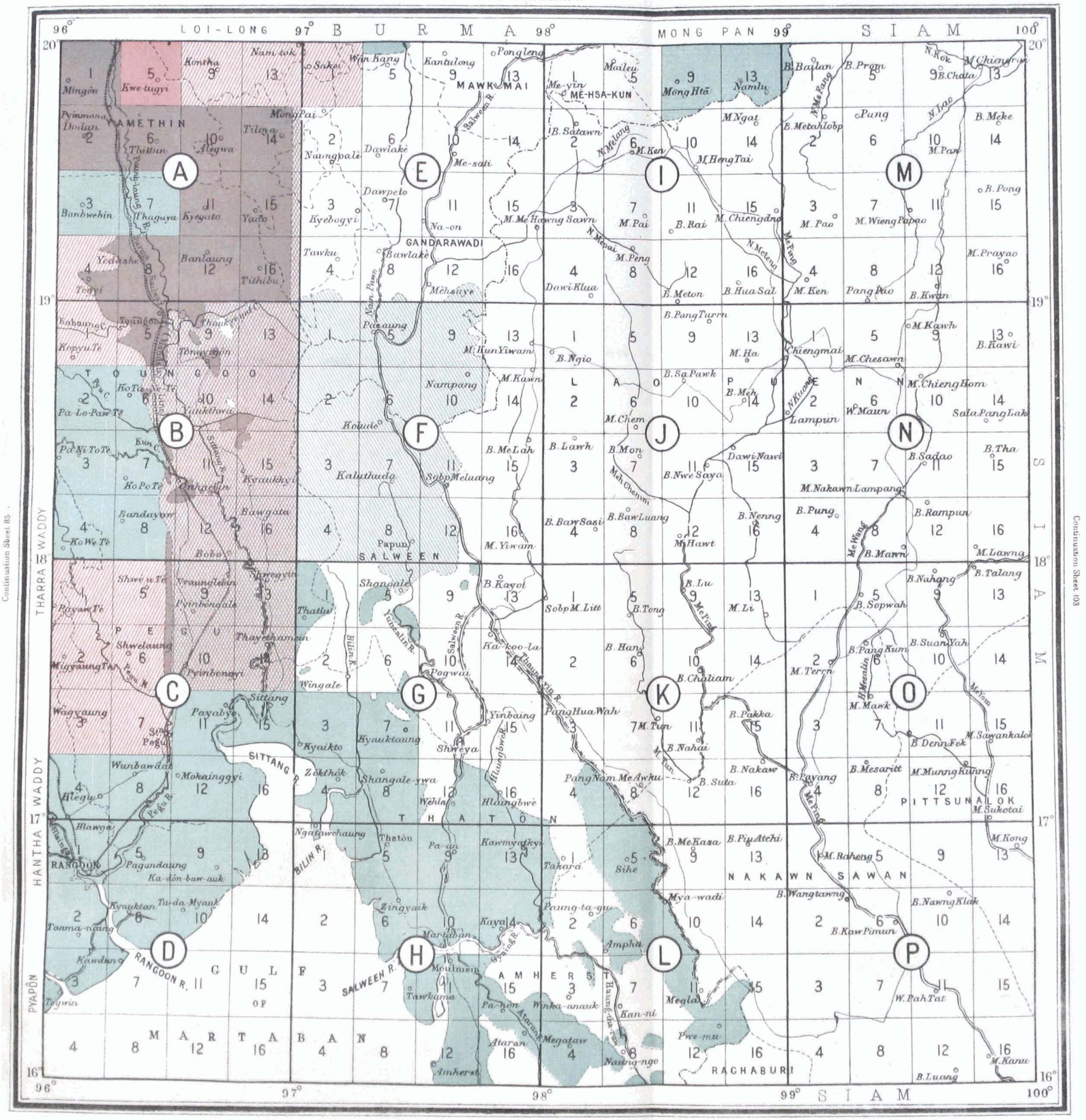
Photo. S. I. O., Calcutta.

SHEET N° 94.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.



NOTE.

1. The number in the heading is that of the Sheet of the India and Adjacent Countries Series on the Scale of 1/1,000,000
2. The letters denote the Degree Sheets on the Scale of 1 Inch = 4 Miles contained within the above while the small figures denote the numbers of the 1 Inch Sheets contained in each Degree Sheet.
3. When ordering a sheet on the 1/1,000,000 Scale only the number given in the heading should be used, *e.g.* N°93 In the case of a Degree Sheet, the number in the heading and the Degree Sheet letter must be given, *e.g.* 93A. For a 1 Inch Sheet, the number in the heading the Degree Sheet letter, and the 1 Inch Sheet number must be quoted, *e.g.* 93 $\frac{A}{8}$.

Published under the direction of Colonel F.B. Longe, R.E., *Surveyor General of India.*

1907

Scale 1 Inch = 28 Miles.

Miles 10 0 10 20 30 40 50 Miles

INDEX TO ADJOINING SHEETS.

84	93	102
85	94	103
86	95	104

REFERENCES.

1. Degree Sheets published on the 1/4 Inch Scale
2. Sheets published in new style on the 1 Inch Scale
3. ——— old
4. Triangulated in advance
5. ——— during year under report
6. Surveyed
7. Previously surveyed but not published

Sheets under 3 only approximately conform to limits shown on Index

No. 156, S. I.—June 07.—550

Reg. No. 304-S. 07.

Hello. S. I. O., Calcutta.

season was very short and half the officers were transferred to other parties in the middle of it. The party was inspected both during the field and recess seasons by the Deputy Surveyor General.

78. Next season the triangulation of sheets $55\frac{H}{4, 8, 12, 16}$ will be taken up and the detail survey of sheets $55\frac{H}{10, 11, 14, 15}$.

LOWER BURMA.

No. 3 PARTY.

79. This party was employed as in former seasons on a topographical survey on the scale of 1 inch to a mile, based on triangulation combined with a supplementary topographical survey of such areas as have been surveyed cadastrally and also, to a certain extent, of forest reserves that had been previously surveyed. The season's outturn and cost-rates are as follows :—

Personnel.

Mr. E. F. Litchfield, Deputy Superintendent, 1st grade, in charge.
Mr. W. M. Gorman, Extra Assistant Superintendent, 5th grade.
Mr. J. O'B. Donaghey, do. do. 6th „
Mr. E. Claudius, Sub-Assistant Superintendent, 1st grade.
Munshi M. Asmatullah Khan, do. 2nd „
Mr. H. D. W. Stotesbury, do. 3rd „
28 Surveyors, draftsmen, etc.

	Square miles.	R
Triangulation	3,731	7·5
New detail survey	1,594	21·6
Supplementary survey of cadastral area	2,096	14·1
do. do. of forest reserves	140	

The number of square miles to each point fixed by the triangulation is 10·2. The supplementary survey was done on tracing prints as explained in last year's report. The work done on the maps of the previously surveyed forests consisted merely of the addition of new roads and extra clinometer heights. Owing to the recent change in longitude a strip of country had to be surveyed for addition to the eastern margins of 3 of last season's sheets and of some of the sheets lying to the west of those surveyed this season, while in others the survey had to be carried still further as the previous surveys being Forest work had not been carried to the margins of the sheets.

80. The recess office, at Bangalore, closed on the 16th November 1905 and re-opened on the 16th May 1906 and field work was actually in progress for five months. The number of surveyors was 16, excluding 4 who were under training, and the average outturn *per* man *per* working day was 1·5 square mile of new survey and 2·5 of supplementary. The average number of plane-table fixings *per* square mile was 6·9 for new survey and 7·6 for supplementary. The vertical interval employed in the contouring this season was 100 feet except in sheets $94\frac{A}{1, 2}$ where it is 50 feet. The number of clinometer heights fixed was 3,078, which together with the heights provided by triangulation and bench-marks gives an average of 1 height to every 1·2 square miles. The new detail survey this year was confined entirely to the western slopes of the Paunglaung range of hills of which the highest point, 8,607 feet above mean sea level, falls into this season's work. The higher hills were bold and steep, with fairly open tops but the valleys and lower spurs were thickly wooded.

81. The cost-rate for new detail survey is slightly below the average of the past three seasons and that of the supplementary survey is R4 less than last season's, but it includes work done in the forest areas which was, as explained above, of a very simple nature.

82. The fair mapping of the season's work was not completed but the whole of the mapping that remained unfinished at the close of last season was completed and despatched to Calcutta for publication. The work is being carried on in the drawing office at Bangalore and it is hoped that the maps will all be completed by the time the party returns to recess quarters, they are being drawn on the $1\frac{1}{2}$-inch scale, the details having been enlarged by pantagraph from the field maps. Two triangulation charts were despatched to Calcutta for publication. The Deputy Surveyor General inspected the party during the recess.

83. The programme for next season consists of the triangulation of sheets $94\frac{C}{11, 12, 15, 16}$ and $94\frac{G}{1, 2, 3, 4, 5, 6, 7, 8}$ and the detail survey on the 1-inch scale of degree sheet 94 F, an area of about 3,000 square miles.

UPPER BURMA.

No. 10 PARTY.

Personnel.

Captain A. A. McHarg, Offg. Deputy Superintendent, 2nd grade, in charge.
Mr. R. Waller-Senior, Extra Assistant Superintendent, 3rd grade.
Mr. P. J. Barrington, Extra Assistant Superintendent, 4th grade.
Mr. W. G. Jarbo, Extra Assistant Superintendent, 6th grade.
Mr. C. West, Sub-Assistant Superintendent, 1st grade.
Mr. E. M. Kenny, Sub-Assistant Superintendent, 2nd grade.
Munshi Abdul Rahim, K.S., Sub-Assistant Superintendent, 2nd grade.
16 Surveyors, etc.

84. The party continued work in Upper Burma on the scale of 1 inch to the mile in continuation of that of former seasons. Field work was in progress from about the beginning of December 1905 to the end of May 1906, the programme was completed and the outturn and cost-rates for the season are as follows:—

	Sq. miles.	Cost *per* sq. mile.
Triangulation	2,815	₹ 9·3
Detail survey, new	2,323	₹ 22·4
„ „ supplementary	1,016	₹ 20·2

85. The triangulation occupied two Provincial officers and one surveyor for nearly 5 months. The greater part of the area triangulated was heavily wooded and about half of it was devoid of prominent points and extremely difficult to triangulate; in two sheets triangulation was impossible and these were thoroughly traversed to furnish both fixed points and heights. The number of stations observed at in the triangulation was 94, the number of stations fixed was 74, intersected points 420, and the average number of square miles to each point and height was 5·6. The traversing occupied one Provincial officer for nearly two months and two surveyors for the whole field season; the outturn was 410 linear miles and 2,055 stations were observed at.

86. The average number of surveyors employed on the detail survey was 15 and the average outturn *per* man for the season was 223 square miles, and *per* working day 1·64 square miles of new survey or 1·27 of supplementary survey. The daily outturn of supplementary survey is less than that of the new survey because several surveyors under training were employed on it. The average number of plane-table fixings and heights *per* square mile was 5·7 and 2·7. The Arakan Yoma range of hills occupied the greater part of the area of which new survey was done, it proved to be a very unhealthy tract and several members of the party suffered severely in consequence. The hills ran to a height of 6,550 feet above sea level. Above 3,000 feet they were covered with dense tree forest and below that level with bamboo jungle and in all parts they were sparsely inhabited, the western slopes entirely so. The cultivated area which came under supplementary survey was open and easy but absolutely devoid of water during the dry season except in the immediate vicinity of the Irrawaddy river.

87. All the computations of the triangulation and traversing which were reported to be in arrears last season have now been completed and only 2 charts are now in arrear. The fair mapping of the season's work was also completed as well as the arrears of the previous season. The Deputy Surveyor General inspected the party during the recess.

88. Next season the triangulation of degree sheet 84 M. will be completed and the southern half will be surveyed on the 1-inch scale as well as the 2 standard sheets remaining unsurveyed in degree sheet 84 N., in all about 2,500 square miles.

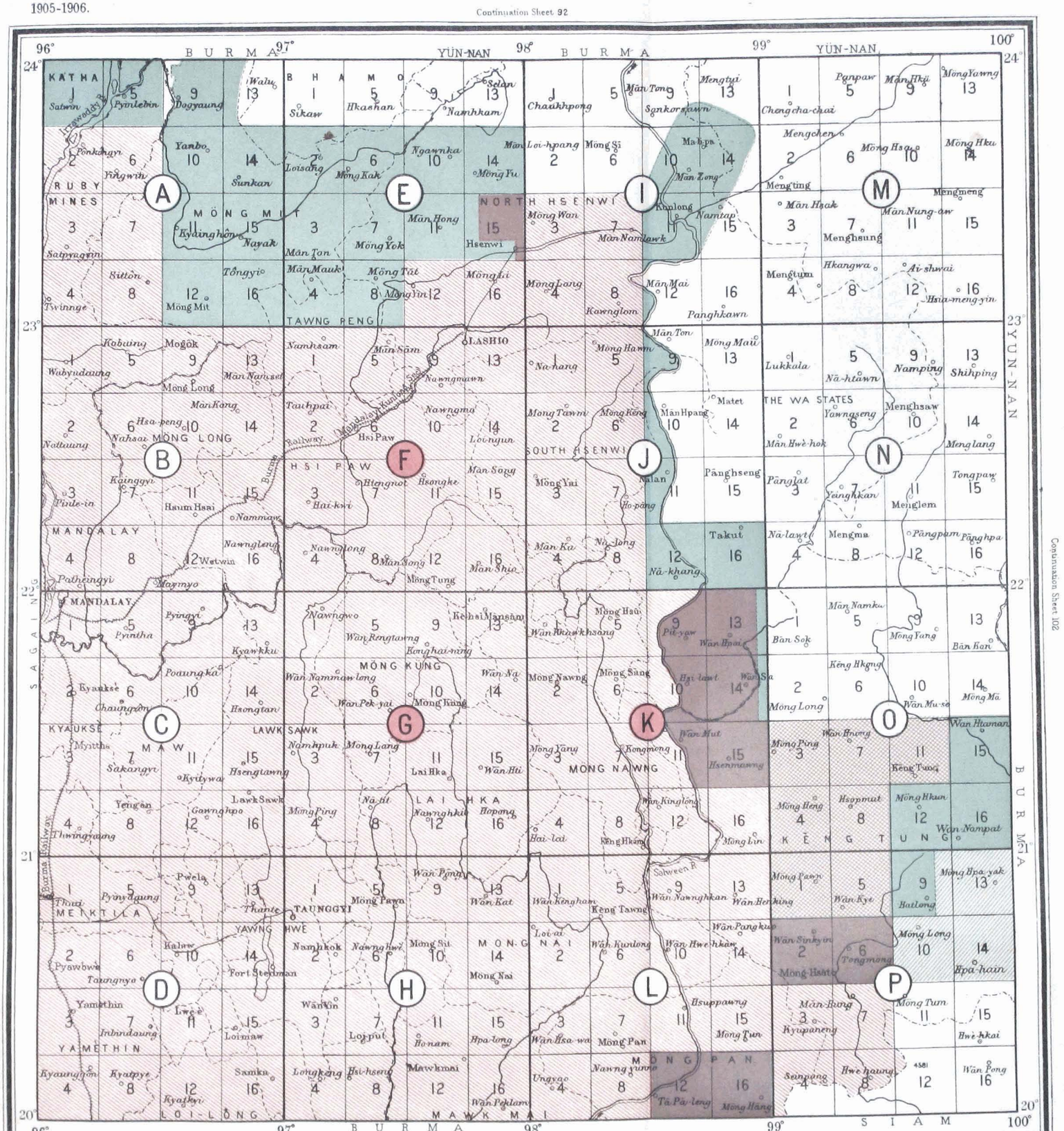
SHEET N° 93.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-1906.

Continuation Sheet 92



NOTE.

1. The number in the heading is that of the Sheet of the India and Adjacent Countries Series on the Scale of 1/1,000,000.
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Published under the direction of Colonel F.B. Longe, R.E., *Surveyor General of India.*

1907.

Scale 1 Inch = 28 Miles.

Miles 10 0 10 20 30 40 50 Miles

INDEX TO ADJOINING SHEETS.

83	92	101
84	93	102
85	94	103

REFERENCES.

1. Degree Sheets published on the 1 Inch Scale
2. Sheets published in new style on the 1 Inch Scale
3. " " old " "
4. Triangulated in advance
5. " during year under report
6. Surveyed " "
7. Previously surveyed but not published

Sheets under 3 only approximately conform to limits shown on Index

Hello S. I. O., Calcutta

Reg. No. 345-S. 07.

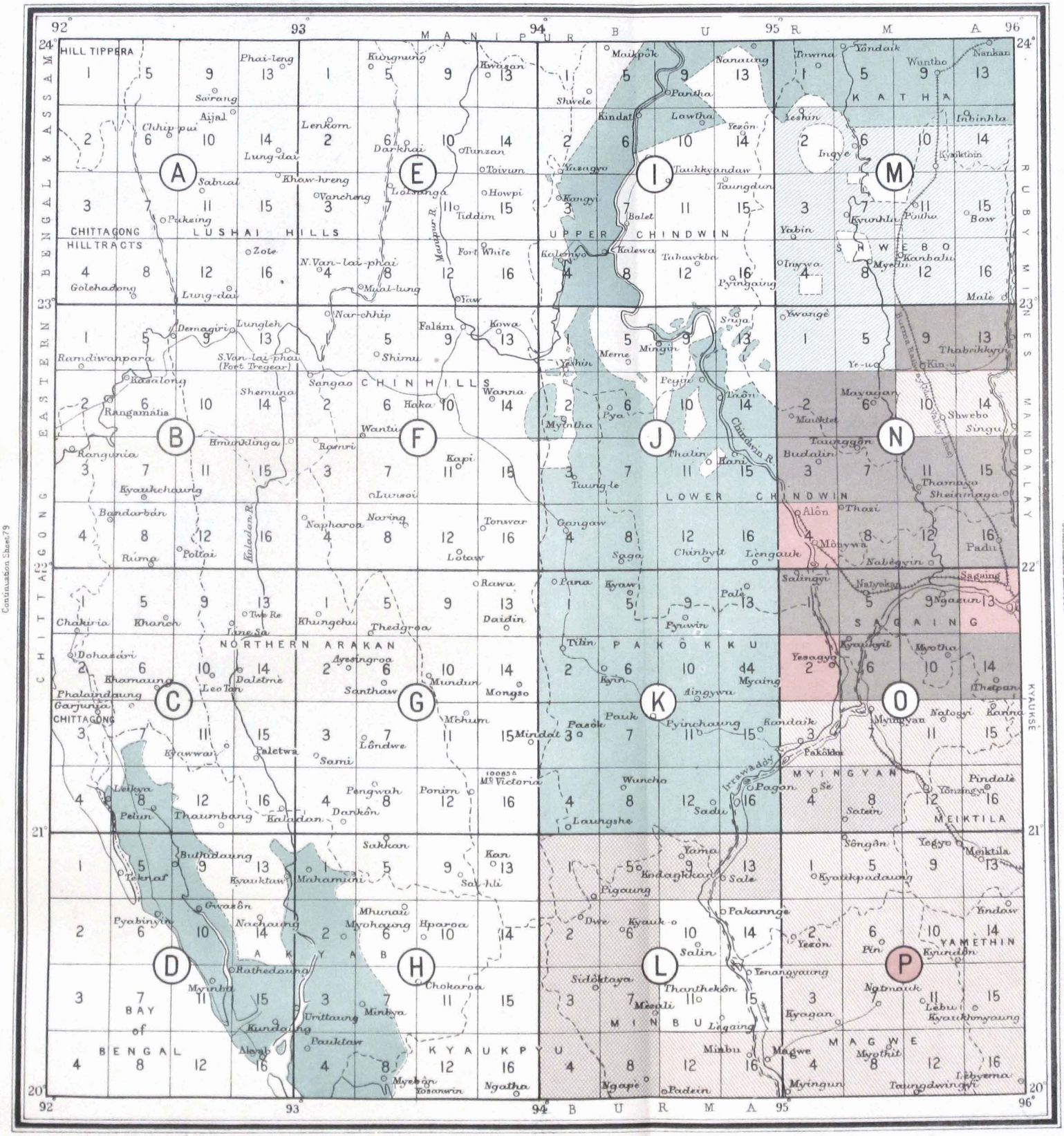
SHEET N° 84.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.

Continuation Sheet 83



NOTE.

1. The number is the reading is that of the Sheet of the India and Adjacent Countries Series on the Scale of 1/1000000.
2. The letters denote the Degree Sheets on the Scale of 1 Inch = 4 Miles contained within the above while the small figures denote the numbers of the 1 Inch Sheets contained in each Degree Sheet.
3. When ordering a sheet on the 1/1000000 Scale only the number given in the heading should be used, *e.g.* N°93 In the case of a Degree Sheet, the number in the heading and the Degree Sheet letter, must be given, *e.g.* 93A For a 1 Inch Sheet, the number in the heading, the Degree Sheet letter, and the 1 Inch Sheet number must be quoted, *e.g.* 93 $\frac{A}{3}$.

Published under the direction of Colonel F.B. Longe, R.E., *Surveyor-General of India.*

Scale 1 Inch = 28 Miles.

Miles 10 0 10 20 30 40 50 Miles

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REFERENCES.

1. Degree Sheets published on the 1 Inch Scale
2. Sheets published in new style on the 1 Inch Scale
3. " " " " old
4. Triangulated in advance
5. " during year under report
6. Surveyed
7. Previously surveyed but not published

Sheets under 3 only approximately conform to limits shown on Index

No. 139, S. I.—June 07.—650.

Reg. No. 319-S. 07.

Helio. S. I. O., Calcutta

SHAN STATES, BURMA.

No. 11 PARTY.

89. This party, much reduced in strength, returned to the Shan States this season to resume the 1-inch survey and instead of returning to Bangalore for recess as hitherto, it remained at Taunggyi, the capital of the Southern Shan States, where it will recess for a few years while the work lies in the extreme east of the States, in order to reduce the immense amount of time lost in returning to India every year. Even from Taunggyi the journey to and from the field occupied from 3 to 4 weeks each way. The party left Bangalore on the 25th October and field work commenced about the middle of December and closed about the 3rd week of April when the programme of detail survey was completed. That of the triangulation was not completed as Mr. Morton, who was carrying it out, fell ill in December and was laid up for a whole month. A sufficient area had however been triangulated in advance in previous seasons to provide a full programme of detail survey for next season.

Personnel.

Lieutenant R. H. Phillimore, R.E., Officiating Assistant Superintendent, 1st grade, in charge.
Babu Pramadaranjan Roy, Sub-Assistant Superintendendent, 1st grade.
Mr. S. S. M. Fielding, Sub-Assistant Superintendent, 1st grade, from 14th May 1906.
Mr. V. W. Morton, Sub-Assistant Superintendent, 1st grade.
14 Surveyors, etc., and 4 Soldier Surveyors under instruction.

90. The season's outturn was 737 square miles of triangulation and 2,078 square miles of detail survey. The number of square miles to each point fixed by the triangulation was 7·6, the average number of plane tablers was 12 and their average outturn 1·42 square miles *per* working day and 161 square miles for the season, which is quite up to the average of former seasons. The average number of plane-table fixings *per* square mile was 6·5. A vertical interval of 100 feet was employed for the contouring except in one sheet which contained the valley in which the large town of Kengtung is situated, the only large open valley met with ; this valley contains several hundreds of villages and the hills surrounding it are bare and open, having been denuded of forest by the inhabitants. The country surveyed lay entirely within the State of Kengtung, the largest of the Southern Shan States, and included the main watershed of the Salween and Me-hkong rivers, which rises here to a height of 7,600 feet above sea level, the general elevation of the larger valleys being about 1,400 feet ; to the east of the Salween the entire country is mountainous and exceedingly intricate ; the rolling downs so characteristic of the western states are not met with here and one steep mountain range succeeds another, divided by narrow valleys. The general direction of the valleys is north and south, some of the rivers flowing to the north and some to the south with their basins dovetailed together in a most intricate manner. The lower slopes of the valleys are of confused contour and are thickly wooded, as are the summits and western slopes of the main range. Communications are good, the country being well provided with roads, mule-tracks, and foot-paths, and fairly well populated. Two tribes, the Kaws and Muhsös, unlike the Shans, were of great assistance to the survey and willingly furnished labour for transport and clearing purposes, and next season it is intended to engage two men of these tribes for each surveyor's squad and thus reduce the number of *khalásis* imported from India.

91. The health of the party was generally good with the one exception mentioned above, though Babu Roy and most of the surveyors suffered from malaria at times. Morning mists interfered much with the work, during December and January. These mists hang over all the rivers till 10 or 11 o'clock every day, they do not rise above an elevation of about 3,500 feet, but unless the surveyor has work to take him above that level he has to sit idle for 2 or 3 hours every morning.

92. The cost-rates are much the same as those of former seasons ; that of the triangulation is somewhat higher owing to Mr. Morton's illness and to the fact that the expenditure includes the cost of a small escort given to the triangulators who were working along the Siam frontier. The rates do not include expenditure in connection with the instruction of surveyors.

93. The computations of the triangulation and the fair mapping of the whole area surveyed were completed, and the maps together with 2 triangulation

charts were forwarded to head-quarters for publication. The Deputy Surveyor General inspected the party during the recess.

94. Next season the detail survey will be done on the scale of $1\frac{1}{8}$ inch=1 mile, as an experiment, to ascertain whether the slight increase in scale will enable a vertical interval of 50 feet to be employed for the contouring of the hills, without unduly enhancing the cost of the work. The sheets to be surveyed are 93 $\frac{O}{12, 15, 16,}$ and 93 $\frac{P}{9, 10, 13}$, 1,664 square miles, and sheets 93 $\frac{P}{11, 15,}$ 102 $\frac{C}{4, 8, 12}$, 102 $\frac{D}{1, 2, 3, 5, 6, 9}$ will be triangulated up to the boundary line, the area being 1,781 square miles.

NORTH-WEST FRONTIER PROVINCE.

No. 12 PARTY.

95. The administrative control of the party was transferred from the Superintendent, Trigonometrical Surveys, to the Surveyor General of India, on 1st October 1905, and again to the Superintendent, Northern Circle (Frontier Surveys), on 6th August 1906.

Captain E. T. Rich, R.E., remained in charge of the party throughout the year, with the exception of a few days in October 1905, during which Mr. C. F. Erskine held temporary charge.

Personnel.

Captain E. T. Rich, R.E., Offg. Deputy Superintendent, 2nd grade, in charge from 9th October 1905.
Lieutenant M. N. MacLeod, R.E., Assistant Superintendent, 2nd grade, from 19th April 1906.
Mr. R. F. Warwick, Extra Assistant Superintendent, 3rd grade, in charge till 8th October 1905.
Munshi Rahmatullah, Extra Assistant Superintendent, 5th grade.
Babu Dhani Ram, Extra Assistant Superintendent, 6th grade.
Mr. H. C. W. Stotesbury, Sub-Assistant Superintendent, 1st grade, from 14th October 1905.
13 Surveyors, etc.

96. The field season extended from 22nd October 1905 to 13th June 1906, during this time the following programme of work was completed:—

(*a*) A network of triangulation covering 700 square miles.
(*b*) Rigorous detail survey on the scale of 2 inches=1 mile of 470 square miles of the area triangulated.
(*c*) Reconnaissance survey on the scale of 2 inches=1 mile of 143 square miles.
(*d*) Reconnaissance survey of 140 square miles on the 1 inch=1 mile scale.

97. The country surveyed was of a very varied nature and included portions of the flat and highly cultivated plains of Peshâwar, and its adjoining rugged hills; these hills, rising to nearly 7,000 feet in height, are similar to those generally met with on the North-West Frontier and consist of bold rocky spurs sparsely covered with scrub jungle and broken up by innumerable stoney nalas and dry ravines, knife-edged ridges rising to sharp peaks are common, and on these in February, the snow line is as low as the 5,000 feet level; the annual rain-fall in the hills is small and the water-supply, obtained chiefly from wells, only suffices for the maintenance of a scanty population and a very limited area of cultivation.

98. The cost-rates of the season's work are as follows:—

	Cost per square mile. R a. p.
Triangulation	14 11 0
2″ Rigorous survey	105 15 0
2″ Reconnaissance	24 8 0
1″ Reconnaissance	10 0 0
Fair mapping	31 11 0

99. The high rate for rigorous survey is due chiefly to the strength and number of guards attached to the surveyors, and also to the large number of Imperial and Provincial officers in the party in proportion to the strength of surveyors; to the latter cause is also attributable the high rate for fair mapping.

100. During the recess the fair drawing on the $1\frac{1}{2}$-inch scale of the current season's survey has been almost completed, the computation of the triangulation has been finished, and a triangulation chart has been drawn. During the field

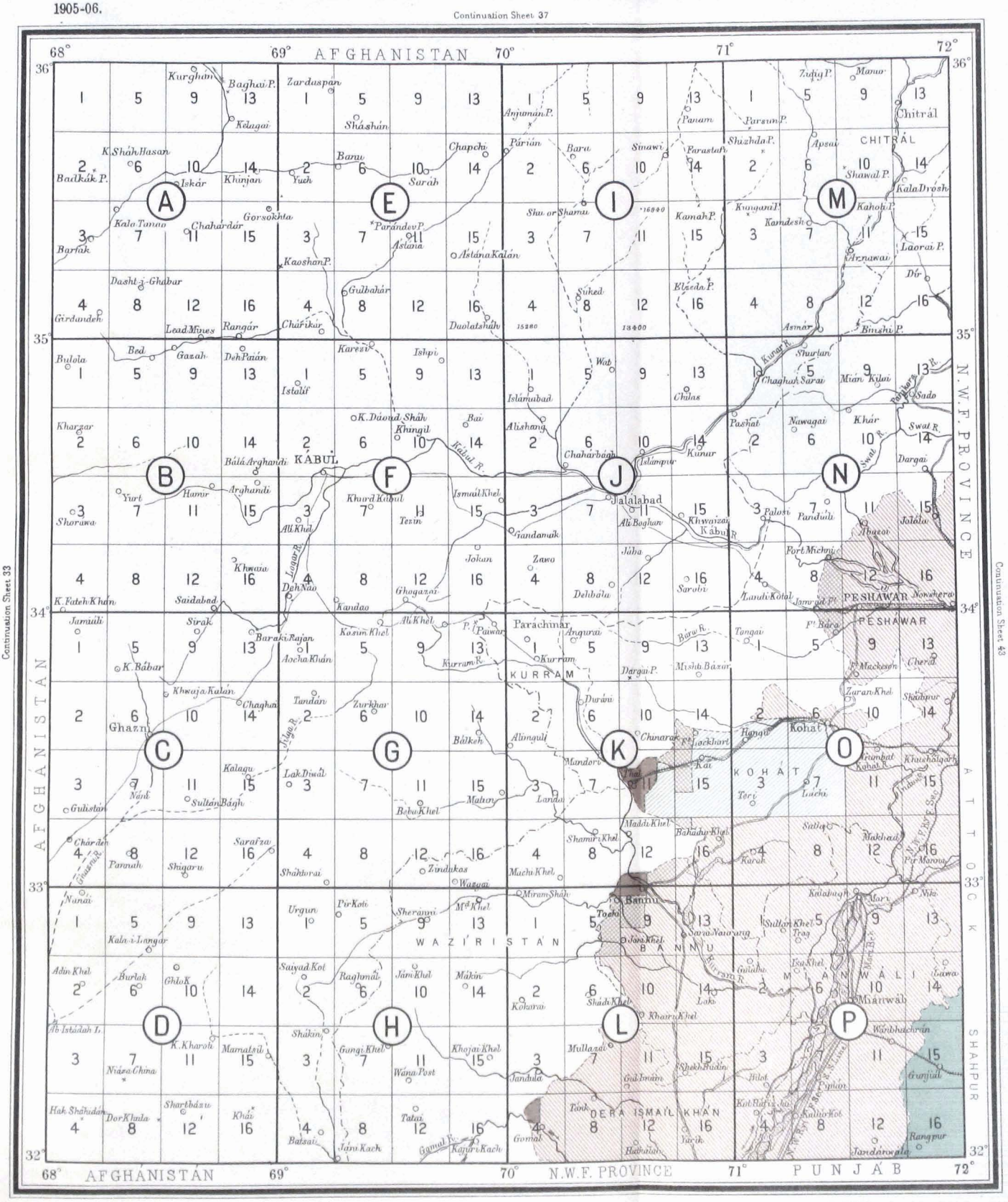
SHEET N° 38.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.

Continuation Sheet 37



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Published under the direction of Colonel F.B. Longe, R.E., *Surveyor General of India.*

1907.

Scale 1 Inch = 28 Miles.

Miles 10 0 10 20 30 40 50 Miles

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REFERENCES.

1. Degree Sheets published on the 1 Inch Scale
2. Sheets published in new style on the 1 Inch Scale
3. " " old
4. Triangulated in advance
5. During year under report
6. Surveyed
7. Previously surveyed but not published

Sheets under 3 only approximately conform to limits shows on Index.

No. 418. S. I.—June 07.—550.

Reg. No. 327-S. 07.

Helio. S. I. O., Calcutta.

season the draftsman of the party completed all the fair mapping of the work of previous seasons in Sind.

101. The programme of survey for the season 1906-07 consists of an extension of the triangulation and 2-inch survey.

102. The party was inspected by the Surveyor General and by the Superintendent, Frontier Surveys, at Mussooree during the recess.

NORTH-WEST FRONTIER PROVINCE.

No. 14 Party.

103. The party remained under the administrative control of the Surveyor General until 6th August 1906 when it passed into that of the Superintendent, Northern Circle (Frontier Surveys).

Personnel.

Captain H. L. Crosthwait, R.E., Officiating Deputy Superintendent, 1st grade, in charge from 1st October 1905 to 9th September 1906.
Lieutenant E. C. Baker, R.E., Assistant Superintendent, 2nd grade, in charge from 10th to 30th September 1906.
Mr. G. P. Tate, Extra Assistant Superintendent, 3rd grade.
Mr. C. George, Extra Assistant Superintendent, 3rd grade, from 1st to 31st October 1905.
Mr. J. O. Griff, Extra Assistant Superintendent, 5th grade.
Mr. H. H. B. Hanby, Extra Assistant Superintendent, 5th grade, from 3rd October 1905.
Mr. J. H. S. Wilson. Extra Assistant Superintendent, 6th grade.
Mr. E. S. Biggie, Extra Assistant Superintendent. 6th grade.
Mr. H. B. Simsons, Sub-Assistant Superintendent, 1st grade.
Mr. A. B. Hunter, Sub-Assistant Superintendent, 2nd grade.
Surveyors, etc., 22.

104. Captain H. L. Crosthwait, R.E., held executive charge of the party throughout the year, with the exception of September 1906, when he proceeded on leave, and Lieutenant E. C. Baker, R.E., held charge.

105. The field season commenced on 25th September 1905 and closed on 20th May 1906, during this period the following programme of work was completed:—

(*a*) Triangulation and computation of 1,210 square miles for the current season's survey.
(*b*) Triangulation of about 1,000 square miles in Kohat district for next year's surveys.
(*c*) Detail survey on the scale of 2 inches = 1 mile of 737 square miles.

106. The country surveyed was very hilly and broken, and varied in altitude from 3,500 to 13,000 feet, at the higher levels work was much interfered with by the weather.

107. The cost rate for triangulation was—

	Per square mile.
(*a*) triangulation and computation for current work . .	25 0 0
(*b*) triangulation for next year's work . . .	10 8 0

108. The detail survey has cost about R110 per square mile, this large rate is due to the heavy charges for militia, local guards, transport, local and other allowances to surveyors, etc., amounting to R54 out of the total of R110 per square mile of survey.

109. During the recess the fair drawing of the 8 standard sheets showing all the area surveyed has been practically finished, 6 of these will be submitted to press in the course of the next few months, but the other two cannot be published until next season's surveys have been added to them. All the computations have been completed. A small detachment of draftsmen was employed at Dehra Dun throughout the field season in completing the mapping of the Cawnpore sheets, which had fallen into arrears on account of the special work which the party was called on to perform in connection with the Delhi manœuvre map.

110. The programme for next season's survey is an extension of the recent work of this party eastwards in the Kohat district, and it will extend on the north as far as the administrative border of Kohat and will be bounded on the south by the 33rd parallel, it will therefore include the larger part of Kohat district.

111. The party was inspected by the Surveyor General at Mussooree in August.

NORTH-WEST FRONTIER PROVINCE.

No. 15 Party.

112. The programme of the party for the season consisted in the execution of topographical surveys on the scale of 2 inches to the mile for publication on the scale of 1 inch = 1 mile.

Personnel.

Major C. L. Robertson, C.M.G., R.E., Deputy Superintendent, 1st grade, in charge.
Lieutenant H. S. May, R.E., Assistant Superintendent, 1st grade.
„ O. H. B. Trenchard, R.E., Assistant Superintendent, 2nd grade, from 16th January 1906.
Mr. J. A. Freeman, Extra Assistant Superintendent, 5th grade.
Mr. D. Hunter, Extra Assistant Superintendent, 6th grade.
Mr. H. C. H. Cooper, Extra Assistant Superintendent, 6th grade.
Subadar Kanak Singh, Sub-Assistant Superintendent, 2nd grade.
Mr. E. B. West, Sub-Assistant Superintendent, 2nd grade.
Mr. P. D. Simpson, Sub-Assistant Superintendent, 2nd grade.
Mr. E. C. O'Sullivan, Sub-Assistant Superintendent, 2nd grade.
Mr. T. P. Dewar, Sub-Assistant Superintendent, 2nd grade.
Mr. D. K. Rennick, Sub-Assistant Superintendent, 2nd grade.
Mr. A. G. Harrington, Sub-Assistant Superintendent, 3rd grade.
Mr. E. A. Wainwright, retired Provincial Officer.
Mr. J. McHatton, retired Provincial Officer.
Surveyors, etc., 79.

113. Surveys of the Murree, Nowshera, Campbellpore, Bannu, Kohat, Abbottabad, Delhi, Muttra, Roorkee, Dalhousie, and Bukloh cantonments were carried out by a detachment of the party working under Mr. J. McHatton up to the end of December 1905. From 1st January 1906 this work and the men who were employed on it were transferred from the party and the report on these operations will be found under the heading cantonment surveys.

114. Surveyor Lal Singh, R.S., accompanied Colonel Bruce on his journey through Eastern Turkestan and China.

115. The members of the party employed in the North-West Frontier Province assembled at Dera Ismail Khan about the end of September 1905, and after some delay reached their ground by the end of October. The party continued in the field till 12th July 1906.

116. The health of the party was good until towards the close of the field season, when the strain of carrying on work in the field during the hot weather months told severely on the health of all, and fever was very prevalent.

117. On the party's taking the field, the supervision of the arrears of mapping was entrusted to Mr. E. A. Wainwright, who, on retiring from the service at the end of 1903, had been re-employed in connection with this work, and the officer in charge of the party was thus relieved of the immediate control of this work during the field season. The draftsmen of the party were also placed under Mr. Wainright as a detachment of the party, and much of the arrears of mapping was worked off by the end of September.

118. The late return of the party to recess quarters, the difficulty of obtaining a speedy supply of reductions of the field sections during the rains, and changes in the style of mapping all contributed to delay the preparation of the fair sheets, and the mapping is consequently still in arrears.

119. The outturn of survey and mapping, and the cost-rates are given below:—

	Area in square miles.	Cost rate per square miles.		
		₹	a.	p.
Triangulation secondary series . . .	800	at 29	15	6
Triangulation for 2-inch survey . . .	1,350	„ 38	9	9
Detail survey on 2-inch scale . . .	1,741·34	„ 85	13	6
Mapping 2-inch surveys	2,495·57	„ 4	13	2

120. The fair mapping of the arrears completed was carried out in accordance with the orders obtaining at the time of its commencement, for publication to the scale of survey in 2 colours only.

121. The programme for the field season 1906-07 has been twice changed since the 1st August 1906. The final programme contemplates the execution of some 800 square miles of topographical survey on the scale of 2 inches = 1 mile, and as much triangulation in advance as time will permit. There is no triangulation suitable for 2″ topography ready in this area, and the triangulators will not be able to reach their ground and commence work before the middle of November 1906 and the commencement of topographical operations must therefore be postponed till the latter part of the following month.

SHEET N° 39.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.

Continuation Sheet 38

Continuation Sheet 34

Continuation Sheet 44

NOTE.

1. The number in the heading is that of the Sheet of the India and Adjacent Countries Series on the Scale of 1/1,000,000.
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Published under the direction of Colonel F.B. Longe, R.E., *Surveyor General of India.*

Scale 1 Inch = 20 Miles.

Miles 10 0 10 20 30 40 50 Miles

INDEX TO ADJOINING SHEETS.

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REFERENCES

1. Degree Sheets published on the 1 Inch Scale
2. Sheets published in new style on the 1 Inch Scale
3. " " old
4. Triangulated in advance
5. " during year under report
6. Surveyed
7. Previously surveyed but not published

Sheets under 3 only approximately conform to limits shown on Index

No. 474, S. I.—July 07—650.

Reg. No. 326-S. 07.

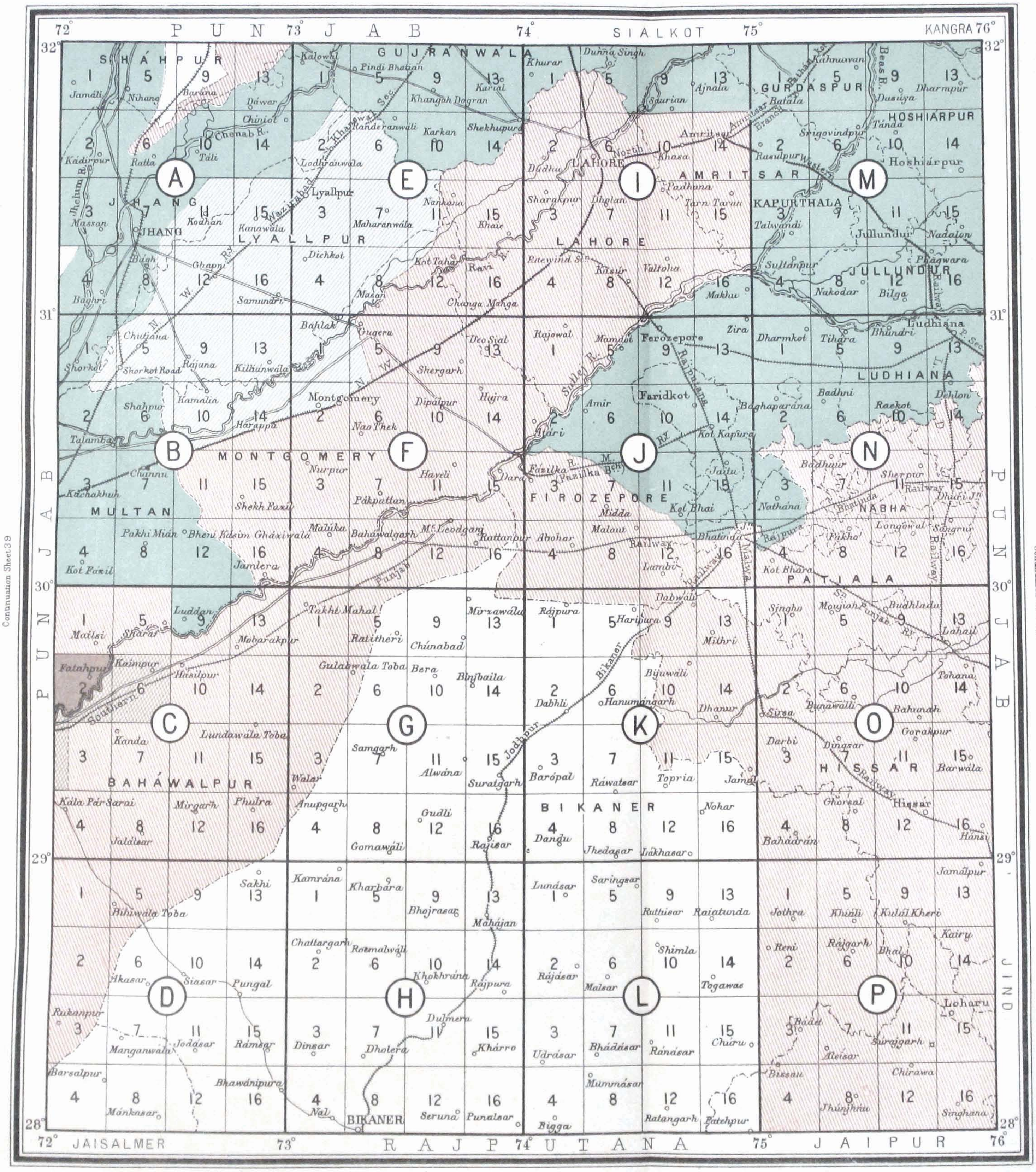
Helio. S. I. O., Calcutta

SHEET Nº 44.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.



NOTE.

1. The number in the heading is that of the Sheet of the India and Adjacent Countries Series on the Scale of $\frac{1}{1000000}$
2. The letters denote the Degree Sheets on the Scale of 1 Inch = 4 Miles contained within the above while the small figures denote the numbers of the 1 Inch Sheets contained in each Degree Sheet
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Published under the direction of Colonel F.B. Longe, R.E., Surveyor General of India.

1907.

Scale 1 Inch = 28 Miles

Miles 10 0 10 20 30 40 50 Miles

INDEX TO ADJOINING SHEETS.

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40	45	54

REFERENCES.

1. Degree Sheets published on the $\frac{1}{4}$ Inch Scale
2. Sheets published in new style on the 1 Inch Scale
3. " " " old " "
4. Triangulated in advance
5. " during year under report
6. Surveyed
7. Previously surveyed but not published

Sheets under 3 only approximately conform to limits shown on Index.

No 406, S. I.—July 07.—550

Reg. No. 324-S. 07.

Helio S I O Calcutta

122. The personnel of the party has undergone great changes in all grades during the season. One Imperial branch officer, all the senior Provincial officers, and more than one-third of the native surveyors have been transferred from it to other parties. The result, so far as size is concerned, is a unit more suited than formerly to the work in hand, but the lack of experienced Provincial assistants is found a disadvantage. These transfers were necessitated by the concentration of a large number of parties on or near the frontier, the members of which were in many cases unsuited for the work that they would have been called upon to perform.

123. The party was inspected by the Surveyor General in August 1906 in Mussooree.

PUNJAB.

No. 18 Party.

124. The party remained under the administrative control of the Surveyor General until August 28th when it passed into that of the Superintendent, Northern Circle (Frontier Surveys).

Personnel.

Captain M. O'C. Tandy, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Lieutenant F. F. Hunter, I.A., Assistant Superintendent, 2nd grade, till 26th April 1906.
Mr. W. Robert, Extra Deputy Superintendent, 1st grade, till 26th February 1906, and subsequently specially re-employed.
Mr. G. A. Knight, Extra Assistant Superintendent, 1st grade.
Mr. J. Marten, Extra Assistant Superintendent, 2nd grade, from 16th June 1906.
Mr. G. J. S. Rae, Extra Assistant Superintendent, 5th grade.
Mr. C. E C. French, Extra Assistant Superintendent, 6th grade.
Mr. J. R. Newland, Sub-Assistant Superintendent. 1st grade
Babu Maya Das Puri, Sub-Assistant Superintendent, 1st grade.
Mr. L. Williams, Sub-Assistant Superintendent, 2nd grade, till 15th November 1905.
Mr. F. C. Pilcher, Sub-Assistant Superintendent, 2nd grade, till 15th November 1905.
Mr. A. G. Harrington, Sub-Assistant Superintendent, 2nd grade, till 15th November 1905.
Mr. F. H. Grant, Sub-Assistant Superintendent, 2nd grade, till 15th November 1905.
Mr. C. E. Tapsell, specially re-employed till 28th February 1906.
Surveyors, etc , 95.

125. The recess office closed in Simla on 1st November 1905, and opened again on 12th June 1906.

126. Although the field season was extended to rather over 7 months it was found impossible to complete the full programme of supplementary survey and two standard sheets (about 525 square miles) had to be omitted, with this exception no change was made from the sanctioned programme.

The year's work was of a very varied character and extended into 16 districts of the Punjab and North-West Frontier Province and Jammu and Bahâwalpur States, it will be described under 9 headings.

127. *Supplementary Topographical Survey on the 2-inch scale.*—The necessity for completing to margin 6 standard sheets which had been partly surveyed in previous years and the consequent scattering of the surveyors over a large area in Multân, Muzaffargarh, Dera Ghâzi Khan districts and Bahâwalpur State made the supervision of this work rather difficult for the small staff available.

The nature of the work was similar to that of previous years, the only difference being that the compilations from the settlement maps were checked in the field much more thoroughly than they had been in the past, this decreased the rate of outturn and is responsible for the increased cost of ₹15-8 per square mile as compared with ₹11-2 for last year, the total outturn of this class of work for the year was 2,343 square miles. As in previous years wherever riverain plane tabling on the 4-inch scale had been recently carried out the area thus surveyed has not been revised but will be used in the preparation of the fair maps.

The total area of supplementary, revision, or re-survey carried out during the year was 3,047 square miles giving an average cost-rate of ₹13'3, adding to this the cost of compilation, traversing and fair drawing, the cost of the current year's finished maps will be ₹23'3 per square mile as compared with ₹20'1, ₹19'7 and ₹21'6 the figures for the past three years. Considering the more detailed check to which the compilation has been subjected and the extra detail shown on the fair maps this increase is not extravagant.

At the commencement of the field season only 16 surveyors were available for field work as a section including 4 surveyors was detained in Simla in order to complete the fair drawing of certain maps, to this must be largely attributed the abandonment of two standard sheets from the programme.

128. *Revision Survey.*—Three hundred and thirty square miles of the Muzaffargarh "Thal" were revised on blue prints of the existing maps on the scale of 2 inches to 1 mile; this "Thal" consists of a sea of irregular sandhills of from 10 to 50 feet in height with few and very scattered habitations; the ground being too uneven to permit of accurate chaining, and the traversed trijunctions being very far apart, this survey was based on a compass traverse and the distances were measured with the subtense bar; one surveyor was employed on the work from January to June, his monthly outturn was 55·8 square miles and the cost R5·8 per square mile. Copies of the published 4-inch and 6-inch maps of Dera Gházi Khan and Bahá-walpur towns were brought up to date during the year, as they fell within the area of survey, and the course pursued was thought preferable to making a new 2-inch survey or to accepting the old maps without revision.

129. *Resurvey.*—The 374 square miles of desert falling south of the Southern Punjab Railway in Baháwalpur State were resurveyed on the 1-inch= 1 mile scale, the country was somewhat similar to the Muzaffargarh "Thal" but the sandhills being smaller and less well defined it was decided to do the survey on the 1-inch scale and to enlarge it before fair drawing; the system of survey was identical with that employed in the 2-inch revision but the reduced scale and the easier nature of the ground allowed a monthly outturn of 99·1 square miles per man and a cost rate of R3·9 per square mile.

130. *District Traverse for Supplementary Surveys.*—This was carried out in Jhang, Lyallpur, Montgomery and Shahpur districts and in Baháwalpur State. In the two former districts main traverses had been run in 1904-05 and the season's work consisted in supplementing this with minor circuits picking up trijunctions and base lines; this traverse was also extended so as to include such portions of Montgomery district as had not been previously traversed; the traverse in Baháwalpur State was required for the current season's surveys. Although Shahpur district had been completely traversed in previous years, before the formation of the Jhelum Colony, the work was now of little value for topographical surveys and it was therefore decided to retraverse the area covered by the new colony. Main traverses were completed during the year throughout the colony and sub-circuits throughout a small portion of it. The area and the cost of these traverses for the year (inclusive of the work in Kohat) is approximately 4,600 square miles costing R5·8 per square mile against R4 for last year.

131. *Special Traverse and Survey in Kohat District.*—This consisted in fixing by traverse or triangulation all the boundary pillars on some 100 miles of the northern boundary of Kohat district; in surveying this boundary on blue prints of the existing 1-inch maps; and in the detailed traverse of about 180 square miles of the district; the work was carried out at the request of the Settlement Officer, Kohat.

132. *Riverain Traverse.*—During the year all the riverain traverses required by the Settlement Commissioner have been completed, the work though small in extent was extremely scattered and lay on the Indus river in Miánwáli, Dera Ismail Khan, Peshawar and Attock districts, on the Ravi river in Montgomery and Gurdaspur districts and Jammu State, on the Sutlej river in Multán, Ferozepur and Ambála districts and Baháwalpur State. 729 linear miles of traverse were run at a cost of R9·3 per square mile as against R9·5 for last year.

133. *Map Compilation and Reduction of village maps.*—For current supplementary surveys a section was employed on this work in Baháwalpur State and Multán during the first few months of the field season; compilation for next year's survey has not been undertaken during the recess on account of the uncertainty as to where the party will be working.

The cost of compilation has been R1·2 per square mile. The reduction and compilation of village maps has continued throughout the year for the riverain maps and during the year over 11,000 village *musavis* have been dealt with.

134. *Fair Drawing and Recess duties.*—One section remained at Simla until the end of February fair drawing certain maps, by this date it had practically finished the fair drawing, and what little work still remained has been completed during the recess and the last of these maps will be sent to press before the party takes the field. The cost of this survey inclusive of triangulation and fair drawing has amounted to R307·3 per square mile.

One section remained in Simla under Mr. Tapsell, who had been specially re-employed after his retirement in order to supervise the fair drawing of the

Punjab plains maps, until 28th February, when the period of this officer's re-employment expired and the section was transferred to Multán; during the year all arrears of this work have been completed.

A section under Mr. Robert, also a re-employed officer, remained at Simla throughout the year and was employed on the drawing of the Himalayan arrears and on the preparation of triangulation charts. There still remain 14 fair maps and 19 triangulation charts to be drawn, but 6 of the maps and 7 of the charts are now in hand and it is hoped that all these arrears may be worked off during next recess. The work done during the year has included drawing on the 4-inch and 2-inch scales for reproduction, and on the 2-inch and 1½-inch scales for reduction to 1-inch, and it is therefore not possible to give an accurate cost-rate per square mile.

On the riverain fair drawing a section has been employed throughout the year at Multán and Simla; as the officer in charge of this section had at the same time to superintend field work, the examination of fair sheets has fallen somewhat behind-hand, but some 50 fair sheets are now practically ready for press and another 150 are in various stages of preparation; the riverain field work being now completed the remainder of the fair drawing becomes an arrear, it is probable that a section of about 15 men will be required for this work for about two years. The approximate cost of reducing and compiling the village '*musavis*' and fair drawing the maps has been R3·34 per square mile, this rate is much the same as last year.

Two strong sections have been employed during recess on fair drawing the current year's surveys on the 1½-inch scale for reduction to 1-inch. Although the total area surveyed was only 3,047 square miles, the addition of riverain areas and the portions of 6 standard sheets partially surveyed in 1903—05 has raised the total area of fair mapping to 4,180 square miles or 16 standard sheets; every effort has been made to get this work completed, and although the shortness of the recess consequent to the prolongation of the field season has rendered this difficult, it is hoped that all will be finished before the end of the recess and that only a small amount of final examination will remain undone.

135. *Special maps, etc.*—Lieutenant F. F. Hunter, I.A., was attached to the party till April and employed on the compilation of a special map for the Foreign Department and one draftsman was placed at his disposal for this purpose.

The fair drawing of 5 special maps on various scales has been completed for the Foreign Department during the year.

During the recess proposals have been made with a view to modifying and improving the present system of settlement surveying in the Punjab, an experiment on the basis proposed is now being carried out in Gujranwala district and as the system has been favourably reported on, it has been decided to employ it in the re-survey of Gujránwála and Siálkot districts which is to be carried out during the coming winter; it is hoped that 4 settlement kanungos will be sent to the party for the last few weeks of the recess to carry out the plotting of the traversed points on the 3,000—4,000 *musavis* which will be required for this survey.

136. *Programme for next year.*—This allows for:—

Triangulation for the current and for next year's surveys in parts of Bannu, Dera Ismail Khan and Miánwali districts. Such traverse work as may be required for the surveys in Dera Ismail Khan and Bannu; the completion of the traverse of the Jhelum colony in the Shahpur district commenced during this year, and perhaps a traverse of the proposed new colony in the lower Bari Doab.

Two-inch supplementary survey or re-survey in Bannu, Dera Ismail Khan and Kohat districts.

137. The party was inspected during the recess by the Surveyor General on the 8th October and by the Superintendent, Northern Circle (Frontier Surveys), on the 22nd and 26th August.

NORTH-WEST FRONTIER.

QUETTA PARTY.

Personnel.

Captain G. A. Beazeley, R.E., Officiating Deputy Superintendent, 1st grade, in charge, from 5th August.
Mr. H. C. H. Cooper, Extra Assistant Superintendent, 6th grade, from 20th August.
And the following Probationary Sub-Assistant Superintendents, 3rd grade :—
Mr. L. Williams from 21st August.
Mr. J. McCraken from 5th September.
Mr. F. C. Pilcher „ 21st August.
Babu A. K. Mitra „ „ „
Mr. A. A. Graham „ „ „
Mr. R. C. Hanson „ „ „
Mr. A. J. A. Drake „ „ „
Mr. F. H. Grant „ „ „
Two soldier surveyors under instruction.

138. This party was formed at the end of August.

139. It was formed primarily as an instructional one to give the above young provincial officers a training in frontier work before drafting them into the frontier parties.

140. As the party had, by the end of September, only completed a very small area, the result of the season's work will come into next year's report.

FOREST SURVEYS.

NO. 9 PARTY (INDIA).

141. The Party was employed on 4-inch forest surveys in most of the provinces of the Bengal presidency and on 2-inch topographical surveys in Assam. There was no month in the year in which some of the party were not in the field.

Personnel.

Major P. J. Gordon, I.A., Superintendent, Forest Surveys, in charge.
Mr. C. George, Extra Assistant Superintendent, 3rd grade.
Mr. C. Litchfield, Extra Assistant Superintendent, 5th grade.
Mr. P. A. T. Kenny, Sub-Assistant Superintendent, 1st grade.
59 Surveyors.

142. Two camps under Messrs. George and Kenny continued forest surveys on the 4-inch scale in the Katha and Shwebo districts of Upper Burma and one under Mr. Litchfield completed the 4-inch forest surveys in Nowgong and also surveyed an area of 571 square miles in the Durrang district of Eastern Bengal and Assam. Small sections under native surveyors were employed on 4-inch detail surveys in Hazára, Ráwalpindi, Lahore, Tehri Garhwál, Pilibhit and the Garo hills. Work in Pilibhit had to be stopped owing to a severe outbreak of cholera, from which 1 surveyor and 2 khalasis died, and in the Garo hills the season's work narrowly escaped being lost through a wild elephant having, in the course of an attack on the surveyor, stepped on his plane table.

143. A small area was triangulated in Tehri Garhwál and in Chittagong the Sitapahár reserve was traversed, the result of this traverse showed the area of the reserve to be over 27 square miles instead of 11 as estimated when the reserve was notified.

144. The area topographically surveyed on the 2-inch scale was that included in standard sheets 83 $\frac{B}{9, 13}$ as well as the portions of reserved forest situated to the east, west and north of these sheets. Considerable difficulty was found in surveying the Bhutan boundary as many of the pillars had disappeared and it is probable that the maps will have to be published provisionally without any demarcated boundary being shown thereon. The surveyors were new to this class of work and the average outturn was only 52 square miles *per* surveyor for a season of six months. Much of the country consisted of uncultivated tracts covered with high grass and consequently difficult to survey. Short lines of levels had to be run in order to obtain additional heights in this flat country.

145. A survey on the 4-inch scale was made of the boundaries of the *rakhs* of the Salt range in the Shahpur district of Punjab.

RUSSIAN TERRITORY
AFGHANISTAN
BALUCHISTAN
RAJPUTANA
Tropic of Cancer
Gulf of Cutch
Gulf of Cambay
Ran of Cutch
BOMBAY
KANDAHAR
QUETTA
KABUL
PESHAWAR
LAHORE
Herat
Hindu Kush Mts.
Suleman Range
Indus R.
Aravalli Hills
Mouths of the Indus

146. The outturn for the year under report and the two preceding years are given in the following table:—

Description of Survey.	Outturn in square miles.			Cost-rate *per* square mile.		
	1903-1904.	1904-1905.	1905-1906.	1903-1904.	1904-1905.	1905-1906.
Detail Survey 4 inches = 1 mile.						
North-West Frontier Province Punjab	209	262	78	25·0	24·6	52·8
Central Provinces	2·5	...	0·5	57·6	...	...
United Provinces of Agra and Oudh.	36	...	98	27·1	...	32·0
Bengal	310	232	...	64·0	76·7	...
Eastern Bengal and Assam	160	148	19	85·2	85·5	129·8
Burma	447	501	570	90·7	91·4	100·3
TOTAL	1164·5	1143	765·5	...	...	...
Detail Survey 2 inches = 1 mile.						
Eastern Bengal and Assam	...	...	571·3	...	* ..	30·5
4-inch Boundary Survey.						
Punjab	...	...	839(*a*)	...	...	4·3(*b*)
Burma	...	..	* 40(*a*)	...	...	...
TOTAL	...	...	879(*a*)	...	...	...
Traversing	1552(*a*)	1444(*a*)	541(*a*)	23·9(*b*)	19·2(*b*)	21·4(*b*)
Levelling	..	..	130(*a*)	...	...	6·1(*b*)
Triangulation	2483	2242	447	7·7	6·2	3·5

* On 2-inch scale. (*a*) Linear miles. (*b*) *Per* linear mile.

The outturn cannot be well compared with that of previous years as much of the work was of a different nature. The sanctioned programme was completed with the exception of about 40 square miles in Pilibhit where the survey had to be abandoned on account of a severe epidemic of cholera, and of some 30 square miles in Chittagong which could not be arranged for owing to the area of the reserve proving, after traverse, to be nearly three times the notified area.

The cost-rates owing to the work being performed under different conditions from those of last year require some explanation. In spite of the increase in the rates the work was done as economically as formerly. In the Punjab and Frontier Province the forest areas were widely scattered and some of the expenditure for work shown in last year's returns had to be included in calculating the cost-rates. In the United Provinces the high rate was due to the work being interrupted by cholera. In Eastern Bengal and Assam the forest areas surveyed presented considerable difficulties and were much scattered. In Burma no traversing or triangulation was done, and the plane-tabling had to bear the whole of the supervision charges instead of only a portion of them as formerly.

The cost of the 2-inch surveys in Assam may be considered moderate, considering the physical difficulties of the country and the fact that all the surveyors were new to this class of work.

A comparison of the cost of one year's work with another is always difficult and unsatisfactory as conditions are never exactly the same for any two years.

147. During the year good progress was made in the drawing of forest maps of which 196 including second editions was sent to press and 220 published.

148. It is proposed next season to break up No. 9 party as a forest survey party and to reconstruct it as a topographical party. Most of the surveyors will be transferred to Frontier Survey parties.

149. The total expenditure for the year amounted to R1,20,283, of which R72,354 are chargeable to the Forest department.

BOMBAY FORESTS.

No. 17 Party.

150. The party left Poona for the field at the end of November, and returned to its recess quarters early in June, giving a full working season of six months.

Personnel.

Mr. B. G. Gilbert Cooper, Superintendent, 2nd grade, in charge.
Mr. S. F. Norman, Extra Assistant Superintendent, 1st grade.
Babu Amar Singh, Extra Assistant Superintendent, 5th grade.
Mr. P. R. Anderson, Extra Assistant Superintendent, 6th grade.
41 Surveyors, etc.

The party was divided into three camps under Mr. S. F. Norman, Babu Amar Singh, and Mr. P. R. Anderson respectively, and continued the survey on various scales of forest areas in the Northern and Central Circles of the Bombay presidency; these operations comprised:—

(1) *Northern Circle.*—Completion of the detail survey on the 8-inch scale of teak reserves in the Thána district.

(2) *Central Circle.*—Continuation of the supplementary triangulation and detail survey on the 4-inch scale in the Khándesh district. Completion of detail survey on the 4-inch scale in the Sátára district.

151. There was a considerable amount of sickness in the party, especially in Thána and West Khándesh. In Sátára the health of the men was somewhat better. One surveyor was pensioned and two died from plague during the year, adding to the already long death roll from this cause in the party.

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

Description of Survey.	Outturn in sq. miles.			Cost-rates *per* sq. mile.		
	1903-04.	1904-05.	1905-06.	1903-04.	1904-05.	1905-06.
				R	*R*	*A*
Triangulation . . .	677	1,010	680	15·3	12·2	13·2
Topography 4-inch scale . .	576·19	597·48	630·85	67·5	62·3	87·4
Topography 8-inch scale .	157·75	187·47	126·00	138·8	144·8	173·2

The cost-rates show a considerable increase over those of last season. This is due to a great extent to the inclusion for the first time of the charges for the publication of maps in the accounts. There were also local considerations which affected the rates and the outturn in an adverse manner, such as the necessity for the employment of coolie carriage in Sátára and Thána, and the difficult country met with in these districts.

153. The total expenditure for the year amounted to R82,630, of which R60,156 are chargeable to the Forest department, the balance R22,474 being an Imperial charge against the Survey of India.

154. One hundred and thirty-eight sheets have been sent to press and 72 have been published during the year.

At the end of the current recess 143 sheets will still remain unmapped, but it is hoped that, with the aid of a drawing section during the field season, most of the forest maps will be sent to press by the end of next year.

155. Large scale surveys of forests in Bombay have now been practically completed with the exception of those in Bijapur, where the value of the reserves was not deemed sufficient to justify the expenditure, and of the remaining forests in Khándesh, an area of nearly 1,500 square miles. It was originally intended to survey these forests on the 4-inch scale, but as, in the opinion of the conservator, maps on the 1-inch or 2-inch scales will suffice for Forest administrative purposes, the Government of Bombay has decided, with a few unimportant exceptions, to forego this part of the party's programme: it has therefore been decided to employ the party in future on topographical surveys. The programme for next season will consist of triangulation in degree sheet Nos. 46-K and 46-O and revision of 2-inch surveys and re-survey on the 2-inch scale of the area formerly surveyed on the 2-inch scale in sheet No. 46-K, also the 4-inch survey of forest boundaries in the same sheet, and the survey of about 60 square miles of forest for the sake of completing in a uniform scale the 4-inch survey of certain talukas.

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

MADRAS FORESTS.

No. 19 Party.

157. The party, divided into 4 camps under Provincial officers, was distributed as follows:—

Personnel.

Mr. G. T. Hall, Extra Deputy Superintendent, in charge.
Mr. J. Smith, Extra Assistant Superintendent, 4th grade.
Mr. W. F. E. Adams, Extra Assistant Superintendent, 5th grade.
Mr. M. J. Sheehan, Extra Assistant Superintendent, 5th grade.
Mr. B. C. Newland, Sub-Assistant Superintendent, 3rd grade.
Babu Balaji Dhondiba, Sub-Assistant Superintendent, 3rd grade (Probationary).
57 Surveyors, etc.

No. 1 camp under Mr. J. Smith with 12 surveyors and 5 apprentices employed on 4-inch surveys of forests in the Godavari district.

No. 2 camp under Mr. W. F. E. Adams with 11 surveyors and 3 apprentices employed on 4-inch surveys of forests in North Malabar and South Canara districts.

No. 3 camp under Mr. M. J. Sheehan with 12 surveyors and 5 apprentices employed on 4-inch surveys of forests in the Ganjam district.

No. 4 camp under Babu Balaji Dhondiba with 3 surveyors employed on 4-inch forest surveys in the Chingleput and Ganjam districts.

Mr. B. C. Newland and one surveyor were also employed on triangulation in North Malabar in preparation for the proposed 2-inch topographical survey in that district.

Two traversers were employed in traversing the recently demarcated Mysore-South Canara Boundary, and one for a short period in traversing the boundaries of Forest reserves in North Malabar.

158. The party left its recess quarters in Bangalore early in November 1905 and, with the exception of the detachment working in South Canara which was detained till the end of June, closed work at the end of May.

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

	Area surveyed.			Cost-rates *per* sq. mile.		
	1903-04.	1904-05.	1905-06.	1903-04.	1904-05.	1905-06.
				₹	₹	₹
Triangulation	1,937	1012	2,150 (*a*)	...	...	6 (*a*)
Ditto	...	...	70 (*b*)	9	14	33 (*b*)
Traversing (*c*)	247	29	174	19	31	28
Topography	803	750	832	102	124	104

(*a*) For 2-inch topography. (*b*) For 4-inch topography. (*c*) Linear miles.

The work was examined by 290 linear miles of test line and numerous *in situ* fixings.

The cost-rates generally show a satisfactory decrease over those of last season.

160. The country surveyed presented much the same difficulties as that surveyed in previous years. There was much sickness among the members of the party especially in Ganjam and North Malabar, and during the recess season much valuable time was lost from sickness contracted in the field.

161. The difficulty of securing a sufficiency of labour retarded the progress of the work in Ganjam, and assumed an acute phase in North Malabar, where labour is scarce and rates high; in spite of the assistance of the civil officer of the district, work was often at a standstill owing to want of men. The permanent employment and high wages offered by planters, and the contract system of the

Forest department, are more attractive to the inhabitants than employment with a survey party for a short period and often at a distance from their homes. It is probable that next season all the labour required for the Malabar survey will have to be imported. Many hours daily were often lost through coolies insisting on returning to their homes, sometimes miles away, and only returning next morning after the best hours for survey work had passed.

162. The average outturn *per* man *per* mensem ranged from 3·3 square miles in Malabar to 5·4 in Chingleput. The poor outturn in the former district was due in great measure to the labour difficulties referred to above.

163. With the exception of the Malabar sheets, which will be taken up next season, all maps will be completed before the end of the recess, but some of these will have to be withheld from press pending verification of boundaries and the survey of omissions. 81 maps were sent to press and 61 were published during the year.

164. The total expenditure of the party for the year was R1,06,926, of which R68,209 is debitable to the Forest department.

The Madras government having agreed to forego further large scale forest surveys, with the exception of those in Ganjam which it is proposed to complete, the party will in future be employed on regular topographical surveys.

The programme for 1906-1907 comprises—

(1) Triangulation in degree sheets 58A and58B.
(2) 2-inch topographical survey of 2,000 square miles in North Malabar and Coorg falling in degree sheets 49M and 58A.
(3) 4-inch survey of about 340 square miles of forest in Ganjam and North Coimbatore.
(4) Traversing of 150 square miles of forest boundaries in Trichinopoly and of reserves falling in the area to be topographically surveyed in North Malabar.

165. The party was inspected during August by the Superintendent of Forest Surveys.

166. The season's work was verified with the aid of the government notifications by the district forest officers of Godavari, Ganjam, South Canara, North Malabar, and Chingleput.

BURMA (FORESTS).

NO. 20 PARTY.

Personnel.

Captain A. Mears, I.A., Officiating Deputy Superintendent, 2nd grade, in charge.
Mr. P. F. Prunty, Extra Assistant Superintendent, 1st grade.
Mr. C. C. Byrne, Extra Assistant Superintendent, 6th grade.
Babu Pramada Ranjan Roy, Sub-Assistant Superintendent, 1st grade, from 11th June 1906.
Mr. S. S. Fielding, Sub-Assistant Superintendent, 1st grade, from 20th March to 13th May 1906.
Mr. J. H. Williams, Sub-Assistant Superintendent, 1st grade.
Munshi Amjad Ali, Sub-Assistant Superintendent, 2nd grade.
66 Surveyors, etc.

167. The party left recess quarters at Dehra Dún on the 6th November and the majority of the camps had commenced field work by the 1st of December. The field season was closed in Upper Burma on the 8th May and about a week later in Lower Burma.

168. The party was divided into 5 camps as follows :—

(1) Mr. P. F. Prunty with 2 native triangulators, 12 traversers and 5 computers in Pakôkku district.
(2) Mr. C. C. Byrne with 10 surveyors in the reserved forests of the Lower Chindwin Forest division.
(3) Mr. J. H. Williams with 11 surveyors in the reserved forests of the Yaw and Lower Chindwin Forest divisions.
(4) Munshi Amjad Ali with 13 surveyors in the reserved forests of the Thaungyin and Thayetmyo divisions.
(5) Surveyor Moung Kyaw Nyein with 5 surveyors in the reserves of the Lower Chindwin division. Mr. S. Fielding on return from sick leave at the end of March took over charge of this camp.

169. Subsidiary triangulation based on the Manipur Minor Meridional Series was carried out in standard sheets Nos. 84 $\frac{J}{4,8}$, 84 $\frac{K}{1\text{ to }8}$ for the purpose of supplying points for the 2-inch topographical survey of these sheets, the triangulation extended over an area of about 1,622 square miles. Mr. Prunty, assisted by two native triangulators, carried out the triangulation in addition to supervising the traverse work.

170. It was found necessary, owing to the greater portion of the area being thickly wooded, to run 881 linear miles of theodolite traverses. These traverses were principally confined to forest boundaries and the main valleys. The theodolite was on an average set up 13 times in the mile. Nearly all the traverses were set up and proved in the field.

171. Topographical survey on the 4-inch scale was carried out over an area of 682 square miles in the reserved forests of the Yaw, Lower Chindwin, Thayetmyo and Thaungyin divisions. Owing to the wooded nature of the country the slow and laborious method of plane table traversing had as usual to be adhered to, and few opportunities occurred of working by interpolation. Food depôts were formed, as formerly, for the purpose of supplying the establishment working in the reserves, but owing to better communications little difficulty was experienced this year in rationing these depôts, except in the Patôlon Extension II and Mepalè-Thaungyin reserves.

172. The area topographically surveyed was examined by one linear mile of test line to every one and three-quarters square miles of 4-inch survey.

173. The health of the party was good except in the Thaungyin division where fever and dysentery were prevalent.

174. The triangulation and traverse computations and fair mapping are all up to date. Thirty-one sheets have been submitted for publication during the year under report and 27 have been published.

175. The total expenditure of the party for the year was R1,52,254 as compared with R1,47,546 for the previous year. The increase is due to the extra expenditure which had to be incurred on the 4-inch detail survey of the Mepalè-Thaungyin reserves. R71,704 of the total is chargeable to the Forest department.

176. The following table gives the outturn and cost-rates for the year under report and the two preceding years:—

Description of work.	Outturn.			Cost-rate *per* sq. mile.		
	1903-04.	1904-05.	1905-06.	1903-04.	1904-05.	1905-06.
				R	R	R
Triangulation . . .	610	800	1,622	7·4	7·8	9·1
Traverse	948(*a*)	976(*a*)	881(*a*)	44·5(*b*)	44·5(*b*)	42·6(*b*)
Topography 4 inch=1 mile .	671	680	682	135·7	142·5	147·7

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

The triangulation cost-rate, although higher than that of the previous season, is not excessive, and but for abnormal weather during March and April when the work was practically at a standstill, would have been much lower. The traverse cost-rate was normal and satisfactory. The cost of the 4-inch topographical survey has increased by R5 *per* square mile. This rise was solely due to the expensive nature of the work in the reserves of the Thaungyin division. These dense and unhealthy forests necessitated the strengthening of all the plane tablers' squads, and a considerable additional expenditure was incurred for the carriage of food supplies for the establishment in this sparsely inhabited country. The cost-rate *per* square mile for the Thaungyin area by itself amounts to over R154, whereas that of the Chindwin work is R142.

177. The following is the programme for season 1906-1907:—

1. Triangulation and traverse survey of degree sheet 78 P chiefly in the Sylhet district of Assam, in preparation for its topographical survey on the 2-inch scale.

2. The Topographical survey on the 2-inch scale of standard sheets Nos. 84 $\frac{J}{4,8}$, 84 $\frac{K}{1,2,5,6}$ district Pakôkku, Upper Burma, excluding those small areas already surveyed on the 4-inch scale.
3. Topographical survey on the 4-inch scale of an area of about 50 square miles of forest reserves, Thaungyin.
4. A plane-table survey on the 4-inch scale of the boundaries of the reserved forests of the Minbu division.

178. The Superintendent, Forest Surveys, inspected the party in the field during the month of February and in recess in August.

CADASTRAL AND TRAVERSE SURVEYS.

BENGAL.

179. The operations in Bengal remained under the supervision of Major R. T. Crichton, I.A., Superintendent, Provincial Surveys.

The outturn of the season was as follows :—

	Square miles.
Traversing	6,179
Cadastral Survey	1,814
Record writing	1,601
Topographical survey	1,050
Traverse for topographical survey	1,050

Major Crichton inspected all the parties and camps several times during the field season and once again during recess. He inspected the Bengal Drawing Office frequently during the year and also the office of the Calcutta Suburbs Survey.

No. 4 Party (Bihar).

180. This party consisted of one traverse and two cadastral camps and was employed mainly in the Purnea, Bhágalpur and Monghyr Districts.

Personnel.

Captain F. C. Hirst, Officiating Deputy Superintendent, 2nd grade, in charge.
8 Writers and Accountants.

Traverse.

Mr. C. S. Gasper, Extra Assistant Superintendent, 4th grade.
Mr. C. A. O'Donel, Extra Assistant Superintendent, 6th grade.
Mr. F. W. Marten, Sub-Assistant Superintendent, 1st grade.
Mr. A. B. Smart, Sub-Assistant Superintendent, 2nd grade.
1 Supervisor, 2 Hospital Assistants, 42 Traversers, 45 Computers, etc.

Cadastral.

Mr. C. S. Kraal, Extra Assistant Superintendent, 2nd grade.
Mr. N. Bedford, Extra Assistant Superintendent, 4th grade.
Mr. J. H. Murphy, Extra Assistant Superintendent, 5th grade.
Mr J. C. Lears, Sub-Assistant Superintendent, 1st grade.
Mr. O J. H. Hart, Sub-Assistant Superintendent, 1st grade.
Mr. P. Kennegy, Sub-Assistant Superintendent, 1st grade.
Mr. T. F. Kitchen, Sub-Assistant Superintendent, 3rd grade.
3 Supervisors, 62 Inspectors and 850 detail surveyors.

The somewhat high cost rate for traversing in Bhágalpur is due to the hilly and undulating nature of the country, the remaining traversing rates are fair. The rates for cadastral survey and record writing are good. Topographical rates are good, but since the scale used is the 16-inch, they cannot be compared with last year's rates; the procedure in dealing with topographical work is the same as that adopted during the last two years, with the exception of such modifications as the increase of scale has rendered necessary.

The traversing has been connected with the Great Trigonometrical Survey wherever possible and proves well. There were 36,065 theodolite stations, which were marked with 1,997 stones at trijunctions, 31,149 cylinders and 2,919 pegs. Demarcation on the whole was fair. The detailed survey was checked by 4·7 linear miles of test survey *per* square mile of detail and over 30 *per cent.* of the entries in the records were checked by the Survey staff.

BENGAL.

INDEX TO CADASTRAL SURVEYS.

1905-06.

Nos. 4, 5, & 6 PARTIES.

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.

	Previous Seasons	Season 1905-06.
Cadastral 16″ with (Records)		
Do. without (Records)		

Scale of Miles.

Published under the direction of Colonel C. Strahan, R.E., *Surveyor General of India.*

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

BENGAL.

INDEX TO TRAVERSE SURVEYS.

1905-06.

Nos. 4, 5, & 6 PARTIES.

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.

Previous Seasons — Season 1905-06.

Traversing

Scale of Miles.

Litho. S. I. O., Calcutta

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

District.	Nature of operations.	Area in square miles.	Cost-rate *per* square mile.
			Rs.
Bhágalpur	Traversing for Cadastral Survey	365	44·7
	Cadastral Survey	1,276	76·1
	Record writing	1,108	58·6
Purnea	Traversing for Cadastral Survey	37	33·8
	Traversing for Topographical Survey	33	20·0
	Cadastral Survey	485	73·5
	Record writing	485	45·7
	Topographical Survey (16 inches = 1 mile).	23	10·0
Monghyr	Traverse for Cadastral Survey	1,217	31·2
	„ „ Topographical Survey	275	...

No. 5 PARTY (CHOTA NAGPUR).

Personnel.

Captain F. C. Hirst, I.A., Assistant Superintendent, 1st grade, in charge to 5th November 1905.

Captain L. C. Thuillier, I.A., Officiating Assistant Superintendent, 4th grade, in charge from 18th November 1905 to 26th February 1906.

Mr. T. W. Babonau, Extra Assistant Superintendent, 4th grade, in charge from 27th February 1906.

Traverse.

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

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

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

1 Supervisor, 50 Traversers and 25 Computers.

Cadastral.

Mr. H. W. Biggie, Extra Assistant Superintendent, 5th grade, to 16th October 1905.

Mr. P. F. Delaney, Sub-Assistant Superintendent, 1st grade, to 16th October 1905.

Mr. A. B. Smart (Junior), Sub-Assistant Superintendent, 3rd grade, to 16th October 1905.

4 Supervisors.

182. This party had only one traverse camp. The operations were carried on in the districts of Midnapore, Singhbhum, Ranchi and Sonthal Parganas. The two cadastral camps were transferred to the Settlement Department on 16th October 1905.

The traversing has been connected with the Great Trigonometrical Survey. There were 48,839 theodolite stations, of this number 4,943 were trijunctions marked by stones and the remaining 43 896 were marked by cylinders, pegs and country stones. The cost-rate for traversing is low considering the hilly nature of the areas in districts Singhbhum and Ranchi, where the subtense bar was constantly used. Demarcation in the Sonthal Parganas was fairly good, no demarcation was done in the other districts. As there are no old maps showing village boundaries the surveyors had to survey the villages as pointed out locally.

The areas traversed are as follows :—

District.	Nature of operation.	Area in square miles.	Cost-rate *per* square mile.
			Rs.
Midnapur	Traversing	187	31·5
Singhbhum	Do.	573	35·1
Ranchi	Do.	873	34·4
Sonthal Parganas	Do.	797	33·8

No. 6 Party (Eastern Bengal).

Personnel.

Mr. A. W. Smart, Extra Deputy Superintendent, in charge.
Mr. C. H. G. Johnson, Extra Assistant Superintendent, 4th grade.
Mr. E. G. Hardinge, Extra Assistant Superintendent, 6th grade.
Mr. O. E. C. Judd, Sub-Assistant Superintendent, 1st grade.
Mr. P. F. Delaney, Sub-Assistant Superintendent, 1st grade.
Mr. I. Newton, Sub-Assistant Superintendent, 3rd grade.
2 Supervisors, 55 Traversers, 35 Computers and 22 Surveyors.

183. This party comprised one traverse camp, and one camp employed on both traversing and topographical survey.

The outturn for the season is as follows:—

District.	Nature of operations.	Area in square miles.	Cost-rate *per* square mile.
Dacca	Traversing for cadastral surveys .	1,638	41·2
Khulna	Ditto ditto . .	106	44·7
24-Parganas . .	Traversing for topographical survey	1,050	49·0
	Topographical survey . . .	1,050	37·8

In addition to the above, in district Dacca 698 acres were cadastrally surveyed with a record-of-rights for land acquisition purposes at a cost of R515. A traverse survey was also made of the Provincial boundary of districts Backerganj, Faridpur and Khulna at a cost of R275.

184. In the traversing of Dacca there are 39,290 theodolite stations marked with 6,983 stones, 6,026 galvanized iron cylinders, 1,014 glazed earthen cylinders and 25,267 pegs. The chaining represents 7,240 linear miles and 221 azimuths were observed to check the angular work. There was absolutely no demarcation of the village boundaries, and no assistance was rendered by the landlords and tenants. The southern and western portions of the area surveyed were low-lying and intersected by large rivers, creeks, and marshes, to the north and east the country was higher and partly covered with low scrub jungle. The cost-rate is very fair considering the nature of the country.

185. The operations in Khulna comprised the traversing of the Dehi Bhadra Estate situated in the north-west corner of the district. Azimuth observations were taken at 29 stations, and there are 2,255 theodolite stations marked with 279 stones, 49 galvanized iron cylinders and 1,927 pegs. The Estate is very swampy and intersected with small streams. The Dalbhanga marsh covers a large area on the south-east. The cost-rate for such a small and detached area is good.

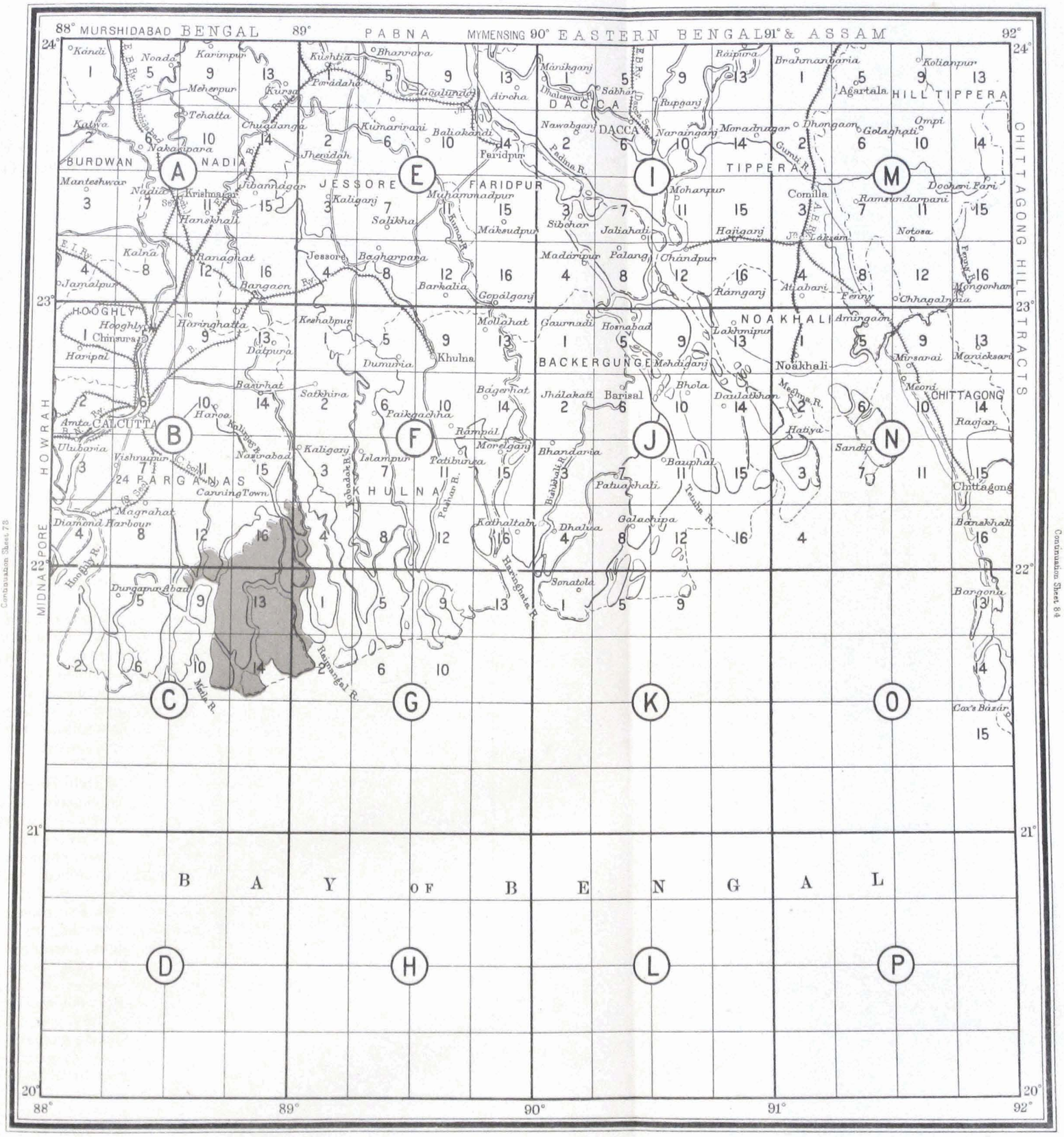
186. The combined operations in the 24-Parganas Sundarbans involved exceptional trouble and anxiety. At the outset, 366 *khalasis* absconded as they refused to live in boats and to work in the dense forest and jungle. Arrangements were then made for recruiting men at Calcutta, Gonda and Arrah, and it was not till the 1st January 1906 that work was fairly started. The whole of the area traversed and topographically surveyed was a network of rivers and creeks covered with dense impenetrable jungle. The system of zig-zag traversing of rivers, streams and creeks was again adopted this season with complete success. There are 3,571 theodolite stations marked with 393 galvanized iron cylinders, 294 trunks of trees cut off at the required height, and 2,884 pegs. In addition cross sticks painted white were fixed over the stations for easy identification by the detail surveyors. A steam launch, a barge, and 80 country boats were hired for the establishment to live in, and for the supply of fresh water and food, which had to be obtained from Calcutta and Canning Town. Great difficulty was experienced throughout the season in keeping the men from absconding, owing to their being compelled to live in boats, and from their fear of being carried off by tigers.

SHEET N° 79.

OF THE INDIA AND ADJACENT COUNTRIES SERIES.

SHOWING PROGRESS OF MODERN TOPOGRAPHICAL SURVEYS

1905-06.



NOTE.

1. The number in the heading is that of the Sheet of the India and Adjacent Countries Series on the Scale of 1000000.
2. The letters denote the Degree Sheets on the Scale of 1 Inch = 4 Miles contained within the above, while the small figures denote the numbers of the 1 Inch Sheets contained in each Degree Sheet.
3. When ordering a sheet on the 1000000 Scale, only the number given in the heading should be used, *e.g.* N°93. In the case of a Degree Sheet, the number in the heading and the Degree Sheet letter must be given, *e.g.* 93A. For a 1 Inch Sheet, the number in the heading the Degree Sheet letter and the 1 Inch Sheet number must be quoted, *e.g.* 93 $\frac{A}{5}$.

No. 141, S. I.—July 07.—580

Published under the direction of Colonel F.B. Longe, R.E., *Surveyor General of India.*

1907

Scale 1 Inch = 28 Miles.

Miles 10 0 10 20 30 40 50 Miles

INDEX TO ADJOINING SHEETS.

72	78	83
73	79	84
74		85

REFERENCES

1. Degree Sheets published on the 1 Inch Scale
2. Sheets published in new style on the 1 Inch Scale
3. ,, ,, old
4. Triangulated in advance
5. ,, during year under report
6. Surveyed
7. Previously surveyed but not published

Sheets under 3 only approximately conform to limits shown on Index

187. The topographical survey in the 24-Parganas Sunderbans comprised an area of 456 square miles surveyed on a scale of 4 inches = 1 mile, and 594 square miles on the scale of 2 inches = 1 mile. The establishment suffered severely from malarial fever, dysentery and skin diseases; 12 men died during the season, of whom one was killed by a tiger. The cost-rates are very good considering the difficult nature of the country, the heavy expenditure for boats, etc., and the high salaries paid to the establishment.

BENGAL DRAWING OFFICE.

188. During the year under report the work in the Bengal Drawing Office has been heavier and more varied than before, and owing to the increase of work and the need of more accommodation both the photo. room and grainer's shed have been doubled and two portable iron sheds have been erected.

Standard maps.—Seven sheets of Bihar were completed and submitted to the Surveyor General's office for publication and 61 sheets are in hand. This large number of sheets has been taken up with the object of facilitating the preparation of district, *thána* and trijunction-mark maps.

District maps.—The district maps of Puri and Champaran were completed and sent for publication and those of Darbhanga and Chittagong are nearing completion.

Traversec harts.—Four charts of the Orissa division have been completed and 53 are in hand; the charts of Bihar district will shortly be commenced.

Thána and trijunction-mark maps.—The *thána* map, which is prepared on the 1-inch scale, in connection with the *thána* jurisdiction list of villages, shows village boundaries in outline, all village numbers, such village names as can conveniently be fitted in, railways, main roads, canals, rivers, and other main water channels. The trijunction-mark map on the 2-inch scale shows village boundaries in outline and all permanent marks by their proper symbols and with serial numbers; all *thána* numbers of villages are given and such names as will conveniently fit in, but the topographical details of the *thána* map are omitted. Both these maps are compiled for the local Government. The trijunction-mark maps of 77 *thánas* of the Orissa division and Bihar have been completed during the year; 68 of these have been reproduced and 922 copies of them supplied to district officers. Those of 12 *thánas* of districts Bhágalpur, Monghyr, Singhbhum and Tipperah have been commenced and are in hand. Twenty *thána* maps of districts Cuttack, Darbhanga, Monghyr, Bhágalpur, Singhbhum and Chittagong have been completed and 200 copies of each have been supplied; those of the Surjapur pargana of district Purnea have been commenced. Traces for reproduction have also been made from originals supplied by the Special Officer for the Revision of Boundary Commissioner's lists of 112 *thána* maps of 11 districts.

Reproduction of Village maps.—During the year 6,509 paper traces have been prepared from original sheets for reproduction, 10,875 have been examined, 543,101 copies have been printed and 455,295 despatched. Two hundred copies of each of the 396 *thána* maps of 30 districts have been reproduced from originals and supplied to the Special Officer for the Revision of Boundary Commissioner's lists. Two hundred copies each of 8 wall maps and 50 copies each of 79 town maps and one copy each of 155 cadastral sheets have also been reproduced. This section has also touched up 953 sheets for reproduction; compared the original maps of 840 villages of Bihar against Settlement traces, corrected 3,086 copies of 1,354 villages of district Balasore and 157 traces of 144 villages of the Banki Government Estate according to Settlement traces.

Badar Section.—The "*badars*" of 1,161 villages of Bihar, and of districts Midnapur, Ranchi and Backerganj have been corrected during the year. Headings and adjoining names have been corrected on 5,486 cadastral sheets of Bihar and village names on the 4-inch sheets of 141 villages. *Thána* numbers have been entered and names corrected of 4,838 villages in traverse volumes and 3,532 villages in traverse field books. Village names in headings and adjoining sheet numbers have been entered in 2,489 sheets of district Ranchi and Revenue Survey numbers in 2,136 sheets of districts Singhbhum and Midnapur, the originals being received incomplete in these respects. *Thána* lists have been completed for 6,546 villages of Bihar, and 2,834 16-inch maps of district Backerganj of 1903-04 were also touched up for reproduction.

Map Record Section.—Fifteen thousand two hundred and sixty-nine original sheets have been received during the year for record, making a total now of 96,861 sheets in this section—21,522 traces are now also stored in this section and others are being transferred gradually from the reproduction section. A proposal with estimates is now before the Board of Revenue for the erection of a separate fire-proof record room for this section.

MISCELLANEOUS SURVEYS.

189. *Calcutta Municipality.*—The work in this area was conducted under Mr. R. B. Smart, Extra Deputy Superintendent (retired), the operations being confined to the same area as last season, the principal work was the demarcation of holdings within and without the municipal limits and was a tedious operation, the more so as numerous detached holdings although borne in the Collector's Register have not been located, and apparently their existence is not known except on paper as there is no map showing the position of detached lands. Besides demarcation, settling of boundary disputes had also to be attended to in the field. The area traversed for locating detached holdings was—(*a*) 951 acres for survey on 50 feet to the inch, and (*b*) 493 acres on the scale of 32 inches to the mile, (*c*) the detail survey of 40 acres was completed on the scale of 50 feet although a larger area had to be surveyed in skeleton to determine the detached holdings, (*d*) the detail survey of 227 acres and its demarcation on the scale of 32 inches to one mile. Of the 393 fair maps to be completed, 253 have been drawn in skeleton, *i.e.*, all details have been shown, leaving the boundaries to be completed after attestation, and when the records of an entire Sub-Division are returned the maps are inked up.

190. *Patna Division Diara Survey.*—In paragraph 224 of last year's report mention is made of a proposal to mark permanently selected points in the Ganges *diara*. During the year under report 288 marks were laid down. Of these 99 were on islands and high sand banks and consisted of heavy 10-foot scantlings with cross feet arranged so as to give the marks, when buried about 5 feet deep, sufficient purchase to withstand considerable water pressure. The marks along the edges of the *diara* tract have mostly disappeared proving that the existing permanently marked lines bounding the *diara* cannot be drawn closer together with safety. The examination of the marks on islands and sand banks cannot be undertaken till the river has fallen.

191. *Darjeeling-Nepal Boundary.*—Mr. C. A. O'Donnel was deputed to relay this boundary which was disputed in several places and lies chiefly along the Mechi river. One hundred and twenty points at the main bends of 51 linear miles of boundary have been temporarily marked. The permanent marking will be undertaken by the local officials. Mr. O'Donnel's maps have been sent to the Deputy Commissioner of Darjeeling.

192. *Bhâgalpur-Nepal Boundary.*—Several pillars and posts having been reported to be missing, steps were taken to replace them. During the year 20 selected points have been marked with stout wooden posts, but the experience of several seasons shows that no satisfactory permanent demarcation of the boundary can be expected in this tract as the Kosi River changes its course every year.

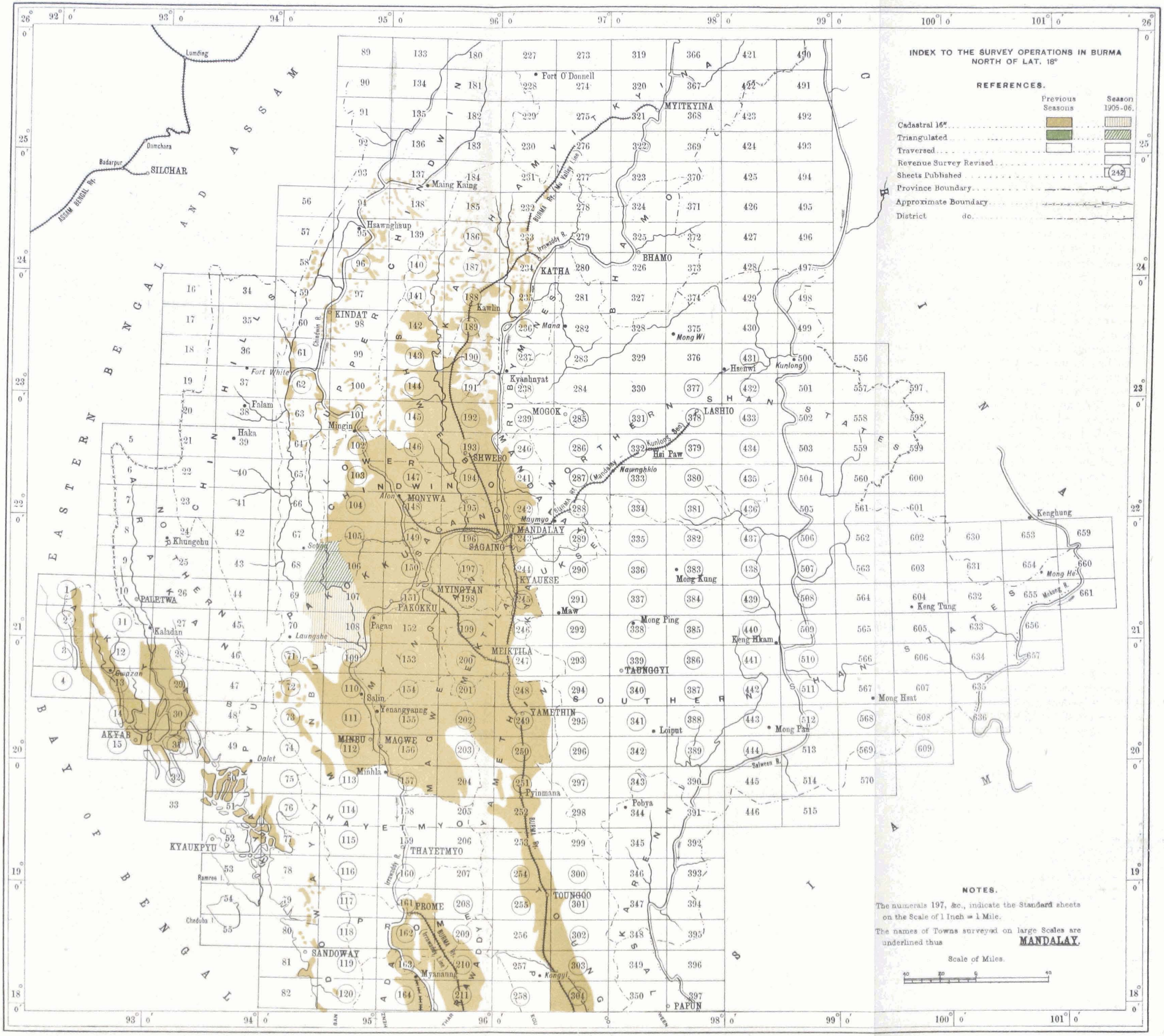
UPPER BURMA.

No. 7 PARTY.

193. The cadastral survey of the Pakokku district was continued and the operations were confined to that district. The programme of cadastral survey for the season was only 900 square miles, but the area surveyed contained so little cultivation that it was completed long before the end of the field season and as the establishment is virtually

Personnel.

Major C. W. H. Symonds, I.A., Deputy Superintendent, 1st grade, in charge up to 26th September 1906.
Mr. J. S. Swiney, Extra Assistant Superintendent, 2nd grade, up to 18th December 1905.
Mr. O. D. Smart, Extra Assistant Superintendent, 3rd grade, in charge from 27th September 1906.
Mr. C. G. Lee, Extra Assistant Superintendent, 4th grade.
Babu Jagdamba Prasad, Extra Assistant Superintendent, 6th grade.
Babu Abinash Chandra Bose, Extra Assistant Superintendent, 6th grade, *sub. pro tem.*
Mr. C. S. Littlewood, Extra Assistant Superintendent, 6th grade.
Mr. S. F. Norman, Sub-Assistant Superintendent, 1st grade, from 30th January to 3rd August 1906.
Mr. W. E. Swiney, Sub-Assistant Superintendent, 2nd grade.



No. 138, S. I.—July 07.—$50.

Published under the direction of Colonel F. B. Longe, R.E., *Surveyor General of India,*

Reg. No. 356-S. 07

Helio. S. I. O., Calcutta.

guaranteed employment for at least 6 months, field work was continued after the programme had been completed and resulted in the following outturn :—

	Traversing.			Detail survey on 16-inch scale.						
	Kwins.	Square miles.	Cost *per* square mile.	*Kwins.*	Sheets.	Fields.	Acres.	Square miles.	Cost *per* square mile.	Average size of fields in acres.
			R			(*a*)	(*a*)	(*a*)	R	(*b*)
Cadastral	279	535	91	557	1372	198,498	710,879	1,095	95·5	0·89
Topographical	11	13		7	23	...	...	16		
Water area	...	...	...	...	...	...	37,760	59	...	...
Total	290	548	...	564	1395	198,498	748,639	1,170		

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

194. Field work commenced on the 10th November 1905 and closed on the 21st April 1906. The traversing of the whole area which is to come under survey of the Pakôkku district was completed. The country traversed was mostly hilly and covered with scrub jungle and there were very few villages and roads. Water was scarce in the north-east portion of Pauk township at the end of the field season, and fever was very prevalent during November and December. The average number of traversers was 11 for 5½ months and owing to the difficult nature of the country their daily average outturn was only 12 angles and 124 chains. Double chaining was employed in all circuits and the total length of the traverses was 1,262 linear miles. No Great Trigonometrical Survey stations were sufficiently near to allow of connections being made this season, but sufficient connections had been made in previous seasons and in the adjoining Lower Chindwin district to check the traversing. The average linear error *per mille* for the season is 0·51 link and 11·48 feet *per* mile for the whole district. This latter is a large error, and is due to the difficult nature of a large portion of the area traversed, and also to the fact that at the time the greater part of the traversing was done there were no trigonometrical stations to connect with, the triangulation having been done subsequently by No. 10 party. The theodolite was set up at 11,346 stations of which 10,096 were new and were all marked with galvanized iron cylinders, at an approximate cost of 14 annas per station. Azimuths were observed at 62 stations and vertical angles at 1,569. The origin of survey was the same as that of previous seasons.

195. The cadastral survey was carried out by 2 camps. The average number of *amins* employed was 87 for 140 days with 10 Inspectors. The area surveyed cadastrally lay mainly in the Seikpyu township but a portion fell into the Pakokku and Pauk townships. Only 259 square miles consisted of cultivated land which contained 184,747 fields of an average size of 0·89 acre. The rest of the area, 736 square miles, consisted of jungle in which no details were surveyed, the traverse lines being accepted as the boundaries of the *kwins*. The work was checked by 360 linear miles of test lines by Imperial and Provincial officers, and 252 linear miles of independent lines, which give an average of 2·4 linear miles of test survey to each square mile cadastrally surveyed in addition to the Inspectors' check lines. The small area that was surveyed topographically consisted of land in the bed of the Irrawaddy which is subject to periodical inundations, and following the practice of former seasons, only the *kwin* boundaries, limits of cultivation, water-channels and the sites of villages which are occupied during the dry season were mapped. The original maps of this area, 23 in number, have been handed over to the Deputy Commissioner and no copies have been printed.

196. The 16-inch maps were all completed and sent to Calcutta for reproduction with the exception of the 23 mentioned above and those of 42 *kwins* on 136 sheets which have also been sent direct to the Deputy Commissioner, as they contain no interior details and no copies will be printed of them at present. No printed copies of any of the 16-inch maps had been furnished to the local authorities up to the end of the season. The whole of the season's work has been added to the 2-inch fair maps which have been in progress for several seasons,

and all of which have been despatched to head-quarters except sheets $84_{\frac{K}{3,7,11,15}}$ which have been retained as the work of the ensuing season has to be added to them. All these maps have been prepared in the old form. The 3 sheets of arrears 2-inch mapping of the Shwebo district alluded to in paragraph 232 of last season's report, have all been submitted to head-quarters and also 1 sheet of the Pakokku district. During this season 36 traverse charts have been completed on the 1-inch scale and five sent to Calcutta for publication. The Deputy Surveyor General inspected the party at Maymyo to which place the recess quarters of the party have been moved.

197. The cost-rates all include a charge for instruments. That of the cadastral survey is considerably lower than it was last season when it was R114. This is due to the larger area surveyed this season and the small amount of cultivation in it. The cost of the traversing shows a rise of R33 per square mile which is attributable to the smaller area traversed, the more difficult nature of the country, and much sickness amongst the traversers during November and December.

198. During the ensuing season the cadastral survey of the Pakôkku district will be completed, the area remaining for survey being 514 square miles, and 600 square miles will be traversed in the Thayetmyo district, where an area of 2,150 square miles in the Minhla and Sinbaungwè townships is to come under survey. The traversing and cadastral survey of 200 square miles in the Pyapôn district will also be done.

CANTONMENT SURVEYS.

No. 1 SECTION.

199. This was formerly a detachment of No. 15 Party, but was this year placed under the orders of the Deputy Surveyor General. Mr. J. McHatton remained in charge with an establishment of 11 surveyors, 3 computers and 2 draftsmen. During the season the survey of the following 15 cantonments was completed on the scale of 16 inches to the mile. Their bazaars were surveyed on the scale of 64 inches to the mile:—Murree (comprising 6 cantonments), Campbellpore, Kohat, Roorkee, Subathu, Kasauli, Jutogh, Dagshai, Solon and Bakloh. The cantonments of Nowshera, Abbottabad, Dalhousie and Delhi were partly surveyed. The total areas traversed and surveyed and the cost-rates *per* acre were:—

	Acres.	Cost-rate.
Traversed	11,393	R 0·4
Surveyed on the 16-inch scale . . .	8,020	„ 1·4
„ „ 64 „ „	162	„ 0·5

200. Many of the cantonments are situated in the hills and the work was much interfered with by rain. Delays occurred at the commencement of the season owing to changes in the programme having to be made at the request of the military authorities. The survey of Abbottabad was completed but additions and alterations are now being made to the cantonment and these will be inserted on the maps next season if possible. Kasauli also will have to be revisited, although the survey was completed this season, as the boundary was not demarcated at the time of survey. The work at Dagshai and Solon consisted of a revision of the surveys of 1878 to 1881.

201. The maps of 10 cantonments and their bazaars, Cherat, Murree (6), Kohat, Campbellpore and Roorkee were forwarded to the office of the Superintendent, Trigonometrical Surveys, for publication and those of 18 cantonments, namely, Amritsar, Ferozepore, Jhelum, Jullundur, Karachi, Lahore Fort, Mian Mir (part), Ambála, Sialkot, Ráwalpindi, Cherat, and Murree (6) were published, as also those of the bazaars of Fyzabad, Meerut, Multan and Cawnpore.

Next season the following cantonments will be surveyed:— Delhi, Muttra, Shahjahánpur, Sitapur, Benares, Dalhousie, Lansdowne, Ranikhet, Almora, Naini Tal and Landour.

No. 2 SECTION.

202. This is a small detachment temporarily formed in December 1905 for the survey of 18 military cantonments and their bazaars in the Poona and Mhow divisions of the Western Command. The cantonments are being surveyed on the scale of 16 inches to the mile and the bazaars on the 64-inch scale. The cantonments of Poona, Kirkee, Deolali, Purandhar, Baroda, Ajmere, and Khandala were surveyed in outline but the contouring still remains to be done ; Mount Abu, Ahmedabad and Nasirabad were also partly surveyed. The total area surveyed on the 16-inch scale was 10,397 acres and 379 acres on the 64-inch scale. Work was carried on throughout the season, the detail survey having been commenced about the 1st February 1906. No cost-rate can be given as the mapping of no cantonment was completed owing to orders to show contours on the maps having been given very late in the season.

Personnel.

Mr. E. G. Little in charge till 17th August 1906.
Mr. L. J. Pocock in charge from 18th August 1906.
2 Inspectors, 2 Traversers, 7 Surveyors, 2 Computers, 5 Draftsmen.

The Deputy Surveyor General inspected the section at Poona in July and tested some of the work in progress there.

During the ensuing season the cantonments already partly surveyed will be completed and the survey of Ahmednagar, Aurangabad, Neemuch, Sehore, Mhow and Indore will be taken up, leaving Jubbulpore and Pachmari for survey the season after.

No. 3 SECTION.

203. This section was formed this season for the survey of the cantonments of the 9th (Secunderabad) Division including the civil station of Bangalore. Work commenced in February 1906 and continued throughout the year. The survey of the cantonments of St. Thomas' Mount, Poonamallee, Palláverám and Trichinopoly was completed, but the boundaries not having been demarcated the maps cannot be published and final cost-rates cannot be given ; portions of Fort St. George, Bangalore, Wellington and Cannanore were also surveyed. The cantonments are being surveyed on the scale of 12 inches to the mile and the bazaars on the 48-inch scale. The total area surveyed on the former scale was 7,620 acres and on the latter 205 acres, while the total area traversed was 15,112 acres. Five sappers of the Queen's Own Corps of Sappers and Miners were employed on the detail survey.

Personnel.

Mr. L. J. Pocock in charge till 13th August 1906.
Mr. E. G. Little in charge from 14th August 1906.
2 Inspectors, 7 Surveyors, 2 Traversers, 2 Computers, 2 Draftsmen.

204. The Bangalore station and cantonments were surveyed on the 12-inch scale in 1885 and an attempt was made to revise the old maps, but these proved hopelessly out of date and the station has increased so much that an entirely new survey will have to be made and the scale of 16 inches to the mile will be adopted. This will necessitate the retention of the section for another season.

205. The above named 8 cantonments are all that are to come under survey in this Division and they will be completed next season as well as the bazaars of Secunderabad and Bolarum, the total area remaining for survey being 12,482 acres of cantonments and 1,597 acres of bazaar.

The Deputy Surveyor General inspected the section at Bangalore and tested the work there.

TRIGONOMETRICAL SURVEYS.

INDIA TRIANGULATION.

No. 24 PARTY.

206. The programme for the season was to connect the new Kalat Longitudinal series with the Great Indus series and thus base it on the Principal Triangulation of India. Bad weather was experienced at Zamziri hill station, an early fall of snow occurring on 11th December, and the party was delayed a fortnight in consequence. The triangulation was closed on the base Kharko—Gand Pahar on the 1st March 1906. On completion of the triangulation an astronomical azimuth was observed at Gand Pahar H. S.

Personnel.

Captain H. H. Turner, R.E., Officiating Deputy Superintendent, 2nd grade, in charge up to 25th March 1906.
Mr. J. Eccles., M.A., Superintendent, 1st grade, in charge from 26th March to 6th May 1906.
Lieutenant C. M. Browne, D.S.O., R.E., Assistant Superintendent, 2nd grade, in charge from 7th May 1906 to 6th June 1906.
Major G. P. Lenox Conyngham, R.E., Superintendent, 2nd grade, in charge from 5th June 1906 to 27th June 1906.
Lieutenant C. M. Browne, D.S.O., R.E., Assistant Superintendent, 2nd grade, in charge from 28th June 1906.
Mr. C. D. Simons, Sub-Assistant Superintendent, 2nd grade.
„ C. H. Tresham, Sub-Assistant Superintendent, 2nd grade.
3 Recorders and 1 Writer.

Four trigonometrical figures were completed, seven new stations built and fixed, and one astronomical azimuth observed.

The average triangular error was as follows :—

No. 1 Quadrilateral	. . . . .	0″·352
No. 2 „	. . . . .	0″·409
No. 3 Tetragon	. . . . .	0″·609
No. 4 Quadrilateral	. . . . .	0″·276
Mean triangular error for 16 triangles		0″·412

The Kalát Longitudinal series and the Mekran series comprise all the Principal triangulation that has been so far completed in Baluchistan. Of the secondary work but little remains, most of the stations having disappeared.

207. To complete the Principal triangulation of Baluchistan the following work remains to be done:—

(*a*) The Kalát and Mekran series must be continued to longitude 64° and there connected by a meridional series.

(*b*) A branch series must be extended westwards from 64° from the Kalat series to Koh-i-Malik-Siah and another from the Mekran series to Charbar: these, it may be hoped, will be eventually connected about longitude 59°.

(*c*) On the east it is proposed to carry a series north-east from Kalat through Toba and Zhob to the Indus.

SCIENTIFIC OPERATIONS.

OBSERVATIONS FOR AZIMUTH.

No. 22 PARTY.

208. As no officer was available for astronomical work, No. 22 party did not undertake a regular programme of field-work during the year 1905, but was employed on miscellaneous duties under the Superintendent of Trigonometrical Surveys.

Personnel.

Lieut.-Colonel S. G. Burrard, R.E., F.R.S., Superintendent, Trigonometrical Surveys, in charge.
1 Surveyor.
1 Computer.

209. From 1802 to the present time rigorous astronomical observations for azimuth have been regularly taken at intervals of 40 or 50 miles along all Series of the Principal Triangulation: no immediate use had, however, been made of the results. The geodetic evidence furnished by the azimuth observations has now been analysed, and an account of the investigation will be published in the forthcoming Professional Volume No. XVIII.

210. When a comparison is made between a value of azimuth calculated through the triangulation and an observed value, the difference is made up of four entangled components :—

1stly.—The *calculated* azimuth has been adversely affected owing to the projection of the triangulation upon a spheroid that is too small.

2ndly.—The triangulation has been started with a wrong orientation.

3rdly.—The triangulation has slowly accumulated an error of direction in its passage across India, and the azimuths calculated from it have become more and more incorrect, as the distance from the origin has increased.

4thly.—The *observed* value of azimuth is in error owing to the deflection of gravity out of the true vertical.

211. Colonel Lambton observed azimuths in order to deduce a figure for the Earth from the discrepancies between his observed and calculated values. Colonel Everest observed azimuths in order to keep a check upon the direction of his triangulation. General Walker regarded azimuthal observations as so many determinations of the directions of gravity.

From the investigation made at Dehra Dún during the year 1905-06 the following errors of azimuth have been found generated in the triangulation at the extremities of the principal Series.

From Kalianpur in Central India to—

Karachi	−2″·3
Dehra Dún	−0″·1
Calcutta	−5″·9
Chittagong	−5″·4
Akyab	−0″·8
Prome	−1″·9
Moulmein	−9″·1
Vizagapatam	−1″·6
Bombay	−2″·4
Mangalore	−4″·5
Bangalore	−5″·9
Madras	−3″·6
Cape Comorin	−8″·6

212. The negative sign denotes that in every part of India the azimuths calculated from the triangulation are too large. The persistency of the sign may be explained by the supposition that the Principal Triangulation has been started from an erroneous azimuth. The side of origin was from Kalianpur to Surantad and this was given an azimuth of 190° 27′ 6″·29, a value derived from astronomical observations. If we decrease the initial azimuth, all geodetic azimuths become decreased by the same amount. Kalianpur is now known to overlie a line of subterranean density, and as the direction of gravity does not coincide with the vertical, it has not proved a suitable site for the origin of the survey. It would, however, be incorrect to take a mean of the above negative differences and to apply it as a correction to the initial azimuth. The error of azimuth generated in the Indian triangulation tends to accumulate in one direction, and the large errors at Moulmein and Cape Comorin are clearly more due to a steady accumulation than to an error of origin. The true azimuth at Kalianpur will have to be deduced from the results of pendulum observations.

213. A Professional Volume containing an account of the Latitude observations taken in India and of the deduced deflections of the plumb-line has been compiled by the Superintendent of Trigonometrical Surveys during the years 1904—1906. The numerous tables were prepared in the first instance in No. 22 party and subsequently checked in the Computing Office. The volume is now complete and will shortly be published. It will be numbered XVIII.

PENDULUM OPERATIONS.

No. 23 Party.

Personnel.

Major G. P. Lenox Conyngham, R.E.
Babu Hanuman Prasad, Extra Assistant Superintendent, 6th grade.
1 Writer and Computer.
1 Surveyor.

214. During the year 1905-06 the work undertaken consisted of a series of pendulum observations at stations lying, roughly speaking, on a line stretching from Simla to Quetta.

The objects of the season's work were—

(1) To ascertain whether the marked deficiencies in gravity which had been observed in the outer Himalayan ranges and the submontane tracts, both on the meridian of Dehra Dún and on that of Darjeeling, would again be found in the neighbourhood of Simla.

(2) To see whether the pendulums would throw light on the deflections of the plumb-line indicated by the Amritsar-Multán arc of Longitude. (On this arc the plumb-lines are deflected inwards, although the position of the Himalaya and the Suleiman mountains would lead one to expect outward deflections.)

(3) To make a first step towards the examination of the plains of Sind and the Baluchistan mountains.

(4) To make a set of observations at Captain Basevi's station at Mian Mir. This was the last station at which Basevi observed before starting on his journey to Moré, and the only one at which he used the special stand which he had constructed for that difficult expedition. It has been thought that this stand may have been less rigid than the ordinary one, and that therefore his observations at Mian Mir and Moré may require a special correction.

215. One of the difficulties of pendulum operations is to ascertain the temperature of the pendulum. To assist in this a dummy pendulum containing a thermometer had been constructed in Calcutta and much was hoped from its use. Its indications, however, proved untrustworthy, though the reason was not at first apparent. Eventually it was traced to the fact that there was too close a connection between the dummy pendulum and the brick pillar on which the apparatus is erected. The pillars are generally only built a few days before the observations begin and are consequently often damp and colder than the air of the room; the temperature of the dummy pendulum is apt therefore to be unduly lowered by too rapid conduction.

It is hoped that steps now being taken will render the dummy pendulum a valuable adjunct.

216. The time observations have been performed throughout by Babu Hanuman Prasad. An innovation was introduced into the method of using the Transit instrument. Formerly it used to be reversed once or twice during a night's work, now it is reversed in the middle of the observation of each star. The new method has several advantages and the results obtained were very satisfactory; the average probable error of the rate of the clock derived from observations of one star on successive nights is $\pm 0^{s}.047$. This small value testifies not only to the suitability of the method but also to the care and skill of the observer.

217. At no fewer than six of the stations visited it was necessary to compute an orographical correction, that is to say, a correction on account of the irregularity of the surface of the region surrounding the station. Much time and trouble were spent on this subject with a view to rendering the process of calculation more accurate, more systematic and less laborious. A certain amount of success has been achieved but rather in the direction of system than of ease.

218. The results of the season's work are given in the following table :—

Station.	Latitude.	Height above sea level.	Observed g.	g reduced to sea level $= g_o''$.	Theoretical value at sea level $= \gamma_o$.	$g_o'' - \gamma_o$.
	° ′ ″	Feet.	cm.	cm.	cm.	cm.
Simla	31 6 19	7,043	978·842	979·267	979·386	−0·119
Kalka	30 50 8	2,202	979·149	·280	·364	−0·084
Ludhiana	30 55 25	833	·276	·325	·371	−0·046
Pathankot	32 16 33	1,088	·239	·303	·481	−0·178
Mian Mir	31 31 36	708	·385	·426	·420	+0·006
Ferozepur	30 55 48	647	·343	·380	·372	+0·008
Montgomery	30 39 47	557	·323	·356	·351	+0·005
Multán	30 11 11	404	·245	·269	·312	−0·043
Dera Gházi Khan	30 3 49	397	·194	·217	·303	−0·086
Jacobabad	28 16 34	183	·188	·199	·166	+0·033
Sibi	29 32 46	434	·121	·146	·262	−0·116
Mach	29 52 25	3,522	978·962	·173	·288	−0·115
Quetta	30 12 15	5,520	·852	·176	·314	−0·138

219. Turning now to the objects which underlay the choice of stations we find—

(1) At Simla a deficiency very similar to that at Mussooree but considerably less than those at Kurseong, Darjeeling and Sandakphu.

At Kalka a deficiency less than those at Dehra Dún or Siliguri, but at Pathankot one which is markedly greater than has been found anywhere else.

In the following table the figures relating to all these places are collected:—

	Station.	Latitude.	Height.	$g_o''-\gamma_o$.	Thickness of corresponding disc D.	H — D.
		° ′				
Himalayan.	Sandakphu	27— 6	11,766	−0·147	4,180	7,586
	Darjeeling	27— 3	6,966	−0·143	4,070	2,896
	Kurseong	26—53	4,913	−0·130	3,700	1,213
	Mussooree (Camel's Back)	30—28	6,924	−0·109	3,100	3,824
	,, (Dunseverick)	30—28	7,131	−0·115	3,270	3,861
	Simla	31— 6	7,043	−0·119	3,380	3,663
Submontane.	Siliguri	26—42	387	−0·135	3,840	−3,453
	Dehra Dún	30—19	2,241	−0·121	3,440	−1,199
	Kalka	30—50	2,202	−0·084	2,386	−184
	Pathankot	32—17	1,088	−0·178	5,055	−3,967

At Darjeeling we are within sight of the gigantic peaks of Kinchinjunga and Everest. The theory of isostasy requires that where the elevation of the crust is great, there the density of the subjacent strata must be deficient, but it would be unreasonable to expect a constant relation between height and density to hold good for individual peaks or valleys. The truth of the theory has by no means been demonstrated; at present all that can be said is that there is a tendency indicated in the direction to which it leads; and that wide regions must be considered and not isolated spots. The defects in gravity at the Himalayan stations which have so far been visited seem to show that there is a relation between height and density, though they do not support the theory of complete compensation.

The distances of the four submontane stations from the foot of the Himalayas and from the Siwaliks are not identical and the results obtained may be taken to indicate that much depends upon the exact position of each station and that the force of gravity varies rapidly in the submontane tracts. Further investigation may disprove this, but it is certainly desirable that some region be examined in detail so that a definite idea of the form of the trough which seems to lie along the base of the hills may be gained.

(2) The pendulum observations taken at stations situated on a line running across the plains of the Punjab explain the cause of the inward deflections at Amritsar and Multán. Underlying the plains skirting the mountains on either side of the Punjab there are great deficiencies of density equivalent to troughs: under the centre of the Punjab plains an excess exists equivalent to a buried range. Amritsar and Multan are situated near the hidden excess and its attraction on their plumb-lines is more powerful than the attraction of the distant hills.

(3) The observations in Sind and Baluchistan have the same general characteristics as those near the Himalayas. We find deficiencies in the value of g on and immediately below the hills and an excess further off. The large excess at Jacobabad is noteworthy.

(4) The observations at Mian Mir show an excess in gravity of 0·006, whereas Capt. Basevi's results showed a defect of 0·106. But this difference is mainly accounted for by the difference in the adopted value of g at Dehra Dún.

Basevi's difference between Dehra Dún and Mian Mir is 0·311, the value now obtained is 0·320. The discrepancy of 0·009 is not large and we cannot conclude from it that the new stand employed by Capt. Basevi at Mian Mir and Moré was unsatisfactory.

Basevi's value of $g_0'' - \gamma_0$ at Moré was 0·518, on account of the more recently adopted value of g at Dehra Dún we should be justified in reducing this to about 0·400, but even this value is remarkably high and requires corroboration.

TIDAL AND LEVELLING OPERATIONS.

No. 25 Party.

Tidal Operations.

Personnel.

Mr. C. F. Erskine, Officiating Superintendent, 2nd grade, in charge from 9th January 1906.
Mr. J. P. Barker, Extra Assistant Superintendent, 3rd grade, in charge from 1st October 1905 to 8th January 1906.
Mr. H. G. Shaw, Extra Assistant Superintendent, 4th grade.
„ E. H. Corridon, „ „ „ 6th „
Munshi Syed Zille Hasnain, Sub-Assistant Superintendent, 1st grade.
Mr. A. M. Talati, Sub-Assistant Superintendent, 2nd grade.
„ O. N. Pushong „ „ „ „
28 Surveyors, etc.

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

	Stations.	Date of commencement of observations.	Date of closing of observations.	Number of years of observations.	Remarks.
1	*Aden*	1879	Still working	26	
2	*Karachi*	1881	„	25	
3	Okha Point	1874	1875	1 } = 3	Closed on 3rd January 1906. Observations between 1904 and 1905 rejected as unsatisfactory.
		restarted 1904	1906	2 }	
4	*Bombay (Apollo Bandar)*	1878	Still working	28	
5	*Bombay (Prince's Dock)*	1888	„	18	Property of Port Trust.
6	*Madras*	1880	1890	10 } =21	
		restarted 1895	Still working	11 }	
7	*Kidderpore*	1881	„	25	
8	*Rangoon*	1880	„	26	
9	*Port Blair*	1880	„	26	

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

222. The 9 tidal observatories at work were inspected during the year: the registrations have been satisfactory at all of them.

223. The tidal observatory at Okha, at the mouth of the Gulf of Cutch, was re-opened in January 1904 and closed in January 1906, after a complete year's satisfactory tidal registrations had been obtained. The tide-gauge was connected by spirit-levelling with Bench-marks the heights of which had been determined by spirit-levelling in 1874. The length of the line relevelled was about 11 miles in the course of which 6 old Bench-marks were connected. The object of these operations was to test whether any change in the relative level of land and sea had taken place in this vicinity during the last 30 years. The mean level of the sea at Okha was first determined from tidal observations in 1874-75. The results of the investigations prove that no such change is discernible in this neighbourhood.

224. In the following tables are given the annual and decadal percentages of the predicted time, and height errors of high and low water at open coast and riverain stations :—

Percentage of errors in Predicted Times and Heights at open coast stations from Automatic Registrations.

Year.	Number of Stations.	In time.		In height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1896	9	71	70	97	97	97	93
1897	8	71	75	96	97	97	97
1898	9	74	70	96	96	95	95
1899	9	74	66	95	95	93	92
1900	11	66	60	93	88	93	89
1901	11	71	60	93	91	93	91
1902	9	76	67	94	95	96	96
1903	8	80	77	92	93	94	94
1904	6	82	75	99	98	96	96
1905	7	82	79	96	95	96	97
Average of 10 years	9	75	70	95	95	95	94

Percentage of errors in Predicted Times and Heights at Riverain stations from Automatic Registrations.

Year.	Number of Stations.	In time.		In height.			
		Within 15 minutes of actuals.		Within 8 inches of actuals.		Within $\frac{1}{10}$ of mean range at springs.	
		H. W.	L. W.	H. W.	L. W.	H. W.	L. W.
1896	2	56	55	63	42	87	74
1897	2	59	61	75	57	96	91
1898	2	53	59	71	61	90	91
1899	2	55	59	76	65	95	94
1900	2	59	62	70	57	89	87
1901	2	63	65	70	59	90	92
1902	2	63	54	76	53	96	90
1903	2	55	61	70	60	88	87
1904	2	45	61	72	65	94	95
1905	2	52	62	72	57	94	92
Average of 10 years	2	56	60	72	58	92	89

225. The project of re-establishing a tidal observatory at Moulmien has received the sanction of Government, but the question of a suitable site has not yet been definitely settled.

Levelling Operations.

226. During the past year there were two Levelling Detachments at work, and a third is now being organised. Before taking the field both detachments were employed in revising the line of levels from Mussooree to Kolukhet (8 miles) by double levelling, to check the heights obtained by single levelling in May 1905. The general result of the revision was that a slight subsidence was shown to have occurred at Mussooree, but the actual amount was too small to be measured without laborious repetitions of levelling.

227. During the field season Levelling Detachment No. 1 connected 18 Standard Bench-marks in the United Provinces and 1 at Gwalior, and levelled across the Brahmaputra river to link up the line of levels from Parbatipur to Dhubri with the line from Fakirganj to Gauhati; the outturn of work being 131·1 miles of double levelling and 13·2 miles of single levelling. This detachment left Dehra on 8th November 1905 and returned to recess quarters on 11th April 1906.

228. Levelling Detachment No. 2 was employed in levelling from Sukkur to Shikarpur, and from Lahore to Ráwalpindi along the North-Western Railway, and in connecting the Standard Bench-marks at the two latter stations. The outturn of work amounted to 244 miles of double levelling. This detachment left Dehra on 3rd November 1905 and returned on 24th April 1906.

229. The programme for the coming season will be as follows:—

Detachments Nos. 1 and 3 to be employed on the revision of the line of levels between Bombay and Madras, and connecting Standard Bench-marks *en route*.

Detachment No. 2 to work in the United Provinces, Central India and the Punjab, for the purpose of connecting Standard Bench-marks at 10 Cantonment stations, and to complete the lines of levels in the Punjab partially executed last season.

Determination of Heights by the Horizontal Bar method.

230. A system of determining the heights of points situated on steep ground by means of cross staves and a mason's level has been in force in the Levelling party for many years past; it was however considered unsatisfactory and the heights determined with it were only published to the nearest foot. During the past field season the system was revised and improved. A light wooden bar fitted with a pair of wires at each end with which to read the vertical staves, and a pair of brass slides carrying a slow motion screw to hold this bar on the staves were constructed. Experimental observations were taken with the new apparatus in the field and the results obtained were found to agree within very close limits with those of spirit levelling of precision.

This system can now be used with advantage in levelling over steep and intricate ground where the ordinary levels cannot be used.

Refraction observations.

231. The following preliminary results were obtained—

(*a*) From mutual observations between Mussooree and Dehra Dún.
The co-efficient of refraction varied by 0·02 between 8 A.M. and 3 P.M. in both spring and autumn, but as the apparent elevations were affected proportionally to these variations there was no change in the resulting difference of height. Refraction was the same in both seasons.

(*b*) Between Mussooree and Nag Tibba.
The variation in the co-efficient of refraction between 8 A.M. and 3 P.M. was 0·005, but there was no change in the resulting difference of height.

(*c*) Between Mussooree and Nojli.

Refraction varied considerably between 8 A.M. and 3 P.M. during each season, and also between the two seasons themselves. In the autumn the deduced difference of height varied by 70 feet and in the spring by 32 feet between 8 A.M. and 3 P.M.

232. With the aid of the refraction co-efficients obtained from the above-mentioned observations the elevations of the following snow peaks were measured throughout the recess season, Bandar Punch (20,720 ft.), Srikanta (20,120 ft.), Jaunli (21,760 ft.), Kedarnath (22,770 ft.), and Nanda Devi (25,645 ft.); if these observations can be repeated for a series of years it may be possible to deduce the varying effects of refraction and the changes in the heights of these peaks due to the increase and decrease of snow. The measurements are intended to serve as a preliminary step towards the determination of the present rate of growth of the great Himalayan range.

MAGNETIC.

No. 26 PARTY.

233. Field operations were carried out in Chota Nagpur, Orissa, the Agency tracts of the Vizagapatam district (including Bastar and Jeypore States) and Eastern Bengal and Assam, by three detachments. A fourth detachment was employed in filling up gaps in previous season's work but was withdrawn early in March to observe at repeat stations. Transport and other difficulties prevented such rapid progress as in former years, and the detachment working in Orissa suffered so much from the climate that it had to be withdrawn from field work for two months. For these reasons the total number of new stations was only 130, as compared with 206 in the previous season; the total number of stations occupied to date is 938 with 22 repeat stations.

Personnel.

Captain R. H. Thomas, R.E., Officiating Deputy Superintendent, 2nd grade, in charge.
Lieutenant C. M. Browne, D.S.O., R.E., Officiating Assistant Superintendent, 1st grade, from 28th November 1905 to 26th February 1906.
Mr. E. C. J. Bond, Extra Assistant Superintendent, 6th grade.
Mr. H. P. D. Morton, Sub-Assistant Superintendent, 1st grade.
Babu R. P. Ray " " " "
Mr. E. A. Meyer " " 2nd "
Babu N. R. Mazumdar " " " "
16 Observers, etc.

234. From November to February a second Imperial officer, Lieutenant C. M. Browne, D.S.O., R.E., was posted to the party, after preliminary training he observed at four repeat stations.

235. During the recess season the computations of the field work were completed, and the tabulation and reduction of the base station results for 1905 are also practically finished. Observations for log $\pi^2 k$ have been taken with the standard and field magnets and are now under reduction. The field instruments were all compared with the standard at the beginning and end of the field season.

236. The station Declination and H. F. instruments continued to work satisfactorily throughout the year, but at Toungoo the H. F. instrument required opening up on account of interference, it was thoroughly cleaned and a new quartz suspension was mounted and the results have since been satisfactory; the experiments for determining the temperature co-efficient gave discordant results, due presumably to the system not having thoroughly settled down after the mounting of the new suspension, they will be repeated next year. The Vertical Force instrument erected at Dehra Dún has not yet given satisfactory results owing to the very high temperature coefficient; since this instrument was constructed a new pattern of compensating bar has been devised by the manufacturers in conjunction with the Kew authorities, who had experienced similar difficulties with the instruments destined for Toungoo and Kodaikanal, bars of this pattern are now being obtained for the three instruments which have arrived in India and it is hoped that the present difficulties will be overcome. The second V. F. instrument was erected in Barrackpore in July last, but defects in the driving clock necessitating prolonged repairs have caused delays, and the installation cannot be completed till November next. A third

V. F. instrument has recently been received, it is hoped that it will be possible to erect it at Kodaikanal during next field season.

237. The mean values of the magnetic elements at the observatories for 1905 are follows :—

	Declination.	H. F.	Dip
Dehra Dún	2° 39′·9 E.	·33383 C. G. S.	43° 24′·2
Barrackpore	1° 18′·0 E.	·37242 C. G. S.	30° 22′·5
Kodaikanal	0° 31′·9 W.	·37403 C. G. S.	3° 16′·7
Toungoo	0° 48′·4 E.	·38675 C. G. S.	22° 58′·3

238. The secular changes at the base stations for the period 1904-05 deduced from the mean monthly values are as follows :—

	Changes in the year.		
	Declination.	H. F.	Dip.
Dehra Dún	— 0′·9	— 22 γ	+ 6′·7
Barrackpore	— 4′·4	+ 17 γ	+ 3′·0
Kodaikanal	+ 4·7	+ 22 γ	+ 5′·6

Pending the precise reduction of the observations at repeat stations, which will be shortly initiated, it was thought that a preliminary reduction, utilizing only approximate corrections for diurnal variation and instrumental differences, might give a reasonably close approximation to the true secular change, this was accordingly done for such repeat stations as have been established for over three seasons. In the case of declination it was found that a period of even four years was too short to give a reasonable approximation to the true secular change, this rough method not being sufficiently precise for the appreciation of the small changes involved, and this portion of the investigation was therefore abandoned ; it appears certain, however, that easterly declination is decreasing and westerly increasing over the whole of India at a very small average rate, probably about 2 to 3 minutes *per annum*, the rate of change being greater in the south of India than in the north.

In Horizontal Force the results were more promising and indicate that the annual changes are large. The following are the average changes in the districts noted, but the figures should only be regarded as preliminary approximations as in many cases the period used is only two years, and in some, especially in the south of India, the corrections for diurnal variation are at times very large :—

North-Western India and Sind	— 35 γ *per* annum.
North Central India	— 25 γ ,,
South Central India	— 14 γ ,,
Eastern India	— 14 γ ,,
United Provinces of Agra and Oudh	— 26 γ ,,
Bengal	+ 23 γ ,,
Deccan and East Coast	+ 11 γ ,,
South India	+ 14 γ ,,

It thus appears that north of a line passing roughly through Dhárwár and Sambalpur Horizontal Force is decreasing, and south of it increasing. No corrections have been made to the observed results in computing the secular change in dip, but the error arising from this omission is likely to be small owing to the small diurnal range of the Vertical Force component.

The following are the average annual changes in dip that have been found :—

North-Western India and Sind	+ 6′·3 *per* annum.
North Central India	+ 6′·7 ,,
South Central India	+ 5′·7 ,,
Eastern India	+ 6′·5 ,,
United Provinces of Agra and Oudh	+ 5′·3 ,,
Bengal	+ 3′·0 ,,
Deccan and East Coast	+ 6′·3 ,,
South India	+ 7′·4 ,,

239. The values of declination found in India proper range from 3° 50′ E. in the extreme north at Dargai (Malakand) to 1° 5′ W. at Cape Comorin, the general trend of the true isogonals being from east to west. The line of no declination passes from the coast near Kárwár northwards to Belgaum where it turns south through Dhárwár and passing near Guntakal junction it runs south to Tumkar, from Tumkar it trends sharply northward to a point near Secunderabad whence it again turns south to near Cumbum (Southern Mahratta Railway) and then passes through a point some 40 miles south of Ongole. Isolated cases of westerly declination are met with north of this line in Lat. 19° Long. 74° near Bijapur, Bidar, and Yelgonda. The isogonals have been plotted on a chart on the scale of 80 miles to the inch, and it appears that most of the irregularities in the lines are confined to a region which is roughly indicated by the boundaries of the Deccan trap and the nearer outlying parts ; there are however some strikingly abnormal values found outside this area, of these the following are noteworthy :—

(*a*) Ongole 2° 15′ E., where the normal declination is about 0° 0′.
(*b*) Harpanahalli 1° 55′ W., the normal declination of the district being 0° 5′ W.
(*c*) Kuvoy (near Cannanore) 1° 35′ E., where one would expect about 0° 50′ W.
(*d*) Quilon 0° 10′ E., the normal declination being 1° 5′ W.
(*e*) Near Indore 0° 20′ E., ,, ,, ,, 1° 10′ E.
(*f*) Near Pokaran (Rajputana desert) where the declination changes from 3° 5′ E., to 0° 15′ E., in 40 miles.
(*g*) Ganges valley, Buxar, 3° 35′ E., when the normal in about 1° 40′ E.
(*h*) ,, ,, Saran, 0° 45′ E., ,, ,, ,, ,,

Of these, the values at Ongole and Harpanahalli are probably due to the known hæmatite ores of the former and the Sandur magnetites in the case of the latter.

240. Observations for determining the moment of inertia of the survey magnets have been carried out during the recess season with the inertia bars to which reference was made in last year's report. The work has proved arduous, involving the opening up of old computations for the correction of erroneous values for expansion and the investigation of the causes of the differences found in previous years. It is moreover disappointing to find that series of observations on different days with the same magnet while affording very accordant results *inter se* give discordant mean values. The observations are still in progress and until they are computed it is impossible to draw any final conclusions, although, from the evidence already collected, it seems probable that the change in Bar No. 2 as revealed by the Kew measurements of 1901 and 1905 occurred between the recess seasons of 1903-04, and further that in 1902-03 the dimensions were as originally measured and that in 1904—1906 these corresponded to the new Kew values. As regards Bar No. 17, the dimensions appear to have been the same in 1902 and 1906, but this conclusion depends only upon the results obtained from one magnet and it remains to be seen whether further experiments will confirm this view. The most satisfactory result of the experiments is that none of the field magnets appear to have lost weight, and we are therefore in a position to state what their moments of inertia were at any time. The standard magnet No. 17 does appear to have lost weight, but as this rests on the single series of experiments referred to above, it cannot be considered as finally established.

241. A table showing the approximate preliminary values (uncorrected) at the field stations for 1905-06 is appended together with a reference index chart.

242. Next year's programme provides for one detachment working in Eastern Bengal and Assam, one in the difficult country south-east of the Central Provinces, and the remaining two in Burma.

Summary of the Outturn of work of the field parties during the year 1905-06.

TOPOGRAPHICAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Triangulation.											Traverse.					Detail Survey.			
			Instrument used, Diameter in inches.	Area in square miles.	Square miles to each point trigonometrically fixed.	Square miles to each height.	Minor.			Tertiary.			Intersected points.		Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error *per* station in seconds.	Linear error *per mille*.	Area in square miles.	Plane table fixings *per* square mile.	Linear miles of test lines.	Number of *in situ* test fixings.
							Stations fixed.	Triangular error in seconds.	Error *per* mile in feet.	Stations fixed.	Triangular error in seconds.	Error *per* mile in feet.	Number of points fixed.	Error *per* mile in feet.									
8	17	Bombay Forests	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	126	215	119·8	...
4	6	Bengal, 24-Parganas	...	...	...	...	...	...	...	...	...	...	...	...	456	478	1,612	..	...	456	...	206	...
9		Tehri Garhwal Forests	7	100·7	2·8	2·8	...	...	...	32	12	0·5	40	1·8	...	...	...	...	...	80·5	151	...	289
		Chittagong ,,	5	...	...	...	...	...	...	...	...	...	...	...	...	36·8	1,353	2·0	1·5	...	...	...	...
		Pilibhit ,,	5	...	...	...	...	...	...	...	...	...	...	...	...	64	392	0·4	1·6	17	70	...	...
		Katha ,,	5 & 6	...	...	...	...	...	...	...	...	...	...	...	...	115	2,501	5·7	4·6	317·5	166	141	...
		Mu ,,	5	...	...	...	...	...	...	...	...	...	...	...	...	125	2,026	7·7	4·2	252	171	104·5	...
		Rawalpindi ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	44·3	155	72	...
		Lahore ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9	72	15	...
		Bashahr ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	365(a)	...	...	...
		Shahpur ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	474(a)	...	...	...
		Hazara ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	24·8	166	43	...
		Betul (C. P.) ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0·5	60	...	...
		Garo hills ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15·3	273	...	...
		Nowgong ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4	129	...	...
	17	Bombay Forests	6	680	6·6	6·6	...	...	...	93	12	0·4	612	0·6	..	...	...	...	...	630·9	148	180·8	...
		Ganjam—Madras Forests	5 & 6	70	1·6	1·6	...	...	...	8	17	0·3	..	...	..	...	...	...	...	288·5	110		314
	19	S. and N. Malabar, Canara	...	...	...	...	...	...	...	...	...	...	..	...	...	174	3,612	5·0	2·7	194·3	153	100	177
		Godavari ,,	..	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	297·2	107	89·6	55
		Chingleput ,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	51·8	78	19	55
	20	Burma, Lower Chindwin. Pakokku, Amherst Forests. Thaton districts	...	...	..	..	...	...	...	...	...	...	..	...	...	...	..	...	...	682·2	178	380	...
		TOTAL	...	850·7	...	...	...		...	...	...	...	...	...	456	992·8	...	...	...	(b) 3,365·8	...	...	...
2	1	Central Provinces	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,320(c) 766(d)	28	219	1,096
	2	Berar	6	1,850	2·9	2·7	54	10·3	0·15	24	11·9	0·2	535	0·4	...	...	...	...	...	1,122	25·9	545	818
	6	Bengal, 24-Parganas	...	...	...	...	...	...	...	...	...	...	...	..	594	632	2,099	...	...	594	...	267	...
	9	Darrang Forests	5 & 7	345·8	31·6	34·6	..	..	...	7	12	0·3	...	...	...	230	1,942	7·0	8·3	571·3	72	206	...
	12	N.-W. Frontier	6	700	4·9	4·9	13	3·3	0·03	5	4·0	0·1	131	0·2	...	...	...	...	...	753(e)	24	...	...
	14	N.-W. ,,	7	2,210	3	3	...	...	...	70	7	1·4	806	(f)	...	...	...	...	...	736·8	28	...	531
	15	N.-W. ,,	6 & 8	2,150	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)	...	...	...	...	...	1,741·3	34	..	693
	18	Punjab	5 & 6	..	...	..	...	...	...	...	...	...	...	...	6,350	4,497	9,889	3·0	0·2	3,047(g)	20	690	44
	19	Madras Forests	6	2,150	4·3	4·3	...	...	...	60	21	0·4	438	0·7	...	...	...	...	...	...	...	...	...
	20	Burma (Pakokku)	5 & 6	1,622	12	12	...	...	...	42	13	0·7	44	1·1	...	881	11,717	1·9	2·8	...	...	...	...
		TOTAL	...	11027·8	...	...	..	...	...	...	...	...	...	...	6,944	6,240	..	...	...	10,653·4	...	...	...
1	3	Lower Burma	6	3,731	10·2	10·2	15	9·3	0·09	33	5	0·08	323	0·95	...	...	...	...	...	(h) 3,830	7	322·5	651
	10	Upper Burma	6	2,815	5·6	5·6	32	11·4	0·11	42	6·3	0·13	420	1·02	...	470	2,055	3·4	0·7	3,340	5·7	458	1,015
	11	Shan States, Burma	6	737	7·6	8·1	...	...	...	8	5·0	0·11	89	0·27	...	...	..	..	...	2,078	6·5	...	580
		TOTAL	...	7,283	...	...	...	...	...	...	...	...	...	...	..	470	...	...	...	9,248	...	...	...

(a) Linear miles of boundary survey.
(b) Exclusive of 839 linear miles of boundary survey.
(c) Reserves.
(d) Supplementary survey.
(e) Includes 113 square miles of 2-inch reconnaissance and 14 square miles of 1-inch reconnaissance.
(f) Computations incomplete.
(g) Includes 830 square miles of 2 inch revision and 374 square miles of 1-inch resurvey.
(h) 1,594 square miles new survey, 2,096 supplementary survey, and 140 supplementary survey of forests.

Summary of the Outturn of work of the field parties during the year 1905-06.

CADASTRAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Traversing.						Detail Survey.					Record writing.		
			Instrument used. Diameter in inches.	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Angular error *per* station in seconds.	Linear error *per mille*.	Area in square miles.	Linear miles of test lines.	Number of villages.	Number of fields.	Average size of fields in acres.	Area in square miles.	Number of villages.	Number of fields.
16	4	Bengal, Bhágalpur	5 & 6	365 (a)	1,446	11,258	...	...	1,276 (b)	5,677	2,285	1,018,516	0·78	1,108	2,290	924,141
		„ Purnea	5 & 6	70 (c)	178	718	...	...	508	2,344	701	243,064	0·78	485	701	243,064
		„ Monghyr	5 & 6	1,492 (h)	4,685	32,535	...	...	...	...	...	...	...	...	...	...
		„ Patna	5 & 6	54	106	310	...	...	8	46	...	10,614	0·5	8	2	10,614
...	5	„ Midnapur	5 & 6	187	794	5,737	...	...	...	...	...	...	...	...	...	...
		„ Singhbum	5 & 6	573	2,147	19,477	...	...	...	...	...	...	...	...	...	...
		„ Ranchi	5 & 6	873 (d)	2,476	16,855	...	...	... (d)	...	...	...	...	...	...	...
		„ Sonthal Parganas.	5 & 6	819	2,556	17,595	...	...	22	...	...	...	...	...	...	...
...	6	E. Bengal, Dacca	5 & 6	1,638	7,240	49,444	...	...	...	...	...	...	...	...	...	...
		„ Khulna	5 & 6	106	393	2,556	...	...	...	...	...	...	...	...	...	...
...	7	Burma	5 & 6	548	1,262	11,346	0·4	0·5	1,170	1,794	564	198,498	(e) 0·89	...	...	...
		TOTAL	...	(f) 6,725	23,283	...	...	...	(g) 2,984	...	...	...	...	1,593	...	...

(a) Includes 33 miles of traversing for topographical surveys.
(b) Includes 23 square miles of topographical survey.
(c) Includes 275 square miles of hilly ground for topographical survey.
(d) Includes 22 square miles by No. 4 Party.
(e) Calculated on the cultivated area, no survey done in jungle.
(f) Includes 330 square miles of traversing for topographical surveys.
(g) Includes 45 square miles of topographical survey.
(h) Includes Diara Survey.

SPECIAL SURVEYS.

Scale of Survey, inches = 1 mile.	Number of Party.	*Locale* of Operations.	Spirit Levelling Operations.			Traversing.			Detail Survey.		Record writing.	
			Miles levelled over.	Permanent bench marks.	Trigonometrical stations connected with.	Area in square miles.	Linear miles of new chaining.	Number of stations at which the theodolite was set up.	Area in square miles.	Linear miles of test lines.	Area in square miles.	Number of fields.
105·6	Detachment	Calcutta Suburbs	...	...	...	1	44	275	·06	6	·06	1,261
32	„	„ „	...	...	...	1			·35		·35	
16	„	Cantonment Section No. 1, Northern and Eastern Commands.	...	...	...	18	46	3,315	·13	28	...	...
64	„	„ „ „	...	...	...				0·25			
16	„	Cantonment Section No. 2, Western Commands.	...	...	...	25	307	2,896	·16	100	...	...
64	„	„ „ „	...	...	...				0·6			
12	„	Cantonment Section No. 3, Secunderabad Division.	...	...	...	24	209	1,901	·12	40	...	...
48	„	„ „ „	...	...	...				0·32			
...	25	India (Tidal and Levelling)	388	36	5	...	...	...	...	...	...	...
		TOTAL	388	...	...	69	597	...	42·58	...	0·41	...

Statement showing the cost-rate of work executed by the field parties during the year 1905-06.

Number of Party.	Nature and *Locale* of field operations.	Cost-rate *per* square mile.							Stone embedding.	Completion of vernacular records, assessment statistics, etc.	Total cost of party inclusive of charges for instruments for local Governments.
		Triangulation.	Traverse.	Detail survey and preparation of maps on scales of							
				1″	2″	4″	8″	16″			
	Topographical Surveys.	₹	₹	₹	₹	₹	₹	₹	₹	₹	₹
1	Central Provinces	...	...	...	45·6	...	...	...	...	...	88,821(a)
2	Berar	11·9	...	...	63·9	...	...	...	...	...	1,00,840(b)
3	Lower Burma	7·5	...	21·6 / 14·1(c)	...	...	...	...	...	...	93,843
4	Bengal (Purnea)	...	20·0	...	...	...	...	10	...	...	See below.
6	Bengal (24-Parganas Sundarbans).	...	50·4	...	36·3	43·3	...	...	...	...	"
10	Upper Burma	9·3	...	22·4 / 20·2(c)	...	...	...	...	...	...	1,04,133(d)
11	Burma (Shan States)	15·5	...	27·8	...	...	...	...	...	...	74,552(e)
12	North-West Frontier Province.	14·7	...	10·0(f)(g)	105·9(g) / 24·5(f)(g)	...	...	...	...	...	85,859
14	North-West Frontier Province.	17·7	...	...	110·7(g)	...	...	...	...	...	1,49,191
15	North-West Frontier Province.	35·4	...	...	85·8(g	...	...	...	...	...	2,43,667
18	Punjab	...	5·8 / 9·3(h)	7·0(i)	20·2 / 10·3(j)	...	...	...	...	...	1,30,416
	Forest Surveys.										
9	Ráwalpindi and Lahore	...	...	...	...	37·8(g)	...	...	...	...	1,20,283
	Hazára	...	...	...	...	84·8(g)	...	...	...	...	
	Tehri Garhwal	9·3	...	...	...	35·1	...	...	...	...	
	Pilibhit	...	9·5(k)	...	...	17·6(g)	...	...	...	...	
	Chittagong, Durrang, Nowgong and Garo.	1·9	18·7(k)	...	30·5(g)	129·8	...	...	...	...	
	Katha and Mu	...	28·4(k)	...	...	100·3(g)	...	...	...	...	
17	Bombay	13·2	...	...	...	87·4	173·2	...	...	...	82,630
19	Madras	33 (l) / 6·0(m)	28·1	...	...	104·1	...	...	...	...	1,06,926
20	Burma	9·1	42·6(k)	...	...	147·7	...	...	...	...	1,52,254
	Cadastral Surveys.										
4	Bhágalpur	...	44·7	...	...	...	...	76·1	...	58·6	3,17,522(n)
	Purnea	...	33·8	...	...	...	...	73·5	...	45·7	
	Monghyr	...	31·2	...	...	...	...	...	...	...	
5	Midnapur	...	31·5	...	...	...	...	...	...	...	96,278(o)
	Singhbum	...	35·1	...	...	...	...	...	...	...	
	Ranchi	...	34·4	...	...	...	...	...	...	...	
	Sonthal-Parganas	...	33·8	...	...	...	...	...	...	...	
6	Dacca	...	41·2	..	...	...	...	...	...	...	1,99,975(p)
	Khulna	...	44·7	...	...	...	...	...	...	...	
7	Burma (Pakkoku)	...	75·0	...	...	...	...	95·5(q)	16·0	...	1,82,029(r)
Detachment.	Cantonment Section No. 1, Northern and Eastern Commands.	...	6·3(s)(q)	...	...	...	...	1·3(s)(g)	...	...	18,860(t)

(a) Includes ₹3,079 for triangulation charts, ₹4,844 for traversing village boundaries for the Settlement department, ₹14,055 for fair mapping.
(b) Includes ₹1,606 for traversing forest boundaries for the Forest Department.
(c) Supplementary survey.
(d) Includes ₹5,298 for traversing for which no area can be given.
(e) Includes ₹9,193 expended on the instruction of surveyors.
(f) Reconnaissance.
(g) Exclusive of mapping.
(h) Riverain traverse.
(i) Resurvey.
(j) Revision survey.
(k) Cost per linear mile.
(l) For 4-inch survey.
(m) For 2-inch survey.
(n) Includes ₹41,966 for miscellaneous surveys.
(o) Includes ₹6,536 for miscellaneous surveys.
(p) Includes ₹94,307 for topographical and ₹16,326 for miscellaneous surveys.
(q) Does not include cost of preparation of standard maps and charts.
(r) Includes ₹1,663 for the completion of records of Rangoon town, ₹4,754 for traverse charts, and ₹3,606 for fair mapping.
(s) Cost per acre and includes 64-inch survey.
(t) Includes ₹3,960 for mapping.

Statement showing cost of Scientific Parties for the survey year 1905-06.

Number of Party.	Name of Party.	Nature of Scientific Work.								Total cost of Party.
		Astronomical determinations.	Principal Triangulation.	Determinations of Gravity.	Tidal observations.	Preparation of Tide tables.	Levelling operations.	Magnetic observatories.	Magnetic Field work.	
		R	R	R	R	R	R	R	R	R
22	Astronomical	5,507	...	...	...	...	...	...	...	5,507
23	Pendulums	...	...	31,844	...	...	...	...	...	31,844
24	Triangulation	...	52,028	..	...	...	...	...	...	52,028
25	Tidal and Levelling	...	...	...	11,817	24,374	40,103	...	...	76,294
26	Magnetic	...	...	...	...	..	...	11,408	54,355	65,763
	Total	5,507	52,028	31,844	11,817	24,374	40,103	11,408	54,355	2,31,436

APPENDIX.

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1905-06.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	°	C.G.S.	
809	Diamond Harbour.	88 5	22 11 20	88 11 40	29 12	E 1 12	0·3744	
810	Canning	„ 6	22 18 20	88 39 50	29 35	„ 1 10	0·3742	
811	Bangaon	88 7	23 1 50	88 50 20	30 57	„ 1 11	0·3728	
812	Jessore	89 1	23 9 50	89 12 40	31 15	„ 1 12	0·3727	
813	Khulna	90 1	22 49 0	89 33 20	30 40	„ 1 11	0·3727	
814	Barisál	„ 2	22 41 10	90 22 0	30 17	„ 1 5	0·3743	
815	Morelganj	„ 3	22 27 10	89 51 50	29 55	„ 1 3	0·3751	
816	Chandpur	86 2	23 14 0	90 38 0	31 29	„ 1 10	0·3731	
817	Madáripur	„ 3	23 10 50	90 12 30	31 21	„ 1 10	0·3731	
818	Dolaiganj	„ 4	23 42 10	90 25 30	32 26	„ 1 11	0·3708	
819	Sripur	„ 5	24 12 50	90 29 0	33 16	„ 1 19	0·3697	
820	Mymensingh	„ 6	24 46 0	90 23 40	34 27	„ 1 29	0·3670	
821	Jagannathganj	„ 7	24 41 10	89 45 50	34 18	„ 1 2	0·3684	
822	Porabari	„ 8	24 13 20	89 51 30	33 24	„ 1 24	0·3688	
823	Faridpur	„ 9	23 37 10	89 51 10	33 8	„ 1 17	0·3710	
824	Kumarkhali	„ 10	23 51 50	89 14 0	32 33	„ 1 17	0·3692	
825	Chuadanga	85 8	23 38 40	88 51 40	32 13	„ 1 17	0·3700	
826	Krishnagar	„ 9	23 22 40	88 29 10	31 44	„ 1 24	0·3704	
827	Plassey	„ 10	23 46 20	88 17 10	32 5	„ 0 53	0·3718	
828	Nawabganj	„ 11	24 35 40	88 16 0	34 8	„ 1 39	0·3665	
829	Bulbulchundee	„ 12	24 58 50	88 14 30	35 0	„ 1 29	0·3636	
830	Malanchi	„ 13	24 18 40	88 57 50	33 46	„ 1 3	0·3696	
831	Santahar	„ 14	24 48 10	88 59 20	34 16	„ 1 30	0·3671	
832	Fulchhari	90 1	25 11 40	89 37 0	35 12	„ 1 26	0·3646	
833	Kaunia	„ 2	25 47 10	89 25 0	36 28	„ 1 35	0·3621	
834	Cooch Behar	„ 3	26 18 30	89 26 20	37 16	„ 1 43	0·3608	
835	Jainti	„ 5	26 41 20	89 36 30	38 23	„ 2 15	0·3521	
836	Parbatipur	93 3	25 39 10	88 55 10	36 7	„ 1 32	0·3631	
837	Panchabibi	92 4	25 11 30	89 1 40	35 12	„ 1 37	0·3644	
838	Chilahati	91 5	26 14 30	88 48 10	37 0	„ 1 41	0·3601	
839	Siliguri	„ 6	26 42 20	88 26 10	37 55	„ 1 55	0·3572	
840	Radhikapur	„ 7	25 38 30	88 26 50	36 10	„ 1 28	0·3629	
841	Barsoe	„ 8	25 38 50	87 55 40	36 12	„ 1 34	0·3614	
842	Kishanganj	„ 9	26 5 50	87 56 50	36 37	„ 1 35	0·3615	
843	Purnea	„ 4	25 46 30	87 31 10	36 25	„ 1 20	0·3621	
844	Madhipura	96 6	25 55 40	86 47 30	36 29	„ 1 29	0·3611	
845	Banarhat	95 6	26 47 30	89 1 20	38 16	„ 1 40	0·3572	
846	Dhubri Ghat	„ 7	26 1 0	89 59 50	36 31	„ 1 21	0·3636	
847	Goálpárá	„ 8	26 11 10	90 37 40	36 47	„ 1 41	0·3617	
848	Kholabhanda	94 1	26 10 0	91 8 20	36 57	„ 1 35	0·3615	
849	Palásbári	„ 2	26 7 40	91 32 40	36 57	„ 1 33	0·3622	
850	Mangaldai or Karupatia Ghat.	„ 3	26 28 50	92 8 20	37 34	„ 1 43	0·3617	
851	Tezpur	„ 4	26 37 50	92 48 20	38 46	„ 1 11	0·3611	
852	Beháli Mukh	98 1	26 46 20	93 21 50	38 11	„ 1 37	0·3598	
853	Kokila Mukh	„ 2	26 51 10	94 8 50	38 22	„ 1 30	0·3603	
854	Názirá	„ 3	26 54 30	94 43 50	38 30	„ 1 19	0·3601	
855	Sapekhati	98 1	27 6 40	95 9 40	38 53	„ 1 26	0·3599	
856	Márgherita	„ 2	27 17 20	95 41 20	39 5	„ 1 18	0·3594	
857	Táláp	„ 3	27 40 10	95 33 40	39 53	„ 1 29	0·3577	
858	Oating	98 4	26 26 10	93 59 30	37 55	„ 1 46	0·3600	
859	Manipur Road (Dimápur).	„ 5	25 54 50	93 43 50	36 42	„ 1 13	0·3649	
860	Lumding	„ 6	25 44 50	93 10 40	36 12	„ 1 26	0·3666	
861	Kámpur	96 5	26 9 40	92 39 30	36 49	„ 1 27	0·3626	
862	Jági Road (Nakholá).	„ 6	26 7 20	92 11 30	37 6	„ 1 36	0·3646	
863	Shillong	„ 7	25 35 0	91 53 40	35 38	„ 1 21	0·3654	
864	Shangpung	„ 8	25 28 50	92 21 0	35 54	„ 1 40	0·3642	
865	Korongima	„ 9	25 26 10	92 43 30	35 54	„ 1 18	0·3660	
866	Háflang	94 7	25 11 30	93 1 10	35 14	„ 1 33	0·3629	
867	Karimganj	84 1	24 52 0	92 22 10	34 37	„ 1 25	0·3683	
868	Tilágáon	„ 2	24 26 40	91 57 30	33 49	„ 1 20	0·3697	
869	Sáistáganj	„ 3	24 16 50	91 26 10	33 30	„ 1 15	0·3700	
870	Kamalasagar	„ 4	23 44 40	91 9 10	32 26	„ 1 17	0·3720	
871	Laksam	„ 5	23 15 40	91 7 20	31 30	„ 1 12	0·3735	
872	Noakhali	84 1	22 48 20	91 6 30	30 36	„ 1 6	0·3748	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1905-06—contd.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
873	Jamtara	7	23 58 40	86 48 50	32 59	E 1 23	0·3662	
874	Dumka	14	24 15 50	87 14 40	33 17	,, 1 33	0·3664	
875	Godda	15	24 50 20	87 12 30	34 40	,, 1 8	0·3615	
876	Deoghur	8	24 29 0	86 41 0	33 45	,, 1 25	0·3658	
877	Ganwan	9	24 37 10	85 55 20	34 1	,, 1 42	0·3645	
878	Bagodar	10	24 4 50	85 49 30	33 5	,, 1 20	0·3658	
879	Hazaribagh	11	23 59 40	85 22 10	32 38	,, 1 16	0·3682	
880	Chorparan	12	24 22 30	85 15 40	33 33	,, 1 17	0·3645	
881	Emaumgunj	4	24 27 20	84 34 50	33 27	,, 1 14	0·3651	
882	Chatra	5	24 12 10	84 53 0	32 51	,, 1 26	0·3647	
883	Balumath	6	23 50 10	84 47 40	32 21	,, 1 17	0·3710	
884	Lohardaga	7	23 25 30	84 41 10	31 27	,, 1 15	0·3677	
885	Latehar	8	23 45 10	84 29 50	32 16	,, 1 21	0·3698	Re-observed.
886	Daltonganj	3	24 2 10	84 3 40	32 38	,, 1 20	0·3662	
886	Meeral	9	24 11 20	83 42 30	32 56	,, 1 20	0·3671	
887	Dúdhi	10	24 12 40	83 14 30	33 8	,, 1 31	0·3647	
888	Manchee	11	24 39 40	83 25 50	34 10	,, 1 50	0·3617	
889	Sháhganj	10	24 42 30	82 56 40	34 5	,, 1 20	0·3613	
890	Lalganj	11	25 1 20	82 22 10	34 36	,, 1 32	0·3604	
891	Mauganj	2	24 40 50	81 50 40	34 11	,, 1 37	0·3598	
892	Sohagi	3	24 59 20	81 42 0	34 37	,, 1 21	0·3601	
893	Rewah	4	24 33 0	81 17 50	33 50	,, 1 22	0·3611	
894	Rámnagar	5	24 11 0	81 8 50	33 17	,, 1 26	0·3614	
895	Majhuli	6	24 6 50	81 37 0	33 12	,, 1 7	0·3652	
896	Jiawan	7	24 20 20	82 16 20	33 29	,, 1 24	0·3683	
897	Saipur	8	24 2 30	82 41 30	32 44	,, 1 21	0·3653	
898	Goini	9	23 48 0	82 19 20	32 0	,, 1 23	0·3673	
899	Bharatpur	11	23 44 10	81 46 10	32 21	,, 1 14	0·3638	
900	Ninguani	12	23 18 50	82 0 30	31 16	,, 1 17	0·3631	
901	Baikunthpur	13	23 16 20	82 33 0	31 7	,, 1 12	0·3674	
902	Mátin	12	22 43 50	82 25 0	30 32	,, 1 14	0·3085	
903	Korba	13	22 20 30	82 42 30	29 40	,, 0 59	0·3701	
904	Dharamjaygarh	5	22 28 10	83 13 20	29 50	,, 1 6	0·3693	
905	Sikirma	6	22 26 40	83 56 20	29 45	,, 1 4	0·3682	
906	Jashpur	7	22 52 40	84 8 30	30 43	,, 1 7	0·3694	
907	Champa	12	23 13 0	83 45 10	31 11	,, 1 19	0·3673	
908	Kalnai	8	22 46 30	83 30 20	30 24	,, 1 11	0·3701	
909	Bisrampur	13	23 6 30	83 12 10	30 59	,, 1 13	0·3659	
910	Kunra	13	25 22 30	71 2 40	35 1	,, 1 53	0·3489	
911	Khésar	14	25 21 50	70 28 40	34 39	,, 1 37	0·3475	
912	Mithrea	15	25 9 40	70 0 0	35 11	,, 1 39	0·3449	
913	Piareh Koláchi	16	25 1 30	69 26 20	34 32	,, 2 6	0·3471	
914	Talhár	6	24 53 0	68 49 0	34 4	,, 1 43	0·3477	
915	Mirpur Batoro	7	24 44 10	68 15 20	33 52	,, 1 37	0·3476	
916	Sháhbandar	8	24 10 0	67 54 0	32 47	,, 1 33	0·3494	
917	Mirpur Sákro	9	24 33 10	67 37 0	33 33	,, 1 37	0·3476	
918	Mandvi (Cutch)	8	22 49 30	69 22 0	30 20	,, 1 46	0·3547	
919	Jakhau	10	23 13 10	68 43 10	30 53	,, 1 31	0·3534	
920	Banri	11	23 44 50	69 29 40	32 25	,, 1 40	0·3502	
921	Trangeri Bet	12	23 51 20	70 4 20	32 43	,, 0 57	0·3511	
922	Lodhráni	13	23 53 50	70 37 30	32 10	,, 1 30	0·3538	
923	Suigám	15	24 9 10	71 21 10	32 42	,, 1 4	0·3562	
924	Kalavád	10	22 12 20	70 22 50	29 37	,, 0 55	0·3577	
925	Salaya	9	22 18 10	69 36 20	30 1	,, 1 38	0·3582	
926	Dwárka	1	22 14 40	68 57 10	29 39	,, 1 41	0·3562	
927	Gigásarán	11	21 17 0	70 57 10	27 25	,, 0 50	0·3623	
928	Ghoba	11	21 25 40	71 34 20	27 47	,, 0 41	0·3608	
929	Sendwa	14	21 40 50	75 5 20	28 31	,, 0 47	0·3670	
930	Bori	14	22 8 10	77 25 10	28 23	,, 1 9	0·3632	
931	Dhár	15	22 21 20	77 51 20	29 22	,, 1 4	0·3666	
932	Jámundonga	16	22 23 0	78 31 30	29 39	,, 1 0	0·3660	
933	Jangawáni	12	22 23 30	79 9 20	29 32	,, 1 13	0·3694	
934	Hospet	2	15 16 50	76 23 0	14 31	W 0 4	0·3797	
935	Rassul	6	20 37 20	85 19 10	26 5	E 1 4	0·3780	
936	Hondapa	2	20 56 30	84 12 10	26 42	,, 0 57	0·3762	
937	Charmal	9	21 6 20	84 12 50	27 7	,, 0 53	0·3749	
938	Sonpur	3	20 50 40	83 54 30	26 25	,, 0 46	0·3759	
939	Bisipara	4	20 24 50	84 12 30	25 33	,, 0 48	0·3764	
940	Mojjagada	5	20 1 10	84 31 0	24 50	,, 0 43	0·3779	
941	Dashpala	6	20 18 40	84 54 0	25 28	,, 0 49	0·3774	
942	Sihawa	4	20 18 40	81 54 40	25 47	,, 0 54	0·3729	
943	Raigarh	5	19 53 20	82 4 20	24 50	,, 0 53	0·3755	
944	Dabgaon	6	19 27 0	81 24 40	23 48	,, 0 31	0·3758	
945	Jeypore	4	18 51 30	82 34 40	22 37	,, 0 29	0·3767	
946	Padva	5	18 22 20	82 40 40	21 29	,, 0 18	0·3800	
947	Raivalsa	4	18 13 50	83 1 30	21 3	,, 0 41	0·3794	

Abstract showing the approximate magnetic values at stations observed at by No. 26 Party during season 1905-06—concld.

Serial No.	Name of station.	Survey No.	Latitude.	Longitude.	Dip.	Declination.	Horizontal Force.	Remarks.
			° ′ ″	° ′ ″	° ′	° ′	C.G.S.	
948	Bobbili	$\frac{18}{77}$ 5	18 34 30	83 21 10	21 59	E 0 27	0·3794	
949	Rayagadda	$\frac{20}{84}$ 7	19 9 50	83 24 40	23 6	„ 0 25	0·3778	
950	Tikarapara	„ 8	19 37 40	83 29 20	24 2	„ 0 35	0·3770	
951	Dadpur	„ 9	19 58 40	83 14 10	24 45	„ 0 29	0·3761	
952	Junagarh	$\frac{20}{88}$ 7	19 51 50	82 56 10	24 36	„ 0 23	0·3765	
953	Jamgaon or Jaipatna.	„ 8	19 28 10	82 48 20	23 45	„ 0 26	0·3769	
954	Jagdalpur	$\frac{20}{88}$ 9	19 5 40	82 1 40	22 51	„ 0 38	0·3766	
955	Thakawada	$\frac{14}{88}$ 6	18 44 30	81 48 30	22 30	„ 0 28	0·3767	
956	Govindpili	„ 7	18 34 50	82 17 0	21 55	„ 0 31	0·3799	
957	Malkangiri	„ 8	18 21 50	81 53 30	21 33	„ 0 24	0·3802	
958	Pusigudiam	„ 9	17 53 0	81 31 10	20 16	„ 0 25	0·3804	

Repeat Stations.

I	Udaipur	24 35 33	73 41 57	33 37	E 1 26	0·3532	
II	Karáchi	24 49 50	67 2 2	33 58	„ 1 41	0·3464	
III	Quetta	30 11 52	67 0 20	42 54	„ 3 0	0·3238	
IV	Baháwalpur	29 23 27	71 40 37	41 56	„ 2 53	0·3324	
V	Ráwalpindi	33 35 16	73 3 6	48 4	„ 3 43	0·3129	
VI	Bharatpur	27 13 31	77 29 28	38 35	„ 2 2	0·3464	
VII	Bangalore	12 59 35	77 35 58	9 39	W 0 30	0·3814	
VIII	Dhárwár	15 27 26	74 59 35	15 10	„ 0 6	0·3763	
IX	Porbandar	21 38 20	69 37 6	28 32	E 1 16	0·3606	
X	Fyzabad	26 47 27	82 7 40	37 47	„ 1 52	0·3534	
XI	Sambalpur	21 28 3	83 58 26	27 43	„ 0 58	0·3726	
XII	Waltair	17 42 54	83 19 1	20 21	„ 0 23	0·3782	
XIII	Darjeeling	26 59 49	88 16 39	38 14	„ 1 45	0·3567	
XIV	Gaya	24 46 30	84 58 54	34 9	„ 1 16	0·3664	
XV	Secunderábad	17 27 11	78 29 16	20 0	„ 0 23	0·3791	
XVI	Bhusával	21 2 46	75 47 18	26 49	„ 0 56	0·3681	
XVII	Jubbulpore	23 8 57	79 56 44	30 51	„ 1 8	0·3643	
XVIII	Tavoy	14 4 50	98 12 30	12 17	„ 0 42	0·3947	
XIX	Lashio	22 56 47	97 44 40	31 16	„ 0 54	0·3759	
XX	Akyab	20 7 53	92 53 18	25 26	„ 0 49	0·3829	
XXI	Silchar or Cáchár.	24 49 43	92 47 21	34 37	„ 1 22	0·3688	
XXII	Dibrugarh	27 29 24	94 55 40	39 25	„ 1 27	0·3584	

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

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

The survey numbers refer to the published chart: thus No. $\frac{20}{78}$ 3 denotes No. 3 station in the dotted square, the spherical co-ordinates of whose centre are 26° North Latitude, and 76° East Longitude.

All Longitudes are referrible to that of Madras observatory taken at the value 80° 14′ 47″ East from Greenwich.

G. I. C. P. O.—No. 117 S. G.—2-12-07—450—A. D'C.

PART of SOUTH SHAN STATES. | *Magnetic Variation 1°-45′ East.* | BURMA. | *Scale 1 Inch to 4 Miles, or 1:253,440.* | DEGREE SHEET No. 93 H.

Compiled in the Bangalore Drawing Office from Standard Sheets on the Scale of 1 Inch=1 Mile.

No. 427, S. I.—July 07.—1,400.

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Heliozincographed at the Survey of India Offices, Calcutta.

NOTE.—The Longitudes are referrible to the Greenwich Meridian, taking that of Madras Observatory as 80°-17′-21″ East. They require a correction of −2′-27″ to make them accord with the most recent value of the Geodetic Longitude of that Observatory, *viz.*, 80°-14′-54″.

SYMBOLS and ABBREVIATIONS.

State Boundary	
Metalled Road (with Mile-stone)	
Stream or Chaung	Nam or Ch.
Foot-path	
Telegraph Line	
Swamp	
Travellers' Bungalow	T.B.
Post Office	P.O.
Telegraph Office	T.O.
Trigonometrical Station and point with height	△ 5170
Clinometric height	890

REFERENCES and AREAS.

Division	State	Sq. Miles
S. Shan States	Mawkmai	936·72
,,	Mong Nai	799·48
,,	Yawng Hwè	677·55
,,	Hsahtung	389·05
,,	Mong Pawn	366·42
,,	Mong Sit	356·85
,,	Sämkä	219·59
,,	Wänyin	218·94
,,	Hopong	212·12
,,	Lai Hka	138·62
,,	Nam Hkok	108·25
,,	Nawng Wawn	28·40
,,	Sakoi	2·04
,, (Myelat)	Namtok	3·85
	Total	4457·88

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GENERAL REPORT

ON THE

OPERATIONS

OF THE

Survey of India

ADMINISTERED UNDER

THE GOVERNMENT OF INDIA

DURING

1905-06.

PREPARED UNDER THE DIRECTION OF

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

SURVEYOR GENERAL OF INDIA.

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