SURVEY OF INDIA

GENERAL REPORT

1930 TO 1931

From 1st October 1930
To 30th September 1931

PUBLISHED BY ORDER OF

BRIGADIER R. H. THOMAS, D.S.O.,

SURVEYOR GENERAL OF INDIA.

Printed at the Photo.-Litho. Office,
Survey of India,
CALCUTTA,
1932.

Price One Rupee, or One Shilling and Nine Pence.

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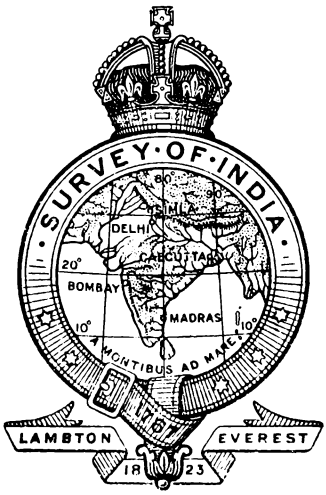

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PREFACE

THE WORK OF THE SURVEY OF INDIA

The department is primarily responsible for all topographical surveys and explorations, and for the maintenance of geographical maps of the greater part of Southern Asia. Also for geodetic work, which includes—the main trigonometrical framework, extending in some cases far beyond the frontiers of India, and control networks of precise levelling based on tidal observatories; tidal predictions and the publication of tide tables for 40 ports between Suez and Singapore; the magnetic survey; astronomical, seismographic, and meteorological observations at Dehra Dūn; and geodetic investigations of an international character, in regard to which India enjoys a unique position between the greatest highlands of the world and a deep ocean extending to the Antarctic. Indian geodesy has thus disclosed by far the largest known anomalies of gravitational attraction in the earth's crust, and these have led to some of the most important developments of modern geodetic research, whilst the Great Trigonometrical Survey of India enjoys an international reputation for its very valuable contributions to estimates of the size and figure of the earth. The calculations of astronomy and some important data in physics depend ultimately on these terrestrial measurements.

In the past the department has also carried out the original large scale revenue surveys for most of India, and was still conducting this work for Central and Eastern India and Burma up to 1905, when all revenue surveys were handed over to the Provinces concerned, together with officers and staff as required, in order to concentrate the energies of the department on a complete new series of modern topographical maps on the 1-inch to 1 mile scale. It was hoped to complete this series by 1930, but owing to retrenchment and the war little more than half has been done up to date, in spite of the reduction of the scale of survey for less important areas. Thus, although new surveys covering an area about equal to that of England are carried out every year, the maps of nearly half the country are still very old and only kept up to date roughly by means of rather perfunctory information supplied by local officials; the old maps are also about two miles out as regards geographical position, being based on a longitude of Madras determined in 1815.

Owing to the serious financial situation of the country this year, vast economies and reorganisation of the Survey of India have become imperative, the consequence of which will result in considerable retardation of work in the future and the completion of the series will not now be possible before 1950.

Boundary surveys and records of international, state, and provincial frontiers have always formed an important item of topographical work; and in recent years there has been considerable progress in the preparation of Guide Maps for important cities and military stations, where the 1-inch to 1 mile scale is quite inadequate.

Miscellaneous. While expending on topographical and geodetic work all funds allotted by Imperial Revenues, the department is steadily developing the policy of aiding local surveys in various ways, on payment by those concerned. These miscellaneous operations include: all forest and cantonment surveys: many riverain, irrigation, railway, and city surveys, and surveys of tea gardens, mining areas, &c., with a great deal of control levelling for the same; administrative assistance and officers are also given in aid of the revenue surveys of various Provinces and States. The Printing Offices do much work

for other Government departments, such as printing special maps, illustrations for Archæological Reports, all diagrams for Patents, &c. The Mathematical Instrument Office gives valuable aid to all Government departments by maintaining a high standard of instrumental equipment, especially in connection with optical work, and by the manufacture and repair of high-class instruments which would otherwise have to be imported from abroad.

Military, &c. The department is also responsible for all survey operations required by the Army, and has been rapidly developing measures to meet the greatly increased complexity of modern military requirements, especially in connection with air-survey. In view of its high military importance, air-survey work for various civil purposes is receiving all possible encouragement and assistance, while the latest methods of stereo-photography are being studied experimentally.

Administration is by the Surveyor General under the Education, Health and Lands Department of the Government of India. The Head-quarters Office is at Calcutta under the Assistant Surveyor General, and there are seven Directors, one for each of the five Survey Circles into which the country is divided, one for the Geodetic Branch at Dehra Dūn, and one for the Map Publication and other technical offices at Calcutta.

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SURVEY OF INDIA

GENERAL REPORT

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INTRODUCTION AND SUMMARY.

1. Annual Reports are published in three separate volumes as follows:

General Report.

Geodetic Report.

Map Publication and Office Work Report.

The first two are for the survey year ending 30th September, while the last is for the financial year up to 31st March.

The Map Publication Report contains all the INDEX MAPS showing the progress of map publication on all scales, with reports on publication and issues, printing and drawing, and of such offices as the Mathematical Instrument Office, which have to conform with the financial year.

The Geodetic Report includes full details of all scientific work.

This General Report only gives brief abstracts of the above (*vide* Abstracts II and III in the Table of Contents), but gives complete reports of the survey operations of the ordinary field parties and detachments. Abstracts I and IV (*vide* Table of Contents) summarize these latter reports and enable the reader to look up such portions as may concern him. The Index Map appearing at the end shows the progress of modern topographical surveys and compilation. Maps of sorts are of course available for all parts of the Indian Empire, but some are very old, and all previous to 1905 were based on the old longitude of 1815, (which was over 2 miles out), and are excluded from the Index Map.

2. General. Brigadier R. H. Thomas, D.S.O., held the post of Surveyor General upto 22nd August 1931, when he proceeded on 3 months' leave, Colonel R. H. Phillimore, D.S.O., officiating during this period.

The post of Assistant Surveyor General was filled by Captain G. H. Osmaston, M.C., R.E., upto 8th October 1930, and thereafter by Major R. S. Wauchope, O.B.E., I.A.

3. *The total cost* of the Department for the past financial year ending 31st March 1931, as compared with that of previous years, was as follows:

	1928-29	1929-30	1930-31	REMARKS.
	Rs.	*Rs.*	*Rs.*	(*a*) Including Rs. 4,40,626 for English Charges (High Commissioner) on Stores, and loss or gain by exchange.
Gross actual cost ...	63,37,651(*a*)	65,06,335(*b*)	60,98,804(*c*)	(*b*) Including Rs. 4,44,690 for do. do.
Deduct receipts and credits	25,34,105	24,79,158	23,31,369	(*c*) Including Rs. 2,99,160 for do. do.
Net actual charges ...	38,03,546	40,27,177	37,67,435	

The total area of new surveys of all kinds completed during the year was 57,582 square miles (p. 26).

4. Organization. The whole area of India and Burma is divided for the purposes of the Survey of India into five Circles. The limits of these are shown by blue lines on the index map at the end of the book. In order that civil administrations and the public may know which Director to address on survey matters, a list of Provinces and States comprised in each Circle is given in the loose slip containing Survey Notices.

It has been decided with the sanction of the Government of India that from the 1st April 1932, the Engraving Office will be entirely separated from No. 1 Drawing Office into which it has merged and re-formed as a separate unit under the Director, Map Publication, the professional work and discipline being placed under the new Head Engraver. The Copper-plate Printing Section will be retransferred, with effect from the same date from the Photo.-Litho. Office to which it was transferred, to the re-formed Engraving Office under the direct supervision of the Head Engraver for professional work and discipline. A Head Engraver was recruited from England and assumed charge of the Engraving Section from 11th March 1931.

The Government of India in their Department of Education, Health and Lands letter No. 397-S dated the 29th November 1930 have sanctioned that the posts of Managers in the Photo.-Litho. Office and the Head Engraver in the Engraving Section of No. 1 Drawing Office shall carry gazetted status.

The following Detachments were formed:

(i) Under the administration of the Director, Geodetic Branch,—
The "Latitude Detachment" with effect from the 1st October in charge of Mr. R. B. Mathur, B.A., Extra Assistant Superintendent.

(ii) Under the administration of the Director, Central Circle,—
The "Khairpur Rectangulation Detachment" with effect from the 1st October, in charge of Mr. Amrit Ram, Sub Assistant Superintendent, with head-quarters at Rohri, to carry out

rectangulation and levelling for irrigation projects in Khairpur State (Sind).

(iii) The "Air Survey Traverse Detachment" with effect from the 1st November in charge of Mr. Jagannath, Sub Assistant Superintendent, with head-quarters at Fyzābād (U. P.), to supply traverse data to the Indian Air Survey and Transport Ltd. for control of Air Survey of certain districts in the U. P. required by the Local Government.

The Magnetic Detachment having concluded its field work was disbanded with effect from the 8th April 1931.

On completion of its work, No. 24 (Sind Rectangulation) Party was disbanded on 1st October 1930, the Latitude Detachment on 17th March 1931, the Khairpur Detachment on 31st August 1931 and the Air Survey Detachment on the afternoon of 30th September 1931 respectively.

5. Notable events of the survey year were as follows:

Gilgit Survey.—About 8,000 sq. miles were surveyed on the scale of $\frac{3}{8}$ inch to 1 mile in the Gilgit Agency. As in Chitrāl, this survey involved high climbs in the glaciated areas of the Hindu Kush, Kailās, and Great Himālayan ranges. Surveys in high mountain regions have hitherto been carried out chiefly by exploration parties specially equipped for the purpose. The undertaking of such work by a regular survey unit during the past few years has resulted in the training of a number of young surveyors in Alpine technique which should prove of value in the mapping of Himālayan areas in the future.

Sikkim and Nepāl Surveys.—By the courtesy of the Sikkim and Nepāl *Darbārs* the original survey of sheets 78 A/4 and 78 A/8 was completed to edge (p. 76).

Primary Triangulation.—The Indian primary triangulation has now been connected to that of Siam by connection of the latter to the revised Möng Hsāt and Great Salween series in latitude 20°30′, and to the Burma Coast Series in latitude 10°30′.

Base Measurement.—A base has been measured at Kengtung, in the Southern Shan States, using the modern invar wire equipment. This is the first base to be measured in India or Burma since that at Mergui in 1881-82, and is of course the first to be measured with the new apparatus.

N. W. F. Province.—One field survey section was mobilized during October and took part in the operations against the Afridis on the Kajūri Plain during the cold weather. The section was disbanded early in March 1931.

Exercises.—An exercise in air survey was carried out by 'E' Company which was also attended by Captain D. R. Crone, R.E., Officer in charge, No. 18 Party, in co-operation with No. 31 (A. C.) Squadron R. A. F. at Quetta.

An Air Survey Exercise was carried out by No. 18 (Air Survey) Party at Murree from the 15th to 19th June.

Major E. O. Wheeler, M.C., R.E., Officer Commanding, 'E' Company attended the Exercise in Command and Staff duties with the Signals of Western Command from 11th to 13th September 1930.

The G. O. C.-in-Chief, Western Command, thanked the Director, Frontier Circle, for permitting Captain D. R. Crone, R.E., to take part in

the Air Survey Exercise carried out at Quetta from May 26th to June 4th and requested that his thanks might be conveyed to Captain Crone. He also thanked Major E. O. Wheeler, M.C., R.E., for all the hard work he and his staff put in, in connection with the Air Survey Exercise and also for his very interesting report. He observed that the information obtained from the exercise was most valuable.

Exploration.—Khan Sahib Afraz Gul Khan continued on deputation with Sir Aurel Stein's Expedition to Central Asia. He rejoined 'A' Company on the 16th September 1931.

Dr. E. Trinkler has furnished the results of his surveys carried out in Lingzitang during his last Tibetan Expedition.

Adventures and Casualties.—Disturbances broke out about last Christmas in Tharrawaddy district in the area under survey by No. 11 Party, one camp having to rapidly evacuate their area with the loss of some Government and private property. Owing to the unsettled state of the district, the operations of No. 11 Party have been suspended since December last. The party has now been entirely withdrawn from the area and has been allotted a fresh programme in the Mogok (Ruby Mines) sub-division of Katha district and the adjacent territory of Northern Burma.

The Surveyor General records with the deepest regret the death of the following officers:

Lt.-Colonel H. T. Morshead, D.S.O., R.E., Director, Burma Circle, who was shot dead by some unknown person while out riding at Maymyo, on the morning of the 17th May 1931.

Lieut. C. J. Price, R.E., on the 22nd June 1931, drowned whilst fishing off the coast of Cornwall.

Lieut. I. M. Cadell, R.E., who died of pneumonia at Loi Hkiao H. S. in the Southern Shan States, while completing the connection between the Indian and Siamese systems of primary triangulation.

Seven khalasis and one private servant in No. 15 Party also died, mostly of beri-beri and fever.

Two deaths from malaria and one death from cholera occurred in No. 4 Party (p. 73). One death from malaria and one death from colic occurred in No. 9 Party (p. 75).

Conferences.—On the 9th June 1931 Lt.-Colonel S. W. S. Hamilton, D.S.O., R.E., Director, Frontier Circle, attended what is hoped to be the last of a series of conferences held by the Army Department over the past few years to decide the conditions of service for civilian personnel on mobilization.

Lt.-Colonel S. W. S. Hamilton, D.S.O., R.E., Director, Frontier Circle, while on tour in November 1930 conferred with the Brigadier, General Staff Northern Command and with the G.O.C. Peshāwar District. He also visited Miri Khel and inspected the work and personnel of No. 1 Field Survey Section which was formed in October 1930. Subsequently he conferred with the Signal Officer-in-Chief, Army Head-quarters, and other officers at Delhi in December 1930 regarding Mobilization arrangements.

As a result of his visit to Army Head-quarters it has now been agreed that Signallers required for Indian Field Survey Companies will be provided on mobilization, under arrangements to be made by the Adjutant-General's Branch.

Lectures.—Lt.-Colonel L. G. Crosthwait, I.A., Director, Southern Circle, delivered lectures on "Surveys in Peace" and "Surveys in War" at Poona on the 19th and 20th September 1930.

Lt.-Colonel C. M. Thompson, I.A., Officer in charge, No. 12 Party delivered two lectures on the 12th and 20th February 1931 to the North Bengal Mounted Rifles at their Annual Camp of exercise at Jalpaiguri on the subject of Map Reading and Sketching.

Instruments.—An improved pattern of Macleod Bar was designed and made in the Workshops at Dehra Dūn. This bar known as the "Penney Bar" is now in constant use with the Duplicating Presses in the Photo.-Zinco. Office and it is hoped that by its aid the making of paper mosaics of Plane-table Sections will eventually be abolished.

Lt.-Colonel R. F. Barber, D.S.O., M.I.Mech.E., R.A.O.C., Assistant Director of Ordnance Services (Technical), Army Head-quarters, Simla, accompanied by the Inspector of Guns, Cossipore, visited the Mathematical Instrument Office on the 9th June 1931 and discussed matters relative to Dial Sights.

Distinguished visitors.—Their Excellencies the Right Honourable the Earl of Willingdon, P.C., G.C.S.I., G.C.M.G., G.C.I.E., G.B.E., Viceroy and Governor General of India and the Countess of Willingdon were pleased to visit the Geodetic Branch Offices at Dehra Dūn on the 30th April 1931.

His Highness the Mahārāja of Sirmūr visited the several Offices of the Geodetic Branch on the 7th January 1931.

The Hon'ble Khan Bahadur Mian Sir Fazl-i-Husain, K.C.I.E., Kt., Member in Charge of the Government of India, Department of Education, Health and Lands, visited the Head-quarters Offices at Calcutta on the 19th December 1930.

Mr. Ram Chandra, M.B.E., I.C.S., Joint Secretary, Department of Education, Health and Lands, and Mr. A. D. Blascheck, F.C.H., Inspector General of Forests, visited the several Offices of the Geodetic Branch on the 19th December 1930.

The Hon'ble Sir Steuart Pears, K.C.I.E., C.S.I., Chief Commissioner, North-West Frontier Province, visited the office of No. 18 (Air Survey) Party at Peshāwar on the 1st May 1931.

6. Appreciations.—The following extract from an article "Geodesy in India" which appeared in Nature No. 3196, Volume 127 for 31st January 1931 (review of Geodetic Report, Volume V) is published for information:

> "The Survey of India has made remarkable contributions to "geodesy in the past. It is doubtful if any single volume has "approached in interest and instruction that of the year under "review".

The following is an extract from a letter from Mr. Visser regarding surveyor Muhammad Akram who was attached to the Visser Expedition:

> "The principal region which was unexplored in the Shyok district "is now mapped. The surveyor acted *splendidly*. He had a "very hard time. I think he deserves to get on".

With reference to para. 6 of Survey Notes for June 1930, the following is an extract from the yearly report of the Officer in Charge, Bacteriophage Inquiry, Bankipore, to the Indian Research Fund Association:

"For the purpose of filling the bottles, special fillers were made for "us by the Mathematical Instrument Office, Calcutta. That "institution made them in an exceptionally short time, which alone "enabled me to prepare the necessary quantity of Bacteriophage "for our experiments at Puri. They were excellently made, and "answer all the requirements. Actually it is the only apparatus "made in India I have, which perfectly answers its purpose".

The Superintendent, Mathematical Instrument Office, has received the thanks of the Bridge Engineer, Bengal Nāgpur Railway, for valuable assistance and advice in the design of the clockwork recording arrangement for a new pattern Bridge Seismograph.

7. Personnel.—Casualties, retirements and recruitments were as follows :—

Class I Officers—Lt.-Colonel F. F. Hunter, D.S.O., I.A., Messrs. E. G. Hardinge and W. G. Jarbo retired.

Dr. J. deGraaff Hunter, M.A., Sc.D., F.Inst.P., was confirmed as Director and Lt.-Colonel J. D. Campbell, D.S.O., R.E., was appointed Director (temporary).

Captains G. W. Gemmell, I.A., J. B. P. Angwin, R.E., and Mr. E. A. Meyer were confirmed as Superintendents.

The following officers were confirmed in their appointments as Assistant Superintendents :

Lieut. C. J. Price, R.E.
,, R. H. Sams, B.Sc., R.E.
,, C. A. K. Wilson, R.E.

Captain W. G. Irvine-Fortescue, M.C., R.E., and Lieuts. J. S. O. Jelley, R.E., and R. P. Buchanan, B.A., R.E., were appointed to the Department.

Class II Officers—Messrs. R. P. Ray, C. West and R. E. Saubolle retired. Mr. P. G. Burby resigned.

Rai Sahib Chuni Lal Kapur reverted from foreign service with the Bhopāl Darbār on 16th July 1930.

Rai Sahib A. K. Mitra, Officiating Chief Draftsman, Map Publication Office, and Mr. F. H. Grant, Officiating Head Draftsman, No. 1 Drawing Office, were confirmed in their respective appointments. Mr. O. N. Pushong was confirmed as Chief Draftsman, Forest Map Office.

Mr. F. E. R. Calvert was dismissed from the public service. Two probationers were discharged.

Seven probationers in Class II service were confirmed in their appointments.

Upper Subordinate Officers—Messrs. Jit Singh Rawat, Abdul Aziz Khan and Latif Khan retired. Mr. Amrit Ram died.

Two Lower Subordinate officers were promoted to the Upper Subordinate Service.

Ten candidates, one of whom was a Geodetic Computer, were appointed on probation in the Upper Subordinate Service and posted for training under the orders of the Director, Geodetic Branch.

I.—ABSTRACT OF SURVEYS IN EACH PROVINCE AND STATE.

8. The prime duties of the Survey of India are geodetic, topographical, and geographical, but the department is also developing co-operation with local survey agencies, with a view to mutual economy, and is now doing a considerable amount of miscellaneous outside work on payment, besides advising and assisting Provincial Governments with local and settlement surveys as required. The following abstract shows the nature and *locale* of the field operations actually carried out by the Department during the past year, grouped under the following sub-heads:—

Air Surveys.	Riverain Surveys.
Exploration.	Boundary Surveys.
Topographical Surveys.	Geodetic.
Forest Surveys.	Framework.
Cantonment and City Surveys.	Levelling.
Cadastral Surveys.	Miscellaneous.
Railway Surveys.	Training.

9. N. W. F. Province, Kashmīr and the Gilgit Agency.

Air surveys in Tīrāh and Mohmand Tribal territory. Supplementary air survey in Peshāwar (p. 59).

Topographical surveys in Bannu district in the Khyber Agency, in tribal territory of the Dīr, Swāt and Chitrāl Agency and Hazāra district and in the Gilgit Agency and Baltistān (p.p. 55, 56).

Geodetic. Observations of latitude at 8 stations (p. 12).

Framework. Triangulation and traversing in the Bannu district (p. 56).

Magnetic. Magnetic observations at 1 station (p. 13).

10. Baluchistān.

Topographical surveys in Kalāt State (p. 58).

Cantonment surveys. Corrections to the 16-inch map of Quetta Cantonment (p. 58).

Framework. Triangulation in Kalāt State (p. 58).

Magnetic. Magnetic observations at 1 station (p. 13).

11. Sind.

Framework. Triangulation in Lārkāna and Karāchi districts (p. 58).

12. Punjab, Punjab States and Delhi.

Topographical surveys in Rāwalpindi, Lahore, Amritsar, Gurdāspur, Siālkot, Gujrānwāla and Shekhūpura districts (p. 55).

Geodetic. Gravity at 6 stations (p. 12).

Latitudes and longitudes at 4 stations (p. 13).

Observations of latitude at 18 stations (p. 12).

Framework. Triangulation in Patiāla State (p. 63).

Rectangulation in Ferozepore, Ludhiāna, and Hissār districts and in Faridkot, Patiāla and Kalsia States (p. 60).

Levelling. Secondary levelling for the Bhakra Dam Irrigation Project in Ferozepore, Ludhiāna, Hissār, and Rohtak districts and in Patiāla, Faridkot, Nābha, Jind and Simla Hill States (p. 87). Tertiary partal

levelling from N. to S. and check-levelling of single tertiary lines from E. to W. in Bahāwalpur State (p. 87).

Tertiary levelling in Ferozepore district and in Faridkot and Kalsia States (p. 60).

Magnetic. Magnetic observations at 6 stations (p. 13).

Miscellaneous. 4-inch detail survey in Muzaffargarh district (p. 60).

13. Rājputāna Agency, Ajmer-Merwāra and Bīkaner.

Topographical surveys in Ajmer-Merwāra district and Jaipur, Jodhpur and Tonk States (p. 62).

Geodetic. Gravity at 11 stations (p. 12).

Latitudes and Longitudes at 5 stations (p. 13).

Observations of Latitude at 18 stations (p. 12).

Framework. Triangulation in Bīkaner, Jaipur, Jodhpur, Būndi, Kishangarh, Shāhpura, Udaipur and Tonk States and Ajmer-Merwāra district (p. 62).

Traversing for large scale survey of Kailāna Tank and Jodhpur town in Jodhpur State (p. 62).

Levelling. Fixing of check-levelling bench-marks by high precision levelling for the connection of the proposed new Standard bench-mark at Bīkaner (p. 14).

Tertiary levelling in Jodhpur State for large scale survey of Kailāna Tank (p. 62).

Magnetic. Magnetic observations at 6 stations (p. 13).

Miscellaneous. Large scale survey of Kailāna Tank and Jodhpur town in Jodhpur State in continuation of 1927-28 work (p. 62).

14. Central India Agency and Gwalior.

Topographical surveys in Rewah State (p. 64); in Bhopāl, Narshinghgarh and Rājgarh States of the Bhopāl Agency, and in Gwalior State (p. 62).

Geodetic. Gravity at 2 stations (p. 12).

Levelling. High precision levelling from Dhūlia to Sehore viâ Dewās and from Bīna to Gwalior viâ Jhānsi (p. 14).

Magnetic. Magnetic observations at 1 station (p. 13).

15. United Provinces.

Topographical surveys in Mirzāpur district (p. 64).

Cantonment and City surveys. Revision survey of Chakrāta Cantonment and revision survey for town guide map of Lucknow (p. 65).

Framework. Traversing for Air surveys in Alīgarh, Fyzābād, Bareilly, Pīlibhīt, Shāhjahānpur, Kheri and Gonda districts. (p. 66).

Levelling. High precision levelling from Bīna to Gwalior viâ Jhānsi (p. 14).

Magnetic. Magnetic observations at 5 stations (p. 13).

16. Central Provinces.

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Forest surveys in Bastar State (p. 68).

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Levelling. High precision levelling from Bīna to Gwalior viâ Jhānsi and from Mhasvād to Akola and back (p. 14).

Magnetic. Magnetic observations at 5 stations (p. 13).

17. Bombay Presidency, States of Western India and Baroda.

Topographical surveys in Belgaum, Dhārwār, Bijāpur and North Kanara districts, Kolhāpur and Savanūr States and the Southern Marātha Jāgīrs and Goa (p.p. 69, 70).

Framework. Triangulation in Belgaum, and Bijāpur districts, Kolhāpur State, Southern Marātha Jāgīrs and Portuguese Territory (Goa).
Traversing in Dhārwār, and North Kanara districts (p. 70).
Rectangulation in Thar Pārkar district and Khairpur State in Sind (p. 67).

Levelling. High precision levelling from Baroda to Bombay viâ Surat, from Mhasvād to Dhūlia, from Dhūlia to Sehore viâ Dewās and from Mhasvād to Akola and back. (p. 14).
Tertiary Levelling for the Lloyd Barrage in Sukkur district and for the preparation of special contour charts in Khairpur State, in Sind (p. 67).

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18. Hyderābād.

Topographical surveys in the Warangal district (p. 68).

Magnetic. Magnetic observations at 2 stations (p. 13).

19. Madras Presidency, and Madras States.

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Forest surveys in the Central Salem Forest Division (p. 71). Special forest surveys in Ganjām district (p. 75). Several reserved and protected forests in the Ganjām Forest Division were included in the ordinary survey (p. 75).

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20. Bihār and Orissa.

Topographical surveys in Cuttack and Angul districts (p. 74) and Purnea district (p. 77), in Athgarh, Barāmba, Dhenkānāl, Hindol, Tigiria, Baud Daspalla, Khandpara, Nayāgarh and Narsinghpur States (p. 74).

Forest surveys. Several reserved and protected forests in the Angul Forest Division were included in the ordinary survey (p. 75).

Framework. Traversing in Balasore, Shāhābād, Gaya and Patna districts and Mayūrbhanj State (p. 73). Triangulation in Bonai, Pāl Lahara Bāmra and Rairākhol States (p. 75).

Levelling. Secondary levelling for the Bihār and Orissa Flood Area Irrigation Project in Balasore, Puri, and Cuttack districts and for the East Indian Railway on lines from Pradhānkhunta to Pāthardi, from Dhānbād to Jamuniātānr, from Mānpur to Luckeesarai and from Patna to Gaya (p. 87).

21. Bengal Presidency and Sikkim.

Topographical surveys in Midnapore, Bānkura, Hooghly, Howrah, Murshidābād, Birbhūm, Burdwān, (p. 73); Jalpaiguri, Dināpur, Rangpur and Darjeeling districts, (p. 77); in Cooch Behār State, Sikkim, and Nepāl (p. 77).

Forest surveys. Several reserved forests in the Jalpaiguri and Darjeeling Forest Divisions were included in the ordinary survey (p. 78).

Framework. Triangulation and Traversing in Tippera, Noākhāli and Chittagong Hill Tracts districts and Tripura State (p. 77).

Levelling. Secondary levelling from Tinpahār to Purnea (p. 87). Levelling in Darjeeling district (p.p. 77, 78).

Miscellaneous. Six-inch town surveys in Darjeeling district (p. 77).

22. Assam and Bhutān.

Framework. Triangulation in Lushai Hills district (p. 76).

Miscellaneous. Special large scale surveys of Digboi oil-field private estate in Lakhimpur district (p. 76).

23. Burma, Andaman and Nicobar Islands.

Topographical surveys in the Henzada, Prome, Pegu, Thayetmyo, Tharrawaddy, Toungoo, Katha, Myitkyina, and Upper Chindwin districts, Northern Shan States, Möng Mit State, and Somra Tract (p.p. 79—83).

Forest surveys in the Thayetmyo Division of the Delta Circle, Zigon Division of the Hlaing Circle, Mansi Division of the Northern Circle and Upper Chindwin Division of the Chindwin Forest Circle (p. 84).

Framework in the Upper Chindwin district and Somra Tract (p. 80). Primary triangulation in the Southern Shan States and Victoria Point. Measurement of a base line at Keng Tung (p. 13).

Levelling. Secondary levelling from Taunggyi to Keng Tung and for the Burma Railways across Irrawaddy bridge near Sagaing (p. 87).

Miscellaneous. Special survey of the Hlawga Rubber Estate near Rangoon (p. 82).

II.—ABSTRACT OF GEODETIC OPERATIONS.

DIRECTOR:— { Dr. J. de Graaff Hunter, M.A., Sc.D., F. Inst. P., from 1-10-30 to 19-4-31.
Lt.-Colonel F. J. M. King, R.E., from 20-4-31.

24. General.—Besides geodetic work, the Director, Geodetic Branch, administers the following offices at Dehra Dūn:—*No. 2 Drawing Office*, the *Forest Map Office* and the *Publication and Stores Office*, whose work is reported in the annual Map Publication and Office Work Report; and also the following survey operations which are reported in other parts of the General Report:—*Levelling* carried out in aid of special engineering projects, *vide* paras. 153-55; *Training School* (paras. 156-57).

25. Geodetic.—Purely geodetic operations include miscellaneous computations and research, preparation and publication of records, observatory work (astronomical, magnetic, seismological and meteorological); important series of triangulation, geodetic levelling, precise latitudes, longitudes, azimuths, and gravity determinations, in all parts of India; and prediction of tides at 40 eastern ports between Suez and Singapore.

These geodetic operations are fully described in the annual Geodetic Report of the Survey of India. The following is a brief abstract of the geodetic operations described in the Geodetic Report for the current year, (Vol. VII), which includes complete index maps and detailed results.

Geodetic Operations for 1930-31.

26. Observatory Section.—The continuous record of the longitude of Dehra Dūn was maintained by bi-weekly observations with the bent transit, and by the reception of the Bordeaux and Rugby time-signals. The Riefler clock has been running well. The new Shortt clock has been fitted with improved means of reading the arc.

The latitude variation programme has been continued, the usual difficulty being met with in the monsoon months.

The invar wires of the base-line apparatus have been standardized on their return from the field, and their coefficients of expansion have been determined. The two fundamental standards, nickel and silica metres, have been returned to the National Physical Laboratory for re-standardization.

The steel tapes of the levelling party have been regularly checked and the levels overhauled. A revised pattern of Hunter Short Base has been prepared. Various new instruments have been examined.

The magnetic observatory maintained its continuous record of the three magnetic elements. The Omori Seismograph has been in regular operation and meteorological observations have been made twice daily.

27. Computing Office.—The computation of the western half of the revised Möng Hsat series, as observed by No. 15 Party in 1929-30, has been completed. The Chittagong series has been adjusted between its terminal stations in the Manipur Meridional and Burma Coast series. The part of the new Geodetic Handbook dealing with computation of triangulation has been sent to press.

The rough graphical adjustment of minor triangulation in sheets 34 and 39, which was attempted but abandoned in 1927 on account of the confusion of the old records, has been taken up again and charts showing the necessary corrections are being prepared.

All the topographical astronomical computation forms have been revised and reprinted to suit changes in the arrangement of the Nautical Almanac. The new forms are primarily intended for use with the abridged edition, but the complete edition can also be employed.

19 Persian and 4 Indian triangulation pamphlets have been compiled. 4 new pamphlets have been passed through the press, and 3 have been reprinted. Three levelling pamphlets have been reprinted, and addenda to five others have been printed.

The preservation and maintenance by local officials of protected triangulation stations and bench-marks have been supervised.

The following publications have been seen through the press:—

(*a*) Geodetic Report, Vol. VI.
(*b*) Supplement to Geodetic Report, Vol. VI.
(*c*) Auxiliary Tables, Part IV (Triangulation Tables only).

28. Tidal Section.—Automatic registrations were continued at Aden, Basra, Karāchi, Bombay, Madras, Kidderpore, Rangoon, Trincomalee and Colombo. Observations on tide-poles were continued at Bhāvnagar, Chittagong, Akyab and Pilakāt Creek (Rangoon river).

The tidal observatories at Kidderpore and Bombay were inspected by the port authorities in July 1930 and March 1931 respectively. Aden tidal observatory was dismantled in March 1931 for rebuilding and was started again in May 1931, visual observations being made in the interval.

The "Tide Tables for the Indian Ocean" for 1932 were completed and advance copies of certain ports were prepared and sent to the Hydrographic Departments of the Admiralty, United States and Japan.

29. Latitude Detachment.—Astronomical latitudes were observed with the small Zenith telescope at 44 stations situated at intervals of about 12 miles along a north and south line from the Banihāl Pass to Ajmer; 8 stations being in Kashmīr, 18 in the Punjab and 18 in Rājputāna. These observations furnish a very valuable section of the Indian geoid connecting up with the observations made in Kashmīr in 1925. The close intervals at which observations have been made, and the careful alignment of the stations, gives this section a degree of precision which has never before been attained.

Two nights' work was done at each station with an average of 8 pairs of stars each night. 32 stations were coincident with primary triangulation stations, but at 12 stations the position was found by resection from surrounding topographical triangulation. The observer was Mr. R. B. Mathur, B.A.

30. Gravity Observations.—(No. 14 Party).—Observations to determine the force of gravity were made at 22 stations distributed as follows:—Bahāwalpur State, three; Punjab, three; Jaisalmer State, three; Bikaner, two; Jodhpur, one; Ajmer, one; Neemuch, one; Ratlām, one; Gwalior State, one; Jaipur State, two; Kotah State, one; Central Provinces, three. Major E. A. Glennie, D.S.O., R.E., was in charge.

Gravimetric observations, using a gradiometer, were made in Bahāwalpur and Jaisalmer States.

31. Latitude Observations.—(No. 14 Party).—Latitude observations were made at four stations in Bahāwalpur State and five stations in Jaisalmer State.

32. Longitude Observations.—(No. 14 Party).—Longitude observations were made at four stations in Bahāwalpur State and five stations in Jaisalmer State.

33. Triangulation.—(No. 15 Party).—Two detachments were employed on primary triangulation in Burma, as a result of which connections have now been made with the Siamese Survey in latitudes 20°30′ and 10°30′. No. 1 Detachment started in the middle of the Möng Hsat series, where work had ceased the previous year, and proceeded towards the east connecting up with the Siamese triangulation. The series was then continued towards the north and connected with the Great Salween series near Kengtung. The party suffered a great loss in the death of Lieutenant I. M. Cadell, R.E., from pneumonia on December 27th. He was replaced by Captain G. Bomford, R.E.

On completion of the main series a base was measured at Kengtung, and connected to the previous year's triangulation. The modern apparatus (invar wires in catenary) was used, and the base was measured in both directions with two different pairs of wires. The base is about 8 miles long, over flat ground, mostly paddy fields. The two measures differ by 1 part in 2,000,000. An astronomical azimuth was observed at Kengtung, where it is proposed to form a Laplace station. Rougher azimuths and latitudes were observed at 4 neighbouring stations to measure the deviation of the vertical.

A Wild Precision theodolite was used throughout, and it generally behaved extremely satisfactorily. Observations were made at 15 stations, the average triangular error being 0″·77. At a few stations in the middle of the season some trouble was caused by slip of the lower plate, but this was remedied by a change of the programme of observation.

No. 2 Detachment, under Mr. M. N. A. Hashmie, B.A. made a connection between the terminal stations of the Burma Coast series and the Siamese primary triangulation in latitude 10°30′. Observations were made at 8 stations with a 12-inch theodolite, the average triangular error being 0″·32. The reconnaissance had not been carried out in advance, and in very thick jungle the undertaking proved a difficult one.

34. Magnetic Detachment.—A magnetic detachment under Mr. Shyam Narain, B.Sc. visited 37 repeat stations in Northern India, and made comparative observations at Alībāg observatory. These stations are all those which are dependent only on the Dehra Dūn and Alībāg observatories. It had been hoped to reopen the Toungoo and Kodaikānal observatories and to observe the remaining repeat stations during 1931-32, but financial stringency has resulted in postponement.

35. High Precision Levelling.—(No. 17 Party).—Out of a total length of 16,000 miles of levelling of high precision required for the new geodetic level-net of India, 584 miles were completed during 1930-31, making a total of 8,977 miles completed up-to-date.

During 1930-31, 964 miles of single levelling on the high precision system were carried out as follows :—

In fore direction only.—264 miles.

Bombay.	Baroda-Surat-Bombay	264 miles.

In back direction only.—468 miles.

Bombay.	Mhasvād-Dhūlia ...	47 ,,
Bombay and C. I.	Dhūlia-Dewās-Sehore	256 ,,
C. P., U. P. & C. I.	Bina-Jhānsi-Gwalior ...	165 ,,

In both directions.—232 miles.

Bombay and C. P.	Mhasvād-Akola ...	232 ,,

Preparations have been made for the renewal of the Standard Bench Mark at Bikaner, whose safety is endangered by the encroachment of habitations.

Reports of secondary and tertiary levelling will be found under Section X of this report (p. 87).

III.—ABSTRACT OF MAP PUBLICATION AND OFFICE WORK.

36. Full Reports of the work of all drawing, printing, and miscellaneous offices of the department, with *Index Maps* showing the progress and present state of map publication on various scales have been published separately in the *Map Publication and Office Work Report* for the financial year ending 31st March 1931. The following extracts from the full Report show the most important results of all this work, in the shape of Publications and Issues, etc.

Table I *(a)*—Maps published at Calcutta, during the year 1930-31.

Class of maps.	Scale.	New publications.	Revised editions, new editions and reprints.	Number of Copies printed.	Value. Rs.
		Departmental.			
GENERAL MAPS.					
Maps of India	Various	2	5	21,116	34,941
GEOGRAPHICAL MAPS.					
Southern Asia Series ...	1:2 million	1	3	2,384	3,471
India and Adjacent Countries Series	1:1 million	4	15	9,759	15,496
La Carte Internationale du Monde	1:1 million	...	2	600	1,800
TOPOGRAPHICAL MAPS.					
Quarter-inch, Modern ...	1″=4 miles	28	34	29,645	43,481
,, (Prely.) ...	Ditto	2	6	4,334	6,716
,, (Provl.) ...	Ditto	...	27	6,278	9,309
Half-inch, Modern ...	1″=2 miles	37	46	44,602	87,357
,, (Prely.) ...	Ditto	1	1	1,024	2,048
One-inch, Modern ...	1″=1 mile	142	92	137,457	2,10,344
,, (Prely.) ...	Ditto	7	14	27,030	46,146
,, (Provl.) ...	Ditto	...	4	674	434
Old-style maps	Various	...	26	3,654	4,787
SPECIAL MAPS.					
District maps	1″=4 miles	...	2	550	925
Provincial maps	Various	1	2	1,158	3,968
Plans of Cities and Cantonments	Ditto	3	3	3,124	7,580
Index maps	Ditto	...	8	3,514	1,223
Miscellaneous maps ...	Ditto	57	445	91,865	15,400
Manœuvre and Radius maps ...	1″=1 mile	2	3	4,424	8,337
Total ...	.....	**287**	**738**	**393,192**	**5,03,763**
		Extra-departmental.			
Maps...	Various	227	23	167,620	43,461
Plans and diagrams ...	Ditto	127	45	177,482	9,771
Illustrations	.....	247	3	143,032	20,188
Miscellaneous	.....	17	26	45,321	2,503
Total ...	.....	**618**	**97**	**533,455**	**75,923**
Grand Total ...	.....	**905**	**835**	**926,647**	**5,79,686**

Table I *(b)*—Maps published at Dehra Dūn.

Class of maps.	Scale.	New publications.	Reprints and new editions.	Number of sheets printed.	Value. Rs.
	Departmental.				
Cantonment maps ...	Various	...	166	14,289	12,983
Forest maps ...	,,	21	87	6,551	9,153
Miscellaneous ...	,,	8	40	13,495	8,090
Total ...	...	**29**	**293**	**34,335**	**30,226**
	Extra-departmental.				
Maps	Various	12	24	71,285	20,645
Plans and diagrams ...	,,	59	25	55,169	7,046
Charts	,,	232	...	14,533	7,645
Forest maps ...	,,	89	8	6,939	9,021
Total ...	...	**392**	**57**	**147,926**	**44,357**
Grand Total ...	...	**421**	**350**	**182,261**	**74,583**

Table I *(c)*—Maps published at Bangalore.

Class of maps.	Scale.	New publications.	Reprints and new editions.	Number of sheets printed.	Value. Rs.
	Departmental. Nil.				
	Extra-departmental.				
Forest maps, Mysore ...	4″=1 mile	5	...	100	100
Forest maps, Hyderābād	2″=1 mile	7	...	560	677
Private Estates ...	Various	3	...	22	876
Do. ...	16″=1 mile	35	...	360	10,723
Plans and diagrams ...	Various	11	4	3,560	1,315
Total ...	...	**61**	**4**	**4,602**	**13,691**

Table I *(d)*—Maps published at Quetta.

Class of maps.	Scale.	New publications.	Reprints and new editions.	Number of sheets printed.	Value. Rs.
		Departmental.			
Maps	Various	48	4	1,462	1,438
Plans and diagrams ...	,,	34	3	5,745	533
Charts, Forms	,,	8	...	102	78
Total ...	...	**90**	**7**	**7,309**	**2,049**
		Extra-departmental.			
Maps	Various	35	18	5,971	1,948
Plans and diagrams ...	,,	1,013	5	25,926	7,760
Charts, Forms	,,	6	...	560	164
Total ...	...	**1,054**	**23**	**32,457**	**9,872**
Grand Total ...	...	**1,144**	**30**	**39,766**	**11,921**

Table I *(e)*—Maps published at Murree and Peshāwar.

Class of maps.	Scale.	New publications.	Reprints and new editions.	Number of sheets printed.	Value. Rs.
		Departmental.			
Maps	Various	...	...	11,363	1,633
Plans and diagrams ...	,,	...	...	199	280
Charts, Forms	,,	...	...	3,090	488
Total ...	...	...	...	**14,652**	**2,401**
		Extra-departmental.			
Plans and diagrams ...	Various	...	70	7,863	2,605
Charts, Forms	,,	...	...	25	30
Total ...	...	...	**70**	**7,888**	**2,635**
Grand Total ...	...	...	**70**	**22,540**	**5,036**

Table II.—Abstract of Modern Topographical Maps.

	One-inch sheets.	Half-inch sheets.	Quarter-inch sheets.
Topographical maps published in 1930-31	142	37	28
Do. do. published in previous years.	2,908	795	255
Total published ...	**3,050**	**832**	**283**
Number of sheets in India ...	**6,218**	**1,630**	**450**

37. Notes.—*Calcutta.*—In addition to the work shown in Table I(*a*), 113,164 copies of 155 maps were gridded during the year.

38. *Dehra Dūn.*—In addition to the work shown in Table I(*b*) above, 95,884 prints of 998 originals, consisting of plane-table sections, triangulation charts and pamphlets, and forest maps were printed.

39. *Quetta.*—The Quetta Cantonment (16-inch) map has been corrected up to date on the ground, and the correction of the 14 fair sheets concerned is now in hand.

Table III.—Letterpress publications.

(a) PUBLISHED AT CALCUTTA.

1. General Report of the Survey of India, 1928-29. (475).
2. Map Publication and Office Work Report, 1929-30. (300).
3. Survey of India Notes,—issued monthly. (350).
4. List of maps published,—issued monthly. (800).
5. Correction slips to Handbooks, Type Table, Border Specimen, Conventional Signs, etc. (158,380).
6. List of maps published (F. O. U. O.)—issued quarterly. (200).
7. Government of India and Circular Orders and Circular Memos., etc. (5,900).
8. Instructions and application forms for candidates for Class II Service. (5,000).
9. Calendar for 1931. (3,500).
10. Camp Officer's Record Book. (200).
11. Triangulation Pamphlet. (100).
12. Advertisement for the Survey of India maps. (1,020).
13. Miscellaneous departmental forms. (900).

(b) In hand at Calcutta.

1. *Survey of India General Report, 1929-30.*
2. *Confidential Supplement to the General Report, 1929-30.*
3. *New Catalogue of Maps, 1931.*
4. *Index to Annual Reports of the Survey of India, 1904-05 to 1926-27, compiled by Lt.-Col. A. H. Gwyn, I.A.*

(c) PUBLISHED AT DEHRA DŪN.

1. Geodetic Report Vol. V, 1928-29. (450).
2. Correction slip to Geodetic Report Vol. IV & V. (500).
3. Special Publication No. I. (450).
4. Handbook of Topography, Chapter III. (750).
5. Do. Do. VIII. (750).
6. Union of Geodesy India, 1930. (300).

*Numbers in brackets after each item denote the number of copies printed.

Table III.—Letterpress publications.—*(Concld.).*

(c) PUBLISHED AT DEHRA DŪN.—*(Concld.).*

7. Supplement to Geodetic Report, Vol. VI. (550).
8. Report on Military Training at Quetta (Special Publication No. II.) (200).
9. Lt.-Col. Campbell's Papers on Rectangulation Survey. (100).
10. 3 Rectangular Co-ordinates (Lambert). (400 of each).
11. Handbook of Geodetic Triangulation. (400).
12. Tide Tables (68 Ports combined volume) for Indian Ocean for 1931 Part I. (3,000).
13. Tide Tables Supplementary Tables, Part II. (3,000).
14. Do. for Rangoon Rivers. (1,000).
15. Do. Bombay Port. (900).
16. Do. Hooghly River and for Port Commissioners. (1,300).
17. 18 Triangulation Pamphlets. (100 of each).
18. Addenda to Triangulation Pamphlets. (1,295).
19. 57 Correction slips to Triangulation Pamphlets. (100 of each).
20. 50 Do. Do. Do. (125 Do.).
21. 271 Professional forms. (310,945).
22. 409 Miscellaneous jobs. (271,995).
23. 8 Lists of bench-marks for various cantonments. (3 of each).
24. List for Mussoorie Guide Map with correction slip. (1,500).
25. List of Primary bench-marks. (200).
26. List of Publications corrected to 31st January 1930. (250).
27. List of Reserves in Chhindwāra Forest Division. (100).
28. Correction slip to Auxiliary Table, Part I. (300).
29. 3 Do. to Secondary Levelling Lines. (400).
30. How to obtain maps. (10).
31. Errata to Departmental Paper No. 13. (400).
32. Calendar for 1931. (300).
33. Auxiliary Table, Part III (set up and stereotyped).
34. Table 46 and 47 Sur. Do.

(d) In Hand at Dehra Dūn.

1. *Tide Tables for Indian Ocean for 1932.*
2. *Geodetic Report, Vol. VI.*
3. *Geodetic Triangulation.*
4. *Auxiliary Tables, Part IV. Sec. (a).*
5. *Do. II.*
6. *11 Levelling Pamphlets.*
7. *11 Triangulation Pamphlets.*
8. *Addenda to Levelling Pamphlets.*

40. Map Issues.—Table IV shows the total number of maps issued by the Survey of India during the year; following this table is a diagram showing the progress of map sales during the last four years.

Comparing the sales of different units with those of the previous year's, increases are apparent in almost all cases, far the greatest being in Burma where three times the value of maps was sold, regarding which the following special note from the Director Burma Circle is quoted:

> "The sale of maps during the year under report has eclipsed all "previous records of the Burma Circle. This increase is partly "attributed to the disturbed political state of the Province, "which has stimulated the demands for maps on the part of "the civil and military authorities; there is also, however, a "distinct upward tendency in the sales to the general public."

*Numbers in brackets after each item denote the number of copies printed.

As an example of the class of work which is now being dealt with, it may be of interest to record the supply of a complete set of the $\frac{1}{4}$-inch maps of the Province, numbering about 90 sheets, mounted in pair, Michelin Style, in polished teakwood box, at a cost of about Rs. 300, for the personal use of His Excellency The Governor of Burma. This set was so greatly appreciated that a duplicate set has since been ordered.

Table IV. Maps issued by Survey units.

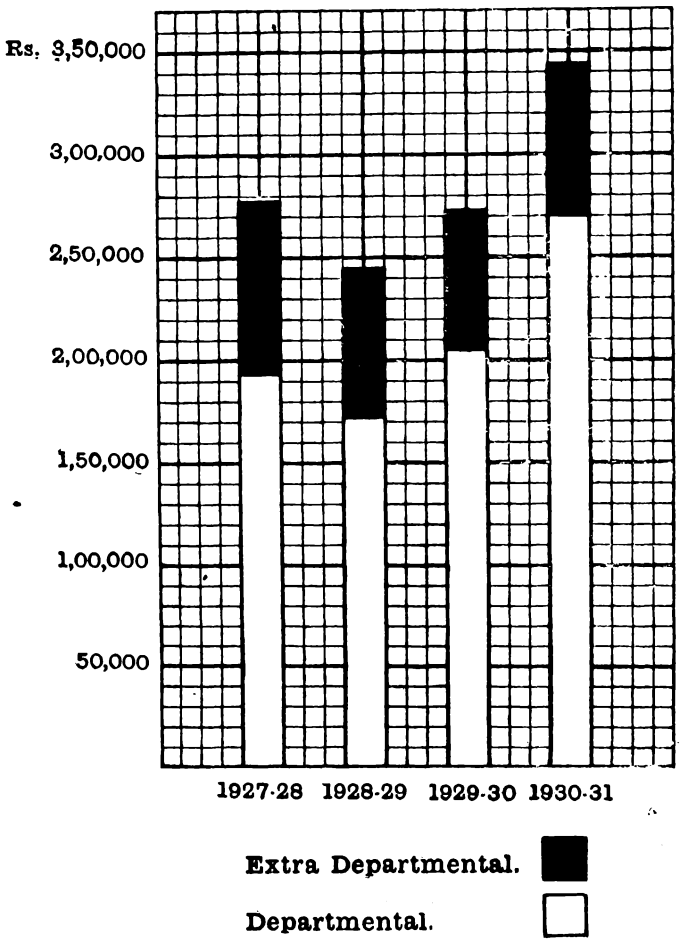
D = Departmental X = Extra-departmental.		On book transfer (to Government officials).		On cash payment.		Free issues.		TOTAL.	
		Number of copies.	Sale Value. Rs.	Number of copies.	Sale Value. Rs.	Number of copies.	Face Value. Rs.	**Number of copies.**	**Sale Value. Rs. †**
Calcutta	D	160,543	1,55,899	78,590	99,447	36,131	39,889	275,264	2,55,346
	X	405,559	51,871	112,723	16,156	8,488	6,316	526,770	68,027
Dehra Dūn	D	19,776	19,091	9,107	8,627	2,802	5,240	31,685	27,718
	X	143,352	39,701	2,610	1,709	.....	.....	145,962	41,410
Simla	D	.....	.....	262	434	1,008	1,758	1,270	434
Rāwalpindi ("A" Company)	D	.....	.....	52	128	.....	.....	52	128
Quetta ("E" Company)	D	42	84	234	355	.....	.....	276	439
	X	14,862	6,800	17,595	3,072	.....	.....	32,457	9,872
Peshāwar (No. 18 Party)	D	9,000	514	2	16	5,650	1,871	14,652	530
	X	1,069	567	5,548	1,131	1,271	395	7,888	1,698
No. 23 Party	D	.....	.....	.....	.....	435	653	435	.....
Mussoorie	D	7	11	307	496	5	7	319	507
Bangalore	D	343	848	4,681	8,479	.....	.....	5,024	9,327
	X	.....	.....	4,682	2,291	.....	.....	4,682	2,291
Shillong	D	20	39	560	974	.....	.....	580	1,013
Maymyo	D	1,624	5,962	972	2,113	376	633	2,972	8,075
Totals	...	756,197	2,81,387	237,925	1,45,428	56,166	56,762	1,050,288	4,26,815

† These figures do not include the value of free issues.

Note:—From this year the figures under the heading "Free issues" do not include maps transferred to Circles.

PROGRESS OF MAP SALES.

1927—31



41. Map Record and Issue Office. The total number of departmental maps sold during the year was 239,133, an increase of 40,862 or about 20% over the previous year's sales. Payments for these maps amounted to Rs. 2,55,346, exceeding the last year's figures by Rs. 69,156. This increase is largely due to maps required by the Army Department in connection with active service operations around Peshāwar during the autumn.

The value of cash sales decreased by Rs. 6,669 from Rs. 1,06,146 to Rs. 99,477 or by about 6½%, but considering the present state of trade depression, and also the fact that last year's figures were the highest yet recorded, this very slight falling off cannot be considered as unsatisfactory.

Modern closed steel racks have now entirely replaced the old wooden structures in the Records Section, and the complete rearrangement of the originals, P. T. Sections, etc., is in hand.

The Map Mounting Machine has worked very satisfactorily, and, as long as cloth was available, about 400 maps were mounted a day. The total number of maps mounted by machine during the year was 53,552 which represents a saving of Rs. 16,733 over the cost of hand-mounting.

Wall maps as well as dissected maps have still to be mounted by hand, but it is hoped that it may be possible to perfect a system by which dissected maps can also be mounted by machinery. It has not yet been found possible to obtain the right type of cloth in India for use in the map mounting machine, and for this reason the machine was out of action for some weeks while supplies were being obtained from England. Experiments, however, to find a satisfactory paste of local manufacture have proved successful, and there should be no difficulty in future in obtaining adequate supplies in this direction.

The preparation of a new Catalogue of Maps was taken in hand during the year, the main object being to increase the value to the public of this book by simplifying the index maps, and also to make it possible to keep the catalogue absolutely up to date without undue labour.

42. Stock of Maps. The tables below give the stock of maps as it stood on 31st March 1931:

Calcutta.

Class of maps.	Number of copies in stock.	Present Face Value. Rs.
1/2M Southern Asia Series	8,834	20,604
1/M India and Adjacent Countries ...	42,685	82,325
1/M Carte Internationale du Monde ...	4,860	14,253
One-inch maps	1,135,035	17,12,968
Half-inch maps	323,647	6,35,527
Quarter inch maps	235,500	3,66,357
General maps of India	21,273	38,639
Provincial maps of India	7,348	23,878
Cantonment and Town maps	44,293	1,25,103
Miscellaneous maps	63,543	90,535
TOTAL ...	1,887,018	31,10,189

Dehra Dūn.

Class of maps.	Number of copies in stock.	Present Face Value. Rs.
1/2 M Southern Asia Series	95	230
1/M India and Adjacent Countries	703	1,274
1/M Carte Internationale du Monde ...	374	1,052
Two-inch maps	6,693	12,873
One-inch maps	24,862	37,168
Half-inch maps	5,369	10,788
Quarter-inch maps	4,267	6,017
General maps of India	261	379
Provincial and District maps of India ...	416	906
Cantonment and Town maps (Special and Guide)	7,880	17,645
Miscellaneous maps	7,196	10,394
TOTAL ...	58,116	98,726

Bangalore.

Class of maps.	Number of copies in stock.	Present Face Value. Rs.
1-inch, ½-inch, ¼-inch and 1/M maps ...	35,526	56,983
Miscellaneous maps	3,445	6,882
TOTAL ...	38,971	63,865

Mussoorie.

Class of maps.	Number of copies in stock.	Present Face Value. Rs.
1-inch, ½-inch and 1/M maps	32,672	52,040
Miscellaneous maps	6,885	14,060
TOTAL ...	39,557	66,100

43. Mathematical Instrument Office. The demands on this office for supply of instruments, as well as the repairs show a decrease, which is due to the general trade depression.

	1928-29.	1929-30.	**1930-31.**
	Rs.	*Rs.*	**Rs.**
1. Total value of stores issued ...	5,39,308	4,20,131	**3,78,291**
2. ,, ,, ,, repairs carried out to orders	2,44,069	2,21,510	**2,13,906**
3. ,, ,, ,, instruments, &c., returned to store	32,356	44,921	**48,547**
4. *Book Value of stock in—*			
(*a*) Serviceable store	3,09,675	4,10,839	**4,54,147**
(*b*) Repairable ,, ...	96,260	1,06,575	**1,28,331**
(*c*) Material ,, ...	2,02,847	2,00,288	**2,06,718**
5. *Value of New Instruments—*			
(*a*) Manufactured in Workshop ...	1,90,821	1,79,842	**1,62,717**
(*b*) Purchased locally	46,893	28,363	**45,930**
(*c*) Imported through the Stores Department, London ...	2,20,876	2,31,128	**1,47,130**
6. Total value of work done in the workshop	5,76,546	5,25,686	**4,67,145**
7. Value obtained by sale of obsolescent and condemned stores ...	1,980	1,148	**2,625**
8. *Employees—*			
(*a*) Average number	480	490	**463**
(*b*) Cost of employees including pension contribution ...	1,93,538	2,02,734	**1,94,262**

IV.—ABSTRACT OF TOPOGRAPHICAL WORK.

44. The following tables show the progress achieved to date in the topographical survey programme assigned to the Department in 1905.

Tables A & B. The figures in Tables A and B published hitherto were found to be incorrect owing to unsystematic treatment in the past, alterations in circle boundaries and accidental omissions of surveys by one circle in an adjoining circle's area. In order to make information readily available to the public regarding areas of modern surveys completed and published, the two tables have been recast and the areas are now given *by scales and not by circles*, the latter being of purely departmental interest.

To avoid delaying the publication of this report, it has not been found possible to calculate the figures for each scale for each quinquennium between 1905 and 1930, and consolidated figures are therefore given. These figures are more accurate than the previous ones, but may be subject to slight correction when the figures prior to 1930 are more closely examined.

Tables C I and C II supersede Tables C and D of previous General Reports and have been introduced to facilitate a more accurate assessment of cost rates for all varieties of survey. The new Tables are divided into two sections, C I for survey in the field and C II for mapping in recess. A reference to these and to the map publication cost rates, ascertainable from the Director, Map Publication, should allow of a complete estimate for producing any map.

45. Progress. It was hoped in 1905 that maps on the scale of 1 inch to 1 mile would be available for the whole Indian Empire within 25 years; but the work has been greatly retrenched and delayed from various causes, and in 1913 the Secretary of State sanctioned a scheme for the reduction of the scale of survey in the less populous areas. Allowing for the surveys to be carried out on the reduced scales of ½ inch and ¼ inch to 1 mile, under this scheme, we may roughly regard half the work as being completed by 1925; though there is a tendency to revert to the 1-inch scale in special cases owing to the pressing requirements of geologists and engineers, and in accordance with the modern military view that this is the smallest scale suitable for tactical operations.

The present position of the mapping of India is shown in the *Index Map* at the end of this volume.

Revision of modern surveys has also become necessary in some important frontier tracts and is badly needed in some other areas. Moreover some areas surveyed on smaller scales have had to be re-surveyed on a larger scale.

The figures for this work are given in italics in Table B.

Table A.—Progress of Topographical Surveys since 1905.

Survey years.	1-inch and larger scales.	¾ and ½-inch scales.	⅜ and ¼-inch scales.	TOTALS.
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-10 ...				
1910-15 ...				
1915-20 ...	864,143	156,795	17,400	1,038,338
1920-25 ...				
1925-30 ...				
1930-31 ...	**35,724**	**13,915**	**7,943**	**57,582**
Totals to 1931 ...	**899,867**	**170,710**	**25,343**	**1,095,920**
Balance remaining	*441,652*	*254,578*	*107,801*	*804,031*
Total programme	**1,341,519**	**425,288**	**133,144**	**1,899,951**

Table B.—*Revision and Resurvey of the above work.*

Up to 1930 ...	*8,071*	*Nil*	*Nil*	*8,071*
1930-31 ...	*2,901*	*314*	*Nil*	*3,215*

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
"A" Company (F.C.).—Punjab, North-West Frontier Province, and Gilgit Agency.				Sq. m.	Rs.	Sq. m.	Rs.	**FRONTIER CIRCLE.**
Medium hills partly wooded	1½-inch	Original survey ...	43 B/13 & 14	55	61·6(b)			(a) Area surveyed by No. 1 Field Survey Section cost borne by Army Deptt.
Ditto	1½-inch	Revision survey	Ditto	50	34·7			(b) Much idle time due to political difficulties.
Ditto	1½-inch	Re-survey ...	43 G/5 ...	119	57·6(c)			(c) Training area.
Punjab plains ...	1-inch	Revision survey	44 I/1, 5, 9, 10, 13, & 14.	1,520	11·9			(d) Includes all Original surveys of every class and scale.
Low bare hills and cultivated plains	3-inch	Original survey ...	38 K/12 & 38 L/9.	62	100·9(e)	8,506(d)		(e) Includes all Revision and Re-survey of every class and scale.
Medium mountains partly wooded (up to 14,000 feet)	1-inch	Original survey ...	43 B/13 & 43 F/1 & 5.	297	36·5		**Cost 1,75,164 Cost rate 17·3 per sq. m.**	(f) Includes triangulation of all scales of work.
Bare snow-clad mountain ranges; deep valleys (3,000-26,000 feet)	¾-inch	Original survey ...	42. H & L & 43. A, E, I & M	7,943	3·3			
Undulating plains and intricate bare hills	1-inch	Original survey ...	38 O/5 ...	149	(a)	1,689(e)		
Low hills and plains ...	3-inch	**Triangulation**	38 K/12 & 38 K/9.	60	(a)	60(f)		

TABLE C I.—FIELD WORK.—Areas and Cost rates of surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
				Sq. m.	Rs.	Sq. m.	Rs.	**FRONTIER CIRCLE.—*Contd.***
"E" Company.—Baluchistān and Sind.								
Medium rugged and broken hills rising from open plains and valleys	¾-inch	**Triangulation**	Portions of 34. L and 35. I, J, M, N, O. (*vide* index).	7,580	5·1	**7,580**		Columns 4 & 5 include preparation for the field, whether made in this or the preceding survey year.
Ditto	¾-inch	Original survey ...	35 I/S.W. ...	1,059	23·0			
Medium rugged and broken hills intersected by deep and narrow valleys	1-inch	Original survey ...	34 L/13, 14, 34 P/1, 2, 6.	1,306	41·6	**3,671**		
Openly cultivated "pat" ...	1-inch	Original survey ...	35 P/5, 9, 10, 13, 14.	1,306	22·5		**Cost 2,45,204(*g*) Cost rate 66·6 per sq. mile.**	(*g*) Includes 4 per cent. overhead due to Circle Director's Office.
Special Surveys.								
City and environs ...	1/25,000	Re-survey ...	Quetta ...	.....	.....			
Cantonment maps ...	16-inch	Corrections ...	Quetta ...	17	110·8	**17**		

		al survey.					
Steep partly wooded *ntainous (3,000—11,000*	1-inch	Original provisional air survey.	38 K/5, 6, 7, 9, 10, 11, [illegible]	908	18·9	Cost 71,692 Cost rate	

Correction to General Report 1930-31. Page 29, TABLE C I. of No. 23 Party (F. C.) Punjab.

Substitute the following Table for the Existing one:—

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in Sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all the classes of Topographical field work including administrative charges.	Remarks.
No. 23 (Irrigation Surveys) Party—Punjab.				Sq. m.	Rs.	Sq. m.		**FRONTIER CIRCLE.—** *Concld.*
Special Surveys.								
Flat cultivated plains interspersed with woods, scrub, date-palms and sand-hills.	4-inch	Original Irrigation survey.	Falling in 39 I, J, K & N.	998	42·03	998		
Flat cultivated plains interspersed with trees, scrub & sand hills.		Rectangulation to 25 acres (including cost and embedding of markstones).	44 I, J, K, M & N.	2,201	122·2	2,201	Cost 4,02,413	
		Tertiary levelling (including computations and compilation of spot level charts).	44 I, J, M & N.	1,006	37·2	1,006		

PLEASE PASTE IN TO 1930-31 GENERAL REPORT

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administration charges.	Remarks.
No. 18 (Air Survey) Party (F.C.) N.W.F. Province.				Sq. m.	Rs.	Sq. m.	Rs.	**FRONTIER CIRCLE.—** ***Concld.***
Tīrāh. Open Medium hills	1-inch	Plane-table control (air survey).	38 K/14 ...	185	3·5	185(a)		
Waziristān. Rugged mountainous country (5,000—11,000 feet)	1½-inch	Original air survey.	38 H/5, 6, 9, 10, 13.	64·4	97·51	974	Cost 71,692 Cost rate 59·7 per sq. mile.	
Tīrāh. Open partly wooded mountainous (5,000—15,000 feet)	1½-inch	Original oblique air survey.	38 K/1 ...	1·7	27			
Tīrāh. Steep partly wooded mountainous (3,000—11,000 feet)	1-inch	Original provisional air survey.	38 K/5, 6, 7, 9, 10, 11, 13 & 38 O/1.	908	18·9			
Kurram Agency. Rolling wooded hills	1½-inch	Revision air survey.	38 G/13	20	28·0	200		
Mohmand. Medium hills with open cultivated valleys.	1½-inch	Revision air survey.	38 N/2, 3, 6, 7.	180	13·8			
SPECIAL WORK ...	.....	Supplementary ...	38 N/8, 12	25	156·0	25		
Peshāwar Guide Map ... City, Cantonment and open cultivated plain	6-inch	Air survey ...	38 O/5, 9 ...	.....	.....			
No. 23 Party (F.C.) Punjab. SPECIAL SURVEYS.								
Openly cultivated plains interspersed with woods scrub and sand hills	4-inch	Original Irrigation survey.	Falling in 39.I, J, K & N.	998	42·03	998	Cost 4,02,413 Cost rate 403 per sq. mile.	Includes cost of fair mapping and 4 per cent. on total cost for Directorate.

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

PARTY AND LOCALITY. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	REMARKS.
No. 1 Party.—Rājputāna and Central India.				Sq. m.	Rs.	Sq. m.	Rs.	**CENTRAL CIRCLE.**
Fairly flat cultivation and thorny scrub with isolated hills	**½-inch**	Revision survey	54 H/N.W., N.E., S.W., S.E. & 55 E/N.E.	5,423	4·2	**5,423**		
Open sandy cultivation and thorny scrub with some sharp rocky hills	**½-inch**	Original survey	45 F/3 (part) F/7, 45 M/11, 15 & 45N/10,14.	1,516	6·4		**Cost 1,67,840 Cost rate 17·3 per sq. mile**	
Ditto	**1-inch**	Original survey	45 F/4, 8, 45 G/1, 2, 5, 6, 45 N/12,16 & 45 N/9, 13.	2,666	12·4	**4,270**		
Open and congested town area with surrounding country	**4-inch**	Original survey	Part of sheets 45 B/15,16 and 45 F/3 (part) (Jodhpur environs).	88	82·4			Special survey excluded.

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
No. 1 Party.—Rājputāna and Central India.—*Contd.*				Sq. m.	Rs.	Sq. m.	Rs.	**CENTRAL CIRCLE.—*Contd.***
Open sandy cultivation and thorny scrub with some sharp rocky hills	1-inch	**Triangulation**	45 M/12 and 16-(part) 45 N/4, 8, 9 & 45 O/1, 2, 5, 6.	2,271(a)	2·4			(a) 644 miles utilized during season 1930-31.
Ditto	½-inch	**Triangulation**	45 I/13, 14, 15, 45 J/1, 2, 5, 6, 9 & 13, 45 M/1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 45 M/11, 13, 14, 15, 45 N/1, 2, 3, 45 N/5, 6, 7, 10, 11, 12, 14 (part) 15, 16. 45 O/9, 10, 13, 14.	10,219	1·5*	**12,610**		* This cost rate includes area of (*b*), referred to in next page, as well.

TABLE C 1.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
No. 1 Party.—Rājputāna and Central India.—*Concld.*				Sq. m.	Rs.	Sq. m. *(Vide page 31).*	Rs.	**CENTRAL CIRCLE.—*Contd.***
Open and congested town area with surrounding country	4-inch	**Triangulation**	Part of sheets 45 F/3, 7.	120[c]	41·0			Special survey excluded.
Partly open and undulating, partly jungle clad hills	½-inch	**Triangulation**	54. D, 55. A	8,700[b]	For cost rate see remark in remarks column marked *	**8,700**		(*b*) Triangulation of 1871-73 & 1872-78 checked by plane-table and Pye's telescopic clinometer. (*c*) Utilized during season 1930-31. * *Vide* remark* on page 31.
Open sandy cultivation and thorny scrub with some sharp rocky hills	4-inch	**Traversing**	Part of 45 F/3 in city area of Jodhpur only.	(*d*) 210 linear miles.	5·6[d]	(*d*) **210 linear miles.**		(*d*) This cost rate includes 7·7 linear miles of traversing and 210 linear miles of levelling. (Special survey excluded).

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

PARTY AND LOCALITY. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	REMARKS.
No. 5 Party.—Central Provinces, Central India and United Provinces.				Sq. m.	Rs.	Sq. m.	Rs.	**CENTRAL CIRCLE.**
Densely wooded hills and plains	1-inch	**Triangulation**	64 F/4, 64 G/1,2,3 and 4 (part), 64 L/1 (part), 3, 4, 5, 7, 8 64 K/4, 8.	3,341	8·7	**3,341**		
Cultivated plains ...	1-inch	**Traverse** ...	64 F/8 (part) 12, 16, 64 G/1 and 2 (parts), 5, 6, 9, 10, 13, 14. 64 K/1 and 2 (parts).	2,485	0·6	**2,485**		
Densely wooded hills and open cultivated plains	**1-inch**	Original Survey ...	64 F/1, 2, 5, 6, 9, 10, 13, 14. 64 J/1, 2, 5, 6, 64 M/1.	2,942[b]	16·4[a]	**5,925**		(a) Excludes men under training. (b) Includes men under training.
Densely wooded hills and open plains	½-inch	Original „ ...	64 M/S.W., S.E., N.W. (less M/1).	2,983	7·0		**Cost 2,05,626 Cost rate 31·4 per sq. mile.**	
Densely wooded hills and plains	**1-inch**	Supplementary Survey.	64 F/1, 2, 5, 6, 9, 10.	623	3·8	**623**		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
				Sq. m.	Rs.	Sq. m.	Rs.	**CENTRAL CIRCLE.—*Concld.***
No. 20 Party.—Cantts. in United Provinces.								
City area and environs in plains	**4-inch**	Revision ...	63. B	27	307·8 per sq. mile.	**27**	**Cost 61,238 Cost rate 2,096 per sq. mile.**	Lucknow and environs.
Hill Cantonment ...	**16-inch**	Resurvey ...	53. F	1,414 acres.	3·0 per acre.	**1,414 acres**		Part Chakrāta.
City area and environs ...	4-inch	**Traversing** ...	63. B	39 linear miles.	63·7 per sq. mile.	**39 linear miles**		Lucknow and environs.
Air Survey Traverse Detachment.—United Provinces.								
Open, cultivated and interspersed with numerous villages and mango-groves and partly broken ground covered with high grass, scrub and dense forest along the Chauka, Gogra, Rāmganga and Rāpti rivers	16-inch	**Traversing** for control of Air Surveys.	53. P, 54. I, M 62. D, H 63. A, E, F, I, J	1,050	21·8 per linear mile.	**1,050**	**Cost 26,036 Cost rate 24·8 per sq. mile.**	

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
No. 6 Party.—Central Provinces, Hyderābād and Madras.				Sq. m.	Rs.	Sq. m.	Rs.	**SOUTHERN CIRCLE.**
Jungle-clad hills and cultivated plains	1-inch	**Triangulation**	65. F, J, K	5,364	5·5	**5,364**		
Cultivated plains ...	1-inch	**Traversing** ...	65. K, L ...	1,075	3·9	**1,075**		
Jungle-clad plains with low isolated hills	**1-inch**	Original survey and re-survey.	65. F, G, J	1,783	23·8	**3,219**	**Cost 1,78,852 Cost rate 55·6 per sq. mile.**	
Jungle-clad hills up to 4,000 feet	**1-inch**	Original survey ...	65. J ...	951	24·9			
Reserved forest with isolated hills	**2-inch**	Original survey and re-survey.	65. B, C, F, G	485	41·8			
No. 7 Party.—Bombay and Goa.								
West coast and forest-clad hills	One-inch	Supplementary **Triangulation**	48. E, I ...	690	3·0	**1,260**		
Open cultivated plateau ...	One-inch	Supplementary **Triangulation**	47. P ...	570	1·8			
Dense forest plateau ...	One-inch	**Traverse** ...	48. I ...	281	12·3	**281**		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scales	Description of survey.	Sheet Nos	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all the classes of Topographical field work including administrative charges.	Remarks.
				Sq. m.	Rs.	Sq. m.	Rs.	**SOUTHERN CIRCLE —Concld.**
No. 7 Party.—Bombay and Goa.—*(Concld.).*								
Open cultivated plateau, forest plateau and forest-clad hills running down to the sea coast	**1-inch**	Supplementary survey.	48. J, M, N	5,825	14·3	**5,825**	**Cost 1,30,709 Cost rate 22·4 per sq. mile.**	
No. 8 Party.—Madras.								
Forest clad hills ...		Boundary **Traverse.**	58. I ...	19 linear miles.	21·0 per linear mile.	**19 linear miles.**		
Forest-clad hills and cultivated plains	**1-inch**	Original survey ...	58. M ...	1,936	14·0	**1,941**	**Cost 1,43,224 Cost rate 24·5 per sq. mile.**	
Forest-clad hills up to 4,000 feet	**4-inch**	Original survey ...	58. I ...	5	210·0			
Forest-clad hills and cultivated plains	**1-inch**	Supplementary survey.	58. I ...	3,892	12·2	**3,892**		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
No. 4 Party.—Bengal and Bihār.				Sq. m.	Rs.	Sq. m.	Rs.	**EASTERN CIRCLE.**
Bengal.—Flat rice-land with densely wooded villages	1-inch	**Traverse** ...	73. O ...	1,640	3·4	**1,640**		
Bihār.—Cultivated plains with wooded villages	1-inch	**Traverse** (Main circuit & plane-table traverse).	72. C & G ...	1,715	2·3	**1,715**		
Bengal.—Undulating wooded country with rice cultivated low lands	**1-inch**	Supplementary survey.	73. N ...	823	28·1			
Bengal.—Thickly populated rice-land with densely wooded villages	**1-inch**	Supplementary survey.	73. N ...	275	28·0	**3,070**	**Cost 1,18,119 Cost rate 38·5 per sq. mile.**	
Bengal.—Variably populated rice-land with densely wooded villages	**1-inch**	Original survey ...	73. M & N ...	1,972	19·3			
No. 9 Party.—Orissa and Madras.								
High forest clad hills, low jungle covered ranges, isolated hillocks and open cultivated lands	1-inch	**Triangulation**	73. C & D ...	3,807	3·7	**3,807**		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
No. 9 Party.—Orissa and Madras.—*Concld.*				Sq. m.	Rs.	Sq. m.	Rs.	**EASTERN CIRCLE.—*Contd.***
Madras.—Ganjām district wooded plains	4-inch	**Traversing** ...	73. D & 74. A	5	77·0	5		
Orissa.—Densely wooded high and low hills with scattered hillocks and open patches of cultivation	1-inch	Original survey ...	73. D & H ...	2,809	19·5			
Ganjām district (Madras) Open hills with scattered hillocks and open patches of cultivation	1-inch	Original survey ...	73. D & H ...	818				
Orissa.—Densely wooded high and low hills with scattered hillocks and open patches of cultivation	1-inch	Supplementary survey.	73. D ...	34	9·3	**Total area surveyed 3,903**	**Cost 1,40,201 Cost rate 35·8 per sq. mile.**	
Ganjām district (Madras). Densely wooded hills and undulating country (forest reserves)	1-inch	Supplementary survey.	73. D ...	241				
Ganjām district (Madras). Wooded plains	4-inch	Special Forest survey.	74. A & 73. D	1	255·0			

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
No. 12 Party.—Assam, Bengal, Bihār and Orissa, Sikkim and Nepāl.				Sq. m.	Rs.	Sq. m.	Rs.	**EASTERN CIRCLE.—** *Concld.*
Low jungle-clad hills in Bengal	1-inch	**Triangulation**	79. M ...	1,456	13·2	Triangulation 5,527 Traverse 1,300 Levelling 24·5 linear miles		
Cultivated plains in Bengal	1-inch	**Traverse** ...	79. M ...	1,298	5·3			
Jungle-clad hills in Bengal and Assam	1-inch	**Levelling** ...	78. B ...	14·7 linear miles	9·2 per linear mile.			
	½-inch	**Triangulation**	84. A ...	4,069	4·1			
Steep wooded hills, Tarai and cultivated plains in Bengal, Bihār and Orissa, Sikkim and Nepāl	**1-inch**	Original survey ...	78. A & B ...	436	28·7	**Total area surveyed 2,449**	**Cost 2,02,333 Cost rate 82·4 per sq. mile.**	
	1-inch	Supplementary survey.	78. B ...	2,005	42·1			
Darjeeling Guide map steep hills and Town area	**6-inch**	Original survey ...	78. A ...	6·0	542·0			
Oil-field and Mining Lease Survey at Digboi in Assam	16- & 8-inch.	**Triangulation**	83. M ...	2·0	383·0			
		Traverse	83. M ...	32·6 linear miles	58·7 per linear mile.			
		& Levelling	83. M ...	9·8 linear miles	35·5 per linear mile.			
	16-inch	Original survey (Oil field).	83. M ...	2·0	3,478·0			

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of Survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
No. 10 Party.—Upper Burma.				Sq. m.	Rs.	Sq. m.	Rs.	**BURMA CIRCLE.**
Low hills and dense jungle	½-inch	**Triangulation**	83 O/NE, SE & SW.	1,575	9·7			
Jungle covered hills averaging about 4,000 feet	½-inch	**Triangulation**	83 K/SE & O/SW, NW.	940	5·6	**3,365**		(a) This work is burdened with the cost of computers who could not be kept fully occupied owing to the sickness of one traverser and the transfer of another from the camp during the field season.
Jungle covered hills and undulating country with some cultivation in valleys	1-inch	**Triangulation**	83 L/7, 8, 11, 12. 84 M/1, 2, 5, 6.	850	29·4			
Plains covered with dense jungle	½-inch	**Traverse** ...	83 O/SE & SW.	150	44·6(a)	**650**		The charges are very high as the cost of reconnaissance of large areas which could not be observed, during the season under report, has been included.
Jungle covered hills and undulating country with some cultivation in valleys	1-inch	**Traverse** ...	83 P/1, 3, 5, L/15, 16.	500	26·2			
Plains covered with dense jungle	**½-inch**	Original survey ...	83 O/SE ...	1,014	22·1			As this traversing is to supplement triangulation the area and cost rate per square mile are purely estimates.
Jungle covered hills and undulating country with some cultivation in valleys	**1-inch**	Original survey ...	83 L/9, 10, 13,14. P/1, 2, 3, 4, 5 ,6, 7, 8, 9, 13; 93 B/16.	2,592	44·3	**3,873**	**Cost 2,48,717 Cost rate 64·2 per sq. mile.**	Ditto ditto. Ditto ditto.
Low hills covered with dense jungle	**2-inch**	Original survey ...	93 B/16 ...	244	.....			Work carried out by pupils under training.
Ditto ditto	**4-inch**	Original survey ...	83 P/13, 14	23	338·8			

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	Remarks.
No. 11 Party.—Lower & Upper Burma.				Sq. m.	Rs.	Sq. m.	Rs.	**BURMA CIRCLE.** *—Contd.*
Densely wooded hills	1-inch	**Triangulation**	85 M/3, 4, 7, 8, 11, 12, 15, 16. 85 N/1.					(*a*) Reconnaissance only expenditure Rs. 13,939.
Cultivated plains	1-inch	**Traverse**	85 N/10	24	35·2	**24**		
Densely wooded hills and cultivated plains	**1-inch**	Original survey	85 N/2, 3, 4, 7, 14, 15, 16. 85 O/1 & 13.	1,077(*b*)	44·5			(*b*) Owing to rebellion, survey of no sheets completed.
Densely wooded hills and plains	**1-inch**	Original survey	93 A/2, 3, 4, 6, 7, 8.	1,624	36·9			
Special Survey						**2,885**	**Cost 2,09,148 Cost rate 72·5 per sq. mile.**	
Densely wooded hills (Forest reserves)	**4-inch**	Original survey	85 N/1, 10, 15.	13	246·7			
High hills partly forest clad	**4-inch**	Original survey	93 A/8 & 12; 93 B/5 & 9.	169	263·1			
Rubber Estate	**8-inch**	Original survey	94 D/1	2	276·5			(*c*) Traverse along Forest boundary and hence cannot be reduced to sq. miles. The area of 6·2 linear miles has therefore been ignored in finding area in col. 6.
Forest Boundary	4-inch	**Traverse**	85 N/11	6·2(*c*) linear miles.	251·6	**6·2 linear miles.**		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1930-31.

PARTY AND LOCALITY. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Area in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total area of each description of survey, regardless of scale and nature of country.	Total expenditure and overall cost rate of all classes of Topographical field work including administrative charges.	REMARKS.
No. 21 (Burma Forest) Party.—Burma.				Sq. m.	Rs.	Sq. m.	Rs.	**BURMA CIRCLE.** —*Concld.*
Jungle-clad hills up to 4,000 ft	4-inch	**Triangulation** for traverse connection.	83. L, 84. I	(a)	.....	.....		(a) No area claimed.
	4-inch	**Traverse** ...	83 P/4; 84 E/14, 15; 84 I/2, 3, 4, 5, 10, 11, 13, 14, 15; 84 M/1.	326	148·8	**326**		Reserved Forests. Cost rate per linear mile is Rs. 89·2.
Jungle-clad hills up to 4,000 ft	**4-inch**	Original survey ...	83 L/7, 8, 11, 12, 15, 16 P/3, 4, 7.	322	423·9	**322**	**Cost 2,31,260 Cost rate 718 per sq. mile.**	Reserved Forests.

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1930-31.

Party and Locality. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure including 5 % D. O. cost for examination and preparation of colour guides in case of fair mapping.	Remarks.
"A" Company (F. C.)—Punjab & N. W. F. P.		Sq. m.	Rs.	Rs.	**FRONTIER CIRCLE.**
Fair-mapping ¾-inch	42 D/S.E.; 37 P/S.E. & N.E.; 42 D/S.W.; 38 L/N.W.& 38 L/S.W.	5,002	5·6	29,463	
Ditto 1½-inch	38 K/1; 38 G/13; 44 I/4; 38 M/16; 38 N/13; 44 I/S, I/11; 44 I/12, 15, 16; 43 J/1; 38 H/14; 43 F/9 & 12; 44 I/1; 44 I/10 & 44 I/13.	4,023	7	29,466	
Computation of **Triangulation** for ¾-inch Survey (Chitrāl)	42. D, 42. H ...	1,000	5	.....	
" " " 1½-inch Survey (Murree)	43 G/5 ...	80	1·8	.....	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1930-31.

PARTY AND LOCALITY. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure including 5 % D. O. cost for examination and preparation of colour guides in case of fair mapping.	REMARKS.
"A" Company (F. C.)—Punjab & N. W. F. P. *—(Concld.).*		Sq. m.	Rs.	Rs.	**FRONTIER CIRCLE.** *—Contd.*
Computation of Kāgān connection with the Topo. series adjustment.	43 I/4 ...	No area allotted to it as it was simply a connection of Gilgit Principal Series with Lt. Angwin's Triangulation of 25-26.	.....	.....	
Computation of Bannu **Triangulation** for 3-inch Survey ...	38 K/12, 38 I/5 & 9.	60	5·6	.....	Bannu Guide Map.
,, ,, Bannu **Traverse** ,, ,, ...	38 L/9 ...	15	55·7	.....	
Adjustment classification and compilation of old Topo. data by 1-inch sheet and by observers.	38. J, 38. K, 38. N, 38. O.	.....	.....	.....	In addition sheets 43. B & 43. C were also compiled but not sent to D. G. B. so to be shown next year.
Computations of time and latitude of Sir Aurel Stein's Expedition in China, also barometric heights.	.....	.....	.....	.....	
Computations of Training exercise work in Murree Hills ...	.....	.....	.....	.....	
Miscellaneous computations of varied nature	.....	.....	.....	.....	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1930-31.

Party and Locality. Class of work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure including 5 % D. O. cost for examination and preparation of colour guides in case of fair mapping.	Remarks.
		Sq. m.	Rs.	Rs.	**FRONTIER CIRCLE.**—*Concld.*
"E" Company—Baluchistan and Sind.					
Original ¾-inch ... ... **Triangulation**	Portions of 34. L, 35. I, J, M, N, O.	7,580	0·3	2,663(*a*)	
Original **1-inch** sheets fair mapping	34 L/1, 2, 5, 6, 9, 10.	1,567	19·9	.....	All costs and cost rates of fair mapping include 5 % D. O. costs.
Do Do	34 P/9, 10, 13, 14.	1,045	10·2	.....	(*a*) Including Rs. 200 estimated to complete.
Original ½-**inch** sheets fair mapping	35 I/NW(*c*) ...	1,054	5·5	47,722	(*c*) Similar to 35 I/NW *vide* Table C. I.
Special Work.					
Corrections to 16-inch Cantonment map fair sheets ...	Quetta ...	17	233·9	3,979	
No. 18 (Air Survey) Party. N. W. F. P.					
Special Work.					
Peshāwar Guide Map **6-inches** to 1 mile fair mapping ...	38 N/8, 12; 38 O/5, 9.	25·0	189·8	4,745	
No. 23 Party—Punjab. Special Surveys.					
Completion of original 4-inch P. T. Sections for reproductions	Falling in 39. I, J, K, & N.	998	20·4	20,415	No D. O. costs.
Fair mapping of **1-inch** Haveli sheets from 4-inch reductions	Falling in 39. M, N, O, K; 44. A & B.	3,128	4·5	14,218	No D. O. costs.

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1930-31.

Party and Locality. Class of work.	Sheet Nos.	Areas.	Cost rate per sq. mile.	Total expenditure including 5% D. O. cost for examination and preparation of colour guides in case of fair mapping.	Remarks.
		Sq. m.	Rs.	Rs.	CENTRAL CIRCLE.
No. 1 Party.—(C. C.) Rājputāna.					
Fair mapping 1½-inch original	45 F/4 & 8, G/1, 2, 5, & 6, N/9 and 13, M/12 and 16.	2,666	6·1	17,308	
Fair mapping Kailāna	Special sheets and completion of old Sheets.	88	32·2	2,979	
Central India and Rājputāna.					
Fair mapping ¼-inch original	One fourth of sheet 45F/SW; one half of sheet 45 M/SE; one half of sheet 45 J/SW, & G/NW; 54 H/NW, NE, SW, SE & 55 E/NE.	7,272	2·8	20,633	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1930-31.

PARTY AND LOCALITY. Class of work.	Sheet Nos.	Areas.	Cost rate per sq. mile.	Total expenditure including 5% D. O. cost for examination and preparation of colour guides in case of fair mapping.	REMARKS.
Rājputāna.		Sq. m.	Rs.	Rs.	CENTRAL CIRCLE—*Contd.*
Computation ½-**inch** original	45 $\frac{M}{1,2,3,4,5,6,7,8,9}$ and 10, 13, 14. 45 I/13, 14 and 15; 45 N/1, 2, 3, 5, 6, 7, 11, 12, 15 and 16; 45 O/9, 10, 13 and 14.	7,697	1·04	8,020	7,697 is the latest available figures on 27-5-32.
Computation 1-inch original	45 N/4 and 8 45 O/1, 2, 5 and 6.	1,607	1·0	1,762	
No. 5 Party.—Central Provinces and Rewah State.					
Original 1-inch ... ... **Triangulation** ...	64 F/4, 64, G/1, 2, 3, 4, (part) 64 L/1 (part) 3, 4, 5, 7, 8; 64 K/4, 8.	3,341	1·4	4,773	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1930-31.

Party and Locality. Class of work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure including 5% D. O. cost for examination and preparation of colour guides in case of fair mapping.	Remarks.
No. 5 Party.—Central Provinces and Rewah State.—*(Concld.).*		Sq. m.	Rs.	Rs.	**CENTRAL CIRCLE.—*Contd.***
Original 1-inch ... ... **Traverse** ...	64 F/8 (part), 12, 16. 64 G/1 and 2 (parts) 5, 6, 9, 10, 13, 14. 64 K/1 & 2 (parts).	2,485	0·6	1,547	
Original **1-inch** fair mapping	64 F/1, 2, 5, 6, 9, 10, 13, 14. 64 J/1, 2, 5, 6. 64 M/1.	3,565	5·0	25,633(c)	(a) Excludes 300 sq. miles not completed by end of Survey year.
Original ½-**inch** fair mapping	64 M/NW (less M/1). 64 M/SW, 64 M/SE.	2,983	1·0	4,077	
Compiled ½-**inch** fair mapping	64 M/NW (less M/2, 5, 6. 64 F/NW, 64 F/NE. 64 J/NW. 64 P/SE.	4,350(a)	1·4	5,436	(b) Excludes 5 sq. miles remaining for completion.
Benares Guide Map **6 inches** to 1 mile fair mapping ...	1 and 2 ...	20(b)	22·1	463	(c) Includes 6,601 cost of men under instruction in fair mapping.

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping 1930-31.

Party and Locality. Class of work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure inculding 5% D. O. Cost for examination and preparation of colour guides in case of fair mapping.	Remarks.
No. 20 Party.—Cantonments in United Provinces.		Sq. m.	Rs.	Rs.	**CENTRAL CIRCLE.—*Concld.***
4-inch ... ... **Traverse** ...	63. B ...	39 Linear miles.	17·7 per linear mile.	692	Lucknow and environs.
16-inch ... ... **Traverse** ...	53. F, K, O 72. G	330 Linear miles.	8·8 per linear mile.	2,889	Dinapore, Rānīkhet, Lansdowne and Chakrāta Cantonments.
64-inch ... ... **Traverse** ...	53. K, F, O 72. G	17 Linear miles.	5·9 per linear mile.	20	Dinapore, Rānīkhet, Lansdowne and Chakrāta Cantonments.
16-inch Cantonment plans fair mapping	47. F, 53. F, 55. J, O 63. B 72. G	17,275 acres.	1·2 per acre.	22,531	Kamptee, Kirkee, Cawnpore, Dinapore, Part Lucknow, Pachmarhi and Chakrāta Cantonments.
64-inch plans fair mapping	53. F, 55. J, O 63. B, 72. G	416 acres.	9·1 per acre.	3,990	Kamptee, Cawnpore, Dinapore, Lucknow, Pachmarhi and part of Chakrāta.
Air Survey Traverse United Provinces Detachment.					
16-inch ... ... **Traverse** for control of Air Surveys.	53. P, 54. I, M 62. D, H 63, A, E, F, I, J	1,050 sq. miles.	4·1 per sq. mile.	4,953	Actual cost is 4,345. 14% overhead charges added to it.

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1930-31.

Party and Locality. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure including 5 % D. O. cost for examination and preparation of colour guides in case of fair mapping.	Remarks.
		Sq. m.	Rs.	Rs.	**SOUTHERN CIRCLE.**
No. 6 Party.—Central Provinces, Hyderabad and Madras.					
Original 1-inch **Triangulation** ...	65. J	2,256	2·6	5,778	
1-inch sheets fair mapping	65. F, G, J	3,109	9·9	30,886	
2-inch sheets fair mapping	65. F, G	485	11·8	5,723	
No. 7 Party.—Bombay and Goa.					
Supplementary 1-inch ... ... **Triangulation** ..	48. E, I, 47. P	1,260	1·4	2,155	
1-inch ... ... **Traverse** ...	48. I	281			
1-inch sheets fair mapping	48. J, M, N	5,825	5·3	30,600	
Compiled ½-**inch** sheets fair mapping	48. N	1,152	1·3	1,500	
No. 8 Party.—Madras.					
Original 1-inch **Triangulation** ...	65. K	2,200	1·6	3,400	
1-inch **Traverse** ...	65. K, L	1,200	1·4	1,700	
1-inch sheets fair mapping	58. I, M	5,828	6·6	38,500	
Forest **4-inch** fair mapping	58. I	5	170·0	850	

TABLE C II.—RECESS WORK.—Cost rate for Computations and fair mapping, 1930-31.

Party and Locality. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure including 5 % D. O. cost for examination and preparation of colour guides in case of fair mapping.	Remarks.
		Sq. m.	Rs.	Rs.	**EASTERN CIRCLE.**
No. 4 Party.—Bengal and Bihar.					
1-inch **Traverse** ...	73. O	1,640	3·0	4,955	
Traverse (main circuit & Plane-table height traverse).	72. C, G	1,715	·6	1,100	
1-inch sheets fair mapping	73. M, N	3,070	13·5	41,703	
No. 9 Party.—Orissa and Madras.					
Original 1-inch **Triangulation** ...	73. C, D	3,807	·9	3,679	
,, 4-inch **Traversing** ...	73. D and 74. A	5	45·6	228	
1-inch sheets fair mapping	73. D, H	3,902	11·8	46,024	
No. 12 Party.—Bengal, Bihar and Orissa, Sikkim and Nepal.					
1-inch **Triangulation** ...	79. M	1,456	1·1	1,688	
1-inch **Traverse and Levelling**	79. M	1,298	1·1	1,445	
Half-inch **Triangulation** ...	84. A	4,609	·4	2,035	
1-inch sheets fair mapping ...	78. A, B	2,441	15·0	36,646	
6-inch sheets fair mapping (Darjeeling guide map).	78. A	6·0	557·8	3,341	
16-inch **Triangulation** ...	83. M	2·0	.....	153	
8-inch **Traverse** ...	83. M	32·6 (L.M.)	2·9(L.M.)	94	
8-inch **Levelling** ...	83. M	9·8 (,,)	7·1(,,)	71	
16-inch sheets fair mapping ...	83. M	2·0	803·0	1,606	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1930-31.

Party and Locality. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure including 5 % D. O. cost for examination and preparation of colour guides in case of fair mapping.	Remarks.
		Sq. m.	Rs.	Rs.	**BURMA CIRCLE.**
No. 10 Party.—Upper Burma.					
Original ½-inch ... ... **Triangulation** ...	83 O/N.E., S.E. & S.W. 83 K/S.E. & O/S.W., N.W.	2,515	1·32	3,346	
Do. 1-inch ... ... **do.** ...	83 L/7, 8, 11, 12. 84 M/1, 2, 5, 6.	850	1·81	1,540	
Original ½-inch ... ... **Traverse** ...	83 O/S.E. & S.W.	150	6·02	903	
Do. 1-inch ... ... **do.** ...	83 P/1, 3, 5; L/15, 16.	500	7·01	3,506	
Do. **½-inch** sheets fair mapping	83 O/S.E. ...	1,077	0·83	946	
Do. **1-inch** do. do.	83 L/9, 10, 13, 14; P/1, 2, 5, 6, 7, 8, 9, 13; 93 B/16.	3,521	12·04	44,030	
Do. **4-inch** do. do.	83 P/13 & 14.	23	48·87	1,180	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1930-31.

Party and Locality. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure including 5% D. O. cost for examination and preparation of colour guides in case of fair mapping.	Remarks.
No. 11 Party.—Lower and Upper Burma.		Sq. m.	Rs.	Rs.	**BURMA CIRCLE.** —*Concld.*
Computation of **triangulation** for One-inch plane-tabling	85. N & O ...	1,128 (a)	3·2	3,619	(a) Area triangulated previous year.
Computation of **traverse** for 4-inch plane-tabling ...	85 N/1 ...	.....	.....	202 (b)	(b) Area computed was included in previous year's report.
Fair mapping on 1½-**inch** scale	93 A/2, 3, 4, 6, 7 & 8.	1,624	18(c)	30,790	(c) High cost rate of mapping is due to the fact that some surveyors were lent to No. 7 D. O. or No. 10 Party for some time and that one computer and an Upper Subordinate Officer have throughout the recess season been attached to No. 10 Party. The charges for these have fallen on No. 11 Party.
Special Work.					
Fair mapping of **4-inch** Forest Sheets	85 N/15 ...	8	79·6	669	
Do. of **4-inch** Mogok Stone Tract Sheets ...	93 A/8 & 12 93 B/5 & 9.	169	36·5	6,471	
No. 21 (Burma Forest) Party.—Burma.					
4-inch fair mapping	83 L/7, 8, 11, 12, 15, 16; P/3, 4, 7.	322	89·5	28,819	
Computations	83 P/4, 84 E/14, 15; 84 I/2, 3, 4, 5, 9, 10, 11, 13, 14, 15; 84 M/1.	326	37·8	12,334	

V.—SURVEY REPORTS, FRONTIER CIRCLE.

DIRECTOR:—Lt.-Colonel S. W. Sackville Hamilton, D.S.O., R.E.

46. Summary.—The units administered by the Frontier Circle were 'A' and 'E' Companies, Nos. 18 and 23 Parties, and No. 6 Drawing Office.

47. *Training.*—One Class II officer and 10 soldier surveyors continued their training in field and recess work during the year in 'E' Company. Of the latter one has been reverted to his regiment. Four R. E. officers on probation received training in air-survey work during the year under report.

48. *Special.*—The survey units on the frontier continued to co-operate closely with military formations at special training exercises (p. 3).

One Field Survey Section mobilized from 'A' Survey Company was attached to the force operating in the Kajuri Plain from October 1930 to March 1931 (p. 3).

49. *The field work* of units was as follows:—

'A' Survey Company. Topography on scales of 3 inches, 1½ inches, 1 inch and ⅜ inch to 1 mile in sheets 38. K, L and O, 43. B, E, F, G, I, M and 44. I. Traversing and triangulation in sheets 38. K and L.

'E' Survey Company. Topography on the scale of ¾ inch to 1 mile in sheet 35. I; on 1 inch to 1 mile in sheets 34. L and P. Triangulation in sheets 34. L and 35. I, J, M, N and O. Corrections to the 16-inch map of Quetta Cantonment.

No. 18 (Air Survey) Party. Compilations of air surveys in sheet 38. O and supplementary air survey of Peshāwar and surrounding country.

No. 23 (Irrigation Surveys) Party.—Detail survey on the scale of 4 inches to 1 mile of Muzaffargarh Project area in sheets 39. I, J, K & N and erection of permanent markstones at the corners of 3,000 acre rectangles in the same area.

Rectangulation and tertiary levelling of the Bhakra Dam Project area in sheets 44. I, J, K, M & N. All the above work was done for the Punjab Government.

'A' Survey Company.

Officer Commanding.—{ Lt.-Col. C. G. Lewis, O.B.E., R.E.; up to 13-8-31.
Mr. W. H. Strong, M.B.E., from 14-8-31.

50. General.—The recess head-quarters remained at Murree. Owing to lack of suitable accommodation at Rāwalpindi it has been decided to move the field head-quarters to Peshāwar where there is sufficient accommodation for both 'A' Company and No. 18 Party in the office building hitherto occupied by the latter. During recess the glazing of the verandah was carried out in that office to provide room for 'A' Company's drawing section.

A field survey section, mobilized from the company, was attached to the Kajuri Plain field force and carried out triangulation and plane-tabling during the cold weather.

The survey of the remainder of the Black Mountain and of Allāi tribal territory of Hazāra district was completed. This had to be abandoned last year owing to political disturbances.

The survey of the Gilgit Agency, the western portion of which was commenced in 1929, was continued during the year. The area surveyed includes the massifs of Nanga Parbat (26,600 ft.) and Haramush (24,200 ft.). In this agency the only area now remaining unsurveyed is that comprising the unadministered territories of Indus Kohistān, Tangir, Darel, etc., and the western portion of the Chilās republic. In the present state of local political relations, the safety of survey parties in the majority of this area cannot be provided for.

Revision surveys on the scale of 1 inch to 1 mile were continued in the Punjab plains in the neighbourhood of Lahore and Amritsar.

51. *Personnel.*—The average strength of the company during the year was 1 Class I officer, 3 Class II officers, 6 Upper Subordinate officers, 39 Lower Subordinate officers and 6 soldier surveyors under training.

Captain Irvine-Fortescue and Lieut. Jenney were attached for training during the summer. Lieut. Sams was transferred to No. 18 Party in March. Mr. Graham (Class II) was transferred to the Geodetic Branch in November; Messrs Strong and Chuni Lal Kapur, R.S. (Class II) joined the company in January and October respectively. Lieut. Sams, Messrs Chiragh Shah C.H. and Muhammad Akbar (U.S.S.), Surveyor Mir Abdullah and Computer Abdul Aziz joined the field survey section which was mobilized for the Kajuri Plain operations during the cold weather, reverting to the company in March.

52. Field work.—*Winter.* Mr. Chuni Lal Kapur, R.S. (Class II) with 7 surveyors, revised 1,520 square miles on the scale of 1 inch to 1 mile in the Lahore, Amritsar, Gurdāspur, Siālkot, Gujrānwāla and Shekhūpura districts of the Punjab (sheet 44. I), and carried out verification of new topographical detail communicated by other departments, in the Shekhūpura, Gujrānwāla, Shāhpur, Lyallpur, Montgomery and Lahore districts (sheet 44. E).

During the early part of the season Mr. Sajawal Khan, C.H. (U.S.S.) had charge of the training camp, consisting of Mr. Bashirullah Khan (U.S.S. on probation), one unclassified surveyor and 6 soldier surveyors. This camp resurveyed 119 square miles on the scale of 1½ inches to 1 mile in the Murree hills (sheet 43. G). In January Mr. Chiragh Shah, C.H. (U.S.S.) on reversion from field service, took over charge of this camp and surveyed 62 square miles on the scale of 3 inches to 1 mile round Bannu for the Bannu Guide map (sheets 38. K and L).

Surveyors Ghulam Muhammad I and Mian Muhammad, working independently, surveyed and revised 66 and 50 square miles respectively on the scale of 1½ inches to 1 mile in Swāt and in tribal territory, Hazāra district.

Mr. Chiragh Shah, C.H. (U.S.S.) carried out some supplementary triangulation in the Murree hills (sheet 43. G) in order to provide extra

frame work for the training camp. He also traversed about 15 square miles near Bannu, where sufficient fixed points for the 3-inch survey could not be provided by triangulation.

Mr. Muhammad Akbar (U.S.S.) completed the triangulation of about 60 square miles for the survey of the Bannu Guide map, and subsequently carried out correction surveys, chiefly to roads, in 21 1-inch sheets in Wazīristān, and Dera Ismail Khān district, N. W. F. P., (sheets 38. H and L, and 39. I). For this purpose he was detached from No. 1 Field Survey Section for about 7 weeks.

Summer.—At the end of March Mr. C. M. Aslam, B.A. (Class II) attended the annual tribal *Jirga* held at Oghi by the Deputy Commissioner, Hazāra district. The rewards sanctioned in connection with surveys in tribal territory in 1929 were distributed, and Mr. Aslam assisted in the successful negotiations with the *Khans* of Allāi and the Black Mountain for the completion of the survey. Subsequently, with 3 surveyors, he surveyed 297 square miles on the scales of 1½ inch and 1 inch to 1 mile in that area (sheets 43. B & F).

Mr. Chiragh Shah, C.H. (U.S.S.) with 4 surveyors and Mr. Muhammad Akbar (U.S.S.) with 3 surveyors surveyed 7,943 square miles on the scale of ⅜ inch to 1 mile in the Gilgit Agency & Baltistān (sheets 42. H, L, 43. A, E, I & M).

Mr. C. M. Aslam carried out some supplementary triangulation in Allāi tribal territory, Hazāra district, and in Indus Kohistān, Gilgit Agency (sheets 43. E & F) to provide extra points for plane-tabling.

53. Field operations in the N. W. F. Province.—A field survey section was attached to the force operating in the Kajuri Plain from October to March. Lieut. R. H. Sams, B.Sc., R.E. (Class I), commanding this section, with Mr. Md. Akbar (U.S.S.) and surveyor Mir Abdullah, surveyed 149 square miles on the scale of 1 inch to 1 mile (sheet 38. O). This area had already been mapped from rapid air-photo compilation, prints of which were used to assist the plane-tablers. Lieut. Sams also carried out supplementary triangulation in the area of operations, and during February he fixed a number of points in the neighbourhood of Shagai Fort & Ali Masjid in the Khyber Pass, for the use of the Royal Artillery.

54. Areas surveyed.—A total area of 10,206 square miles was surveyed, as follows:—

62 square miles of original survey on the scale of 3 inches to 1 mile (sheets 38. K & L).

66 square miles of original survey on the scale of 1½ inches to 1 mile (sheet 43. B).

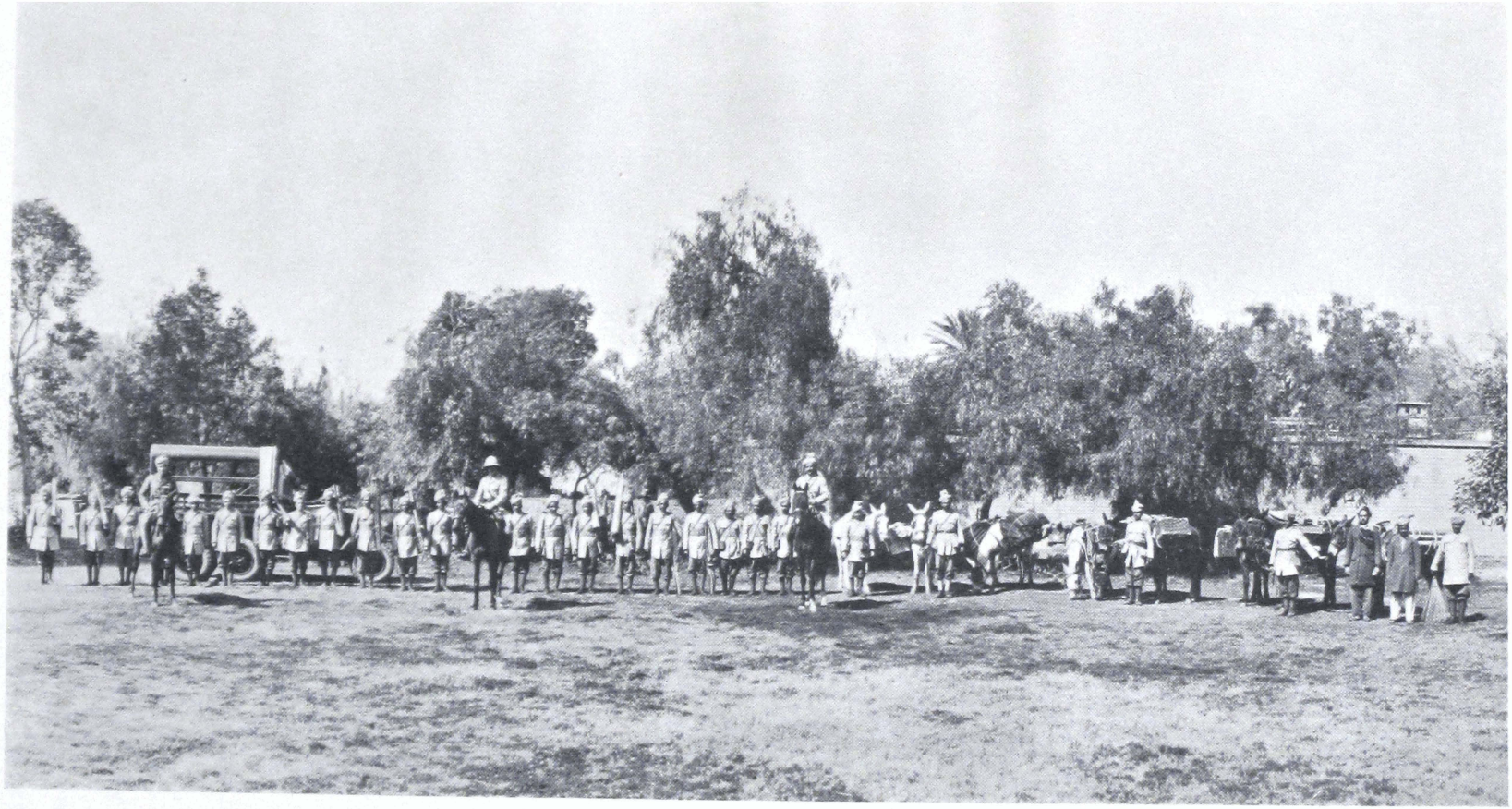
50 square miles of revision survey on the scale of 1½ inches to 1 mile (sheet 43. B).

119 square miles of resurvey on the scale of 1½ inches to 1 mile (sheet 43. G).

297 square miles of original survey on the scale of 1 inch to 1 mile (sheets 43. B & F).

149 square miles of original survey on the scale of 1 inch to 1 mile (sheet 38. O).

1,520 square miles of revision survey on the scale of 1 inch to 1 mile (sheet 44. I).



KHAJURI PLAIN OPERATIONS N.W.F.P. 1930-31.
INDIAN FIELD SURVEY SECTION.

7,943 square miles of original survey on the scale of $\frac{3}{8}$ inch to 1 mile (sheets 42. H & L, 43. A, E, I & M).

55. Office work.—*Section (1).* Mr. W. H. Strong, M.B.E. (Class II) with Messrs D. R. Vohra (U. S. S.) and Sajawal Khan, C.H. (U. S. S.), was in charge throughout most of the year, and completed 11 fair sheets.

Section (2). Messrs Aslam and Kapur were in charge during the winter and summer respectively. Thirteen fair sheets were submitted.

The average strength of the two sections was 14 surveyors & 3 draftsmen.

Computation of current triangulation and traverse work, and the adjustment & compilation of old data were carried out throughout the year by Mr. D. M. Dass (U. S. S.) & 5 computers.

'E' Survey Company.

Officer Commanding.—Major E. O. Wheeler, M.C., R.E.

56. General.—The field and recess head-quarters were at Quetta.

Owing to climatic conditions in the area under survey and to the necessity of nearly all movement being by road, only a portion of the company took the field at a time, the remaining portion continuing fair-mapping at head-quarters. Surveys were extended east-wards and south-wards, the modern survey of sheets 34. L and 35. I being continued, and that of 34. P commenced. 7,580 square miles were triangulated in advance for subsequent seasons.

Personnel.—The average strength during the field season was 1 Class I officer, 4 Class II officers, 3 Upper Subordinate officers and 42 Lower Subordinate officers (excluding the Reproduction Section). Of this strength, 1 Class II officer and 14 Lower Subordinate officers (including clerks) were employed at head-quarters, and 1 Class II officer was under instruction in plane-tabling.

Captain D. R. Crone, R.E., O.C. No. 18 (Air Survey) Party, was attached to the Company for 10 days while carrying out the military training referred to in para. 5: otherwise Major Wheeler was the only military officer with the unit. Mr. Mahammad Najamuddin, B.A. (Class II) was transferred temporarily to the company, while Messrs Seth Ram Gupta (Class II), Sardar Khan (U. S. S.) and Sadiq Ali (Assistant 2nd Division Photo-Litho. Office) were transferred to other units.

57. Field work was organized as follows:—

Winter—

Camp (1).—Mr. F. J. Grice (Class II) assisted by Messrs Muhammad Hasan, K.S. (Class II) and Abdul Rashid (U. S. S.) with 1 Class II officer, 6 surveyors and 9 soldier surveyors, surveyed 2,089 square miles on the scale of 1 inch to 1 mile in sheet 34. P.

Camp (2).—Mr. Khushal Khan (U. S. S.) assisted by 1st Class Surveyor Ahmad Shah, with 1 surveyor, 3 soldier surveyors and later 1 computer, surveyed 1,059 square miles on the scale of $\frac{3}{4}$ inch to 1 mile in sheet 35. I.

Summer—

Camp (3).—Mr. Mahammad Najamuddin, B.A. (Class II) with 4 surveyors and 2 soldier surveyors, surveyed 523 square miles on the scale of 1 inch to 1 mile in sheet 34. L.

Triangulation and traversing.—Messrs Khushal Khan and Sardar Khan (U. S. S.) and 1st Class Surveyor Asghar Ali triangulated 5,481 square miles in sheets 35. I, J, M, N and O for subsequent survey on the scale of $\frac{3}{4}$ inch to 1 mile: 1st Class Surveyor Thakur Singh also triangulated 2,099 square miles in sheet 34. L for subsequent survey on the same scale.

Corrections to existing maps.—The 16-inch map of Quetta Cantonment was corrected up to date, field work being carried out on published sheets.

58. Areas surveyed.—Original survey of 2,612 square miles on the scale of 1 inch to 1 mile, and of 1,059 square miles on the scale of $\frac{3}{4}$ inch to 1 mile; a total area of 3,671 square miles on both scales, all in Kalāt State, in Baluchistān. The corrections to the Quetta Cantonment map were spread over an area of 18 square miles.

The triangulation carried out lay mainly in Kalāt State, with small portions in Las Bela State, Baluchistān, and the Lārkāna and Karāchi districts of Sind.

Nature of area surveyed.—The country surveyed and triangulated included a portion of the plateau of Baluchistān, a portion of the extremely broken and intricate area where the plateau falls away to the low ground on the east and south, and a portion of the low-lying alluvial basin to the north-west of Jacobābād. Throughout the area there is little vegetation and water is very scarce and often impregnated with salts: in the hill areas inhabitants are few, particularly on the edges of the plateau, and many migrate with the season. Even on the plateau the heat is considerable during July and August, and in the low ground is of course notorious throughout the summer; during the winter the temperature in the hills may go below zero Fahrenheit, and even in the Jacobābād plain, the cold is severe at night. The programme of work therefore required careful arrangement, to conform to the varying climate in the area. Donkey transport had to be used in a part of the area; in the remainder, camels.

59. Office work.—Fair-drawing was carried on throughout the year, owing to the company having taken the field in two sections, at different seasons. Drawing sections were under the charge of Messrs F. J. Grice and M. Ansari, B.A. (Class II) assisted by Mr. Mahammad Najamuddin and K. S. Muhammad Hasan (Class II), and Messrs Khushal Khan, Sardar Khan and Abdul Rashid (U. S. S.).

Owing to the field season having continued until the end of June 1931, the mapping of all field work was not completed by the end of the survey year 1930-31. It will however be completed by the end of March 1932.

Reproduction Section.—This section, under the supervision of Mr. Sadiq Ali (Assistant, 2nd division Photo.-Litho. Office) and later under Litho. Draftsman Shahabuddin, worked full time throughout the year, almost entirely on paid for work. This work included the reproduction of a large number of the Khairpur Rectangulation charts for the Director, Central Circle, as well as numerous jobs for the military authorities in Quetta. The special drawing necessary was carried out by the regular drawing sections.

60. Military Training.—During May and June 1931 an exercise in air survey was carried out in co-operation with No. 31 (A. C.) Squadron, R. A. F., at Quetta.

No. 18 (Air Survey) Party.

Officer in charge.—Captain D. R. Crone, R.E.

61. General.—Recess and Field Head-quarters have remained at Murree and Peshāwar respectively. Close liaison with the R. A. F. units of No. 1 (Indian) Group has been maintained. The Bomber Squadrons are fully equipped with the F. 8 automatic film cameras and auxiliary equipment and after a prolonged period of experiment to overcome defects in operation owing to the more severe climatic conditions under which they are required to work in India this equipment used in conjunction with Kodak panchromatic film is now thoroughly reliable. All cameras have been calibrated for the R. A. F. units by the party and the more advanced methods of plotting for hilly country described in Professional paper No. 6 of the War Office Air Survey Committee, modified to suit Indian conditions, have been introduced.

62. Personnel.—Lieut. Price was posted to the party in October and proceeded on leave in March; Captain Fortescue, and Lieuts. Sams and Jenney were trained in photo. and air surveys during Recess.

Mr. S. R. Gupta (Class II) joined the party from 'E' Company for training.

The strength of the party was increased by 3 computers to form a computation section and 1 draftsman and 1 surveyor to form a fair-mapping section.

Four surveyors joining the circle were sent to the party for two years training and a similar number of trained men transfered to 'A' and 'E' Companies during recess. This will be the normal sequence of training in future, and was commenced during the year.

63. Field work.—The photographs provided by the R. A. F. during 1929-30 were sufficient to employ the party fully during the year under report. Further to these the R. A. F. supplied photographs of 25 sq. miles of the country around Peshāwar and of 102 square miles of Peshāwar and Attock Districts to be utilized for revision. The R. A. F. also provided the means for the carrying out of tests of oblique air photography for survey. The results of these tests will not be known until 1931-32.

64. Compilation.—*Tirāh.* A rapid compilation of the tribal territory in 38 O/6 was carried out for the Army. The rigorous survey by the plumb point method of the tribal territory in 38 O/2 was carried out and fair mapping commenced.

Peshāwar. The Supplementary survey of 25 sq. miles of Peshāwar and surrounding country was carried out on the 6-inch scale and the fair drawing of the Guide Map in two sheets commenced during the year.

Revision Survey. No revision survey was taken in hand as the F. 8 enlarger was not in running order.

65. Training.—In the course of their training, the Class I officers carried out rigorous air survey of 34 sq. miles by the plumb point method

in Tirāh, in addition to air survey by rapid active service methods. The party was exercised in rapid air survey compilation on a small exercise in the Murree hills held in conjunction with personnel of 'A' Company.

66. Reproduction Section.—The section has been kept moderately employed during the year on miscellaneous work, details of which are included in the Map Publication and Office work Report.

No. 23 (Irrigation Surveys) Party.

Officer in charge.— Mr. C. H. Tresham.

67. General.—This party which works for the Punjab Government completed the survey of the area commanded by the Muzaffargarh District, Indus Canals Project and continued the survey, commenced by No. 22 Party last year, of the area commanded by the Bhakra Dam Irrigation Project. Field head-quarters were at Ferozepore.

Personnel.—The average field strength of the party, apart from the Officer in charge, was 4 Class II officers, 5 Upper Subordinate officers and 132 surveyors, etc.

68. Field work.—

Camp (1).—Mr. H. H. P. Butterfield (Class II) assisted by Mr. M. L. Kohli (U.S.S.) with 20 surveyors completed 998 square miles of detail survey on the scale of 4 inches to 1 mile in the Muzaffargarh district in sheets 39. I, J, K & N and also erected permanent markstones at the corners of all 3,000-acre rectangles throughout this area.

Camp (2).—Mr. Jiya Lal Sahgal (Class II) assisted by Mr. N. D. Joshi, B.A. (U.S.S.) with 31 Lower Subordinates rectangulated 305 square miles and levelled 1,006 square miles in Ferozepore and Ludhiāna districts and in Farīdkot and Kalsia States in sheets 44. I, J, M & N.

Camp (3).—Mr. Mahammad Najamuddin, B.A. (Class II) assisted by Mr. Laltan Khan (U.S.S.) with 30 Lower Subordinates rectangulated 944 square miles in Ferozepore and Hissār districts and in Farīdkot and Patiāla States in sheets 44. I, J & K.

Camp (4).—Mr. Muhammad Husain Khan, K.S. (U.S.S.) assisted by Mr. Quadir Dad (U.S.S.) with 30 Lower Subordinates rectangulated 952 square miles in Ferozepore and Ludhiāna districts and in Farīdkot and Kalsia States in sheets 44. M & N.

Drawing Section.—Mr. Duni Chand Puri (Class II) with 14 Lower Subordinates completed the fair-mapping of two 1-inch compiled sheets of the Haveli Irrigation Project and the reduction of 741 village *musavis* of the Ferozepore district.

69. Recess Duties.—The fair mapping and computations of all the field work were completed during the year and in addition seven 1-inch compiled sheets of the Haveli Irrigation Project were fair-mapped. The work was supervised by Messrs H. H. P. Butterfield, Jiya Lal Sahgal, Muhammad Husain Khan, K.S. and N. D. Joshi, B.A. assisted by Messrs M. L. Kohli and Quadir Dad.

VI—SURVEY REPORTS, CENTRAL CIRCLE.

DIRECTOR.—Lt.-Col. J. D. Campbell, D.S.O., R.E.

70. Summary.—The units administered by the Central Circle were Nos. 1, 5 and 20 Parties, Air Survey Traverse and Khairpur Detachments, and No. 3 Drawing Office.

No 24 (Sind Rectangulation) Party was disbanded from 1st October 1930 and its personnel distributed amongst the other units of the Circle. Khairpur Detachment was formed from the same date to carry out rectangulation and levelling for irrigation projects in Khairpur State (Sind) under the direct supervision of the Director, Central Circle. It was placed in charge of Mr. Amrit Ram, U.S.S., with head-quarters at Rohri.

The Officer-in-charge, No. 5 Party, in addition to his normal duties, continued to act as Assistant Director of Surveys, Central Provinces, and administered the Revenue, Town and other surveys of that Province.

71. *Training.*—Two Class I officers were under training in No. 5 Party; one of them was transferred to the Frontier Circle in May 1931 and the other to No. 20 Party as Officer-in-charge for a short period during April 1931, being finally transferred to No. 1 Party.

Two Class II officers were confirmed in their appointments. Three other Class II officers on probation were transferred from the Geodetic Branch at the commencement of the field season for training to No. 5 Party.

Two pupil draftsmen were entertained in No. 3 Drawing Office to fill up the vacancies caused by retirement and death.

Six soldier surveyors posted to this Circle in 1929 completed their first period of training in No. 1 Party during field season 1930-31 and are being retained to undergo their second period of extra training. Three soldier surveyors, on completion of their fifth field season in No. 5 Party, have been recommended for permanent retention in the Department on the unattached list.

The U. S. S. computer, who was lent to this Circle, was retransferred to the Geodetic Branch in January 1931 on completion of the training of Topo. computers in this Circle. His services were also usefully utilized in No 1 Party during a part of last field season.

72. The *field work* of parties and detachments was as follows:—

No. 1 Party.—Topography on the scales of $\frac{1}{2}$, 1 and 4 inches to 1 mile in sheets 45. F, G, M and N, 54. H and 55. E. Special traversing and levelling for Kailāna Tank and Jodhpur Town survey. Triangulation in advance in sheets 45. I, J, M, N and O.

No. 5 Party.—Topography on the scales of $\frac{1}{2}$ and 1 inch to 1 mile in sheets 64. F, J and M. Traversing in sheets 64. F, G and K and triangulation in advance in sheets 64. F, G, K and L.

No. 20 Party.—Large scale revision survey of Chakrāta Cantonment and 4-inch revision survey of Lucknow and environs.

Air Survey Traverse Detachment.—Traversing for control of air surveys on the scale of 16 inches to 1 mile in Aligarh, Bareilly, Pilibhit, Shahjahanpur, Kheri, Fyzabad and Gonda districts of the United Provinces.

Khairpur Detachment.—Rectangulation and levelling in Khairpur State and Sukkur and Thar Parkar districts in Sind.

No. 1 Party.

Officer in charge.— { Lieut. H. W. Wright, R.E., up to 28-6-31. / Lieut. C. A. K. Wilson, R.E., from 29-6-31.

73. General.—The party continued operations in Rajputana and Central India Agencies, and Ajmer-Merwara and Punjab Provinces, partly by special arrangements with Indian States, in sheets 45. B, F, G, I, J, M, N and O, 54. D and H, and 55. A and E.

The field head-quarters of the party were at Ajmer.

Personnel.—The field strength of the party, excluding the Officer-in-charge, was 6 Class II officers, 5 U. S. officers and 65 L. S. officers, including 8 soldier surveyors under training.

74. Areas surveyed.—2,666 square miles of 1-inch original survey in sheets 45. F, G, M and N, in Ajmer-Merwara district and Jaipur and Jodhpur States of the Rajputana Agency, 1,516 square miles of ½-inch original survey in sheets 45. F, M and N in Jaipur and Jodhpur States and 5,423 square miles of ½-inch revision survey in sheets 54. H and 55. E in Bhopal Political Agency, C.I., and Gwalior State, were completed.

12,490 square miles were triangulated in sheets 45. I, J, M, N and O in Ajmer-Merwara and Punjab Provinces and Rajputana Agency.

120 square miles of triangulation, 7·7 linear miles of traversing, 210 linear miles of levelling and 88 square miles of 4-inch surveys were specially carried out, in continuation of the 1927-28 Kailana Tank Catchment area surveys by the Rajputana Detachment near Jodhpur, for Jodhpur State, Rajputana Agency.

75. Field work was organized as follows:—

Camp (1).—Mr. D. N. Vasudeva, B.A., (Class II) opened a camp of 3 instructors and 24 surveyors of whom 22 were under instruction. The original survey of 1,604 sq. miles on the scale of 1-inch to 1 mile in sheets 45. F and G in Jodhpur State was finished under Mr. A. B. Hunter.

The area was flat, dry and sandy, largely under intermittent cultivation and thorny scrub, with a few isolated and prominent hills.

Camp (2).—Mr. T. M. C. Alexander, (Class II) with 1 instructor and 9 surveyors, of whom 6 were under instruction, completed the original survey of 1,062 square miles on the scale of 1-inch to 1 mile and 1,061 square miles on the scale of ½-inch to 1 mile, in sheets 45. M and N in Jaipur State.

The planetablers of this camp suffered from lack of previously triangulated data.

The area included Jaipur City, and the surrounding country is wooded and cultivated, but sandy and interspersed with hills.

Camp (3).—Mr. J. C. Berry (Class II), with 10 surveyors, completed the revision survey of 5,423 square miles on the scale of ½-inch to 1 mile in sheets 54. H and 55. E in Bhopāl Political Agency.

The survey of 721 sq. miles of this area was completed after March by 7 surveyors, under 1st class surveyor Najmul Hussain, the balance of surveyors having left the field to form the advanced mapping section.

Camps (4) (5) (6) (7) (8) and (9):—

Mr. M. D. Nangia, B.A., (Class II), Mr. S. M. Murtaza, B.A., (Class II), Mr. I. H. Naqvi (U. S. S.), Mr. A. G. Qureshi (U. S. S.), Mr. D. N. Vasudeva, B.A., (Class II) and Mr. B. B. Kuttappa (U. S. S.) triangulated respectively 3,316, 1,729, 2,136, 2,145, 1,583, and 1,581 square miles in sheets 45. I, J, M, N and O in Ajmer-Merwāra and Punjab Provinces and the Rājputāna Agency.

In general the area was fairly flat and cultivated, with isolated hills.

Camp (10).—During October, November and December Mr. H. C. Deva, B.A., (U. S. S.), with 4 computers supplied the triangulation data of the 1,591 square miles under survey in Camp (2) concurrently with triangulation by Camps (4) and (5).

Camp (11).—Mr. R. N. Hastir, (U. S. S.), with 12 L. S. officers, who included 2 levellers, and 1 traverser and computer triangulated and computed 120 square miles, levelled 210 linear miles, traversed 7·7 linear miles and completed the special original surveys of 88 square miles, on the scale 4-inch to 1 mile, of parts of Jodhpur city and environs in sheets 45 B and F, and completed 455 sq. miles of original survey on scale of ½-inch to 1 mile in Jodhpur State in sheet 45. F.

Firstclass surveyor D. P. Ghasi Ram checked 8,700 square miles of 1871—73 and 1872—78 triangulation by plane-table and telescopic clinometer in sheets 54. D and 55. A in Central India, Gwalior and Rājputāna.

The area was partly open and undulating and partly jungle-covered hills.

76. Recess duties.—Fair-mapping was divided into 4 sections under Messrs A. B. Hunter, T. M. C. Alexander, J. C. Berry and R. N. Hastir respectively.

Mr. A. G. Qureshi was responsible for the completion of all computations.

The mapping of nine 1-inch sheets, all surveyed during this season, and one ½-inch compiled sheet surveyed previously, was completed during the year.

90 square miles of four-inch survey carried out at Jodhpur this season was added to old fair sheets prepared by the Rājputāna Detachment in 1927-28.

No. 5 Party.

Officer in charge.—{ Major L. H. Jackson, I.A., up to 19-10-30.
Mr. J. H. Williams from 20-10-30.

77. General.—The party continued surveys on the 1-inch to 1 mile and ½-inch to 1 mile scales in Central India, Central Provinces,

and United Provinces, in sheets 64 F, J and M. The field head-quarters were again at Nāgpur in order to keep in touch with the Settlement Commissioner, the Officer-in-charge of the party being also Assistant Director of Surveys, Central Provinces.

Personnel.—The field strength, apart from the Officer-in-charge, was 2 Class I (under training), 6 Class II (4 under training) and 3 U. S. officers, 40 surveyors (5 under training), 4 traversers and 6 computers and recorders.

78. Areas surveyed.—3,565 square miles of 1-inch survey (2,942 square miles original and 623 square miles supplementary) in sheets 64. F, J and M and 2,983 square miles of ½-inch survey in sheet 64. M, totalling 6,548 square miles on both scales; 3,341 square miles of triangulation in sheet 64, and 1,074 linear miles of traversing in sheets 64. F, G and K.

The triangulation was connected to the Bilāspur Meridional Series and the traverse with the triangulation carried out by the party.

79. Field work was organised as follows:—

Camp (1).—Mr. C. T. Hurley (Class II), with 6 surveyors, completed 272 square miles on the scale of 1-inch to 1 mile and 817 square miles on the scale of ½-inch to 1 mile in sheet 64 M/NW in Mirzāpur district and Surguja Feudatory State.

The area is mostly wooded, communications being good during the open season, and the lower ground largely cultivated.

Camp (2).—Mr. Shadi Lal Dube (U. S. S.), with 7 surveyors, completed 2,166 square miles on the scale of ½-inch to 1 mile in sheet 64. M (less N. W.) in Jashpur and Surguja Feudatory States. Communications are good and the area mostly jungle clad, the lower areas being cultivated.

Camp (3).—Mr. J. R. Chibbar (U. S. S.), with 14 surveyors, completed 1,614 square miles on the 1-inch to 1 mile scale in sheets 64. F and J, in Bilāspur district and the C. P. Feudatory States in Central Provinces, and Rewah State in Central India. Most of the country is hilly, and densely wooded, with few communications.

Camp (4).—Mr. Hakdad Khan (U. S. S.), assisted by surveyor Abdul Kaiyum Khan with 16 surveyors (including 1 Class I and 3 Class II officers and 5 surveyors under training), completed 1,679 square miles on the 1-inch to 1 mile scale (1,056 square miles original and 623 square miles supplementary survey) in sheets 64. F and J, in Mandla and Bilāspur districts in Central Provinces and the Rewah State in Central India.

The hills are mostly reserved forests and densely wooded, but the greater part of the Mandla district falling in this area is undulating open country largely cultivated, of which large tracts contain just a few conspicuous trees.

Camp (5).—Lieut. C. A. K. Wilson, R.E., (Class I under training) triangulated 957 square miles in sheets 64. K and L in the Raipur district.

The hills are densely wooded and the lower ground difficult for triangulation. Communications are bad.

Camp (6).—Mr. M. A. Khan (Class II) triangulated 1,206 square miles in sheets 64. F and G in Bālāghāt and Drug districts; the area consists of heavily wooded hills, with fair communications.

Camp (7).—Mr. K. C. Gosain (Class II probationer under training) triangulated 1,178 square miles in sheet 64. L in Raipur district. He was later assisted by Mr. N. N. Chuckerbutty (Class II).

Camp (8).—Traverser Amar Singh with 3 traversers traversed 1,074 linear miles in sheets 64. F, G and K in Bilāspur, Drug and Raipur districts. These traverses were run primarily to give heights in the area for further surveys.

The party suffered very much from malarial fever, a large number of officers and surveyors returned ill to recess head-quarters. The Central Provinces has a short cold weather and work is carried out under trying conditions after the middle of March.

80. *Recess duties.*—Fair mapping was divided into three sections under Messrs C. T. Hurley, J. R. Chibbar, and Shadi Lal Dube assisted by Mr. Hakdad Khan. The Computing Section was under Mr. N. N. Chuckerbutty assisted by Mr. M. A. Khan.

The mapping of one ½-inch, and thirteen 1-inch sheets, all surveyed during this season, and four ½-inch compiled sheets surveyed previously, was completed during the year.

No. 20 Party (Cantonments).

Officer in charge.— Mr. J. H. Williams, up to 19-10-30.
Lieut. I. H. R. Wilson, R.E., from 20-10-30 to 7-4-31 and from 27-4-31.
,, C. A. K. Wilson, R.E., from 8-4-31 to 26-4-31.

81. General.—The party carries out original and revision surveys of cantonments and military lands (including cantonment bāzārs) as required by the Engineer-in-Chief and the Director Military lands and Cantonments. The Party is also available for carrying out special large scale surveys.

The permanent head-quarters of the party were at Mussoorie.

Personnel.—The strength, excluding the Officer-in-charge, was 1 U. S. officer, 17 L. S. officers and a permanent drawing section of 6 draftsmen.

82. Areas Surveyed.—27 sq. miles revison survey on scale of 4 inches to 1 mile and 1,414 acres re-survey on scale of 16 inches to 1 mile were completed.

39 linear miles were traversed for 4 inches to 1 mile survey.

83. Field work was organized as follows:—

Camp (1).—Mr. Bakhshi Harnam Singh (U.S.S.) with 5 surveyors completed 1,414 acres of 16 inches to 1 mile re-survey of Chakrāta Cantonment, the rest of the work having been completed the previous year.

Camp (2).—Under the direct supervision of the Officer-in-charge, completed 27 sq. miles of 4-inch revision survey of Lucknow and environs.

84. Recess duties.—Fair mapping was carried out throughout the year under Mr. Bakhshi Harnam Singh (U. S. S.) and 21 sheets on

16 inches to 1 mile scale and 9 sheets on 64 inches to 1 mile scale of Kamptee, Dinapore, Pachmarhi and Lucknow Cantonments and bāzārs were prepared and sent to press for publication. Cawnpore Cantonment and bāzār sheets left over from last year were completed during the early part of the season.

Air Survey Traverse Detachment.

Officer in charge.—Mr. Jagannath.

85. General.—This detachment took up traversing for 16 inch to 1 mile Settlement Surveys, in districts Fyzābād, Gonda, Bareilly, Shāhjahānpur, Pīlibhīt, Kheri and Alīgarh of the United Provinces, in parts of sheets 53. P; 54. I and M; 62. D and H; and 63. A, E, F, I & J at the request of the Settlement Commissioner, U. P. Field work opened at Fyzābād on the 13th November 1930, but head-quarters had to be subsequently moved to Bareilly on 5th February 1931. Field work closed on 18th May 1931.

86. Personnel.—The field strength, apart from the Officer-in-charge, was 17 Lower Subordinate officers *i.e.* 2 Surveyors, 11 Traversers, and 4 Computers.

87. Areas surveyed.—2,424 linear miles of traversing in part of sheets Nos. 53 P; 54 I, M; 62 D, H and 63 A, E, F, I & J in districts Fyzābād, Gonda, Bareilly, Shāhjahānpur, Pīlibhīt, Kheri and Alīgarh were completed.

88. Field work was organized as follows:—

Field Head-quarters were under direct supervision of Officer-in-charge with head-quarters at Fyzābād till 5-2-31 and thereafter at Bareilly. Four Computers and 2 Pupil Surveyors carried out computations and preparation of *Mujmulis*.

Mosaics for the whole area were prepared and supplied direct to the District Officers (Collectors) concerned.

Field Camp, under supervision of Officer-in-charge, consisted of Traverser Nand Kishor Sharma and 10 Traversers, and completed 2,424 linear miles of traversing in districts Fyzābād, Gonda, Shāhjahānpur, Bareilly, Pīlibhīt, Kheri and Alīgarh.

89. Computations.—The whole area was completed in the field Head-quarters and traverse data for districts Gonda, Kheri, Pīlibhīt and Shāhjahānpur were supplied to the Indian Air Survey and Transport Ltd. as requested by the Settlement Commissioner, U. P. Data for the remaining area were supplied during the recess.

The country traversed consists partly of open cultivation interspersed with numerous villages and mango-groves, and partly of broken ground covered with high grass, scrub and dense forest.

The areas traversed were scattered and consisted generally of small blocks.

90. Recess duties.—Computations carried out during the field were finally scrutinized, completed and bound up in volumes, and the Air Survey and Transport Ltd. was supplied with the necessary data.

The Detachment was disbanded from 1st October 1931 on completion of its work.

Khairpur Rectangulation Detachment.

Officer in charge.— { Mr. Amrit Ram (U. S. S.), from 1-10-30 to 8-4-31.
{ Mr. R. N. Hastir (U. S. S.), from 9-4-31.

91. General.—On the disbandment of No. 24 Party this Detachment was formed on 1st October 1930 under the direct administration of the Director, Central Circle and in charge of Mr. Amrit Ram (U. S. S.), with head-quarters at Rohri, to carry out 64-acre rectangulation and levelling for irrigation projects in the Eastern Nāra valley, for the Khairpur State (Sind), in sheets 40. A, B & E.

It also undertook to run a double levelling line to connect certain P. W. D. bench marks in sheet 40. A in Sukkur district for the Bombay Government, and also completed 320-acre rectangulation in sheet 40. G in Thar Pārkar district, left over by No. 24 Party during the last field season, owing to the area being flooded.

Personnel.—Besides the Officer-in-charge, the Detachment had 6 rectangulators, 2 computers and 2 recorders to begin with, but was later on reinforced by 2 surveyors, 5 rectangulators, 1 trig. computer, and 4 recorders who joined it for rectangulation or levelling duties on different dates between 1st March and 14th May 1931.

Two rectangulators were discharged in the beginning of May for unsatisfactory work and conduct.

Mr. Amrit Ram (U. S. S.) proceeded on leave on medical certificate on 9th April 1931, and was relieved of his duties by Mr. R. N. Hastir (U. S. S.).

92. Areas surveyed.—The detachment opened for the field at Rohri in district Sukkur. It completed the programme detailed below:—

1. For Khairpur State (Sind).
   (*a*) 139 sq. miles of 64-acre exterior and interior rectangulation.
   (*b*) 152 linear miles of tertiary double levelling and 518 linear miles of single levelling, for preparation of contour charts.
2. For Bombay Government:—
   (*a*) 24 linear miles of double levelling in Sukkur district, for connection of P. W. D. bench marks of Lloyd Barrage.
   (*b*) 30 sq. miles of 320-acre interior rectangulation in sheet 40. G in Thar Pārkar district.

Levelling was connected with Geodetic bench-marks previously fixed in the area.

The area under survey is surrounded by high sand mounds on all sides. It is covered with dense impenetrable forest and high reed grass, and is very sparsely populated. The Nāra River, which is an offshoot of the Indus River, is fordable at places during the winter months, but during the rainy season can only be crossed by boats at ferries.

93. Recess duties.—During the recess the detachment completed the levelling computations and preparation of *musāvis* for the Lloyd Barrage and *Musāvis* and contour charts of the Khairpur State.

The Detachment was disbanded from 1st September 1931, on completion of its work.

VII.—SURVEY REPORTS, SOUTHERN CIRCLE.

DIRECTOR:—Lieut.-Colonel L. G. Crosthwait, I.A.

94. Summary.—The units administered by the Southern Circle were Nos. 6, 7 and 8 Parties and No. 4 Drawing Office.

95. *Training.*—One Class II officer, 4 Upper Subordinate officers, 16 pupil surveyors, and 3 pupil draftsmen, including 6 entertained during the year, were under training.

96. *Special Surveys.*—Large scale surveys of two private estates were carried out and theodolite traverses were made of the boundaries of Trichinopoly and Cannanore military cantonments for Head-quarters, Madras District.

97. *The field work* of parties, of which the outturn on the scales of 1 inch, 2 inches, and 4 inches to a mile was 14,868 square miles covering 51 sheets was as follows:—

No. 6 Party.—Topography on the scales of 1 inch and 2 inches to a mile in sheets 65. B, C, F, G and J.

No. 7 Party.—Topography on the scale of 1 inch to a mile in sheets 48. J, M and N.

No. 8 Party.—Topography on the scales of 1 inch and 4 inches to a mile in sheets 58. I and M.

98. Triangulation and traverse were carried out in advance for next season's survey.

99. *Sale of Maps.*—The amount realised from the sale of maps was Rs. 7,363.

No. 6 Party.

Officer in charge.—Mr. E. M. Kenny.

100. General.—The party carried out topographical surveys in the East Godāvari district and Jeypore estate of the Vizagapatam district of Madras, the Warangal district of Hyderābād State and Bastar State of the Central Provinces.

The field head-quarters opened at Jeypore in the Vizagapatam Agency on the 26th November 1930, and closed on the 8th May 1931.

101. *Personnel.*—The field strength of the party was 3 class II officers, 5 Upper Subordinate officers, 4 Upper Subordinate probationers and 39 Lower Subordinate officers.

102. Areas Surveyed.—A total of 3,219 square miles was surveyed as follows:—

Original survey on the scale of 1 inch to a mile of 1,817 square miles in sheets 65. F and J, and 917 square miles of re-survey of an area previously surveyed on the scale of half-inch to a mile in sheet 65. G.

The survey on the scale of 2 inches to a mile of 485 square miles of the Golapalli reserved forest of Bastar State, comprising 235 square miles original survey in sheet 65. F, and the resurvey of 250 square miles in sheets 65. B, C and G of an area previously surveyed on the one inch and half-inch scales.

103. Field work was organized as follows:—

Topographical Surveys.—Camp (1), under Mr. E. N. Natesan, B.A., (Class II), assisted by Mr. Muzaffar Husain (U. S. S.), 4 U. S. S. probationers and 14 surveyors completed 985 square miles on the scale of 1 inch to a mile and 485 square miles on the scale of 2 inches to a mile.

Camp (2), under Mr. C. P. E. Davenport (Class II), assisted by Mr. K. B. Muthanna (U. S. S.), and 15 surveyors completed 923 square miles on the scale of 1 inch to a mile.

Camp (3), under Mr. Muhammad Abdul Azim, I.D.S.M., (U. S. S.), assisted by 8 surveyors completed 826 square miles on the scale of 1 inch to a mile.

The country surveyed consisted chiefly of forest-clad plains and hills with scattered villages, that along the Godāvari and Sābari rivers being largely cultivated and well populated.

Camp (3) did not take the field until 2nd January 1931, and owing to sickness among the surveyors and *khalasis* it could not complete its full programme.

Triangulation.—An area of 5,364 square miles was triangulated by Messrs Abdul Ahad (Class II), Sheikh Alauddin (U. S. S.) and Muhammad Mustafa (U. S. S.) and surveyors Ganpat Sayaji and G. K. Mohiuddin in the East Godāvari and Vizagapatam districts in sheets 65. F, J and K. The triangulation has been connected with the geodetic series Nos. 58, 43 and the lines of spirit levels in sheets 65. J and K.

Traversing.—Messrs K. B. Muthanna (U. S. S.) and A. Shamanna (U. S. S.) and surveyor A. Narasinga Rao completed 326 linear miles of theodolite traversing in sheets 65. K and L.

104. Recess duties.—The fair mapping of 11 one-inch sheets and 6 two-inch sheets was completed under Messrs Natesan, Muthanna and Muhammad Abdul Azim.

The computations of the triangulation and traversing were completed under Mr. Muhammad Mustafa.

No. 7 Party.

Officer in charge.— { Mr. S. S. McA'F. Fielding up to 20-5-31
Captain G. W. Gemmell, I.A., from 21-5-31.

105. General.—The party continued topographical surveys in Belgaum, Dhārwār, Bijāpur and North Kanara districts of Bombay, Kolhāpur and Savanūr States and the Southern Marātha Jāgīrs and Goa.

The field season commenced on 21st November 1930 with headquarters at Dhārwār and closed on 22nd April 1931.

Personnel.—The field strength was 1 Class I and 4 Class II officers including one probationer, 3 Upper Subordinate officers, and 40 surveyors, etc.

106. Areas surveyed.—A total of 5,825 square miles of supplementary survey was completed on the scale of one inch to a mile.

107. Field work was organized as follows:—

Camp (1), Mr. F. C. Pilcher (Class II) with one Class II probationer and 15 surveyors completed 2,009 square miles in sheets 48. J, M and N.

Camp (2), Mr. N. S. Harihara Iyer (Class II) with one Upper Subordinate officer and 12 surveyors completed 1,526 square miles in sheet 48. J.

Camp (3), Mr. P. S. Vengusvami (U. S. S.) with 13 surveyors completed 2,290 square miles in sheet 48. M.

The country surveyed was open, and in parts a treeless expanse of undulating plain, in Bijāpur, Dhārwār and Belgaum districts, and intricate and heavily wooded plateau and the densely forested Western Ghāts running down to the coast in North Kanara district. Communications throughout the area under survey were numerous and good.

The surveyors working along the Western Ghāts in North Kanara suffered a good deal from malaria for which the district is notorious.

Triangulation and traversing.—690 square miles of Portuguese Territory (Goa) in 48. E and I were triangulated by Mr. I. K. Ponnappa (U. S. S.).

It was decided in the field that the existing Portuguese triangulation provided ample control and triangulation in Goa was suspended. In addition to the above, 570 square miles of supplementary triangulation was carried out by the same officer in 47. P to test the accuracy and adequacy of the triangulation of 1891—94, which was found satisfactory.

Mr. B. N. Murthy (Class II) and one surveyor completed 135 linear miles of Theodolite Traversing in the heavily forested plateau of 48. I and J.

108. Recess Duties.—The mapping of the 21 one-inch and 1 half-inch sheets was completed under Messrs Pilcher, Harihara Iyer and Vengusvami. A section under Mr. B. N. Murthy completed the computations of triangulation and traversing.

No. 8 Party.

Officer in charge.—
- Mr. B. T. Wyatt, from 1-10-30 to 9-10-30.
- Lt.-Col. R. Foster, I.A., from 10-10-30 to 20-5-31.
- Mr. F. C. Pilcher, from 21-5-31 to 5-6-31.
- Major W. J. Norman, M.C., R.E., from 6-6-31.

109. General.—The party opened its field head-quarters at Cuddalore on the 7th November, and continued topographical surveys in the Salem, North Arcot, South Arcot, Tanjore, and Trichinopoly districts of Madras.

Personnel.—The field strength, excluding the Officer in charge, was 3 Class II, 3 Upper Subordinate and 39 Lower Subordinate officers and 16 pupil surveyors.

110. Areas surveyed.—A total of 5,824 square miles was surveyed in sheets 58. I and M comprising:—

5,819 square miles original and supplementary surveys on the scale of 1 inch to a mile.

5 square miles of reserved forest survey on the scale of 4 inches to a mile.

1 square mile of estate resurvey on the scale of 16 inches to a mile, in 58 B/15.

111. Field work was organized as follows :—

Camp (1).—Mr. M. S. Ganesa Iyer (Class II) with Mr. N. M. Bopaiah (U. S. S.) and 12 surveyors completed 720 square miles of original and 1,029 square miles of supplementary survey on the scale of 1 inch to a mile in sheet 58. I.

Camp (2).—Mr. S. R. Kelkar, B.Sc., (Class II) with 16 surveyors completed 1,014 square miles of original and 726 square miles of supplementary survey on the scale of 1 inch to a mile and 5 square miles of original survey on the scale of 4 inch to a mile in sheet 58 I/9.

Camp (3).—Mr. M. R. Nair, B.A., (Class II) with 12 surveyors completed 18 square miles of original and 1,439 square miles of supplementary survey on the scale of 1 inch to a mile in sheets 58. I and M.

Camp (4).—Mr. Saiyid Budhan (U. S. S.) with 13 surveyors completed 184 square miles original and 689 square miles supplementary survey on the scale of 1 inch to a mile in sheet 58. I.

The country varied from the low lying paddy fields with dense cocoanut groves and undulating plains to hills rising to 5,000 feet. The Shevaroy and Kalrāyan hills in the north of sheet 58. I consist of intricate small valleys, the whole being covered with dense forest. In the south of the area lie the Pachaimalai and Kollaimalai hills rising to about 4,000 feet, fairly heavily wooded with no roads and very few tracks.

The hilly areas have a reputation for unhealthiness and there was a considerable amount of sickness among the surveyors and *khalasis* working in these parts.

Forest surveys.—The Arana and Thirthagiri reserved forests of the Central Salem forest division, an area of 3,138 acres in sheet 58 I/9, were surveyed on the scale of 4 inches to a mile. A theodolite traverse of the boundaries was also carried out.

Special surveys.—551 acres of tea estates were surveyed on payment in sheet 58 B/15.

Triangulation and traversing in advance was carried out in sheets 65. K, L and O by No. 6 party.

112. Recess duties.—The fair mapping of 20 one-inch sheets, the two reserved forests and the tea estates was completed under Messrs Kelkar, Nangia, Nair, Saiyid Budhan and Bopaiah.

The computations of the triangulation and traverse were carried out under Mr. Alauddin.

VIII.—SURVEY REPORTS, EASTERN CIRCLE.

DIRECTOR:—{Lt.-Colonel L. C. Thuillier, I.A., up to 4-3-31
{Colonel H. J. Couchman, D.S.O., M.C., from 5-3-31.

113. Summary.—The units administered by the Eastern Circle were Nos. 4, 9 and 12 Parties, and No. 5 Drawing Office.

The Director, Eastern Circle, also acts as Director of Surveys, Assam, under the local government. This entails the administration of the Assam *Traverse Party*, the Assam *Drawing and Reproducing Offices* at Shillong, and the Assam *Survey School* at Jhālukbāri (Gauhāti) which he inspected.

In addition, as technical adviser to the Governments of Bengal and Bihār & Orissa, the Director, Eastern Circle, visited the Bengal *Drawing Office* at Alipore (Calcutta) and the Bihār and Orissa *Drawing Office* at Gulzarbāgh (Patna).

114. *The field work* of parties comprised 39 one-inch sheets partly or wholly surveyed and other miscellaneous sheets.

No. 4 Party.—Topography, 3,070 square miles on the scale of 1 inch to a mile in sheets 73. M and N.

Traverse in advance in sheets 72. C and G and 73. O.

No. 9 Party.—Topography, 3,903 square miles on the scales of 1 inch and 4 inches to a mile in sheets 73. D and H.

Triangulation in advance in sheets 64. O and 73. C.

No. 12 Party.—Topography, 2,447 square miles on the scales of 1 inch and 6 inches to a mile in sheets 78. A and B.

Special survey of the Digboi oil-field on the scale of 16 inches to a mile in sheet 83 M/11.

Triangulation in advance in sheets 79. M and 84. A.

115. *Training.*—All the pupils attached for training to parties in the field, appear to be promising and likely to become useful surveyors.

No. 4 Party.

Officer in charge.—Captain J. B. P. Angwin, R.E.

116. General.—Original and supplementary surveys were carried out in Bengal; original survey in sheet 73. M, and original and supplementary surveys in sheet 73. N. All survey was on the scale of 1 inch to a mile. The field head-quarters were at Midnapore.

Personnel.—The field strength of the party was 1 Class I officer, 4 Class II officers, 1 Class II probationer, 1 Upper Subordinate officer, 1 Upper Subordinate probationer and about 38 Lower Subordinates. Mr. M. M. Ganapathy, B.A., (Class II) took charge of Camp (II) at the end of January when Mr. P. C. Mitra, B.A., (Class II) proceeded on leave on medical grounds.

117. Areas surveyed.—

Original survey on 1-inch scale	...	1,972 square miles.
Supplementary survey on 1-inch scale	...	1,098 ,, ,,
Traverse (Theodolite) ...	...	980 Linear miles.
Traverse (Plane-table height)	..	543 ,, ,,

118. Field work was organized as follows:

Camp (1).—Mr. S. F. Norman (Class II) with 9 surveyors carried out the supplementary survey of 823 square miles in the undulating laterite country of the north and north-west of the Midnapore district and south of the Bānkura district. The higher ground is covered with dense low *sāl* jungle which gives way to paddy-fields in the low-lying areas.

Mr. Norman subsequently supervised surveys in part of Camp (2) area.

Camp (2).—Mr. M. M. Ganapathy, B.A., (Class II) with 6 to 10 surveyors, after taking over in January from Mr. P. C. Mitra, B.A. (Class II), completed the supplementary survey of 275 square miles in the north-east of the Midnapore district and original survey of 332 square miles in the Midnapore, Hooghly and Howrah districts.

The original number of surveyors was subsequently increased by withdrawals from Camp (1).

The country consists of densely populated rice-lands, in part perennially wet. The villages are thickly wooded with bamboo, palmyra, date-palm and other trees and are mostly built on mounds or irrigation bunds.

The area is very malarial and several surveyors were affected. Two *khalāsis* died.

Camp (3).—Mr. A. R. Quraishi, B.A., (Class II) with Mr. Iltifat Husain (Upper Subordinate) as assistant camp officer, one Class II probationer, 10 surveyors, 2 soldier surveyors and 1 pupil carried out the original survey of 1,640 square miles in the Murshidābād, Birbhūm, Burdwān, Bānkura, Hooghly, Howrah and Midnapore districts.

The area consisted of rice-land with densely wooded villages, crowded together in the south-east and more scattered elsewhere.

Several surveyors suffered from malaria. One *khalāsi* died.

Traverse.—Two traversers completed 781 linear miles of traverse for 1-inch survey in the Midnapore district of Bengal and Balasore district of Bihār and Orissa down to the sea-coast, and in the Mayūrbhanj State. The area is mainly rice-land with wooded villages, and with sand-hills along the coast.

One traverser completed a main-circuit of 199 linear miles as framework for special plane-table height-traverse in Bihār (*see below*) and was then transferred to Camp (3) for instruction in plane-tabling.

Plane-table height-traverse.—Mr. U. D. Mamgain, B.Sc., (U. S. S. Probationer) completed 543 linear miles of special plane-table height-traverse in the Shāhābād, Gaya and Patna districts of Bihār in cultivated plains with wooded villages. This covered six one-inch sheets.

This traverse was undertaken with the object of providing cheaply a network of heights, and at the same time of testing survey blue-prints, in an area where it was considered that the preliminary editions were probably sufficiently accurate geographically to obviate almost entirely the necessity for theodolite traverse.

The results proved very satisfactory and the estimated saving in providing the requisite framework for a degree sheet is about Rs. 15,000.

Full details of the method employed are given in the Technical Supplement.

119. Recess duties.—Fair mapping was organized into four sections under Messrs S. F. Norman, A. R. Quraishi, B.A., M. M. Ganapathy, B.A., and Iltifat Husain with Mr. U. D. Mamgain, B.Sc., as an assistant section officer.

Mr. U. D. Mamgain, B.Sc., was also in charge of the typing section.

The fair mapping of eleven sheets was finished during recess.

Computations under computer A. P. Gupta as head computer, were completed during recess.

No. 9 Party.

Officer in charge.—Mr. V. W. Morton.

120. General.—Original and supplementary surveys were carried out on the scale of 1 inch to a mile in sheets 73. D and H in Bihār and Orissa and Ganjām district of Madras. The field head-quarters were at Cuttack.

Personnel.—The average field strength of the party was 3 Class II officers, 5 Upper Subordinate officers (one on probation) and 43 Lower Subordinate officers, with 3 soldier surveyors under training.

Areas surveyed.—

1-inch Original survey	...	3,627	square miles.
1-inch Supplementary survey	...	275	,, ,,
4-inch special forest survey	...	1	,, mile.
Triangulation ...	...	3,807	,, miles.

121. Field work was organized as follows:—

Camp (1).—Mr. Priya Nath Sur (Class II) with 11 surveyors, 3 soldier surveyors and 2 pupils, carried out original surveys on the scale of 1 inch to a mile of 1,391 square miles in the Cuttack district, and Athgarh, Barāmba, Dhenkānāl, Hindol and Tigiria States of the Orissa Feudatory States.

The country surveyed consisted mainly of densely wooded hills and plains traversed by the Brāhmani river towards the north. Cultivated areas are to be met with in the vicinity of villages and in the portion comprising Cuttack district. The branch railway line from Cuttack to Tālcher and a metalled road to Sambalpur run diagonally through the area. Fair weather motorable roads were plentiful, but the crossing of the Brāhmani river was always a difficult problem for want of regular ferries.

Camp (2).—Mr. Bhupendra Nath Saha, M.Sc., (Class II) with one Class II officer, 12 surveyors and one pupil carried out original and supplementary surveys on the scale of 1 inch to a mile of 1,171 and 224 square miles respectively in Angul district, Baud, Daspalla, Hindol, Khandpara, Nayāgarh and Narsinghpur States of the Orissa Feudatory States, and Ganjām district of Madras.

The country surveyed consisted mainly of high hills covered with dense jungle, in which bamboo predominates, and small hillocks of solid masses of rock, interspersed with patches of cultivation and open lands. The area has a generous supply of fair weather motorable roads.

Camp (3).—Mr. Rohini Kumar Talapatra, B.A., (U. S. S.) with 1 Upper Subordinate probationer and 12 surveyors carried out original and supplementary surveys of 1,065 and 51 square miles respectively on the scale of 1 inch to a mile in Angul district, Baud and Daspalla States of the Orissa Feudatory States, and the Agency Tracts of Ganjām, Madras.

The country surveyed comprised an extensive elevated region, averaging 2,000 feet, above sea level surrounded by hills rising to an altitude of 4,000 feet. A peculiar feature of the country is that the eastern slopes of the hills are bare, due to periodical cultivation by the hill tribes. Fair weather roads are numerous in the area, but streams are unbridged.

Triangulation.—Messrs Atul Chandra Maulick, Hiranya Kumar Kar and Nirmal Chandra Sen triangulated in the Sambalpur district and Feudatory States of Orissa.

The country varied from high forest clad hills to undulating ground, interspersed with isolated hillocks and low jungle-covered ranges. A good motorable road traverses the south-west portion of the area and a branch railway line runs down the west. Transport in the hilly area is mainly by coolies.

Special surveys.—An area of 711 acres of the Galleri Extension Reserves (Blocks I to IV) was surveyed on the scale of 4 inches to a mile for the Madras Forest Department. In addition, 22 linear miles of theodolite traverse was executed to provide data for this survey. The computations were done *pari passu* in the field.

Forest surveys.—The 1-inch survey included several Government reserved and protected forests of Angul and Ganjām districts, and State forests of the Orissa Feudatory States.

122. Miscellaneous.—The party head-quarters were removed from Cuttack to Sambalpur at the close of the field season.

Man-eating tigers, bears and elephants are numerous in the forest areas of the Orissa Feudatory States.

The Agency Tracts and the Feudatory States are very unhealthy, and several surveyors and *khalāsis* suffered from malaria throughout the season. Two *khalāsis* died.

123. Recess duties.—The fair mapping was divided into three sections under Messrs Sur, Hawley and Talapatra, assisted by 2 Upper Subordinate officers.

The computation work was under Mr. A. C. Maulick (U.S.S.).

The fair mapping and computations of all the field work were completed before the end of recess.

No. 12 Party.

Officer in charge.—Lt.-Colonel C. M. Thompson, I.A.

124. General.—Original survey was carried out on the scale of 1 inch to a mile in sheets 78 A/4 (part), 78 A/8 (part) and 78 B/8 in Bengal, Bihār and Orissa, Sikkim and Nepāl. Supplementary survey on the scale of 1 inch to a mile was carried out in sheets 78 B/1 to 78 B/7, 78 B/11 and 78 B/12 in Bengal. The Darjeeling Guide Map survey on

the scale of 6 inches to a mile, falling in sheets 78 A/4, 78 A/8 and 78 B/5, was completed.

A special survey on the scale of 16 inches to a mile, including triangulation, traverse, levelling and contouring at 10-foot intervals was undertaken of the Digboi oil-field in the Lakhimpur district of Assam. The above, as well as a plot on the scale of 8 inches to a mile of the Mining Lease boundaries of the oil-field, was completed, on payment, for the Assam Oil Company Ltd.

Advance triangulation and traversing were carried out in sheets 79. M and 84. A.

By the courtesy of the Sikkim and Nepāl *Durbārs* the party was permitted to complete the original survey of sheets 78 A/4 and 78 A/8 to edge.

The field head-quarters were at Jalpaiguri.

The area under survey in sheets 78. A and 78. B may be divided into 2 portions, (a) the hilly portion from the Singālila range (12,500 feet high) in the north and including the Darjeeling tea gardens, down to the heavily wooded-submontane region of the Tarai, (b) the highly cultivated plains to the south, with numerous bamboo clumps round scattered villages. Weather conditions in the hills are adverse, as fog and mist rise almost incessantly, and the severity of the winter is greatly aggravated by cold winds. The period from November to January is the clearest for survey operations.

As during last season, the supplementary surveys were carried out on blue prints of the preliminary editions. The latter were of satisfactory quality, but the assistance derived therefrom was counterbalanced by the additional labour in securing a more careful and accurate delineation of vegetation and forest growth, with a view to the final maps being reproduced in the new style, with trees printed in green throughout, instead of jungle areas only being indicated by a green wash as heretofore.

Personnel.—The field strength of the party was 2 Class I officers, 4 Class II officers (including 1 probationer since discharged), 8 Upper Subordinate officers and about 43 Lower Subordinates (including 30 plane-tablers).

Areas surveyed.—

1-inch original survey, 436 square miles.
1-inch supplementary survey, 2,005 square miles.
6-inch original survey of Darjeeling, 6·0 square miles.
16-inch original survey of Digboi oil-field, 2·0 square miles.
8-inch plot of Digboi oil-field Mining Lease boundaries, 17·37 linear miles.

Triangulation.—for 1-inch surveys, 1,456 square miles.
for ½-inch surveys, 4,069 square miles.
for Digboi surveys, 2 square miles.

Traversing.—for 1-inch surveys, 1,298 square miles (540 linear miles).
for Digboi surveys, 2 square miles (32·6 linear miles).

Levelling.—for 1-inch surveys, 14·7 linear miles.
for Digboi surveys, 9·8 linear miles.

125. Field work was organized as follows:—

Camp (1).—Mr. J. McCraken (Class II), with an average strength of 17 surveyors, including 4 pupils, 2 soldier surveyors and 1 draftsman, carried out original and supplementary surveys on the scale of 1 inch to a mile of 1,533 square miles in Jalpaiguri, Dinājpur and Rangpur districts and Cooch Behār State, of Bengal and Purnea district of Bihār and Orissa. Mr. M. L. Roy (U.S.S.) took charge of this camp in February on Mr. McCraken's transfer to Burma Circle.

The area surveyed by this camp consisted entirely of cultivated plains with scattered villages. The numerous clumps of bamboo trees are a feature of the landscape in this part of the country.

Camp (2).—Mr. H. H. Creed (Class II) with an average strength of 10 surveyors carried out original and supplementary surveys on the scale of 1 inch to a mile of 670 square miles in Sikkim, Nepāl, Darjeeling and Jalpaiguri districts of Bengal, and Purnea district of Bihār and Orissa. He also carried out the survey of 6·0 square miles on the scale of 6 inches to a mile, remaining to complete the Darjeeling Guide Map. The area of this camp comprised the hilly and submontane tract, as well as a portion of the cultivated plains.

Camp (2A).—Captain G. H. Osmaston, M.C., R.E., with 3 surveyors carried out supplementary surveys on the scale of 1 inch to a mile of 238 square miles in the Darjeeling district of Bengal, including his own plane-table work. The area of this camp covered the greater portion of the tea gardens around Kurseong.

Digboi Oil-field survey.—Mr. S. C. Chatterjee, B.Sc., (U. S. S.) with 1 leveller, 1 traverser, 1 surveyor and 1 draftsman, surveyed an area of 2·0 square miles on the scale of 16 inches to a mile, with 10-foot contour intervals. The triangulation for this work emanated from a Hunter short base, connected to old traverses, and was computed in rectangular co-ordinates. Some levelling and traversing were carried out for purposes of this survey. A plot on the scale of 8 inches to a mile was also made of the Mining Lease boundaries of the oil-field. The whole cost of these surveys, including reproduction costs of the 16-inch maps will be borne by the Assam Oil Company, Ltd.

Triangulation.—Triangulation in sheets 79 M/2, M/5, M/6, M/7 and M/8 was carried out by Mr. S. C. Mukerjee (U. S. S.), which however he was unable to complete though assisted later on by surveyor Ilahidad Khan. Triangulation in sheet 79 M/S.E., was carried out by Mr. Muhammad Siddik (U. S. S.), that in 84 A/N.E., 84 A/S.W., and 84 A/S.E., by Messrs K. L. Dhawan (Class II), Hari Singh (U. S. S.) and surveyor Ilahidad Khan respectively. Triangulation in sheets 84 A/2, A/5 and A/6 was also completed by surveyor Ilahidad Khan.

Traversing.—Traversing in sheets 79 M/1 and M/2 was carried out by traverser Raja Ram Panday, assisted by Mr. K. L. Dhawan (Class II). Traversing in sheets 79 M/3, M/4, M/7 and M/8 was carried out by computer S. C. Bhowmik, assisted by surveyor Hari Dutta.

Traversing for Digboi surveys, amounting to 32·6 linear miles, was carried out by Mr. S. C. Chatterjee (U. S. S.), surveyor Muhammad Rashiduddin and traverser Raja Ram Panday.

Levelling.—Levelling amounting to 14·7 linear miles in sheet 78 B/6 was carried out by computer Attar Singh, between the G. T. S. bench-

mark at Siliguri railway station and Phānsidewa minor station, with the object of correlating triangulation and levelling heights, and to facilitate adjustment of traverses.

Levelling, amounting to 9·8 linear miles for the Digboi surveys, was also carried out by computer Attar Singh.

Forest surveys.—No 4-inch surveys were carried out owing to lack of funds. 4-inch enlargements of the 1 inch surveys of the forests that fall in the Bengal Northern Circle, are however to be supplied to the Forest Department for which a contribution of Rs. 9,180 is to be recovered, spread over three years.

The 1 inch surveys included 243·7 square miles of forests in the Jalpaiguri and Darjeeling districts of Bengal.

Archæological and historical remains.—Bhītargarh in sheet 78 B/11 and Debottar Bhītargarh in sheet 78 B/12, like the Barājhār or Mendabāri ruins in sheet 78 F/6, Rājpat in sheet 78 F/8 and Mahākālguri in sheet F/10, are old forts, apparently erected by the Cooches for defensive purposes against Bhutān. They must date back about 400 years.

The Titālya inspection bungalow is of historical interest, as in 1829, when Titālya was a small cantonment, Colonel Lloyd is believed to have occupied this bungalow, where also probably the treaty of Titālya was signed by which the sovereignty of the Raja of Sikkim was recognized. Colonel Lloyd's report to the East India Company from here secured the sanction to the establishment of a sanatorium at Darjeeling.

Miscellaneous.—The health of the party was generally excellent except for a few cases of malaria.

The weather conditions were unusually good this field season and this facilitated the completion of the programme.

Recess duties.—Fair mapping, consisting of twelve 1-inch sheets, one 6-inch Darjeeling Guide Map (in 2 sheets), one 16-inch Digboi oil-field Map (in 3 sheets) was completed before the end of recess. The drawing was allotted to three sections, supervised by Messrs H. H. Creed (Class II), Moti Lal Roy and S. C. Chatterjee (U. S. S.) respectively, assisted by Mr. K. L. Dhawan (Class II), Messrs Muhammad Siddik, Hari Singh and N. C. Naug (U. S. S.), and two other U. S. S. probationers. Sheets 78 B/1, B/2 and B/3 were completed to edge by Officer in charge No. 5 Drawing Office from enlargements from the quarter inch survey of Nepāl.

Mr. S. C. Mukerjee (U. S. S.) was in charge of the computing section and completed the triangulation and traverse computations.

IX.—SURVEY REPORTS, BURMA CIRCLE.

DIRECTOR:— Lt.-Colonel H. T. Morshead, D.S.O., R.E., up to 17-5-31.
Major K. Mason, M.C., R.E., (officiating from 18-5-31 to 26-5-31).
Lt.-Colonel R. Foster, I.A., (officiating from 27-5-31).

126. Summary.—The units administered by the Burma Circle were Nos. 10, 11 and 21 Parties, and No. 7 Drawing Office.

127. *The field work* of parties was as follows:—

No. 10 Party.—Topography on the scales of ½ inch, 1 inch and 4 inches to a mile in sheets 83. L, O and P and 93. B; triangulation and traverse in advance.

No. 11 Party.—Topography on the scales of 1 inch and 4 inches to a mile in sheets 85. N & O and 93. A & B.

No. 21 Party.—Survey on the scale of 4 inches to a mile of reserved forests in the Chindwin Forest Circles; triangulation and traverse in advance.

128. *Training.*—Sixteen new pupils were entertained during the year; eight pupils were discharged as unlikely to become efficient surveyors.

No. 10 Party.

Officer in charge.—Captain G. F. Heaney, R.E.

129. General.—The main work of the party this season lay in Upper Burma in the basins of the Chindwin and Uyu rivers. A departure from usual practice was the formation of a training camp for the first year pupil surveyors of the whole circle. This camp was situated in the Northern Shan States, not far from Maymyo. While forming part of the party for purposes of pay, it was actually under the direct control of the Director, Burma Circle, and was not visited by the Officer in charge.

Topographical surveys were carried out in the Upper Chindwin, Katha and Myitkyina districts and Manipur State in sheets 83. L, O and P, and a small reserved forest was surveyed in Katha district. The pupil camp carried out surveys in Hsipaw State.

Triangulation and traversing for future surveys were carried out in the Upper Chindwin district.

Field head-quarters opened at Homalin, Upper Chindwin district, on 11th November 1930 and closed on 20th May 1931.

130. Areas surveyed.—The programme consisted of the following original surveys:—

1014 square miles on the scale of ½ inch to a mile; 2592 square miles on the scale of 1 inch to a mile;

244 square miles on the scale of 2 inches to a mile;

23 square miles on the scale of 4 inches to a mile.

The ½-inch work all lay north of latitude 25°.

131. Field work.—The field strength of the party, excluding the pupil training camp, was 4 Class II officers, 3 Upper Subordinate officers and 34 Lower Subordinate officers.

The pupil training camp had a strength of 1 Upper Subordinate officer and 15 pupils at the commencement of the season. One was recruited later. During the season 8 pupils were discharged as unlikely to become efficient surveyors.

Work was distributed as under:—

Camp (1).—Mr. L. B. Fitz-Gibbon (Class II) and 8 surveyors carried out 1114 square miles of original 1-inch survey.

Camp (2).—Mr. Munshi Lal, B.A., (Class II), and 5 surveyors carried out 683 square miles of original 1-inch and 23 square miles of 4-inch surveys.

Camp (3).—Mr. F. W. Smith (Class II), 2 U. S. S. officers, 11 surveyors, 1 traverser and 1 computer carried out 763 square miles of original 1-inch survey, 550 square miles of triangulation and 170 linear miles of traversing for 1-inch survey.

Camp (4).—Mr. H. M. Critchell (Class II), 1 U. S. S. officer, 5 surveyors and 2 computers carried out 1014 square miles original ½-inch survey, 1575 square miles of triangulation and 98 linear miles of traversing for ½-inch surveys.

Pupil Training Camp.—Mr. L. M. Ganguli (U. S. S.) and 16 pupil surveyors carried out original surveys on the scale of 2 inches and 1 inch to a mile of 244 and 32 square miles respectively in Hsipaw State of the Northern Shan States.

In addition, surveyor Maung On Ba working under party headquarters carried out 940 square miles of triangulation for ½-inch survey.

132. Description of country.—The areas surveyed by camps (2) and (3) were respectively in Katha district and astride the Chindwin river. The country was normal for Upper Burma. It consisted largely of low hills covered with jungle, and wide valleys with frequent areas of rice land. One corner of the area of camp (3) included part of the Somra Tract, where the hills attain a height of over 6,000 feet and the country is suitable for rapid sketching.

The work of camps (1) and (4) lay astride the Uyu river and covered a distance of about 160 miles, from the border of Myitkyina district just south of the jade mine area, to within 3 or 4 miles of the Uyu-Chindwin junction near Homalin.

In camp (4) area (sheet 83 O/S.E.) the Uyu river flows through what must be one of the wildest and least inhabited parts of Upper Burma. From where it enters the sheet, in the vicinity of the tiny village of Sezin to where it leaves it at Namtha, the Uyu changes its course from west to south, describing a quadrant roughly centred on the massive and isolated Taungthonlon group of peaks about twenty-five miles to the south east. The country between Taungthonlon and the Uyu is quite uninhabited and covered with dense jungle. Along the river bank are perhaps a dozen hamlets, generally with no means of communication between each other and the outside world except by river. These are the only human habitations in the area.

To the west and north of the Uyu river, as far as the Chindwin and Singkaling Hkamti, twenty-five and forty-five miles away respectively, as the crow flies, lies a dense, uninhabited and pathless jungle. Formerly there were a few villages here, but they have now been abandoned and

the inhabitants have retired either to the vicinity of Hkamti or to the banks of the Uyu. Except for the watershed between the Uyu and Chindwin, which rises in places to 1,500 or 2,000 feet, the country is practically flat, and survey work has to be carried out by laborious traversing.

Below Namtha in Camp (1) area the country, though more inhabited, contains large swampy tracts covered with high grass and was extremely difficult to survey. The unexpectedly slow progress made in these two camps largely accounts for the late date of closing the field season.

The absence of good communications rendered supervision and administration difficult. Ten days by road and river was the shortest time in which a messenger from party head-quarters could reach the head-quarters of Camp (4), and Camp (2) was nearly as far.

The necessity for a change in the triangulation programme during the season to comply with a request from the Geological Survey Department emphasised this difficulty, and contributed to the delay in completing field work.

133. Miscellaneous.—Not far from Homalin a certain amount of trouble was experienced from the "*Wunthanu*" or nationalist movement. This generally took the form of peaceful obstruction, though in one or two cases there were threats of violence. Surveyors were stopped by *wunthanus* and told not to work in the vicinity of certain villages. This movement coincided with another for the non-payment of taxes. Early in April it appeared to be becoming serious around Leiksaw, a village about 20 miles south-east of Homalin, and arrangements were made to provide military police escorts for some surveyors in case of necessity. However, prompt action by the Deputy Commissioner against the leaders had excellent results, and the escorts were not required.

Surveyors' squads consisted of two or three Hazāribāgh *khalasis* and were supplemented in Camps (1) and (3) by Kuki and Nāga coolies recruited in the Somra Tract, and in Camps (2) and (4) by local coolies. This arrangement proved quite satisfactory and is far cheaper than importing Kachin coolies from Myitkyina, as has been the practice hitherto.

134. Recess duties.—The party was organised into two drawing sections and a computing section, under Messrs Fitz-Gibbon (Class II), Smith (Class II) and L. M. Ganguli (U. S.) respectively.

The area surveyed on $\frac{1}{2}$-inch was mapped on $\frac{3}{4}$-inch scale and the programme of fair mapping of 1-inch surveys on $1\frac{1}{2}$-inch scale was completed; the 4-inch forest surveys was fair drawn on the same scale.

No. 11 Party.

Officer in charge:— Lt.-Colonel F. J. M. King, R.E., up to 6-4-31.
Major Kenneth Mason, M.C., R.E., from 7-4-31.

135. General.—Field head-quarters opened at Prome on the 10th November.

The original programme included:—

(*i*) Surveys on the 1-inch scale in the Henzada, Prome, Pegu Thayetmyo, Tharrawaddy and Toungoo districts (3,649 square miles).

(*ii*) Surveys on the 4-inch scale of thirteen reserved forests totalling 48 square miles.

(*iii*) Theodolite traversing of the boundaries of twelve minor reserved forests.

(*iv*) Triangulation and traversing for next season's work in the Prome, Tharrawaddy, Toungoo, Thayetmyo and Yamethin districts.

136. *Personnel.*—The strength of the party was 3 Class II, 4 Upper Subordinate and 33 Lower Subordinate officers. Of the (Class II) officers, Mr. P. G. Burby resigned on the 1st March 1931.

137. The Tharrawaddy Rebellion.—The season commenced normally, the eastern half of the party's area being allotted to Camp (1) under Mr. A. F. Murphy with one U. S. officer and 15 surveyors, and the western half to Mr. P. A. Thomas with 1 U. S. officer and 10 surveyors. Mr. P. G. Burby was employed on triangulation. Just before Christmas, and without any warning whatever, a disturbance suddenly broke out in the village of We-ywa (in the north-east corner of sheet 85 0/14) immediately south of the areas where surveyors Saw Shwe and Khushal Singh were working. The disturbances quickly spread into Insein district and along the foothills of the Pegu Yomas, thus involving a large portion of the area of No. 1 Camp.

No. 1 Camp. Mr. Murphy was on tour at the time, and both he and his surveyors had considerable difficulty in escaping from the affected areas. Much property, both Government and private, had perforce to be abandoned, and it is largely due to the coolness and resource displayed by Mr. Murphy that the losses were not greater. Ultimately the whole personnel of No. 1 Camp was safely evacuated to Prome.

Meanwhile the disturbances continued to spread, and the Henzada district on the west side of the Irrawaddy being next involved. In consequence of this and on the urgent representation of the Deputy Commissioner of Henzada, Mr. Thomas' camp was also withdrawn to Prome. This camp was not actually molested by the rebels and no losses of property were incurred.

Though no actual trouble had then broken out in the area under triangulation north of Prome, the villagers' attitude appeared threatening. It was no longer judged safe to expose isolated men, such as heliotropers, on the tops of lonely hills, and the three triangulators with their squads were accordingly also recalled to Party head-quarters. This precaution proved fully justified, as dacoity has been rife in the area ever since.

It is unfortunate that the rebellion should have broken out within two months of the commencement of the field season, for not a single sheet of the original programme could be completed.

138. Special Surveys.—Pending the arrangement of a fresh programme for the party, work was found for a certain number of men as follows:—

(*i*) Four surveyors were employed on a 4-inch survey of Prome and its environs with a view to the publication of a town guide-map.

(*ii*) One surveyor was employed in making a survey of the Hlawga Rubber Estate (near Rangoon) on the 8-inch scale for Messrs Steel Bros. & Co., Ltd.

(*iii*) Mr. Khan Muhammad (U.S.S.) was despatched to Mergui district to reconcile certain large discrepancies in the alignment of the Burma-Siam frontier, as shown respectively by the 1-inch Survey of India maps, dating from 1918-19, and the more recent Siamese surveys on the scale of 1/50,000. It is satisfactory to be able to record that the Survey of India interpretation proved correct in all but one minor case.

139. Fresh Programme.—By the end of January it had become obvious that a resumption of work in Lower Burma during the current season was out of the question. Early in February therefore with the concurrence of the Government of Burma, a new programme was approved as follows:—

(*i*) No. 1 Camp under Mr. A. F. Murphy undertook a survey on scale of 4 inches to a mile of 169 square miles of what is known as the "Stone Tract" in Mogok subdivision of Katha district in sheets 93. A & B. The cost of this survey is recoverable from the Government of Burma who require the maps in connection with the issue of mining leases in the Ruby Mines area.

(*ii*) No. 2 Camp under Mr. P. A. Thomas undertook the original survey of six sheets in Katha district, and Möngmit State of the Northern Shan States, north of Mogok, on the scale of 1 inch to a mile.

(*iii*) Surveyor Ikbal Muhammad was sent to No. 10 Party for triangulation, Mr. A. K. Talapatra (U.S.S.) to No. 21 Party for traversing, and three surveyors to No. 7 Drawing Office.

The resumption of work was delayed at the last moment by a strike of almost the whole inferior establishment of the party. There is no doubt that many of Mr. Murphy's men had had a severe fright and had been exposed to considerable personal risk and discomfort in their escape from the rebels. During their weeks of enforced inaction at Prome this apparently played on their minds and finally led temporarily to a refusal to resume work. The Kachins, who threatened to become a public danger, were repatriated to Myitkyina and the Hazāribāgh *khalasis* finally gave in when threatened with instant dismissal.

As the result of these delays the field work of the party was not completed until the end of May, when the rains were imminent. Mr. Murphy's Camp suffered no great hardship owing to the high altitude and cool climate of Mogok, but Mr. Thomas's Camp experienced extreme discomfort owing to the heat and the lack of water in the low-lying area between the Shweli and the Irrawaddy rivers. It is hoped that such an exceptionally late field season may never be necessary again.

140. *Miscellaneous.*—The health of the party was good on the whole. Lt.-Col. F. J. M. King had to undergo anti-rabic treatment in Rangoon during the first half of March owing to contact with a mad dog. There were no cases of cholera, thanks to the fact that all *khalasis* are now given anti-cholera inoculation before the commencement of the field season. Mr. Thomas and several of his men suffered a good deal from malaria in April and May, owing to the lateness of the field season.

141. *Recess duties.*—The fair mapping was divided into two sections under Messrs P. A. Thomas and P. C. Sen Gupta and was completed by the end of the recess season, when many of the surveyors were transferred to No. 10 Party.

No. 21 (Burma Forest) Party.

Officer in charge.—Mr. D. K. Rennick, M.B.E.

142. General.—The *raison d'être* of the party is the survey of reserved forest areas in Burma, on scales larger than 1 inch to 1 mile. The total cost of the party is debitable to the Government of Burma.

The party surveyed reserved forests in sheets 83. L and P. The field head-quarters were at Kindat in the Upper Chindwin district.

143. *Personnel.*—The field strength of the party was 2 Class II, 3 Upper Subordinate and 34 Lower Subordinate officers.

144. Areas surveyed.—The party surveyed a total area of 322 square miles on the scale of 4 inches to a mile in the Upper Chindwin Division of the Chindwin Forest Circle, comprising—

130 square miles of the Thaungdut and Thaungdut Extension reserves and 4 square miles of unclassed area adjacent thereto;

127 square miles of the Sanda and Sanda Extension and 15 square miles of unclassed area;

27 square miles of the Paungbyin fuel reserve and 19 square miles unclassed area.

145. Field work was distributed as follows:—

Camp (*1*) under Mr. G. A. Norman, M.B.E., (Class II) with 1 U. S. officer and 8 surveyors worked in the Sanda and Sanda Extension reserves.

Camp (*2*) under Mr. A. V. Dickson, (Class II) with 10 surveyors worked in the Thaungdut and Thaungdut Extension reserves, which completed the survey of the Thaungdut reserve partly done in season 1929-30.

Camp (*3*) under Mr. Raizada Bhamba Ram (U. S.) with 6 surveyors, 2 of whom were under training, surveyed part of the Sanda reserve and the whole of the Paungbyin reserve. One surveyor from Camp (1) and one from Camp (2) were transferred to Camp (3) in March when the survey of the Paungbyin reserve was begun.

Traverse Camp under Mr. Ram Prasad, R.S. (U. S.) with 7 traversers and 2 computers.

Mr. A. K. Talapatra (U. S.) joined the party on the 12th February 1931 and was employed on special traverse work in connection with the survey of the Mining Lease area at Indaw.

146. The area surveyed by Camp (1) lay on the western slopes of the Zibyu range, which carries the common boundary of the Upper Chindwin and Katha districts. The country varied from low to high broken hills ranging in altitude from 500 to 3,000 feet and densely forest clad.

The area surveyed by Camp (2) lay on the eastern slopes of the watershed between the Chindwin and the Kabaw valleys. The Nantha-nyit Chaung with its source in the southern extremity of the reserve runs through the reserve in a northerly direction and then turns sharply east to join the Chindwin River. The height ranged from 600 to 3,600 feet—all dense forest with heavy undergrowth in places.

The area surveyed by Camp (3) was in the same reserve as Camp (1) for the first half of the season. The Paungbyin reserve, surveyed in the latter half, is comprised of low forest clad hills.

147. Triangulation.—Nine stations were fixed, solely for the connection of theodolite traverses, by Mr. Ram Prasad, R.S.

Some supplementary triangulation was done by Mr. Dickson in the Thaungdut reserve to fix additional points for the surveyors doing the detail survey.

All the triangulation is based on the Manipur Longitudinal Series.

148. Traversing.—302 linear miles of forest boundary theodolite traversing and 201 linear miles of interior and connection traversing was carried out by the traverse camp in the Kanti, Kaingshe, Lawtha, Nansapet, Palin and Wegatha reserves of the Upper Chindwin Forest Division and the Natmyaung and Bon Extension I and II reserves of the Myittha Forest Division, to provide data for the ensuing field season. The reserves traversed fall in sheets 84. E and I.

In addition to the above, 21 linear miles of theodolite boundary traverse and 21 linear miles of interior and connection traversing was carried out in the mining lease area of the Indo-Burma Petroleum Company at Indaw in sheet 84. I.

149. Special Surveys.—The party has undertaken the survey on the scale of 4 inches to a mile of the mining lease area of the Indo-Burma Petroleum Company at Indaw. The theodolite traversing of the area was completed during the season and the detail survey will be done on the scale of 4 inches to a mile during the ensuing field season. The Company will pay the whole cost of this survey.

150. Miscellaneous.—The party took the field in the latter half of October and opened at Kindat on the 24th of the same month. Owing to the delay in getting out to the areas of survey by steamer, work commenced about the 15th November.

For the first time in the Party's history Kachin labour from Myitkyina has been given up entirely in favour of Chins, who can be more cheaply recruited from the Chin Hills district immediately west of the Party's area. Though these men are more amenable to discipline and carry heavier loads than the Kachins, they are less skilled at jungle-clearing and tree-climbing. For 4 inch forest survey, individual work is constantly required from the personnel of the squad. The Chins did not adapt themselves to these requirements as well as the Kachins and were not as intelligent. They work better collectively than individually but are nervous in the jungle and are not as healthy as the Kachins.

At the beginning of the season many men left owing to dislike of the conditions but those who remained settled down to them.

The health of the party was not satisfactory. Bad weather in early November made the forest extremely disagreeable and malarious, the Chins being the chief sufferers. The Sub-Assistant Surgeon, Jemadar Gaya Prasad Saksena was almost continuously on tour during the field season. During March, two surveyors were declared unfit for duty, which number increased to five in April. There were others who though not actually unfit were subject to periodical attacks of fever.

In the months of March and April, particularly in the latter month, there was a great scarcity of water in some of the forests. Forest fires also made the conditions very trying.

There were two deaths amongst the inferior establishment of the party during the season. One Indian *khalasi* died of fever and one Chin of Bright's disease a very small percentage considering the unhealthy season. At one time there was not a squad that had not a man or two down with fever.

151. Recess duties.—The fair mapping was divided between two sections under Messrs G. A. Norman and D. N. Saha, assisted by Messrs Kudratullah and R. Bhamba Ram respectively.

The computation section was under Mr. Ram Prasad, R.S.

The fair mapping and computations of all the field work were completed during the year.

X.—MISCELLANEOUS SURVEY REPORTS.

152. This section includes all reports of surveys not administered by the Directors of the five survey circles, such as miscellaneous surveys and commercial levelling administered by the Director, Geodetic Branch, or extra-departmental explorations, etc., in which members of the Department have taken part.

No. 17 Party (Levelling).

Officer in charge.—{ Mr. H. P. D. Morton, up to 7-3-31.
,, D. H. Luxa, from 8-3-31.

153. The high precision levelling done by this party is described in para. 35.

154. *Secondary levelling* in the Punjab, Punjab States and Delhi was carried out for the Bhakra Dam Irrigation Project (559 miles); in Bihār and Orissa for the Bihār and Orissa Flood Area Irrigation Project in Balasore, Puri and Cuttack Districts (392 miles); in Bihār and Orissa for E. I. Railway (162 miles) and for scientific purposes from Tinpahār to Purnea (78 miles); in Burma from Taunggyi to Kengtung (261 miles) for scientific purposes; and for Burma Railways across the Irrawaddy bridge (17 miles).

155. *Tertiary Levelling.* Owing to large discrepancies having been noticed between the Survey and the P. W. D. levelling, this party has for the present undertaken to revise 64 sheets, amounting to about 6,400 linear miles in the Bahāwalpur State, of which about 600 miles have been revised this season, and the remaining portion will be done during 1931-32.

Training School, Dehra Dūn.

Officer in charge.—{ Mr. L. Williams, M.B.E., up to 25-12-30.
,, M. M. Mudaliar, M.A., from 26-12-30.

156. *Class I probationers.*—Captain W. G. Irvine-Fortescue, M.C., R.E., and Lieut. R. P. Buchanan, R.E., were attached to the Training School for periods of about 3 weeks, during which they did 2-inch plane-tabling.

157. *U. S. S. probationers* (first year).—Ten probationers including one Geodetic Computer were appointed in the third week of November 1930. They were put through a course of plane-tabling during which they completed an area of 4 square miles on the 4-inch scale, and about 10 square miles on the 2-inch scale. Each probationer also observed at about half a dozen stations in connection with the triangulation programme. During the recess they were instructed in computations and office work.