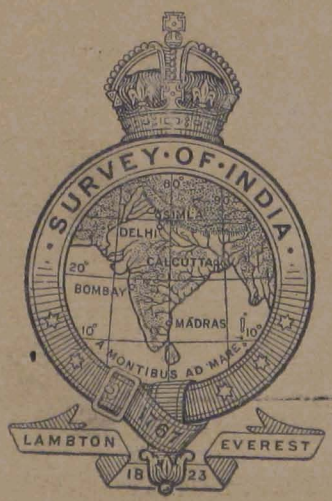
SURVEY OF INDIA

GENERAL REPORT

1929 TO 1930



From 1st October 1929
To 30th September 1930

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,
1930.

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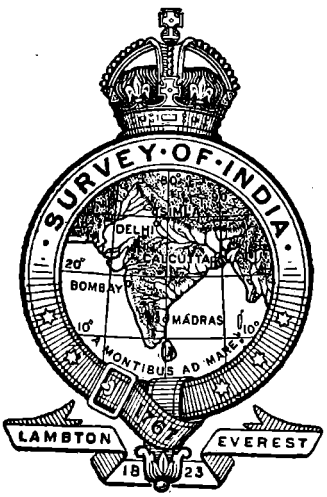

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PREFACE.

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 nearly 40 ports between Suez and Singapore; the magnetic survey; astronomical, seismographic, and meteorological observatories 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 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.

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 Archeological 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 Headquarters 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.

CONTENTS.

SURVEY OF INDIA

GENERAL REPORT

1929 TO 1930

From 1st October 1929

To 30th September 1930

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. There is one Index Map at the end, showing 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 throughout the year.

The post of Assistant Surveyor General was filled by Major Kenneth Mason, M.C., R.E., upto 4th December 1929, and afterwards by Lt.-Colonel C. M. Thompson, I.A., upto 4th May 1930, and thereafter by Captain G. H. Osmaston, M.C., R.E.

3. *The total cost* of the Department for the past financial year ending 31st March 1930, as compared with that of previous years, was as follows:—

	1927-28	1928-29	1929-30	REMARKS.
	Rs.	*Rs.*	*Rs.*	
Gross actual cost ...	58,29,630(*a*)	63,37,651(*b*)	60,61,645*	(*a*) Including Rs. 3,53,100 for English Charges (High Commissioner) on Stores, and loss or gain by exchange.
Deduct receipts and credits	23,24,736	25,34,105	24,79,158*	
Net actual charges ...	35,04,894	38,03,546	35,82,487*	(*b*) Including Rs. 4,40,626 for do. do.

*These figures are not final.

The total area of new surveys of all kinds completed during the year was 61,107 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.

The recruitment of two technical officers from England for the Brush Drawing and Engraving Sections of No. 1 Drawing Office, to which reference was made in last year's report, was deferred in view of the High Commissioner's disinclination to send out newly recruited officers during the hot weather. The situation has since entirely altered owing to intimation having been received that the Ordance Survey had discarded brush drawing. The whole question had accordingly to be reconsidered and it has been decided that Engraving work should continue and that two engraving experts should be recruited, one preferably with a knowledge of pen work.

Nos. 22 (Riverain) and 24 (Sind Rectangulation) Parties on completion of their programme were disbanded from 1st June 1930 and 1st October 1930 respectively.

From the same date the designation of No. 23 Party was changed from "Rectangulation" to "Irrigation Surveys".

Under the orders of the Government of India, the Forest Map Office has been re-placed under the executive control of the Officer in charge of No. 2 Drawing Office and No. 20 Forest and Cantonment Office has been renamed "No. 20 Party (Cantonments)". This Party was transferred from the administrative control of the Director, Geodetic Branch, to that of the Director, Central Circle, from the 1st April 1930.

The temporary executive charge of Officer in Charge, Map Publication Office, which was created for Mr. E. B. West was abolished with

effect from the 5th January 1930, on his taking over charge of No. 1 Drawing Office from Rai Bahadur P. Ray.

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

Bhākra Dam Project.—At the request of the Government of the Punjab the survey of the area commanded by the Bhākra Dam Irrigation Project has been undertaken. The work which will take about 12 years to complete includes:—

(*a*) Triangulation and traversing for the demarcation of 3,000 acre rectangles with permanent markstones.

(*b*) Further demarcation down to 25 acre rectangles with smaller markstones.

(*c*) Levelling and publication of 25 acre spot height charts on the scale of 4-inches to 1 mile.

(*d*) Special topographical survey on the scale of 4-inches to 1 mile and publication of the maps with contours at vertical intervals of a foot.

The project itself involves the construction of a dam 500 feet high on the Sutlej at Bhākra, the storage capacity of which will be over 4½ million foot acres of water, the equivalent of a discharge of 12,500 cubic feet a second for six months. The water will be utilized in increasing the intensity of irrigation on the Sirhind and Western Jumna Canals and extending the irrigation from these canals up to the physical limit of command from Delhi *via* Hissār to the limit of irrigation from the Sutlej Valley Project. The area commanded by the Grey Canals not already absorbed in the Sutlej Valley Project will be converted from inundation into non-perennial irrigation.

The total area in which it is hoped that irrigation will be effected under the Bhākra Dam Project is nearly 12 million acres and into 4½ million acres of this area, irrigation will be introduced for the first time. (p. 49).

Boundary Survey.—Lieut. D. R. Crone, R.E. was deputed to settle a number of boundary disputes between Mandi and Suket States (p. 51).

Manœuvres.—Detachments from E Company took part as formed military units with Western Command Manœuvres between 16th and 25th October 1929.

The only tactical map used on manœuvres was a one-inch map prepared by E Company from Air photographs taken by the Royal Air Force during July and August 1929.

E Company carried out military training from June to October 1929 in co-operation with the Royal Air Force and the Royal Artillery, and with the 2nd Indian Division during the Western Command exercises.

The training embraced the subjects which would form the work of a Survey Company in war and included rapid triangulation, artillery survey, air survey and the rapid compilation and reproduction of a map.

A full report on the above by Major E. O. Wheeler, M.C., R.E., is being published as a Special Publication.

Para. 5 of the Special District Order by Major General J. W. O'Dowda, C.B., C.S.I., C.M.G., Commander, Baluchistān District, dated the 26th

October 1929, regarding the military training in E Company, is reproduced below:—

> "The General Officer Commanding-in-Chief is very glad that it was possible in these exercises to give No. 2 Indian Survey Company an opportunity for carrying out practical work in the field and he congratulates the unit on the results of their activities".

A detachment of No. 18 Party (Air Survey) participated in the Northern Command R. A. Concentration at Hatti in February 1930 and a note by Major W. J. Norman, M.C, R.E., on a strip map prepared by the detachment is being published as an addendum to Major Wheeler's report on military training in E Company.

Deputation of Officers:—Major K. Mason, M.C., R.E. and Mr. B. L. Gulatee, M.A., (Cantab) attended as delegates the 4th General Assembly of the International Union of Geodesy and Geophysics held at Stockholm in August 1930. At the first plenary session of the Union, India's admission as a separate unit to the Union was proposed and carried unanimously.

Major W. J. Norman, M.C., R.E., was deputed to attend as a representative of India, the International Congress of Surveyors and the 3rd International Congress for Photogrammetry held at Zurich in September 1930.

Exploration:—The final results of Dr. William Filchner's astronomical positions of points observed by him in Tibet and China in 1926-27 were received.

Khan Sahib Afraz Gul Khan rejoined A Company in November 1929 on return from deputation with the Visser expedition to the Karakoram.

A brief resume of the expedition is given below:—

> During June and July the great glacier tributaries of the Lower Siachen Glacier and the side valleys and glaciers of the Upper Nubra Valley were explored and mapped. The expedition then crossed the Saser Pass, explored and surveyed the valleys of the Chimshin Jilga and the Tughmo Zarpo Lungpa which drain the east side of the Nubra-Shyok Watershed. Later the source of the Chip-chap and the neighbourhood of the Kara-tāgh Pass and the upper Kara-kāsh River were visited and surveyed. The total outturn of the Khan Sahib was 2,300 square miles of ½ inch survey in 82 working days.
>
> The expedition was encamped 9 miles beyond the upstream end of the Kumdan Lake (and 19 miles from the dam) when the Shyok dam burst at 5 A. M. on August 15th; information was received by the expedition that the lake was entirely emptied but that the breach is narrow and there is every probability of the breach being closed again during the winter.

Surveyor Muhammad Akram was attached to the Visser Expedition on its return to India from Turkistān, and carried out surveys in the Upper Shyok Valley.

N. W. F. Province.—Further surveys in tribal territory, Hazāra district, have been undertaken by A Company, and the survey of the

Black Mountain, which had not been visited since the expedition of 1888-91, is now nearly completed.

Surveyor Narayan Singh of No. 11 Party again accompanied the Civil Officer on an expedition among the Nāgā Tribes in the unadministered territory to the North of Burma (p. 74).

Adventures and Casualties.—The Officer in Charge of No. 8 Party has reported the following incident:—

> On the 1st May 1930 while bathing in a tidal river in the Tanjore district a surveyor was swept out of his depth by the tidal current. Mr. S. R. Kelkar perceiving him in difficulties went to his rescue at considerable personal risk, and his prompt and gallant action undoubtedly saved the surveyor's life.

A very regrettable accident occurred on 22nd April 1930 on the road between Jandola and Khirgi in South Wazīristān. A lorry containing seven khalasis of Khan Sahib Afraz Gul Khan's squad, ran off the road about 4½ miles below Jandola and falling down the steep hill side, was wrecked 50 feet below.

Three of the khalasis were killed and the remainder received more or less serious injuries.

The Mathematical Instrument Office carried out special repairs to an Air Pollution Apparatus for the Calcutta School of Tropical Medicine. It carried out experiments on the testing of mirrors for sextants, and in stainless steel for making Quintant mirrors.

About the beginning of January 1929 the Mathematical Instrument Office designed and made up for the Officer in Charge, Bacteriophage Inquiry, Bankipore, for experimental work on Cholera, three small Ampoule fillers which proved a complete success. Three large instruments of the same nature were made up and supplied in June last to deal with possible outbreaks at Patna. It is understood that these have greatly facilitated the work of the Bacteriologist in charge.

Distinguished visitors.—H. E. Sir William Malcolm Hailey, M.A., G.C.I.E., K.C.S.I., I.C.S., Governor of the United Provinces visited the Geodetic Branch Offices at Dehra Dūn on the 30th October 1929.

6. Appreciations.—The following is an extract from a letter from the Superintending Engineer, New Project, Irrigation Works, Punjab in connection with the completion of the Haveli Irrigation Project Surveys:—

> "I have the honour to express my appreciation of the success of the endeavours of the Geodetic Branch to expedite the reproduction of the Haveli Sheets. The whole of the survey sheets have been mounted in strips and studied in detail by me, and I have found no point on which any criticism could be raised.
>
> I would also express appreciation of the way in which Mr. Simons, Officer in charge No. 23 Party, has carried out the survey work in close collaboration with the Irrigation Department so as to have produced maps which show all the information required in such a satisfactory manner."

The Deputy Commissioner, Hazāra District, North-West Frontier Province expressed his keen appreciation of the work done by Mr. Mohd. Aslam in carrying out surveys on the Eastern slopes of the Black Mountain and of Nandihar and Thalkot in tribal territory during 1929. Political relations were very uncertain but Mr. Mohd. Aslam paid visits

to several of the leading chiefs, which led to a friendly understanding being established, and enabled this survey to be carried through successfully.

The services of Lieut. D. McK. Burn, R.E., and Mr. Chirag Shah (Upper Subordinate Service) were specially commended for their excellent work triangulating in Chitrāl during 1929. These two officers established stations and carried out observations successfully at great altitudes and under very severe weather conditions. Several stations were over 19,000 feet, and on more than one occasion owing to bad weather several nights were spent close to the summits before the observations could be completed.

The Director, Burma Circle, received from the Officer in Charge of the Nāgā Hills Expedition a warm appreciation of the services rendered by Surveyor Narayan Singh, who accompanied the expeditions during seasons 1928-29 and 1929-30.

7. Awards.—The following honour was conferred during the year:—

Rai Sahib ... ... Mr. Amar Krishna Mitra.

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

Class I Officers:—Messrs. C. E. C. French, B. M. Berrill, and Rai Bahadur P. Roy retired. Rai Sahib D. R. Verma was superannuated. Lieut. D. McK. Burn, R.E., reverted to military employ.

Major W. E. Perry, M.C., R.E., has been permanently transferred to the Security Printing, India.

Lieut.-Colonels Couchman, M.C., R.E. and Hamilton, D.S.O., R.E., were confirmed as Directors.

Dr. deGraaff Hunter, SC.D., M.A., F.Inst.P., was appointed Director (temporary).

Captains Heaney, R.E., Osmaston, M.C., R.E., Major J. H. Williams and Messrs. H. B. Simons, V. W. Morton and E. B. West were confirmed as Superintendents.

Captain Bomford, R.E., was appointed Superintendent.

Lieut. R. C. N. Jenney, R.E., was appointed to the Department.

Class II Officers:—Messrs. N. R. Mazumdar, R. E. Saubolle, and T. F. Kitchen retired. Mr. P. K. Ghosh, B.A. (Cantab), resigned. Mr. G. E. R. Cooper died.

Seven candidates were appointed to Class II Service and posted to the Geodetic Branch for training.

Upper Subordinate Officers:—K. S. Hayat Muhammad, R. S. Janna Prasad and Messrs. Mukundananda Acharya and Badlu Ram retired.

Six probationers were confirmed in their appointments.

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

9. 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.

10. N. W. F. Province, Kashmīr and Jammu, and Gilgit Agency.

Air surveys in Dīr, Swāt and Chitrāl Agency, Orakzai and Tīrāh and Kohāt district. Corrections to published sheets by air survey in Peshāwar (p. 48).

Explorations in the Upper Shyok Valley, Kashmīr State (p. 44).

Topographical surveys in Hazāra district, Muzaffarābād district (Kashmīr), Tribal territory and Dīr, Swāt and Chitrāl Agency (p. 45).

Framework. Triangulation in Wazīristān and Chilās (p. 45).

11. Baluchistān.

Topographical surveys in Kalāt State (p. 47). Revision of 1-inch sheets in Sibi, Quetta-Pishīn, Loralai and Zhob districts as regards roads and railways (p. 47).

Framework. Triangulation in Kalāt State (p. 47).

12. Punjab, Punjab States and Delhi.

Air surveys for correction of published sheets in Attock (p. 48).

Topographical surveys in Lahore, Ferozepore, Amritsar, Rāwalpindi and Muzaffargarh districts (p.p. 45, 50).

City surveys. Revision of Delhi Guide Map (p. 54).

Boundary surveys in Mandi and Suket States (p. 51).

Framework. Traversing in Jhang, Multān, Lyallpur and Montgomery districts (p. 44). Triangulation in Hissār district and in Patiāla State (p. 49).

Traversing and Rectangulation in Ferozepore, Hissār, Ludhiāna and Muzaffargarh districts, and in Farīdkot, Kalsia and Patiāla States (p.p. 49, 50).

Levelling. High precision levelling from Ghakkar to Sargodha and back, and from Sargodha to Jhang (p. 15).

Tertiary levelling in Muzaffargarh district (p. 50).

13. Rajputāna Agency, Ajmer-Merwāra and Bīkaner.

Topographical surveys in Ajmer-Merwāra Province and in Jaisalmer, Jodhpur and Kishangarh States (p. 54).

Framework. Triangulation in Jaipur and Jodhpur States (p. 54).

Levelling. High precision levelling from Bhopāl to Nasīrābād, and from Baroda to Mārwār Pāli (p. 14).

14. Central India Agency and Gwalior.

Air survey of Indore City (p. 54).

Topographical surveys in Bhopāl and Tonk States, Bhopāl Agency and Gwalior State (p. 55).

Framework. Triangulation in Rewah State (p. 57). Traversing in Indore City (p. 55).

Levelling. High precision levelling from Gwalior to Jhānsi, Bhopāl to Dewās, Bina to Bhopāl, and Bhopāl to Nasīrābād (p. 14).

Miscellaneous. Survey of Raisen Fort and Sānchi Tope (p. 62).

15. United Provinces.

Topographical surveys in Mirzāpur district (p. 56).

Framework. Traversing for Air surveys in Sītapur and Bahraich districts (p.p. 59, 60).

City surveys. Revision of Benares Town Guide Map (p. 56).

Levelling. High precision levelling from Mussoorie to Dehra Dūn, Sahāranpur to Morādābād, Jhānsi to Bina and Gwalior to Jhansi (p.p. 14, 15).

16. Central Provinces.

Topographical surveys in Bilāspur district and in Korea, Raigarh, Sakti, Surguja and Udaipur Feudatory States (p. 57). In Bastar State (p. 61).

Geodetic. Gravity at Chānda (p. 14).

Framework. Triangulation in Bālāghāt, Bilāspur and Mandla districts and in Jashpur, Kawardha and Surguja Feudatory States, and in Bastar State (p 57).

Levelling. High precision levelling from Jhānsi to Bīna, and Bīna to Bhopāl (p. 14).

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

Topographical surveys in Dhārwār and North Kanara districts (p. 63).

Geodetic. Gravity in Poona, Sholāpur, Bijāpur and Dhārwār districts (p. 14).

Framework. Triangulation in Belgaum, Bijāpur, Dhārwār, North Kanara districts, Kolhāpur and Savanūr States, and Southern Marātha Jāgīrs (p. 63).

Traversing and Rectangulation in Lārkāna, Sukkur, Thar Pārkar and Upper Sind Frontier districts and in Khairpur State (p.p. 58, 59).

Levelling. High precision levelling from Baroda to Mārwār Pāli, and Dewās to Mhasvād *via* Dhūlia (p. 14). Tertiary levelling in Lārkāna, Sukkur, Thar Pārkar and Upper Sind Frontier districts and Khairpur State (p.p. 58, 59).

18. Hyderābād.

Topographical surveys in the Karīmnagar and Warangal districts (p. 61); in Raichūr district (p. 63).

Geodetic. Gravity in Raichūr, Gulbarga, Hyderābād and Karīmnagar districts (p. 14).

Miscellaneous. Survey of Gulbarga and Warangal Forts (p. 62).

19. Mysore.

Topographical surveys in Chitaldrug, Kadūr and Shimoga districts (p. 63).

Miscellaneous. Estate surveys in Hassan and Kadūr districts (p. 63).

20. Madras Presidency, Madras States and French Territories.

Topographical surveys in Ganjām district (p.p. 67, 68); in Guntūr, Kistna and Vizagapatam districts (p. 61); in Bellary district (p. 63); in South Arcot, Tanjore and Trichinopoly districts and in Pondicherry and Kārikāl (p. 64).

Geodetic. Gravity in Bellary, Anantapur, Kurnool, Chittoor and Cuddapah districts (p. 14).

Framework. Triangulation in Vizagapatam district (p. 62); and in Salem, South Arcot and Trichinopoly districts (p. 64); in Ganjām district (p. 68).

Miscellaneous. Estate surveys in Coimbatore and Nilgiri districts and Travancore State (p. 64).

21. Bihār and Orissa.

Topographical surveys in Palāmau district (p. 56); in Cuttack, Patna, Gaya, Monghyr, Hazāribāgh, Santāl Parganas, and Puri districts (p.p. 67, 68) and in Rānpur, Athgarh, Baramba, Hindol, Dhenkānāl, Khandpara, Narsinghpur, Tigiria, Daspalla and Nayāgarh States (p. 68).

Forest surveys. Several Government reserved and protected forests in the Puri Forest Division were included in the ordinary survey (p. 68). Special 4-inch boundary surveys in the Hazāribāgh Forest Division (p. 67).

Framework. Triangulation in Angul and Purnea districts, and in Rairākhol, Sonpur, Athmallik, Tālcher, Baud, Narsinghpur, Khandpara, Daspalla and Nayāgarh States (p.p. 68, 70).

Levelling. Secondary levelling for E. I. Railway (p. 77).

Miscellaneous. Survey of Cuttack Buddhistic Caves (p. 68).

22. Bengal Presidency, Sikkim and Nepāl.

Topographical surveys in Birbhūm, Burdwān, Bānkura, Darjeeling, Jalpaiguri, Rangpur districts (p.p. 67, 69), and in Cooch Behār State, Bhutān, Sikkim and Nepāl (p. 69).

Forest surveys. Several Government reserved forests in Buxa, Darjeeling and Jalpaiguri Forest Divisions were included in the ordinary survey (p. 70).

City surveys in Calcutta including Howrah and Dum-Dum (p. 68).

Geodetic. 2 Stations of Primary triangulation were observed in Chittagong (Chittagong series) (p. 14).

Framework. Triangulation and Traversing in Bīrbhūm, Burdwān, Bānkura, Hooghly, Howrah, Murshidābād, Dināpur, Jalpaiguri, Darjeeling, and Chittagong Hill Tracts districts (p.p. 67, 70); in Tripura State, Bhutān, Sikkim and Nepāl (p.p. 69, 70).

Levelling. Levelling for topographical surveys in Midnapore district (p. 67).

Secondary levelling for the E. I. Railway and for the Commissioners for the Port of Calcutta (p. 77).

23. Assam and Bhutān.

Framework. Triangulation in Cāchār and Lushai Hills districts (p. 70).

24. Burma.

Topographical surveys in Bassein, Upper Chindwin, Henzada, Insein, Katha, Ma-ubin, Minbu, Myitkyina, Sandoway, Tharrawaddy and Thayetmyo districts, and in the Nāga Tribal area. (p.p. 71, 73, 74).

Forest surveys in Mansi Division of the Northern Forest Circle and in the Upper Chindwin Division of the Chindwin Forest Circle (p. 75).

Geodetic. 15 Stations of Primary triangulation were observed in the Southern Shan States. (Mong Hsat and Great Salween Series). (p. 14).

Framework. Triangulation and Traversing in the Upper Chindwin, Henzada, Myitkyina, Pegu, Prome, Tharrawaddy, Thayetmyo and Toungoo districts. (p.p. 71, 73). Triangulation in Chin Hills (p. 70).

Miscellaneous. Special survey of Rubber Estates near Rangoon. (p. 74).

II.—ABSTRACT OF GEODETIC OPERATIONS.

DIRECTOR:—Dr. J. de Graaff Hunter, M.A., Sc.D., F. Inst. P.

25. 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* para. 152; *Cantonment Surveys* (para. 82); *Training School* (para. 153).

No. 20 (Cantonment) Party has been transferred to the Central Circle from 1st April 1930.

26. 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. VI), which includes complete index maps and detailed results.

Geodetic Operations for 1929-30.

27. Observatory Section.—The continuous record of the longitude of Dehra Dūn was maintained by bi-weekly observations with the bent transit, and by reception of the Bordeaux and Rugby wireless time-signals. Since October 1929, when a long-standing leak in the clock case was corrected, the Riefler clock has been running very steadily. A Shortt clock has been received and installed in a temperature-controlled cell, but it has not yet been put into regular operation. A portable wireless receiving set, the R.P. 11 by Marconi, has been put into regular use, and is generally found to give better reception than the large Siemens' set hitherto in use.

A latitude variation programme has been started with the larger Zenith telescope, whose focal length is 41 inches and whose aperture is 3 inches. The programme is divided into a chain of 6 groups of stars, of which two groups are observed on each working night. At least 100 pairs are normally observed each month, although the monsoon makes great difficulties in July, August and September, which have resulted in some reduction during these months.

The 24-metre base-line comparator has been put into working order, and has been used for the standardization of the invar wires with which it is hoped to measure a base at Kengtung (Burma) during the season 1930-31. The thermostat of the 4-metre comparator has also been renewed and the comparator is now fit for use. This thermostat has

been kindly designed and made by Mr. G. F. Wood of the Royal Indian Military College, Dehra Dūn.

The standard tapes of the levelling party have been regularly checked, and the levels have been overhauled. Several Hunter short bases have been standardized. Tests have been made of a Paulin barometer, two new hypsometers with very open-scaled thermometers, the new Wild type theodolite by Watts, and a similar theodolite by Cooke, Troughton and Simms. The Dehra instrument store is now in charge of this section.

The magnetic observatory maintained its continuous record of the three magnetic elements. Preparations were made for the renewal of field observations at repeat stations in Northern India in 1930-31, and for the possible reopening of the Kodaikānal and Toungoo observatories in the following year. Investigations were made to discover whether a proposed extension of the printing office with electrically driven presses would disturb the observatory. It was concluded that it would probably not do so, but that there is a small risk of the observatory having to be removed, if the extensions are undertaken.

The Omori Seismograph has been in regular operation. Meteorological observations have been made daily for the Meteorological Department throughout the year, and twice daily since November 1929.

28. Computing Office.—The computation of tables for use in connection with the military Lambert grid has continued to occupy a large amount of time. A series of 7 grids has been adopted, which covers the whole of India and Burma, and tables are being prepared for (1) the conversion of co-ordinates from spherical to rectangular, (2) the computation of triangulation in terms of the grid, and (3) the plotting of the grid on maps with spherical graticules. These tables are now nearly complete: they will be printed as Part V of the Auxiliary Tables, but little progress has yet been made with their publication. The co-ordinates of 300 points in Waziristān have been converted from spherical to grid, and several requisitions for advance copies of parts of the tables have been met.

The figural adjustments of the secondary triangulation carried out by No. 15 Party in the North-West Frontier Province in 1927-28 have been completed and the positions of the stations have been recomputed on the basis of these adjustments.

The part of the new Geodetic Handbook dealing with the computation of triangulation has been written, but not yet printed. New formulæ have been adopted for the weighting of angles, and the computation of latitudes and longitudes, for which new forms have been prepared.

In order to provide guidance for reconnaissance officers, investigations have been made into the accumulation of error likely to arise in triangulation figures of different kinds. A rigorous solution of the problem is well-known, but it is much too complicated for general use. The investigation has been directed towards the simplification of the solution without serious loss of precision. So far as braced quadrilaterals are concerned, some success has been achieved, but centred polygons have so far proved less tractable.

Solutions for a standard gravity formula, using all the isostatically

reduced observations of which reports are available, have been taken out on the assumptions:—

(1), that the axis of the spheroid does not coincide with the polar axis.

and (2), that the Earth is tending to a tetrahedral form.

Both the above assumptions are plausible on physical grounds, but neither have been confirmed by the solutions obtained. Neither solution satisfies the data so well as a solution made on the physically improbable assumption that the Earth is a three-axial ellipsoid.

Four computers of the Frontier Circle have been given about a year's course of instruction.

The preparation of Part IV of the Auxiliary Tables, which contains tables required in the computation of various geodetic operations, has been completed as regards the tables required for the computation of triangulation, and this portion has been sent to press. A summary of all Indian observations of the deviation of the vertical and of the intensity of gravity has been completed (it has been under preparation for the last two years), and will be published as a Supplement to the Geodetic Report for 1929-30. The deflections are given in terms of both the Everest and International spheroids, and the isostatic anomalies are given wherever available.

The following publications have been seen through the press:—

(*a*) Geodetic Report, Vol. V.

(*b*) Professional Paper No. 24.

(*c*) Geodetic Handbook, Chapter I (Triangulation), First part.

(*d*) Handbook of Topography, Chap. III (Triangulation). Revised Edition.

The compilation of the Persian triangulation pamphlets has been proceeded with, but none have yet been published.

24 Indian triangulation pamphlets have been compiled, mostly on the Burmese frontier, 22 new pamphlets have been passed through the press, and 32 have been reprinted or reproduced by photo-zincography.

One levelling pamphlet has been reprinted, and two are under revision. The data of 3 lines of primary levelling have been published as addenda to existing pamphlets.

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

29. Tidal Section.—Automatic registrations were continued at the following stations:—Aden, Basra, Karāchi, Bombay, Madras, Kidderpore and Rangoon. Automatic registrations were resumed at Trincomalee and Colombo on the 3rd August 1928 and the 14th January 1929 respectively, after the lapse of about 33 years in the case of the former, and 39 years in the latter. In addition, observations on tide-poles were continued at Bhāvnagar, Chittagong, Akyab and Pilakāt or Deserters' Creek (Rangoon River).

The departmental inspection of the tidal observatory at Rangoon was carried out in March 1930. The observatories at Karāchi and Bombay were inspected by the Port authorities concerned during November 1929 and March and April 1930 respectively.

The tidal observations registered at Bassein during 1928 are being

reduced by the method of harmonic analysis, and are expected to be completed by October 1930.

The preparation and publication of the first issue of the amplified Tide-Tables of the Indian Ocean for 1931 has been completed. Advance copies of tide-tables of certain Indian ports for 1931 were prepared and despatched to the Hydrographic Departments of the Admiralty, United States, and Japan by the end of December 1929. The prediction curves of the 40 Indian ports for the year 1932 were run off on the tide-predicting machine, and were completed before the end of April 1930.

30. Gravity Observations.—(No. 14 Party).—Observations to determine the force of gravity were made at 6 stations in the Bombay Presidency, 10 stations in the Madras Presidency, 4 stations in Hyderābād State, one station in the Central Provinces, and one in the United Provinces.

Gravity was markedly in defect at all stations. Considerable improvements in the procedure of observation have been introduced by Major E. A. Glennie, O. C. No. 14 Party, which have resulted in more rapid occupation of stations. The use of the average height map has also greatly accelerated the computations of the results, which were consequently completed earlier than usual, affording Major Glennie the opportunity to do valuable research work in connection with gravity.

31. Triangulation.—(No. 15 Party).—During the season 1929-30 No. 15 Party had two Primary triangulation detachments in the field—No. 1 (Observer Lieut. I. M. Cadell, R.E.) working in Kengtung State connecting the Great Salween Series to Siamese Triangulation, and No. 2 (Observer Mr. Raj Bahadur Mathur, B.A.) completing a link of the Chittagong Series, and then observing the western stations of the Mong Hsat Series.

Weather conditions were difficult, and the out-turn of work of No. 1 Detachment fell far short of what was planned, only six stations being observed.

Both detachments commenced work with Wild Precision theodolites, but ultimately fell back on 12-inch theodolites by Troughton and Simms. Under the difficult weather conditions which prevailed, the former however have scarcely had a fair trial.

32. 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, 1,096 miles were completed during 1929-30, making a total of 8,393 miles completed up-to-date.

During 1929-30, 1,849 miles of single levelling on the high precision system were carried out as below :—

In fore direction only.—467 miles.

U. P., C. I. & C. P.	Gwalior-Jhānsi-Bina	...	165 miles.
C. I. & Bombay.	Sehore-Dewās-Dhūlia-Mhasaād	...	302 ,,

In back direction only.—772 miles.

C. India & C. P.	Bhopāl-Bina	...	89 ,,
Rājputāna & C. I.	Nasirābād-Bhopāl	...	340 ,,
Bombay, Baroda & Rājputāna.	Mārwār Pāli-Viramgam-Baroda	...	343 ,,

In both directions.—241 miles.

United Provinces.	Sahāranpur-Morādābād	241 miles.

Revision in both directions.—296 miles.

Punjab.	Ghakkar-Lāla Mūsa Sargodha ...	260 ,,
United Provinces.	Mussoorie-Dehra Dūn	36 ,,

Revision in the back direction only.—73 miles.

Punjab.	Sargodha-Jhang ...	73 ,,

Reports of secondary levelling will be found under Part X of this report (p. 77).

III.—ABSTRACT OF MAP PUBLICATION AND OFFICE WORK.

33. 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 1930. The following extracts from the full Report show the most important result of all this work, in the shape of Publications and Issues, etc.

Table I *(a)*—Maps published at Calcutta, during the year 1929-30.

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	8	8	23,510	30,402
GEOGRAPHICAL MAPS.					
Southern Asia Series ...	1:2,000,000	1	3	1,961	4,086
India and Adjacent Countries Series	1:1,000,000	2	13	12,880	20,792
La Carte Internationale du Monde	1:1,000,000	1	1	1,000	3,000
TOPOGRAPHICAL MAPS.					
Quarter-inch, Modern ...	1″=4 miles	16	14	15,200	22,797
,, (Prely.) ...	Ditto	4	8	5,486	8,179
,, (Provl.) ...	Ditto	...	16	4,428	6,680
Half-inch, Modern ...	1″=2 miles	44	20	32,174	59,967
,, (Prely.) ...	Ditto	4	3	3,144	6,391
One-inch, Modern ...	1″=1 mile	169	84	146,158	2,19,033
,, (Prely.) ...	Ditto	8	12	14,228	21,640
,, (Provl.) ...	Ditto	1	...	158	158
Old-style sheets	Various	...	94	12,637	17,682
SPECIAL MAPS.					
Provincial Maps	Various	...	8	21,330	16,781
Plans of Cities and Cantonments	Ditto	1	6	2,010	6,595
Index Maps	Ditto	1	11	3,887	2,325
Miscellaneous Maps ...	Ditto	68	45	116,380	20,069
Manœuvre Maps	Ditto	...	2	1,466	3,047
Total ...	.....	**323**	**348**	**418,037**	**4,69,624**
		Extra-departmental.			
Maps...	Various	218	32	129,958	42,227
Plans and diagrams ...	Ditto	142	41	68,755	7,359
Illustrations	.....	185	13	64,361	10,748
Miscellaneous	.....	30	14	36,992	5,993
Total ...	.....	**575**	**100**	**300,066**	**66,327**
Grand Total ...	.....	**898**	**448**	**718,103**	**5,35,951**

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	...	59	6,639	5,649
Forest maps ...	,,	19	61	4,865	4,708
Miscellaneous ...	,,	9	6	3,674	1,442
Total ...	...	**28**	**126**	**15,178**	**11,794**
		Extra-departmental.			
Maps	Various	98	18	95,990	12,803
Plans and diagrams ...	,,	42	...	92,484	3,752
Charts	,,	637	...	33,727	16,561
Forest maps ...	,,	61	6	8,406	5,881
Total ...	...	**838**	**24**	**230,607**	**38,997**
Grand Total ...	...	**866**	**150**	**245,785**	**50,791**

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, Hyderābād and Mysore.	Various	8	...	250	397
Forest maps, Hyderābād	2″=1 mile	7	...	560	3,806
Private Estates ...	Various	6	3	195	412
Do. ...	16″=1 mile	44	...	519	9,948
Plans and diagrams ...	Various	20	4	5,402	1,607
Total ...	...	**85**	**7**	**6,926**	**16,170**

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	35	3	409	348
Plans and diagrams ...	,,	31	...	3,030	295
Charts, Forms	,,	4	...	222	50
Total ...	...	**70**	**3**	**3,661**	**693**
		Extra-departmental.			
Maps	Various	51	8	6,345	1,820
Plans and diagrams ...	,,	1,359	...	30,340	10,214
Charts, Forms	,,	13	...	1,300	209
Total ...	...	**1,423**	**8**	**37,985**	**12,243**
Grand Total ...	...	**1,493**	**11**	**41,646**	**12,936**

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.			
Plans and diagrams ...	Various	...	...	2,418	699
Total ...	...	...	...	**2,418**	**699**
		Extra-departmental.			
Maps					
Plans and diagrams ...	Various	88	...	21,633	3,147
Charts, Forms					
Total ...	...	**88**	...	**21,633**	**3,147**
Grand Total ...	...	**88**	...	**24,051**	**3,846**

Table II.—Abstract of Modern Topographical Maps.

	One-inch sheets.	Half-inch sheets.	Quarter-inch sheets.
Topographical maps published in 1929-30	177	48	20
Do. do. published in previous years.	2,731	747	235
Total published ...	**2,908**	**795**	**255**
Number of sheets in India ...	**6,218**	**1,630**	**450**

34. Notes.—*Calcutta.*—In addition to the work shown in Table I(*a*), material for the original mapping of the Eastern and Burma Circles, and for the compiled mapping of all Circles, and for numerous extra-departmental maps, was supplied. Nine indexes, in colours, for the General and Map Publication Reports and Supplement, were printed.

The Guide for the preparation of Grid Originals was published.

36 sheets were published with the new grid in supersession of the minute mesh.

35. *Dehra Dūn.*—In addition to the work shown in Table I(*b*) above, 81,078 prints of 1,573 originals, consisting of plane-table sections, triangulation charts and pamphlets, and forest maps were printed.

36. *Quetta.*—Included in Table I(*d*) is the Western Command Manœuvre Map, 1929, prepared by "E" Company from air photographs. During the preparation of this map, a large number of photographic reductions were made of original photographs and celluloid strips, for use in indexing and compilation.

Table III.—Letterpress publications.

(*a*) Published at Calcutta.

1. Confidential Supplement to the General Report, 1928-29.—(160).*
2. Map Publication and Office Work Report, 1928-29.—(300).
3. Survey of India Catalogue of Maps.—(1,200).
4. Correction slips, to Topo Handbooks, Type Table, Border Specimen, Conventional Signs, etc.—(100,000).
5. Government of India Orders and Circular Orders and Circular Memos., etc.—(4,000).
6. Survey of India Notes,—issued monthly.—(350).
7. List of Maps published,—issued monthly.—(800).
8. Notes for recent publications of the Survey of India Maps.—(8,000).
9. Rules for map agents.—(500).
10. Rules for the execution of Lithographic and Photographic work for the public service or on payment.—(300).
11. List of Maps published,—issued quarterly.—(200).
12. Instructions for applicants for appointment as Class II officer in the Survey of India.—(1,000).
13. Application form for Class II officers of the Survey of India.—(500).

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

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

(a) PUBLISHED AT CALCUTTA.—*(Concld.).*

14. Memorandum on the competitive examination for Class II officers.—(500).
15. Index for Map Catalogue.—(2).
16. Notices and List of Agents for the Sale of Maps, &c.—(16,200).
17. Index Sheet No. 73 for the Survey of India Catalogue of Maps.—(2).
18. Qualification Card.—(2,000).
19. Price notes.—(600).
20. Rules for the guidance of officers conducting the Class II service examinations.—(300).
21. Agreement form for the Class II service.—(300).
22. Instructions for applicants to the Upper Subordinate service of the Survey of India.—(600).
23. Addenda and Corrigenda to Regulations on the subject of Language Examinations applicable to Officers of the Survey of India.—(450).
24. Particulars of Indent.—(1,000).
25. List of Type Founts compiled by No. 1 Drawing Office, Survey of India.—(100)
26. Rules for overtime work in Circle and Party offices.—(300).
27. Calendars for 1930.—(1,600).
28. Survey of India Camp Officer's Record Book.—(200).
29. List of returns to be submitted by Directors to the Surveyor General of India.—(300).
30 Annual Indent for European Stores.—(Various).

(b) In hand at Calcutta.

1. *Correction slips to Topo Handbooks, Conventional Signs, etc.*
2. *Government of India Orders and Circular orders, etc.*
3. *Statement of returns due to and from Director, Map Publication, corrected to 1-3-30.*
4. *Miscellaneous departmental forms.*

(c) PUBLISHED AT DEHRA DUN.

1. Geodetic Report, Vol. III, 1926-27.—(450).
1*a*. Correction slip to Geodetic Report, Vol. III, 1926-27.—(450).
2. Geodetic Report, Vol. IV, 1927-28.—(450).
3. Professional Paper No. 22 (Three sources of error in Precise Levelling).—(250).
4. Do. do. No. 23 (Air Survey of Waziristan 1923-1928).—(150).
5. Do. do. No. 24 (Notes on Air Survey in India).—(800).
6. Do. do. No. 25 (The representation of glaciated regions on maps of the Survey of India).—(500).
7. Correction slip to Professional Paper No. 25 (The representation of glaciated regions on maps of the Survey of India).—(500).
8. Goverment of India Orders, 1919-1924.—(450).
9. Circular Orders (Administrative), 1919-1924.—(450).
10. Tide Tables for Indian Ports 1930.—(6,425).
11. How to obtain maps.—(4,000).
12. 4 Triangulation Pamphlets.—(100 of each).
13. 1 Addenda to Triangulation Pamphlet.—(100).

* Number in breackets after each item denote the number of copies printed.

Table III.—Letterpress publcations.—*(Contd.).*

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

14. 141 Correction slips to Triangulation Pamphlets.—(14,001).
15. 1 Levelling Pamphlet.—(200).
16. 9 Addenda to Levelling Pamphlets.—(621).
17. 15 Secondary Levelling Lines.—(100 of each).
18. 1 Secondary Levelling Line.—(200).
19. 1 Addenda to Secondary Levelling Line.—(200).
20. 1 Correction slip to Secondary Levelling Line.—(250).
21. English Indent for Printing Office.—(15).
22. Do. do. for Geodetic Branch.—(15).
23. Addenda to Auxiliary Tables 44 & 44 A. Sur.—(620).
24. Calendar for Geodetic Branch, (Provisional).—(100).
25. List of names for Dehra Guide map.—(4).
26. 15 Lists of bench marks.—(3 of each).
27. 55 Correction slips to the Geodetic Library Catalogue.—(120 of each).
28. 1 Do. slip to Accounts Pamphlet.—(800).
29. 2 Do. slips to The Tides (Geodetic Handbook, Part V).—(500 of each).
30. 1 Do. slip to Auxiliary Tables, Part II.—(500).
31. 1 Do. do. to the Forest Map Office Catalogue.—(125).
32. 1 Do. do. to Professional from.—(13,000).
33. 6 Captions for Museum exhibits.—(3 of each).
34. Outer cover for Record Vol. XVII.—(8).
35. Qualification Report form for Lower Subordinates.—(2,000).
36. Road Map reference for the United Provinces.—(2,000).
37. Cover for Departmental Paper No. 12 (Geodesy).—(100).
38. Cover for Professional Paper No. 26—(100).*
39. Lt.-Colonel Hamilton's report on Reproduction methods of Ordnance Survey (100)
40. List of Publications corrected up to 31st January 1929.—(100).
41. 22 Covers for Photozincographed Triangulation Pamphlets.—(100 of each).
42. Primary bench marks for 3 Levelling Pamphlets and 1 Levelling Addenda.—(247).
43. 398 miscellaneous jobs.—(2,49,699).
44. 168 Professional forms.—(1,42,591).

In addition to work shown above Printing Office (Binding Section) has bound Geodetic Library books and registers and other miscellaneous jobs &c. (6,747), 22 photozincographed Triangulation pamphlets (2,200 copies) correction slips pasted (570) forms ruled (48,294) and forms perforated (4,670).

(d) In Hand at Dehra Dūn.

1. *Tide Tables, for Indian Ocean, 1931.*
2. *Auxiliary Tables, Part III.*
3. *Geodetic Report, Vol. V.*
4. *Professional Paper No. 26.*
5. *Topo. Handbook Chapter III.*
6. *2 Levelling Pamphlets.*
7. *30 Triangulation Pamphlets (18 complete and are awaiting charts).*
8. *List of names for Mussoorie Guide map.*
9. *List of Publications corrected upto 31st. January 1930.*
10. *List of Reserves in Chhindwara Forest Division.*

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

37. Map Issues.—The following table shows the number of maps issued during the year.

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	99,845	80,044	98,426	1,06,146	77,213	1,14,166	275,484	1,86,190†
	X	205,819	43,266	85,499	22,839	3,414	914	294,732	66,105†
Dehra Dūn	D	6,914	7,001	1,407	2,392	13,335	24,618	21,656	9,393†
	X	226,090	39,136	1,632	2,090	.....	.....	227,722	41,226
Simla	D	.....	.....	211	350	229	365	440	350†
Rāwalpindi ("A" Company)	D	.....	.....	20	20	.....	.....	20	20
Quetta ("E" Company)	D	170	342	55	82	.....	.....	225	424
	X	27,241	10,290	10,744	1,953	.....	.....	37,985	12,243
Peshāwar (No. 18 Party)	D	.....	.....	22	36	2,418	699	2,440	36†
	X	300	138	21,333	3,009	.....	.....	21,633	3,147
No. 22 Party	D	.....	.....	5	8	.....	.....	5	8
Mussoorie	X	.....	.....	310	475	.....	.....	310	475
Bangalore	D	1,433	2,319	5,801‡	11,467	.....	.....	7,234‡	13,786
	X	.....	.....	5,847	2,416	.....	.....	5,847	2,416
Shillong	D	2	11	1,419	2,250	.....	.....	1,421	2,261
Maymyo	D	778	1,249	810	1,498	263	551	1,851	2,747†
Totals	...	568,592	1,83,798	233,541	1,57,031	96,872	1,41,313	899,005	3,40,827

† These figures do not include the value of free issues.
‡ Includes 14 Map Catalogues.

38. Map Record and Issue Office.—The total number of departmental maps sold during the year was 198,271, being an increase of 75,516 or nearly 62% over the previous year's sales. The proceeds also were greater by Rs. 36,095, the increase for cash sales alone being Rs. 27,063. A comparatively large number of maps were taken on book transfer by the Indian Statutory Commission, but the satisfactory state of affairs, specially with regard to cash sales, is mainly attributable to the new organization, more efficient methods of advertising and the introduction of suitable booklet maps, designed to attract the general public.

The figures for extra-departmental maps show a decrease, the proceeds being less by Rs. 5,643, but the Map Record and Issue Office is only concerned with the despatch of these and with the collection of payments due.

The total number of maps of all kinds issued by the Map Record and Issue Office during the year was 570,216 and the total takings were Rs. 2,52,295. The average number of maps sent out from the office per complete working day being about 2,337.

132 new steel almirahs with a capacity of 2,302 shelves were erected during the year. All published maps are new stored in these almirahs and similar accommodation for originals and records is well in hand and will be completed within the next few months.

The map mounting machine ordered from England has been installed, and, after several months of experiments, is now giving satisfactory results, several hundred maps being mounted daily. Further improvements are being fitted to the machine, and attempts are being made to obtain regular and cheap supplies of suitable cloth and adhesive locally, instead of from England.

39. Stock of Maps.—*Calcutta.* The table below gives the stock of maps as it stood on 31st March 1930:—

Class of maps.	Number of copies in stock.	Present Face Value Rs.
1/2M Southern Asia Series	9,368	19,876
1/M India and Adjacent Countries ...	44,429	86,431
1/M Carte Internationale du Monde ...	4,815	14,412
One-inch sheets	1,138,099	17,07,148
Half-inch sheets	310,307	6,20,582
Quarter-inch sheets	190,774	2,72,967
General Maps of India	20,145	30,910
Provincial Maps of India	7,638	25,761
Cantonment and Town Maps	44,241	1,31,746
Miscellaneous Maps	63,439	88,744

Dehra Dūn.—A comparison of Table I(*b*) with Table IV shows that, during the year, 245,785 sheets were published, and 249,378 sheets issued. Stocks in hand have decreased by 3,593 sheets. The total stock in hand in Dehra Dūn is estimated at 347,899 (including 4,209 sheets received from Calcutta).

Bangalore.—The stock of maps on 31st March 1930 was as follows.—

Class of maps.	Number of copies in stock.	Value. Rs.
1-inch, ½-inch, ¼-inch and 1/M sheets ...	35,109	56,255
Miscellaneous maps	3,699	6,875
TOTAL	38,808	63,130

40. Mathematical Instrument Office.—The demands on the office for the supply of instruments shows a decrease, but the repair and the workshop manufactures are approximately the same as in the previous year, *vide* items 1, 2 and 5(*a*) respectively in the following table.

	1927-28.	1928-29.	**1929-30.**
	Rs.	*Rs.*	**Rs.**
1. Total value of stores issued ...	5,60,829	5,39,308	**4,20,131**
2. ,, ,, ,, repairs carried out to orders	1,54,092	2,44,069	**2,21,510**
3. ,, ,, ,, instruments, &c. returned to store	63,760	32,356	**44,921**
4. *Book Value of stock in*—			
(*a*) Serviceable store	2,87,839	3,09,675	**4,10,839**
(*b*) Repairable ,, ...	97,799	96,260	**1,06,575**
(*c*) Material ,, ...	2,01,072	2,02,847	**2,00,288**
5. *Value of New Instruments*—			
(*a*) Manufactured in Workshop ...	2,92,781	1,90,821	**1,79,842**
(*b*) Purchased locally	93,964	46,893	**28,363**
(*c*) Imported through the Stores Department, London ...	2,47,624	2,20,876	**2,31,128**
6. Total value of work done in the workshop ...	5,49,208	5,76,546	**5,25,686**
7. Value obtained by sale of obsolescent and condemned stores ...	367	1,980	**1,148**
8. *Employees*—			
(*a*) Average number	461	480	**490**
(*b*) Cost of employees including pension contribution ..	1,76,572	1,93,538	**2,02,734**

IV.—ABSTRACT OF TOPOGRAPHICAL WORK.

41. The following Tables show the progress of the topographical programme assigned to the Department in 1905 and the out-turns and cost-rates of different parties during the year under report.

42. 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, combined with the modern military view that this is the smallest scale suitable for tactical operations. Table B gives an idea of the work ahead according to present policy, and the state of the work 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 already much needed in some other areas. Also some areas surveyed on smaller scales have had to be resurveyed on a larger scale. The figures for this work are given in italics at the end of Table A.

Table A.—Progress of Topographical Surveys since 1905.

Scales of survey mostly 1 inch to 1 mile, but including a good deal of ½-inch work, and some ¼-inch occasionally.

Survey years.	Old Northern Circle.	Old Southern Circle.	Old Eastern Circle.	TOTALS
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-10 ...	70,784	44,675	52,885	168,344
1910-15 ...	116,958	70,765	51,654	239,377
1915-20 ...	33,713	59,916	40,654	134,283
1920-25 ...	82,777	106,619	66,703	256,099
Totals to 1925 ...	**304,232**	**281,975**	**211,896**	**798,103**

The Burma Circle was separated from the Eastern Circle in 1922-23. The Northern and Southern Circles were reformed as three Circles in 1925-26. The above totals are therefore redistributed amongst the present five Circles as follows (with slight adjustment based on revised estimates):—

Table A.—*Concld.*

Survey years.	Frontier Circle.	Central Circle.	Southern Circle.	Eastern Circle.	Burma Circle.	TOTALS.
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
Up to 1925 ...	172,382	213,774	200,051	89,587	122,309	798,103
1925-26 ...	4,906	11,621	14,137	6,029	6,012	42,705
1926-27 ...	7,964	6,036	13,753	10,889	5,543	44,185*
1927-28 ...	6,373**	4,035	14,840	17,792††	7,897	50,937
1928-29 ...	8,306	3,952	14,008	14,089	7,533	47,888
1929-30 ...	**13,640§**	**11,351†**	**15,323‡**	**11,688**	**9,105**	**61,107**
Totals to 1930	**213,571**	**250,769**	**272,112**	**150,074**	**158,399**	**1,044,925**
Balance remaining.	*318,044*	*187,231*	*71,438*	135,161	107,476	**819,350**
Total programme.	**531,615**	**438,000**	**343,550**	**285,235**	**265,875**	**1,864,275***
Revision and Re-survey of the above work.						
Up to 1929 ...	*5,384*	*284*	*2,773*	*70*	*1,119*	*9,630‖*
1929-30 ...	*1,498*	*Nil*	*773*	*Nil*	*Nil*	2,271

* Excludes 54,995 square miles, surveyed in Nepāl on the ¼-inch to 1 mile scale.
† Includes 472 square miles, surveyed by the Southern Circle.
‡ Includes 300 square miles, surveyed by the Eastern Circle.
§ Includes 8,563 square miles, surveyed by No. 1 Party, Central Circle.
‖ The total for 1928-29 should be 406 and not 306 as wrongly printed in Table A of the last Report.
** Includes 76 square miles surveyed by the Rajputāna Detachment, Central Circle.
†† Includes 3,619 square miles surveyed by No. 1 Party, Central Circle.

Table B.—Analysis of balance remaining on 1st October 1930.

Proposed scale of survey.	Frontier Circle.	Central Circle.	Southern Circle.	Eastern Circle.	Burma Circle.	TOTALS.
Inches to 1 mile.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1½-inch & over	45,722	*Nil*	*Nil*	*Nil*	*Nil*	45,722
1-inch ...	52,951	35,111	71,438	88,126	88,632	336,258
½-inch ...	198,480	145,462	*Nil*	47,035	18,844	409,821
¼-inch ...	20,891	6,658	*Nil*	*Nil*	*Nil*	27,549
Totals ...	**318,044**	**187,231**	**71,438**	**135,161**	**107,476**	**819,350**

Table C.—Areas and Cost rates of Surveys, 1929-30.

Party and Locality. Character of country.	Scale and description of work.		Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure October 1st 1929 to September 30th 1930.	Overall cost rate of Topographical Survey.	Remarks.
				Rs.	Sq. m.	Rs.	Rs.	**FRONTIER CIRCLE.**
"A" Company.—Punjab, North-West Frontier Province, Gilgit Agency, and Kashmir & Jammu.								
Medium bare hills ...	One-inch	**Triangulation** ...	240	12·8				
Punjab plains	One-inch	**Traversing** ...	1,240	7·1				
High bare mountains (7,000 to 16,000 ft.).	$\frac{3}{8}$-**inch**	Original survey ...	162	17·7				
Snow clad mountain ranges, deep valleys, (7,000 to 20,000 ft.).	$\frac{3}{8}$-**inch**	Original survey ...	.....	9·0[b]				
Ditto ditto ...	$\frac{3}{4}$-**inch**	Original survey ...	1,158[a]	22·0				(a) Summer programme of 1929 completed after 30th September 1929, cost-rate based on whole season's work.
Medium mountains (up to 9,000 ft.) partly wooded.	**One-inch**	Original survey ...	51	.....[c]				
Punjab plains	**One-inch**	Revision survey ...	1,402	18·0	**3,552**	1,97,563[e]	55·3	
Ditto	**1½-inch**	Revision survey ...	56	.....[c]				(b) Cost rate of last year's 3/8-inch survey, not given in Report for 1928-29.
Medium and high mountains, partly wooded (5,000 to 17,000 ft.).	**1½-inch**	Original survey ...	683	62·0				(c) Area too small to give reliable cost rate.
Medium hills, partly wooded ...	**1½-inch**	Revision survey ...	40	.....[c]				(d) Excluded from total area surveyed. Work consisted of corrections to communications and glaciated areas only.
Medium and high mountains, partly wooded (5,000 to 17,000 ft.).	**1½ & 1-inch**	Supplementary survey.	450[d]	17·0				(e) Includes Rs. 8,955 cost of tribal escorts debitable to Army estimates and excludes Rs. 1,047 cost of war training.

Table C.—Areas and Cost rates of Surveys, 1929-30.

Party and Locality. Character of country.	Scale and description of work.		Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure October 1st 1929 to September 30th 1930.	Overall cost rate of Topographical Survey.	Remarks.
"E" Company.—Baluchistan.				Rs.	Sq. m.	Rs.	Rs.	**FRONTIER CIRCLE.—*Concld.***
Bare rugged hills rising from open plateau.	One-inch	**Triangulation** ...	525(f)	9·1				(f) Reconnaissance of 1,045 sq. miles completed in 1928-29 but observation stopped by haze when about 520 sq. miles had been completed. The remaining 525 sq. miles were observed in 1929-30. Cost rate is however for whole work, including reconnaissance.
Ditto ditto and very difficult hills.	¾-inch	**Triangulation** ...	1,587(g)	8·4				
Very difficult rugged hills ...	**One-inch**	Original survey ...	784	65·4				
Bare rugged hills rising from open plateau.	**One-inch**	Original survey ...	783	53·3				
Ditto ditto ...	**¾-inch**	Original survey ...	1,054	29·7	**2,621**	1,88,050(h)	71·7	
No. 18 Party.—Punjab and North-West Frontier Province.								(g) Approximate. Reconnaissance of 2,118 sq. miles completed but observation stopped by haze. Cost rate is for reconnaissance of 2,118 sq. miles and observation and computation of 1,587.
Steep hills medium height ...	**1½-inch**	Air-survey Compilation.	355	110·9(i)				
Medium hills	**Three-inch**	Air-survey Compilation.	47	25·7(i)	**402**	40,558	100·9	
No. 22 Party.—Punjab and Punjab States.								(h) Excludes Rs. 20,481 for Military training, Rs. 9,760 for Instruction to Officers, etc., and Rs. 15,770 for Reproduction Section.
Cultivated plains, sand hills and patches of scrub.	One-inch (to control traversing).	**Triangulation** ...	584	8·3				
Ditto ditto ...	Four-inch	**Traversing** ...	5,378 linear miles.	15·4 per linear mile.		87,522		(i) Cost of compilation only.
No. 23 Party.—Punjab.								
Cultivated plains, desert with scrub and sand hills.	**Four-inch**	Special survey ...	907	86·5	**907**	78,449	86·5	

Table C.—Areas and Cost rates of Surveys, 1929-30.

Party and Locality. Character of country.	Scale and description of work.		Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure October 1st 1929 to Septr. 30th 1930.	Overall cost rate of Topographical Survey.	Remarks.
				Rs.	Sq. m.	Rs.	Rs.	**CENTRAL CIRCLE.**
No. 1 Party.—Rājputāna, Central India and Delhi.								
Open, sandy	½-inch	Original survey ...	8,563	1·6	(b)		(a)	(a) Includes cost of Topo. triangulation and of men under training.
Undulating, with woods and cultivation.	¾-inch	Revision survey ...	3,277	3·3	**14,513**	1,51,501	10·4	(b) Includes area surveyed by men under training.
Flat and sandy, with some rocky hills.	**One-inch**	Original survey ...	2,673	23·8(d)				(c) Excludes cost of mapping.
Partly open and partly congested city (Indore).	**32-inch**	Air-survey ...	10,415 acres.	1·0 per acre.				(d) Excludes cost of training.
Ditto ditto (Delhi)	(i) **Four-inch**	Experimental revision survey.	110	5·4(c)				
	(ii) **50 ft. to one-inch**	Ditto	0·16	3,062·5(c)				
Open, flat	(i) One-inch	**Triangulation** ...	3,475	3·5				
	(ii) Half-inch	**Triangulation** ...	1,869	3·5				
Partly open and partly congested city (Indore).	.....	**Traversing** ...	117 linear miles.	33·7 per linear mile.				
No. 5 Party.—Central Provinces, Central India, Bihār and Orissa and United Provinces.								(e) Includes 1,438 sq. miles surveyed by men under training.
Central Provinces and Central India.								(f) Excludes cost rate of men under training.
Densely wooded hills and plains	One-inch	**Triangulation** ...	2,198	5·0				(g) Excludes Rs. 12,248 debitable to the C. P. Govt.
Central Provinces.								(h) Includes cost of men under training.
Densely wooded hills ...	Half-inch	**Triangulation** ...	2,187	6·1	(e)	(g)	(h)	
Densely wooded hills and plains / *Open, and cultivated plains*	**One-inch**	Original survey ...	3,205(e)	23·2(f)	**4,974**	1,92,272	38·7	
Densely wooded hills and plains	**One-inch**	Supplementary survey	96	10·6				

Table C.—Areas and Cost rates of Surveys, 1929-30.

Party and Locality. Character of country.	Scale and description of work.	Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure October 1st 1929 to Septr. 30th 1930.	Overall cost rate of Topographical Survey.	Remarks.
No. 5 Party.—Central Provinces, Central India, Bihar & Orissa and United Provinces.—*(Concld.).*			Rs.	Sq. m.	Rs.	Rs.	**CENTRAL CIRCLE.—*Concld.***
BIHAR & ORISSA, CENTRAL INDIA AND UNITED PROVINCES.							
Densely wooded hills Cultivated, and wooded plains	**One-inch** Re-survey ...	1,628	17·1				
UNITED PROVINCES.							
Town areas and cultivated plains	**Six-inch** Revision survey ...	45	232·7				
Air Survey Traverse Detachment.—United Provinces.							
Open, cultivated plains, interspersed with numerous villages and mango groves and partly broken ground covered with high grass and scrub, and dense forest along the Chauka, Gogra, Rāpti and Gumti rivers.	16-inch **Traversing** for control of Air Surveys.	3,986 linear miles.	10·75 per linear mile.		42,849		
Outer Himālayan mountain slopes.	**Traversing** of Mussoorie Municipal boundary to provide data for future identification and location of boundary pillars.	82 linear miles.	Unimportant.				

Table C.—Areas and Cost rates of Surveys, 1929-30.

Party and Locality. Character of country.	Scale and description of work.		Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure April 1st 1929 to September 30th 1930.	Overall cost rate of Topographical Survey.	Remarks.
No. 20 Party.—(Cantonments).				Rs.	Acres.	Rs.	Rs.	**GEODETIC BRANCH & CENTRAL CIRCLE.**
Cantonments in United Provinces, Bihār & Orissa, Central Provinces and Punjab.		**Triangulation** ...	43	6·5				
	16-inch	**Traversing** ...	329 linear miles.	59·7 per linear mile.				
	64-inch	**Traversing** ...	17 linear miles.	120·4 per linear mile.				
	16-inch	**Levelling** ...	140 linear miles.	16·4 per linear mile.		(a) 61,323		(a) Excludes Rs. 39,914 on account of expenditure on mapping, but includes proportionate share of pay for September 1930.
Cantonment areas on 16 inches to 1 mile scale.	**16-inch**	Re-survey ...	3,391 acres.	3·0 per acre.				
Congested bazar areas on 64 inches to 1 mile scale.	**64-inch**	Re-survey ...	106 acres.	22·7 per acre.				
	16-inch	Revision survey ...	13,884 acres.	1·4 per acre. (b)	17,681			(b) Excludes cost of mapping.
	64-inch	Revision survey ...	300 acres.	16·4 per acre.				*Note*:—Figures refer to Cawnpore, Lucknow, Lansdowne, Chakrāta, Rānikhet, Dināpore, Pachmarhi and Ambāla.

Table C.—Areas and Cost rates of Surveys, 1929-30.

Party and Locality. Character of country.	Scale and description of work.	Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure October 1st 1929 to Septr. 30th 1930.	Overall cost rate of Topographical Survey.	Remarks.
No. 6 Party.—Hyderābād, Madras and Central Provinces.			Rs.	Sq. m.	Rs.	Rs.	**SOUTHERN CIRCLE.**
Jungle-clad hills with thick forest in plains interspersed with patches of cultivation.	One-inch **Triangulation** ...	2,612	8·9				
Low forest-clad hills and open cultivated plains in Hyderābād, thick forest-clad high hills with plain jungle and patches of cultivation in the Agency Tracts of Madras and Central Provinces, and cultivated open plains in Madras.	**One-inch** Original survey ...	5,675	17·1	**6,448**	(a) 1,78,996	27·8	(a) Excludes Rs. 6,181, cost of cave surveys and other extra-departmental work.
	One-inch Revision survey ...	773	5·7				
No. 7 Party.—Bombay, Hyderābād, Madras & Mysore.							
Partly undulating cultivated plains with low bare hills, and partly densely wooded plateau.	One-inch **Triangulation** ...	4,684	3·4				
Densely wooded undulating plateau.	One-inch **Traversing** ...	41 linear miles.					
Open undulating plains with low sparsely wooded hills.	**One-inch** Original survey ...	653	19·5	**6,353**	(b) (c) 1,40,449	22·1	(b) Excludes large scale surveys on 8-inch and 26-inch scales.
Wooded plateau and heavily forested hills running down to the sea coast.	**One-inch** Supplementary survey	5,700					(c) Excludes Rs. 4,204, cost of estate surveys.
Tea and Coffee Estates ...	**Eight-inch** Original survey ...	4,547 acres (7·1 sq. miles).					
Ditto	**26-inch** Original survey ...	318 acres 0·5 sq. mile).	0·86 per acre.				

Table C.—Areas and Cost rates of Surveys, 1929-30.

Party and Locality. Character of country.	Scale and description of work.	Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure October 1st 1929 to Septr. 30th 1930.	Overall cost rate of Topographical Survey.	Remarks.
No. 8 Party.—Madras.			Rs.	Sq. m.	Rs.	Rs.	**SOUTHERN CIRCLE.—*Concld.***
Cultivated plains and hills ...	One-inch **Triangulation** ...	2,363	3·1				
Cultivated plains	**One-inch** Original survey ...	801	27·3	(*d*) **3,467**	(*e*) 1,01,962	29·4	(*d*) Excludes large scale surveys. (*e*) Excludes Rs. 50,606, cost of large scale surveys.
Ditto	**One-inch** Supplementary survey.	2,666					
Tea Estates	16-inch **Triangulation** ...	15,720 acres (24·6 sq. miles).	·43 per acre.				
Ditto	16-inch **Traversing** ...	17·9 linear miles.	16·8 per liner mile.				
Town Guide map	**Eight-inch** Original survey ...	4,115 acres (6·4 sq. miles).	·11 per acre.				
Ditto	**Eight-inch** Supplementary survey.	800 acres (1·25 sq. miles).	·26 per acre.				
Tea Estates	**16-inch** Original survey ...	20,229 acres (31·6 sq. miles).	2·1 per acre.				

Table C.—Areas and Cost rates of Surveys, 1929-30.

Party and Locality. Character of country.	Scale and description of work.	Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure October 1st 1929 to Septr. 30th 1930.	Overall cost rate of Topographical Survey.	Remarks.
			Rs.	Sq. m.	Rs.	Rs.	**EASTERN CIRCLE.**
No. 4 Party.—Bengal, Bihār and Chota Nāgpur.							
Undulating and flat cultivation, well wooded.	One-inch **Traversing** ...	5,490	5·3				
Ditto ditto	One-inch **Levelling** ...	155 linear miles.	13·6 per linear mile.				
Ditto ditto	**One-inch** Original survey ...	1,085					
Ditto ditto	**One-inch** Supplementary survey.	1,667	24·9	**4,103**	1,33,469	32·5(a)	(a) Includes training of pupils and mapping of 4,354 sq. miles (4,103 party survey and 251 compilation from Rānīganj 4-inch maps).
Thickly wooded rocky hills and open flat cultivation with isolated hills.	**One-inch** Supplementary survey.	1,351					
Thickly wooded hills ...	**Four-inch** Forest boundary survey.	26 linear miles.					
No. 9 Party.—Orissa and Madras.							
Densely wooded ranges alternate with highly cultivated valleys.	One-inch **Triangulation** ...	4,249	4·5				
Densely wooded and barren hills, narrow valleys and open cultivated plains.	**One-inch** Original survey ...	3,612	31·0(b)	**3,612**	1,31,423	36·3(b)	(b) Excludes Rs. 1,666, cost of Calcutta Town Survey but includes cost of training of pupils.
No. 12 Party.—Assam, Bengal, Burma, Bhutān, Nepāl and Sikkim.							
Plains, highly cultivated undulating country with tea gardens and forests, steep wooded hill areas up to 13,000 ft. in Bengal, Bhutān and Sikkim.	One-inch **Triangulation** ...	1,080(c)	16·8				
	One-inch **Traversing** ...	116 linear miles.	12·4 per linear mile.				
	One-inch Original survey ...	1,273	34·7(f)				
	One-inch Supplementary survey.	2,147	30·0(f)	**3,976**	1,94,068	48·8	(d) About 2,000 sq. miles of this half-inch triangulation will be utilized for one-inch survey of Tripura State.
Darjeeling Guide Map:—							
Steep hills and town area ...	Six-inch **Triangulation** ...	(e)					(e) Included in the one-inch triangulation.
	Six-inch Original survey ...	3(g)	957·0				(f) Excludes work done by pupils.
Mainly low densely wooded hills in parts of Assam, Bengal and Burma and steep hills in Bhutān.	Half-inch **Triangulation** ...	5,015(d)	6·6				(g) Part only completed.
	Half-inch Original survey ...	553	7·8				

Table C.—Areas and Cost rates of Surveys, 1929-30.

Party and Locality. Character of country	Scale and description of work.		Area in sq. miles of each description of work.	Cost rate per sq. mile (including computations and mapping).	Total area of Topographical Survey.	Total expenditure October 1st 1929 to Septr. 30th 1930.	Overall cost rate of Topographical Survey.	Remarks.
No. 10 Party.—Upper & Lower Burma.				Rs.	Sq. m.	Rs.	Rs.	**BURMA CIRCLE.**
Upper Burma.								
Low hills covered with dense jungle.	Half-inch	**Triangulation** ...	1,200	9·86				
Plains covered with dense jungle	Half-inch	**Traversing** ...	133 linear miles.	77·52 per linear mile.				
Plains covered with dense jungle	One-inch	**Traversing** ...	400 linear miles.	78·06 per linear mile.				
Hills and undulating country covered with dense jungle.	**One-inch**	Original survey ...	1,367	40·81				
Lower Burma.								
Hills and undulating country covered with jungle.	**One-inch**	Revision survey ...	2,233	35·91	**3,600**	2,07,738	57·7	
No. 11 Party.—Lower Burma.								
Densely wooded hills ...	One-inch	**Triangulation** ...	3,532 1,128	13·0 9·6 (*a*)				(*a*) Excludes computation.
Cultivated tidal delta, paddy land and wooded hills.	One-inch	**Traversing** ...	2,264 linear miles.	7·1 per linear mile.				
Cultivated plains and densely wooded hills.	**One-inch**	Revision survey ...	5,067	26·4		(*c*)		(*b*) Excludes fair-mapping.
Densely wooded hills ...	**Half-inch**	Original survey ...	150	13·2 (*b*)	**5,217**	2,13,453	40·9	(*c*) Includes Rs. 3,564 debitable to the Burma Govt. Forest Dept. but excludes Rs. 1,552 recovered from private agency for 8-inch rubber estate survey.
Rubber Estates	**Eight-inch**	Original survey ...	3,215 acres.	0·4 per acre.				
No. 21 Party.—Upper Burma—*Reserved Forests.*								
Steep and low densely wooded hills.	Four-inch	**Triangulation** ...	275	68·4				
	Four-inch	**Traversing** ...	402 linear miles.	99·4 per linear mile.				
	Four-inch	Original survey ...	288	549·2	**288**	2,25,237	782	The whole cost is debitable to the Burma Govt. Forest Dept.

Table D.—Average monthly out-turns, 1929-30.

All out-turns are given for surveyors (excluding pupils and men under training) for a month of 24 working days.

Party.	Locality.	PLANE-TABLING.						TRIANGULATION.			TRAVERSING.			MISCELLANEOUS.		Remarks.
		¾-inch.	¼-inch.	1-inch.		1½-inch.	4-inch.									
		Original or re-survey.	Original survey.	Original or re-survey.	Supplementary or revision survey.	Original or re-survey.	Original survey.	For ¼-inch survey.	For 1-inch survey.	On ½-inch to control traversing.	Main Circuits.	For Rectangulation.	For 1-inch survey.	1¼-inch Air Survey compilation.	3-inch Air Survey compilation.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Square miles.						Square miles.			Linear miles.			Square miles.		**FRONTIER CIRCLE.**
"A" Company.	Gilgit Agency	97	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Punjab plains	...	...	...	56	...	...	...	...	...	...	...	82	...	...	
	Hazāra district (Kāgān valley).	...	...	...	...	24 (*a*)	...	...	...	...	...	...	...	...	...	(*a*) Actual out-turn. Owing to bad weather throughout the summer, the average number of working days per month was only 17.
"E" Company.	Kalāt State ...	...	...	24	...	...	...	...	...	...	...	...	...	...	...	
	Ditto ...	...	56	...	...	...	...	...	...	...	...	...	...	...	...	
	Ditto ...	...	...	...	...	...	...	522 (*b*)	...	...	...	...	...	...	...	(*b*) Based on the reconnaissance of 2,118 sq. miles and observation of 1,587. Observation stopped by haze.

Table D.—Average monthly out-turns, 1929-30.

All out-turns are given for surveyors (excluding pupils and men under training) for a month of 24 working days.

Party.	Locality.	PLANE-TABLING.						TRIANGULATION.			TRAVERSING.			MISCEL-LANEOUS.		Remarks.
		½-inch.	¾-inch.	1-inch.		1½-inch.	4-inch.									
		Original or re-survey.	Original survey.	Original or re-survey.	Supplementary or revision survey.	Original or re-survey.	Original survey.	For ½-inch survey.	For 1-inch survey.	On ½-inch to control traversing.	Main Circuits.	For Rectangulation.	For 1-inch survey.	1½-inch Air Survey compilation.	3-inch Air Survey compilation.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Square miles.						Square miles.			Linear miles.			Square miles.		**FRONTIER CIRCLE.** *Concld.*
"E" Company *Concld.*	Kalāt State ...	...	...	...	...	...	...	...	969 (c)	...	...	...	...	...	...	(c) Observation only. Reconnaissance completed previous year.
No. 18 Party.	North-West Frontier Province.	...	...	...	...	...	...	...	...	...	...	...	...	7	...	
	Ditto	...	...	...	...	...	...	...	...	...	...	...	...	...	8	
No. 22	Punjab and Punjab States.	...	...	...	...	...	...	...	...	203	57	52	...	...	...	
No. 23	Punjab ...	...	...	...	...	...	10	...	...	...	...	...	...	...	...	

Table D.—Average monthly out-turns, 1929-30.

All out-turns are given for surveyors (excluding pupils and men under training) for a month of 24 working days.

Party.	Locality.	PLANE-TABLING.													TRIANGULATION.				TRAVERSING.						MISC.	Remarks.
		¼-in.	½-in.	1-inch.			4-inch.	6-inch.	16-inch.		32-inch	64-inch.		1"=50'					Main Circuits.			Sub-Cir.			Level-ling	
		Original survey.	Revision survey.	Original survey.	Re-survey.	Supplementary survey.	Experimental Revision survey.	Revision survey.	Re-survey.	Revision survey.	Air survey work.	Re-survey.	Revision survey.	Experimental Revision survey.	For ¼-inch survey.	For 1-inch survey.	For 1½-inch survey.	For 16-inch survey.	For 32-inch Air survey.	For control of Air surveys.	Mussoorie Municipal Boundary traverse.	For control of Air surveys.	For 16-inch survey.	For 64-inch survey.	For 16-inch survey.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
							Square miles.								Square miles.					Linear miles.					Linear miles.	**CENTRAL CIRCLE.**
No. 1	Jaisalmer & Jodhpur States, Rājputāna.	386	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Bhopāl Agency, Central India.	...	136	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Ajmer-Merwāra and Kishangarh & Jodhpur States, Rājputāna.	...	...	30	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Indore City, Central India.	...	...	...	...	...	...	...	...	...	Acres. 880†	...	...	...	...	...	...	...	18	...	...	...	...	...	...	†Verifying and inking up detail on the ground on air photos.
	Delhi City and Environs.	...	...	...	...	...	52	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	Delhi City ...	...	...	...	...	...	...	...	...	...	...	...	...	·8	...	...	...	...	...	...	...	...	...	...	...	

Table D.—Average monthly out-turns, 1929-30.

All out-turns are given for surveyors (excluding pupils and men under training) for a month of 24 working days.

Party.	Locality.	PLANE-TABLING.													TRIANGULATION.				TRAVERSING.						MISC.	Remarks.
		¼-IN.	⅜-IN.	1-INCH.			4-INCH.	6-INCH.	16-INCH.		32-INCH.	64-INCH.		1″=50′					Main Circuits.			Sub-Cir.			Levelling.	
		Original survey.	Revision survey.	Original survey.	Re-survey.	Supplementary survey.	Experimental Revision survey.	Revision survey.	Re-survey.	Revision survey.	Air survey work.	Re-survey.	Revision survey.	Experimental Revision survey.	For ¼-inch survey.	For 1-inch survey.	For 1¼-inch survey.	For 16-inch survey.	For 32-inch Air Survey.	For control of Air surveys.	Mussoorie Municipal Boundary traverse.	For control of Air surveys.	For 16-inch survey.	For 64-inch survey	For 16-inch survey.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
							Square miles.								Square miles.				Linear miles.							
No. 1 *Concld.*	Jaipur & Jodhpur States, Rājputāna.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	260	...	...	...	...	...	...	...	...	...	**CENTRAL CIRCLE.** *Concld.*
No. 5	Bihār & Orissa, Central India and Central Provinces.	...	...	27	34	64	...		...	...	...	...	...	...	536	394	...	...	...	...	...	...	...	...	...	
	Benares City.							Acres.																		
	United Provinces.	...	...	...	...	...	...	2,233	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
									Acres.			Acres.														
No. 20 (Cantonments).	United Provinces, Central Provinces, Bihār & Orissa and Punjab.	...	...	...	...	...	...	...	149	269	...	15	20	...	...	...	...	33	...	...	...	...	13	15	23	
Air Survey Traverse Detachment.	United Provinces.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	48	16	55	...	...	...	

Table D.—Average monthly out-turns, 1929-30.

All out-turns are given for surveyors (excluding pupils and men under training) for a month of 24 working days.

Party.	Locality.	PLANE-TABLING.				TRIANGULATION.		TRAVERSING.		Remarks.
		1-inch.								
		Original or re-survey.	Supplementary or revision survey.	8-inch survey.	16-inch survey.	For 1-inch survey.	For 16-inch survey.	For 1-inch survey.	For 16-inch survey.	
1	2	3	4	5	6	7	8	9	10	11
			Square	miles.		Square	miles.	Linear	miles.	**SOUTHERN CIRCLE.**
No. 6 ...	Hyderābād, Madras and Central Provinces.	35	...	...	...	357	...	...	...	
No. 7 ...	Hyderābād and Madras ...	35	...	...	...	...	...	...	...	
	Bombay, Madras and Mysore ...	...	36	...	...	...	...	...	...	
				Acres.						
	Mysore	...	...	529	...	...	...	...	...	
	Bombay	...	...	...	...	413	...	29	...	
					Acres.		Acres.			
No. 8 ...	Madras	26	34	2 (*a*)	453 (*b*)	391	2,515 (*b*)	...	21	(*a*) Town Guide map. (*b*) Estate survey.

Table D.—Average monthly out-turns, 1929-30.

All out-turns are given for surveyors (excluding pupils and men under training) for a month of 24 working days.

Party.	Locality.	PLANE-TABLING.				TRIANGULATION.		TRAVERSING.	MISCELLANEOUS.	Remarks.
		½-INCH.	1-INCH.							
		Original or re-survey.	Original or re-survey.	Supplementary or revision survey.	6-inch survey.	For ½-inch survey.	For 1-inch survey.	For 1-inch survey.	Levelling.	
1	2	3	4	5	6	7	8	9	10	11
			Square miles.			Square miles.		Linear miles.	Linear miles.	**EASTERN CIRCLE.**
No. 4 ...	Bengal and Bihār and Chotā Nāgpur.	...	27	42	...	...	...	62	61	
No. 9 ...	Orissa and Madras ...	...	27	...	...	...	455	...	...	
No. 12 ...	Assam, Bengal, Bhutān, Nepāl and Sikkim.	175	24	23	0·6	495	198	87	...	

Table D.—Average monthly out-turns, 1929-30.

All out-turns are given for surveyors (excluding pupils and men under training) for a month of 24 working days.

Party.	Locality	PLANE-TABLING. 1-inch. Original or re-survey.	PLANE-TABLING. 1-inch. Supplementary or revision survey.	PLANE-TABLING. ¼-inch. Original survey (Forest).	TRIANGULATION. For ¼-inch survey.	TRIANGULATION. For 1-inch survey.	TRIANGULATION. For 4-inch survey.	TRAVERSING. For 1-inch survey.	TRAVERSING. For ¼-inch survey.	TRAVERSING. For 4-inch survey.	Remarks.
1	2	3	4	5	6	7	8	9	10	11	12
		Square miles.			Square miles.			Linear miles.			**BURMA CIRCLE.**
No. 10 ...	Lower and Upper Burma	30	29	...	760	...	...	26	26	...	
No. 11 ...	Lower Burma ...	...	46	...	...	224	...	51	...	20	
No. 21 (Burma Forest).	Upper Burma Reserved Forests.	...	...	3	...	...	83	...	...	17	

V.—SURVEY REPORTS, FRONTIER CIRCLE.

DIRECTOR:— Colonel R. H. Phillimore, D.S.O., to 22-3-30.
Lt.-Colonel S. W. Sackville Hamilton, D.S.O., R.E., from 23-3-30.

43. Summary.—The units administered by the Frontier Circle were "A" and "E" Companies, Nos. 18, 22 and 23 Parties, and No. 6 Drawing Office.

No. 22 Party having completed its programme of riverain surveys was disbanded with effect from 1st June 1930 and its personnel transferred to No. 23 Party from 1st May 1930.

The designation of No. 23 Party was changed from "Rectangulation" to "Irrigation Surveys" with effect from 1st June 1930.

44. *Training.*—1 R.E. subaltern, 1 Class II officer, 1 Upper Subordinate probationer, and 14 soldier surveyors continued their training in field and recess work in "E" Company. 3 R. E. subalterns received training in Air-Survey work during the summer of 1930.

45. *Special.*—The survey units on the frontier continued to co-operate closely with military formations at special training exercises and at manœuvres (p.p. 3, 4).

Major Wheeler has written a report on this training which together with various conclusions and recommendations has been published as Special Publication No. 2 entitled "Report on Military Training in Quetta, 1929".

A report by Major Norman on the Hatti Exercise, 1929, is included at the end of the Publication.

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

"A" Survey Company. Topography on scales of 1½ inches, 1 inch and ⅜ inch to 1 mile in sheets 43 B, E, F, G, I, J and 44 I. Traversing in sheets 44 B and F and triangulation in sheet 38 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 sheet 34 L. Triangulation in sheets 34 L and 35 I.

No. 18 (Air Survey) Party. Compilations of air surveys in the North-West Frontier Province in sheets 38 N and O.

No. 22 (Riverain) Party. Triangulation, traversing and demarcation of corners of 3,000-acre rectangles for the Punjab Government in the area commanded by the Bhakra Dam Irrigation Project in sheets 44 I, J, K, M, N, O & P; and also traversing of boundaries of hamlets for the same Government in sheet 52 D in Kāngra district.

No. 23 (Rectangulation) Party. Demarcation of rectangles, levelling and special Irrigation Surveys for the Punjab Government in the area of Muzaffargarh (Indus Canal) Irrigation Project in sheets 39 I, J, K, N and O.

"A" Survey Company.

Officer Commanding:— Major C. G. Lewis, O.B.E., R.E., to 24-11-29.
Major K. Mason, M.C., R.E., from 25-11-29 to 3-4-30.
Lt.-Col. C. G. Lewis, O.B.E., R.E., from 4-4-30.

47. General.—The recess and field head-quarters remained at Murree and Rāwalpindi respectively.

The survey of the Kāgān valley in Hazāra district, N. W. F. P., and of part of Chilās district in the Gilgit Agency was completed during the summer. The survey of the Akazai tribal area on the western slopes of the Black Mountain was carried out, at the request of that tribe, who fear aggression by the Wali of Swāt.

A small area remaining for survey in the Kāna tahsīl of Swāt, N.W.F.P., was also completed. The whole of the territory of the Wali of Swāt has now been surveyed. The completion of the survey of Allahi tribal territory in Hazāra district was attempted but had to be abandoned owing to the disturbed political situation. For the same reason the triangulation of Swāt Kohistān in the Dīr, Swāt and Chitrāl Agency, had also to be given up.

Revision surveys on the scale of 1 inch to 1 mile were continued in the Punjab plains in the neighbourhood of Lahore and Ferozepore during the cold weather.

Surveyor Muhammad Akram joined Mr. P. C. Visser's Expedition in the Eastern Karakoram on its return from Turkistān during June and July, and was employed on plane-tabling in the upper Shyok valley. He surveyed an area of 533 sq. miles on the scale of ½ inch to 1 mile which is exeluded from Tables A or C, not being rigorous survey.

48. *Personnel.*—The average strength of the company during the year was 1 Class I officer, 3 Class II officers, 5 Upper Subordinate officers, 38 Lower Subordinate officers and 6 soldier surveyors under training.

Major Mason took command of the company during the time that Lt.-Col. Lewis attended the Senior Officers' School, Belgaum. Lt. Burn was transferred to the Geodetic Branch in December. Lts. C. A. K. Wilson, Price and Sams were posted to the company for 4 months during recess for training. K. S. Afraz Gul Khan and surveyor Fateh Muhammad Khan joined Sir Aurel Stein's Expedition to Central Asia in August; Mr. Chiragh Shah was transferred temporarily to No. 18 Party for the cold weather and returned to the company in April.

49. Field work.—*Cold weather.* Mr. C. M. Aslam, B.A., (Class II) with 6 surveyors, revised 1,402 square miles on the 1 inch and 56 square miles on the 1½ inch to 1 mile scales in the Lahore, Ferozepore, and Amritsar districts of the Punjab (sheet 44 I).

Mr. Sajawal Khan, C.H., (U. S. S.) assisted by surveyor Muhammad Ayub Khan was in charge of a training camp of 6 soldier surveyors and 5 unclassified surveyors in Rāwalpindi and Hazāra districts (sheet 43 G) The best of the field sheets, on the scale of 1½ inches to 1 mile, covering 23 square miles, will be utilised towards the revision of the existing 1-inch map.

Mr. Quadir Dad (U. S. S.) and one traverser carried out traversing for topographical survey of 1,240 square miles in Jhang, Multān, Lyallpur and Montgomery districts of the Punjab (sheets 44 B and F).

Summer. Mr. A. A. Graham (Class II) with Mr. Muhammad Akbar (U. S. S.), Lt. R. H. Sams, B.Sc., R.E., (Class I) under instruction, and 7 surveyors, completed 683 square miles of original survey on the scale of 1½ inches to 1 mile in the Kāgān valley of Hazāra district, N. W. F. P.; 162 square miles of original survey on the scale of ⅜ inch to 1 mile in the Chilās district of the Gilgit Agency; 18 square miles of revision survey on the scale of 1½ inches to 1 mile in the Black Mountain area, Hazāra district; 51 square miles of original survey on the scale of 1 inch to 1 mile in Tribal territory, Dīr, Swāt and Chitrāl Agency and Hazāra district, and 450 square miles of supplementary survey on the scales of 1½ inches and 1 inch to 1 mile in the Muzaffarābād district of Kashmīr, (sheets 43 F, I and J).

K. S. Afraz Gul Khan, C.H., (Class II) carried out a triangulation series of about 240 square miles from Razmak to Tānk following the valley of the Tānk Zām in Wazīristān Agency in sheet 38 L, for the adjustment of topographical triangulation in this region.

Mr. Chiragh Shah, C.H., (U. S. S.) commenced reconnaissance for triangulation for 1½ inches survey in Swāt Kohistān in the Dīr, Swāt and Chitrāl Agency (sheet 43 A), but the work had to be abandoned owing to the armed resistance of the Kohistanis.

Mr. Muhammad Akbar carried out observations to connect the topographical triangulation of Kāgān of 1926 with the G. T. Gilgit Series of 1911, at the head of the Kāgān valley (sheets 43 E and I).

50. Areas surveyed.—A total area of 2,394 square miles was surveyed, comprising:—

162 square miles of original survey on the scale of ⅜ inch to 1 mile in the Gilgit Agency (sheet 43 E and I).

1,402 square miles of revision survey on the scale of 1 inch to 1 mile in Lahore, Ferozepore and Amritsar districts, Punjab. (sheet 44 I).

51 square miles of original survey on the scale of 1 inch to 1 mile in Tribal territory, Dīr, Swāt and Chitrāl Agency and Hazāra district, N. W. F. P., (sheet 43 B).

683 square miles of original survey on the scale of 1½ inches to 1 mile in Hazāra district (sheets 43 E, F, I and J).

18 square miles of revision survey on the scale of 1½ inches to 1 mile in Tribal territory, Hazāra district, N. W. F. P.

78 square miles of revision survey on the scale of 1½ inches to 1 mile in Hazāra, Rāwalpindi, Lahore, and Ferozepore districts, N. W. F. P. and Punjab (sheets 43 G and 44 I).

The supplementary survey of 450 square miles in Muzaffarābād district of Kashmīr has been omitted from the total noted above as this work consisted only of the correction of roads, villages and glaciated areas in the existing maps.

51. Office work.—*Fair-mapping.*—Mr. Graham, assisted by K. S. Afraz Gul Khan and Messrs. D. R. Vohra (U. S. S.) and Muhammad Akbar, was in charge of the fair-mapping during the cold weather; and Mr. Aslam with Messrs. Vohra and Sajawal Khan, was in charge during

the summer. The average strength of the drawing section was 14 surveyors and 2 draftsmen.

In addition to current mapping of 1-inch sheets, the fair sheets of the Nathia Gali and Murree Hills guide maps were submitted for publication on the scale of 3 inches to 1 mile. (The Multān and Murree Hills sheets were not submitted last year as reported).

Computation of traverse work and the compilation and adjustment of old triangulation was carried out by Mr. D. M. Das (U. S. S.) and 5 computers.

"E" Survey Company.

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

52. 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 southward on the Baluchistān plateau, astride the Quetta-Karāchi road. The modern survey of sheet 35 I was continued, and that of 34 L commenced. 1,587 square miles were triangulated in advance for subsequent seasons. (2,118 square miles were reconnoitred, but observation was stopped on account of haze: the balance of observation will be completed in the autumn of 1930).

Personnel.—The average strength during the field season was 2 Class I officers, 4 Class II officers, 4 Upper Subordinate officers and 40 Lower Subordinate officers (excluding the Reproduction Section). Of this strength, 1 Class II officer and 15 Lower Subordinate officers (including clerks) were employed permanently at head-quarters on fair-mapping, and extra-departmental work.

Lt. I. H. R. Wilson proceeded on leave ex-India during the year. K. S. Muhammad Hasan and Messrs. F. J. Grice and Seth Ram Gupta (Class II), were transferred to the Company, while Messrs. J. C. Berry and M. M. Ganapathy (Class II), and K. S. Muhammad Husain Khan and Messrs. Iltifat Husain and N. M. Bopaiah (U. S. S.) were transferred to other units.

53. Field work was organized as follows:—

Winter—

Camp (1).—Mr. Khushal Khan (U. S. S.) assisted by 1st class surveyor Ahmed Shah, with 4 soldier surveyors, surveyed 1,054 square miles on the scale of $\frac{3}{4}$ inch to 1 mile in sheet 35 I.

Summer—

Camp (2).—Mr. A. J. A. Drake, D.C.M., (Class II) assisted by Mr. J. C. Berry, K. S. Muhammad Hasan (Class II), and K. S. Muhammad Husain Khan and Mr. Sardar Khan (U. S. S.), with 1 Upper Subordinate officer, 8 surveyors, 10 soldier surveyors and 1 computer, surveyed 1,567 square miles on the scale of 1 inch to 1 mile in sheet 34 L.

Triangulation and traversing.—Mr. Abdul Rashid Khan (U. S. S.) observed the remaining 525 square miles of triangulation reconnoitred by him in the previous year in sheet 34 L, for 1-inch survey. Mr. Khushal Khan (U. S. S.), in addition to supervising Camp (1), reconnoitred 2,118 square miles in sheet 35 I for subsequent survey on the

¾ inch to 1 mile scale, but was only able to observe 1,587 square miles of this triangulation during the year under report, owing to haze.

Corrections to existing maps.—These were made as regards the new Zhob road (*via* Kila Saifulla) to Fort Sandeman and neighbouring areas; and the Hindubāgh—Fort Sandeman Railway. This work fell in sheets 34 N and 39 B, E and F.

54. Areas surveyed.—Original survey of 1,567 square miles on the scale of 1 inch to 1 mile, and of 1,054 square miles on the scale of ¾ inch to 1 mile; a total area of 2,621 square miles on both scales. All this work, as well as the triangulation carried out, lay in Kalāt State, in Baluchistān.

Nature of area surveyed.—The country surveyed and triangulated was largely on the plateau of Baluchistān, which consists of broad open valleys, between bare and rugged hills, but also included areas to the west, east and south where the plateau breaks into lower ground, and which consists of extremely broken and intricate hills and gorges, very difficult of access and survey. Water is scarce throughout, and often impregnated with salts: inhabitants are few, particularly on the edges of the plateau, and many migrate with the season. The climate is uncertain; temperatures vary from zero Fahrenheit in winter to 110° or more, in the shade, in summer, and variations in temperature are often very great diurnally as well as from day to day. Precipitation also may be considerable in one year and negligible in the next; during the winter of 1929-30 fifteen inches of snow fell on the plateau during a few hours. Haze and dust may seriously hamper work at any time of the year; and this, combined with the general uncertainty of weather conditions make adherence to a rigid programme very difficult.

55. Office work.—Fair-drawing was carried out 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. A. J. A. Drake, and M. Ansari, B.A., (Class II) assisted by Mr. J. C. Berry and K. S. Muhammad Hasan (Class II), and Messrs. Sardar Khan and Khushal Khan (U. S. S.).

Owing to the field season having continued until the end of June 1930, the mapping of all field work was not completed by the end of the survey year 1929-30. It will, however, be completed by the end of March 1931.

Reproduction section.—This section, under the supervision of Mr. Sadiq Ali (Assistant, 2nd division Photo. Litho. Office) worked full time throughout the year, almost entirely on paid for work. This work included the reproduction of a large number of *musavis* for No. 24 (Sind Rectangulation) Party, as well as numerous jobs for the military authorities in Quetta. The special drawing necessary was carried out by the drawing section in charge of Mr. M. Ansari, B.A.

56. Military Training.—Preliminary training in air survey and artillery survey had been carried out during the summer of 1929, and a 1-inch map of the Western Command manœuvre area, 1929, was prepared from air photos taken by the Royal Air Force. This map was used by the troops on the Autumn Exercises in October 1929. During October, "E" Survey Company supplied a Survey unit (about one half the

strength of an Indian Field Survey Company in war) which co-operated with the troops in the Western Command Signal Exercise, from 14th to 16th October, and the Western Command Autumn Exercise, from 22nd to 24th October. Valuable experience was gained on these Exercises in connection with rapid triangulation, air-survey methods and administration. A full report will be found in Special Publication No. 2 entitled "Report on Military Training, Quetta, 1929" by Major E. O. Wheeler, M.C., R.E.

During the summer of 1930, individual training in the use of the Wild theodolite and in Lambert computations was carried out, as well as some combined exercises with the Royal Artillery in rapid triangulation. The training of individual surveyors in air-survey methods was also continued.

No. 18 (Air Survey) Party.

Officer in charge.— { Major W. J. Norman, M.C., R.E., till 26-4-30.
Lieut. D. R. Crone, R.E., from 27-4-30.

57. General.—The party head-quarters remained at Murree and the field head-quarters at Peshāwar.

Training with the Royal Air Force has been carried out and the air-survey of areas near Peshāwar for the correction of the existing 1-inch sheets has been continued.

Personnel.—The average strength of the party apart from the Officer in Charge was one Class II officer till the end of October, 2 Upper Subordinate officers and 10 Lower Subordinates, mostly under training.

3 Class I officers (on probation) were also trained in photo and air surveys during June to September in Murree.

The strength of the reproduction section averaged 6 men.

58. Areas surveyed.—During the year the Royal Air Force supplied air photographs of 230 square miles of tribal territory in Tīrāh in sheet 38 O and of 26 square miles of Peshāwar district in sheets 38 N and O.

59. Ground Photogrammetric surveys.—In order to provide "control" in inaccessible country on which to base the air survey, use has been made of ground stereographic survey employing the Wild method and Photo-theodolite. As there is no machine in India, the plotting has been carried out in Switzerland.

60. Original Survey.—

Tīrāh.—The photographs of Tīrāh in sheets 38 O/2, 5 and 6 were received from the Royal Air Force during March and were compiled by the Arundel method and fitted to the control provided by the ground photogrammetric survey mentioned above (para. 59).

Peshāwar City Maps.—Photography of the city and cantonments was carried out by the Royal Air Force during April, and office copy corrections were compiled, for the correction of the fair sheets of the 12 inches to 1 mile city map, during May.

61. The Reproduction section in the party has been kept fully employed throughout the year. Details of the work done are included in the Map Publication and Office Work Report.

No. 22 (Riverain) Party.

Officer in charge.—Mr. C. H. Tresham.

62. General.—The programme of riverain surveys having been completed last season, the party commenced the survey of the area commanded by the Bhakra Dam Irrigation Project in Ferozepore, Hissār and Ludhiāna districts, and Farīdkot, Patiāla and Kalsia States. It also undertook the survey of a small area in the Kāngra district.

The head-quarters of the party moved from Solon to Ferozepore on 1st October 1929 and returned to Solon on 18th April 1930.

Personnel.—The average field strength of the party, apart from the Officer in charge, was 2 Class II officers, 3 Upper Subordinate officers and 82 Lower Subordinates. The strength of the unit during the year was considerably increased for the Bhakra Dam Irrigation Project survey.

63. Field work was organized as follows :—

Camp (1).—Mr. F. W. Smith (Class II) assisted by Messrs. D. S. Gandhi and N. M. Bopaiah (U. S. S.) with 23 traversers and 12 computers completed the traversing of 4,380 square miles in Hissār district and Patiāla State and embedded permanent markstones at the corners of all 3,000-acre rectangles throughout this area. 334 square miles of triangulation to control the traversing was also done.

Camp (2).—Mr. Mahammad Najamuddin, B.A., (Class II) assisted by Mr. Abdul Ghani Qureshi (U. S. S.) with 23 traversers and 12 computers completed the traversing and the demarcation of corners, of 3,000-acre rectangles with permanent markstones, of 3,506 square miles in Ferozepore, Ludhiāna and Hissār districts and in Farīdkot State. 250 square miles of triangulation was also carried out to control the traversing.

One traverser was sent to survey the boundaries of six hamlets in the Pālampur tahsīl of Kāngra district.

Camp (3).—Mr. Badlu Ram (U. S. S.) with 5 draftsmen completed the traverse charts of riverain work, and hand-coloured 210 sheets of the Punjab-U.P. boundary survey.

64. Areas surveyed.—(*a*) Traversing and demarcation of corners of 3,000-acre rectangles with permanent mark-stones, of 7,886 square miles in the area commanded by the Bhakra Dam Irrigation Project falling in sheets 44 I, J, K, M, N, O and P in Ferozepore, Ludhiāna and Hissār districts, and in Patiāla, Farīdkot and Kalsia States.

(*b*) Traversing of boundaries of 6 hamlets in the Pālampur tahsīl of Kāngra district.

(*c*) Triangulation of 584 square miles to control traverse work in Hissār district and Patiāla State falling in sheets 44 K, O and P.

65. Recess duties.—The work was divided into two sections under Messrs. F. W. Smith and Mahammad Najamuddin (*vide* report of No. 23 Party). Nos. 22 and 23 Parties were amalgamated on 31st May 1930 and No. 22 Party ceased to exist from 1st June 1930.

No. 23 Party.

Officer in charge.— { Mr. H. B. Simons to 19-4-30.
,, C. H. Tresham from 20-4-30.

66. General.—The party continued the survey of the area commanded by the Indus Canals, Muzaffargarh District. The original programme was to complete the rectangulation, levelling and 4-inch topographical survey of the whole area, owing however to abnormal floods during the monsoon rains, this programme had to be modified and it was decided to complete the rectangulation and levelling, and as much of the topographical survey as could be done by the middle of April, the balance to be completed during the following field season.

The head-quarters of the party moved from Solon to Multān on 28th October 1929 and returned to Solon on 28th April 1930.

Nos. 22 & 23 Parties were amalgamated on 31st May 1930.

Personnel.—The average field strength of the party, apart from the Officer in charge, was 3 Class II officers, 2 Upper Subordinate officers and 84 Lower Subordinates.

67. Field Work.—

Camp (1).—Mr. H. H. P. Butterfield (Class II) with 20 surveyors completed 907 square miles of special topographical survey on the scale of 4 inches to 1 mile in the Muzaffargarh district in sheets 39 K, N and O, and embedded permanent markstones at the corners of all 3,000-acre rectangles throughout this area.

Camp (2).—Mr. Jiya Lal Sahgal (Class II) with 28 levellers completed 1,476 square miles of tertiary levelling in the Muzaffargarh district in sheets 39 I, J, K, N and O.

Camp (3).—Mr. D. C. Puri (Class II) assisted by Messrs. Laltan Khan and Lalbir Singh (U. S. S.) with 24 rectangulators completed 783 square miles of rectangulation in the Muzaffargarh district in sheets 39 I, J and N.

Five draftsmen were employed at head-quarters in completing the 4-inch sheets of the Haveli Project and in preparing the height charts, from 6-inch reductions, of that portion of the Sind-Sāgar surveys which falls in the 4-inch sheets of the Indus Canal area, Muzaffargarh District.

Two surveyors were employed directly under the Officer in charge in embedding permanent markstones at the corners of all 3,000-acre rectangles throughout the area commanded by the Haveli Irrigation Project.

68. Areas surveyed.—(*a*) Original survey on the scale of 4 inches to 1 mile of 907 square miles in Muzaffargarh district in sheets 39 K, N and O.

(*b*) Rectangulation down to 25-acre plots, of 783 square miles in Muzaffargarh district in sheets 39 I, J and N.

(*c*) Tertiary Levelling of 1,476 square miles in Muzaffargarh district in sheets 39 I, J, K, N and O.

(*d*) Erection of permanent stones throughout Haveli and part of Muzaffargarh (Indus Canal) Irrigation Projects in sheets 39 K, M, N and O and 44 A and B.

The country comprises cultivated plains watered by inundation canals, and desert with scrub jungle, which in parts is very dense, particularly so at the junction of the Indus and Panjnad rivers.

69. Recess duties.—

Section (1).—Mr. H. H. P. Butterfield (Class II) with 12 surveyors completed the fair contour sheets of the Indus Canal area, Muzaffargarh District surveyed on the scale of 4 inches to 1 mile during the past field season.

Section (2).—Mr. F. W. Smith (Class II) assisted by Mr. Badlu Ram (U. S. S.) with 5 computers, compiled the records of riverain surveys in a fit state for permanent record, and drew up an account showing the work completed and describing its purpose, and the methods employed.

Section (3).—Mr. Jiya Lal Sahgal (Class II) with 12 levellers, completed the fair spot-height charts of the Indus Canal area, Muzaffargarh District.

Section (4).—Mr. D. C. Puri (Class II) assisted by Mr. Lalbir Singh (U. S. S.) with 12 surveyors, completed for reproduction, the plane-table sections of the Indus Canal area, Muzaffargarh District surveyed during the past field season.

Section (5).—Mr. Mahammad Najamuddin, B.A., (Class II) with 6 draftsmen, completed the computations and charts of No. 22 Party's work during the past field season, and prepared charts and plane-table sections of the Bhakra Dam Irrigation Project area for next field season. No. 22 Party's computations and the plotting of village boundaries of the Kāngra survey were completed, and also the hand-colouring of the Punjab-U.P. boundary sheets.

70. Mandi-Suket Boundary Settlement.—

In October 1929, the Darbārs of Mandi and Suket States made a joint request for the deputation of an officer of the Survey of India, to enquire into, and decide upon the boundary between the two States in three areas (in sheet 53 A/14) where the boundary was in dispute; and further to demarcate the line of the boundary in five areas (in sheet 53 E/3) where the Darbārs had come to an agreement based on the Survey of India 2-inch sheets of 1894-97.

Lieut. D. R. Crone, R.E., was deputed for this work and commenced the enquiry into the disputes on 24th February 1930. The mapping of the lines claimed by the States, and the demarcation and mapping of the awards, were done throughout by plane-tabling, on various scales according to the nature of the area involved. The first question to be settled concerned about 50 acres of valuable alluvium brought into dispute by the changing course of a river during the latter half of the last century. The area was mapped on the scale of 15 inches to 1 mile. Evidence was scanty as it related roughly to the period of the eighteen seventies.

The second dispute taken up concerned 100 acres of rough hill grazing land and the right to water in a certain hill stream; the area was mapped on the scale of 6 inches to 1 mile.

The last dispute concerned about 1 square mile of grazing land on a steep rocky hillside, with a few small patches of cultivation, and also the possession of a Devi. The area was mapped on the scale of 3 inches to 1 mile.

Some difficulty was experienced during plane-tabling, as the triangulation which existed had been executed for ½-inch survey only, and for the few stations in existence no markstones were found.

As no one of the decisions was accepted by both parties, all the lines awarded were only marked by temporary pillars. The demarcation of the awards was completed by 9th March.

The demarcation in the five cases in which mutual agreement had been reached, was carried out between 31st March and 5th April.

The mutual agreement was, that the line should be demarcated as shown on the Survey of India 2-inch map of 1894-97, and where this map showed the area as in dispute, that the area so shown should be equally divided between the States. The areas were mainly forest clad hillsides, and extended along portions of the boundary for 15 miles. The published sheet of the 1894-97, 2-inch map, on which plane-tabling for these demarcations was carried out, proved remarkably accurate and faithful in the depiction of hill forms by the old style of form lining.

VI.—SURVEY REPORTS, CENTRAL CIRCLE.

DIRECTOR:— { Lt.-Col. S. W. Sackville Hamilton, D.S.O., R.E., to 19-3-30.
„ „ J. D. Campbell, D.S.O., R.E., from 20-3-30.

71. Summary.—The units administered by the Central Circle were Nos. 1, 5, 20 (from 1-4-30) and 24 Parties, Air Survey Traverse and Bhopāl Detachments, and No. 3 Drawing Office.

The Benares Detachment was disbanded from 1st October 1929 and its personnel distributed amongst the other units of the circle.

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.

No. 20 Party (Cantonments) was transferred from the administrative control of the Director, Geodetic Branch, to that of the Director, Central Circle, with effect from 1st April 1930.

72. *Training.*—Four Class I Officers were under training in No. 5 Party, two were transferred to the Frontier Circle in April 1930, the remaining two to take charge of the Map Record and Issue Office and No. 1 Party in January and May 1930, respectively. Two Class II officers completed their 2nd year of probation in Nos. 1 and 5 Parties and one U. S. officer was confirmed in his appointment. No pupils were entertained during the year under report.

Out of the six soldier surveyors transferred from the Frontier Circle in October 1929, four underwent their 2nd period and two their 1st period of extra training in No. 5 Party. One of the former was found unsuitable for retention in the Department and reverted to his regiment; of the two latter, one has been recommended to undergo a 2nd period and the other was reverted to his regiment at his own request. Six new soldier surveyors, posted to the circle in 1929, are now undergoing their 1st period of training in No. 1 Party. Two soldier surveyors, on completion of their 5th field season in the Department, have been recommended for permanent retention on the unattached list.

The services of a U. S. S. computer were lent by the Geodetic Branch to the circle in order to instruct computers and to raise the general standard of computations.

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

No. 1 Party.—Topography on scales of $\frac{1}{4}$, $\frac{3}{4}$, and 1 inch to 1 mile in sheets 40 N and O, 45 F, G, J, M and N, 46 N and 55 E. Large scale survey of Indore city from air photographs. Triangulation in advance.

No. 5 Party.—Topography on the scale of 1 inch to 1 mile in sheets 63 P, 64 F, J and M. Revision of the town guide map of Benares and neighbourhood. Triangulation in advance.

No. 20 Party.—Large scale surveys of cantonments and bāzārs of five cantonments in Bihār and Orissa, Central Provinces and United Provinces. Traversing and levelling in advance.

No. 24 Party.—Traversing, levelling and demarcation of rectangles for the Bombay Government in the area commanded by the Lloyd Barrage and Canal Project in Baluchistān and Sind.

Air Survey Traverse Detachment.—Traversing for control of air surveys on the scale of 16 inches to 1 mile in Sitāpur and Bahraich districts of the United Provinces.

Bhopāl Detachment.—Forest surveys of the Bhopāl State reserved forests.

No. 1 Party.

Officer in charge.— Captain G. H. Osmaston, M.C., R.E., from 9-5-29 to 31-3-30.
Mr. F. B. Kitchen, from 1-4-30 to 30-4-30.
Lt. H. W. Wright, R.E., from 1-5-30.

74. General.—Instead of carrying on the surveys of last season in Bihār and Orissa, the work there was handed over to No. 5 Party, and new topographical surveys were commenced in Rājputāna and Central India in continuation of the work done by the Rājputāna Detachment two years previously, and also by special arrangement with various Indian States.

The area was very scattered and fell in the following degree sheets:—40 N and O, 45 F, G, J, M and N; 46 N and 55 E. The field headquarters of the party were at Ajmer.

Personnel.—The strength of the party was increased to approximately three times the number of the previous year; this was partly due to the transfer of surveyors from the Benares Detachment, disbanded in October 1929, and also to the posting of soldier and pupil surveyors to the party for training.

The actual field strength of the party, exclusive of the Officer in charge, numbered 3 Class II officers, 1 Class II probationer, 2 U. S. and about 59 L. S. officers, including 6 soldier surveyors and 20 pupil surveyors under training.

75. Areas surveyed.—8,563 square miles of ¼-inch original survey in sheets 40 N and O in Jodhpur and Jaisalmer States; 3,277 square miles of ¾-inch revision survey in sheet 55 E, mostly Bhopāl State; 2,673 square miles of 1-inch original survey in sheets 45 F, G and J in Ajmer-Merwāra district and Kishangarh and Jodhpur States; and 10,415 acres of air survey in Indore city in sheet 46 N, on the scale of 32 inches to 1 mile.

4,813 square miles of minor framework were triangulated in sheets 45 F, G and J for surveys in Jodhpur State, and 531 square miles in Jaipur State. 117 linear miles were traversed in Indore city.

76. Field work was organized as follows:—

Camp (1).—Mr. F. B. Kitchen (Class II) in charge, with 2 instructors and 2 surveyors, surveyed 1,604 square miles on the 1 inch to 1 mile scale in sheets 45 F, G and J in Ajmer-Merwāra Province and Jodhpur State. The training of 14 pupil surveyors was undertaken by this camp.

The area included sharp rocky hills and a flat sandy country-side.

Mr. Kitchen also supervised 1 surveyor on revision of the 4-inch guide map of Delhi.

Camp (2).—Mr. M. N. A. Hashmie, B.A., (Class II) in charge, with 2 instructors and 2 surveyors, surveyed 1,069 square miles on the 1 inch to 1 mile scale in sheet 45 J in Ajmer-Merwāra district and Jodhpur and Kishangarh States. The training of 6 pupil surveyors was also undertaken by this camp.

The country consists of open cultivated plains bordered on the west by the main range of the Arāvalli hills. Various isolated outcrops of the same hills occur throughout the area.

Camp (3).—Mr. T. M. C. Alexander (Class II) in charge, with 14 surveyors, during the period from October till December 1929, surveyed 8,563 square miles on the scale of $\frac{1}{4}$ inch to 1 mile in sheets 40 N and O. The surveyors were then transferred to camps (1), (2), (4) and (5).

The area includes sandy and comparatively waterless tracts with a few scattered villages, and a rocky waste in the north of sheet 40 N.

Camp (4).—Mr. B. B. Kuttappa (U. S. S.) in charge, assisted by Mr. Jagannath (U. S. S.) for traversing, with 5 traversers and 3 computers for six weeks, and 4 surveyors and 1 pupil for 3 months, surveyed Indore city on the scale of 32 inches to 1 mile from air photographs.

The total area surveyed was about 10,415 acres.

The photographs were taken by the Indian Air Survey and Transport Ltd., towards the end of September 1929.

The traversing of the whole area, and fixing of at least 6 control points on every photograph, were carried out during October and the first half of November by 5 traversers under Mr. Jagannath.

The computations were completed under this officer during the same period.

Rectified enlargements, on the scale of 32 inches to 1 mile, of sufficient photographs to cover the area, were then prepared at the headquarters of the Indian Air Survey and Transport Ltd., Dum-Dum, Calcutta, under the supervision of Mr. B. B. Kuttappa.

The inking up of these photographs, as well as surveying contours at 2 ft. interval, occupied 2 surveyors for 13 weeks. These inked up photographs were then bleached, leaving only the inked up lines, and treated as ordinary plane-table sections, being reduced photographically to the scale of 16-inches to a mile. Mosaics were made for the proposed sheets, and blue prints made from these for fair-mapping.

A detailed description of this survey, its cost, and the methods employed, will be found in the Technical Supplement to this report.

Camp (5).—Surveyor D. P. Ghasi Ram in charge, with 7 surveyors from January to March, surveyed 3,277 square miles of $\frac{3}{4}$-inch revision survey which included the major portion of Bhopāl State and parts of Narsinghgarh, Tonk and Gwalior States in sheet 55 E.

77. Recess duties.—Fair-mapping was divided into 3 sections under Messrs. F. B. Kitchen, M. N. A. Hashmie and B. B. Kuttappa.

The mapping of the two $\frac{1}{4}$-inch sheets, three $\frac{1}{2}$-inch sheets, ten 1-inch sheets, and the Indore Air Survey, all surveyed during this season, was completed during the year.

The various triangulators completed their computations with Mr. T. M. C. Alexander, in charge of the section.

Mr. Murtaza, B.A., (U. S. S.) was in charge of a special training section containing 12 pupils; out of these it was possible to employ 4 on fair-mapping after 3 months, and 2 as typers.

No. 5 Party.

Officer in charge.—Major L. H. Jackson, I.A.

78. General.—This party carried out surveys on the 1-inch scale in the Central Provinces, Central India, Bihār and Orissa and the United Provinces in sheets 63 P and 64 J. The town guide map of Benares was also revised on the 6-inch scale. The field headquarters were again at Nāgpur in order to keep in touch with the Settlement Commissioner, Central Provinces; 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 4 Class I officers (under training), 4 Class II officers (1 on probation), 4 U.S. and 43 L.S. officers, including 2 computers.

79. Areas surveyed.—4,929 square miles of 1-inch survey (1,628 square miles re-survey, 3,205 square miles original and 96 square miles supplementary survey) in sheets 63 P and 64 J; 45 square miles of 6-inch revision survey in Benares; 2,198 square miles of triangulation in advance for 1-inch survey in 64 F; and 2,187 square miles of triangulation in advance for ½-inch survey in 64 M. The triangulation in advance for 1-inch survey was connected with the Bilāspur Meridional Series, and that for ½-inch survey was connected with the Calcutta Longitudinal Series.

80. Field work was organized as follows:—

Camp (1).—Head-quarters Garwa Road. Mr. A. B. Hunter (Class II), assisted by 13 surveyors, completed 1,628 square miles of 1-inch re-survey in Palāmau district of Bihār and Orissa, Mirzāpur district of the United Provinces and Surguja State of the Central Provinces. About two-thirds of the area is hilly and wooded, with few villages and lacking in communications; the remainder of the area consists of undulating and cultivated plains with a few isolated hills, and is thickly populated, especially in the neighbourhood of the Koel river. Owing to the passive hostility of the inhabitants and the inability or unwillingness of the local officials to help, it was found necessary early in the field season to supply this camp with permanent camel transport. This camp also completed 45 square miles of revision survey on the scale of 6 inches to a mile in Benares and its immediate neighbourhood.

Camp (2).—Headquarters Ratanpur and later Bilāspur. Mr. Shadi Lal Dube, assisted by 3 surveyors and 10 soldier surveyors under training, completed 1,146 square miles of original and 93 square miles of supplementary survey on the scale of 1-inch to a mile in Bilāspur district of the Central Provinces. The country is, for the most part, sparsely inhabited and consists chiefly of heavily wooded hills and plains necessitating much plane-table traversing. A small portion of the area in the immediate vicinity of Bilāspur consists of open and undulating plains with good communications.

Camp (3).—Head-quarters Katghora. Mr. N. D. Joshi, assisted by 14 surveyors, completed 1,373 square miles of 1-inch original survey

in Bilāspur district and in Korea and Surguja Feudatory States of the Central Provinces. Practically the whole area consists of heavily wooded hills, with very few villages, and with few and poor communications. The country in the immediate neighbourhood of Katghora consists of undulating plains, partly open and partly heavily wooded, with a few small hills.

Camp (4).—Head-quarters Chāmpa. Mr. Hakdad Khan (U. S. S.), assisted by 1 surveyor, 4 Class I and 2 Class II officers (under training), completed 686 square miles of 1-inch original and 3 square miles of 1-inch supplementary survey in Bilāspur district and in Sakti, Raigarh and Udaipur Feudatory States of the Central Provinces. About two-thirds of the area is hilly, heavily wooded, and sparsely inhabited, with very few communications. The remainder consists of open and undulating plains, well populated, and with fair communications.

Camp (5).—Mr. J. R. Chibbar (U. S. S.) triangulated 2,198 square miles in Rewah State of Central India, in Bālāghāt, Bilāspur and Mandla districts, and in Kawardha Feudatory State of the Central Provinces. The country is for the most part hilly, heavily wooded, sparsely inhabited, and with poor communications.

Camp (6).—Mr. M. D. Nangia, B.A., (Class II) triangulated 2,187 square miles in Surguja and Jashpur Feudatory States of the Central Provinces. Almost the whole area consists of heavily wooded hills. Villages are few and far between, and communications poor.

81. Recess duties.—Fair-mapping was divided into 4 sections under Messrs. A. B. Hunter, Shadi Lal Dube, N. D. Joshi and Hakdad Khan (training section). The mapping of all field work, together with 3 half-inch sheets of the previous field season, was completed during the year. Messrs. M. D. Nangia and J. R. Chibbar were responsible for the computations of their triangulation.

No. 20 Party (Cantonments).

Officer in charge.— Mr. C. E. C. French up to 15-12-29.
„ C. West from 16-12-29 to 6-1-30.
„ J. H. Williams, from 7-1-30.

82. General.—The party carries out original and revision survey, of cantonments, military lands and cantonment bāzārs as required by the Engineer-in-Chief and the Army Department; and is also available for other special large scale surveys.

The head-quarters of the party were at Dehra Dūn up to 31st March 1930, and thereafter at Mussoorie under the administrative control of the Director, Central Circle.

This report covers the period 1st April 1929 to 30th September 1930.

83. Areas Surveyed.—The field camp of the party consisting of 12 surveyors and 2 computers, under the supervision in turn of Rai Sahib Jamna Prasad and Messrs. Muhammad Husain and Bakhshi Harnam Singh

(U. S. S.), completed the survey of the following cantonments on the scale of 16 inches to 1 mile, as well as the bazar areas on the scale of 64 inches to 1 mile.

16-inch revision survey.

Lucknow	6,725	acres
Pachmarhi	2,409	,,
Cawnpore	3,782	,,
Dinapore	968	,,

16-inch re-survey.

Chakrāta	3,391	acres

64-inch re-survey.

Chakrata Bāzars	35	acres
Lucknow ,,	71	,,

64-inch revision survey.

Pachmarhi Bazars	55	acres
Cawnpore ,,	188	,,
Dinapore ,,	57	,,

Making a total of 17,275 acres on the 16-inch scale, and 406 acres on the 64-inch scale.

Traversing and Levelling. 346 linear miles of traversing were carried out and the results computed in advance of the ensuing season's detail survey; 140 linear miles of levelling were run at suitable intervals as control work for 5 feet contour intervals in the plains, and 20 feet coutour intervals in hilly cantonments.

16 positions were fixed by theodolite traversing in Lansdowne cantonment for the purpose of testing a range-finding apparatus.

Spot levelling in Lucknow cantonment of 23 positions for an anti-malarial scheme, and 7 linear miles of levelling along the main water supply line in Chakrāta were also carried out.

84. Recess duties.—The field camps returned in July, and the party fair-mapped and submitted for publication the plans of Peshāwar, Belgaum, Poona, Kirkee and Cawnpore cantonments on the scale of 16 inches to 1 mile, with their bāzārs comprising 8 plans on the scale of 64 inches to 1 mile.

A drawing section of 6 draftsmen under Mr. O. D. Jackson (Class II) was maintained throughout the year; 43 originals of cantonment surveys were prepared and sent to press for publication.

No. 24 Party (Sind Rectangulation).

Officer in charge.—Lieut.-Col. A. H. Gwyn, I.A.

85. General.—The work, which is for the Lloyd Barrage and Canal Construction, comprises the laying out, and marking by specially prepared stones, of 320-acre and 64-acre rectangles in the British and Khairpur State areas respectively, and at the same time covering the whole area with a network of levelling. Field head-quarters opened at Sukkur on the 1st November 1929 and closed on the 12th April 1930; the party then moved to Karāchi for recess.

Personnel.—The field strength, apart from the Officer in charge, consisted of 3 Class II officers, and 1 U. S. officer, with 6 traversers, 74 rectangulators, and 21 levellers.

86. Areas surveyed.—252 square miles of demarcation of main rectangles (of 4 square miles) for subdivision later to 64-acre rectangles; 2,335 square miles of 320-acre rectangles; 1,186 square miles of 64-acre rectangles; 836 linear miles of double levelling in British area and 1,062 square miles of single levelling in Khairpur State.

87. Field work was organized as follows:—

Camp (1).—Mr. Abdul Karim, B.A., (Class II), with 54 traversers and rectangulators, carried out the demarcation of main rectangles, and subdivided 105 square miles into 320-acre rectangles and 1,186 square miles into 64-acre rectangles.

Camp (2).—Mr. S. R. Gupta, B.A., (Class II), with 17 rectangulators, subdivided 1,493 square miles into 320-acre rectangles.

Camp (3).—Mr. Amrit Ram (U.S.S.), with 9 rectangulators, subdivided 724 square miles into 320-acre rectangles.

Camp (4).—Mr. O. N. Pushong (Class II), with 17 levellers, carried out 1,062 square miles of 64-acre levelling network in Khairpur State.

Nos. 7 and 8 Detachments—each containing 2 Lower Subordinate officers, carried out 836 linear miles of double levelling in the British area.

88. Recess duties.—Mr. Abdul Karim, B.A., with 14 men computed the levelling heights, and also prepared draft contour charts for Khairpur State; Mr. Amrit Ram prepared *masāvī* originals for reproduction for the Chief Engineer and for the Khairpur State authorities. The miscellaneous index mapping was directly under the Officer in charge.

Bhopāl Survey Detachment.

Officer in charge.—Rai Sahib Chuni Lal Kapur.

89. General.—The detachment completed mapping work on the scale of 16 inches to 1 mile and the preparation of mujmilis on the scale of $\frac{3}{4}$ inch to 1 mile in sheets 54 L and 55 I and J.

The detail survey, on the scale of 2 inches to 1 mile, of all forest blocks in the Bhopāl State, covering approximately 1,400 square miles, was completed, as well as the traversing and levelling of Bhopāl city for the water works scheme.

By arrangement with the Revenue Member, the detachment was inspected by the Director, Central Circle, once during the field season.

The detachment was broken up at the end of June.

Air Survey Traverse Detachment.

Officer in charge.— { Mr. Ram Narayan Hastir up to 30-6-30.
,, Jagannath from 1-7-30.

90. General.—This detachment continued traversing for the Indian Air Survey and Transport Limited for 16-inch settlement surveys in the Sitāpur, Bahraich and Fyzābād districts of the United Provinces, in

sheets 63 A, E, F, I, J and N, and completed the areas left over from the previous field season. It opened in the field at Sītāpur on the 7th October 1929, but head-quarters were subsequently moved to Fyzābād in December 1929; field work closed on 24th April 1930.

Personnel.—The field strength, apart from the Officer in charge, was one U. S. officer, 29 L. S. officers, including 4 surveyors, 16 traversers, 8 computers, one draftsman, and one clerk.

91. Areas surveyed.—3,986 linear miles of traversing in sheets 63 A, E, F, I, J and N in Sītāpur, Bahraich and Fyzābād districts were completed.

92. Field work was organized as follows:—

Camp (1).—Head-quarters Sītāpur till middle of December, and then Fyzābād. Mr. R. N. Hastir (U. S. S.), with 1st Class traverser, Nand Kishore Sharma as assistant camp officer and 12 traversers up to 20th November 1929, and then with 8 traversers, completed 2,213 linear miles of traversing in the Sītāpur and Bahraich districts.

Camp (2).—On the re-transfer of Mr. Jagannath (U. S. S.) with 5 traversers from No. 1 Party, this camp was organized from 21st November 1929 with headquarters at Sītāpur till 4th December 1929, and then at Fyzābād. Mr. Jagannath, with 1st Class traverser Amar Singh as assistant camp officer and 9 traversers, completed 1,773 linear miles of traversing in districts Sītāpur and Fyzābād.

Computations of the work in all three districts were completed in the field under the Officer in charge. Photo prints and traverse data of all flights of Sītāpur and Fyzābād districts and of some flights of Bahraich district were scrutinized by the respective camp officers, and supplied to the Company before closing the field. Data of the remaining flights of Bahraich district were supplied during 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, along the Chauka, Gogra, Rāpti and Gumti rivers. The Chauka river changes its course very frequently leaving many old channels which are inundated during the rainy season, rendering the country difficult to traverse. The main stream now joins the Gogra river about 50 miles higher up than formerly.

Three traversers of the detachment were employed from April to June on traversing the boundary of the Mussoorie Municipality and completed 82 linear miles, connecting every boundary pillar to provide data for its future identification and location.

93. Recess duties.—Computations of the air survey and Mussoorie traverses were finally completed and examined by Messrs. R. N. Hastir and Jagannath and bound up in volumes. Photographs of an area of 500 square miles to be traversed for the U. P. Government during the next field season were examined and docketed

VII.—SURVEY REPORTS, SOUTHERN CIRCLE.

DIRECTOR:—{ Major R. S. Wauchope, O.B.E., I.A., up to 17-10-29.
Lt.-Col. L. G. Crosthwait. I.A., from 18-10-29.

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

95. *Training.*—Two Class II officers continued their training as probationers, and five Upper Subordinate probationers were transferred from the Geodetic Branch for further training. Twelve pupil surveyors were under training, and in addition six were entertained during the year.

96. *Special surveys.*—Large scale surveys were carried out of various places of archæological interest, also of an irrigation project and a transmission line, as well as of 25,094 acres of private estates on the scale of 16 inches to a mile, and of a guide map of Pondicherry on the scale of 8 inches to a mile.

97. *The field work* of parties, of which the total outturn on the scale of 1 inch to a mile was 16,268 square miles, and covered the whole or parts of 58 sheets, was as follows:—

No. 6 Party.—Topography on the scale of 1 inch to a mile in sheets 56 F and N, and 65 D and F, and large scale surveys of places of archæological interest.

No. 7 Party.—Topography on the scale of 1 inch to a mile in sheets 48 J, M, N and O, and the survey of private estates on scales of 8 and 26 inches to a mile.

No. 8 Party.—Topography on the scale of 1 inch to a mile in sheets 58 M and N, 16-inch surveys of estates, and on 8 inch guide map of Pondicherry.

All parties carried out triangulation in advance.

98. *Sale of Maps.*—The amount realised by the sale of maps being Rs. 12,540 shows an increase on the previous year, the mounting charges totalling Rs. 2,860.

No. 6 Party.

Officer in charge.—Major R. S. Wauchope, O.B.E., I.A.

99. General.—The party opened its field head-quarters office at Secunderābād on the 16th December 1929, remaining there until it moved to Waltair at the begining of March 1930. Camps (1), (2) and (3) took the field on the 18th November 1929.

Survey was continued in the Karimnagar and Warangal districts of Hyderābād, in the Guntūr, Kistna and Vizagapatam districts of Madras, and in the Bastar State of the Central Provinces.

Personnel.—The field strength of the party was 1 Class I, 2 Class II officers, 1 Class II probationer, 4 Upper Subordinate officers, 5 Upper Subordinate probationers and 42 Lower Subordinate officers.

100. Areas surveyed.—A total area of 6,448 square miles was surveyed as follows:—

5,675 square miles of 1-inch original survey in sheets 56 N and 65 D and F and 773 square miles of 1-inch re-survey in sheet 56 F in connection with an irrigation project.

101. 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.), and a staff of 1 Class I probationer and 13 surveyors completed 3,695 square miles of original and 773 square miles of re-survey on the scale of 1 inch to a mile.

The country consisted of open cultivated plains and deltaic country in Madras; and open cultivated plains with prominent hills, and some undulating forest land in Hyderābād.

Camp (2), under Mr. C. P. E. Davenport (Class II), assisted by Mr. J. A. Cabral (U. S. S.) and a staff of 1 U. S. officer and 19 surveyors, completed 1,415 square miles of 1-inch original survey.

The area consisted of flat and undulating country covered with dense, and in some parts high forests, occasional groups of hills, and small patches of cultivation.

This camp closed early in April and proceeded to Bangalore forming an advance section to start fair-drawing.

Camp (3) started work under Mr. J. A. Cabral (U. S. S.) but owing to the sickness of Mr. Muhammad Abdul Azim, I.D.S M., (U. S. S.) and consequent transfer of Mr. J. A. Cabral to Camp (2), was taken over later by Major R. S. Wauchope, O.B.E., I.A. This camp, with a staff of 5 U. S. probationers and 2 pupils, completed 565 square miles of original survey on the scale of 1 inch to a mile.

The country consisted of cultivated plains, and undulating and hilly thickly forest clad areas.

Triangulation.—An area of 358 square miles for 2-inch forest surveys and 2.254 square miles for 1-inch surveys was triangulated by surveyors Mohkam Chand, A. Shamanna and A. Narasingha Rao, in the Bastar State of Central Provinces, and Vizagapatam district of Madras, in sheets 65 F, G and J.

The area consisted of forest covered hills and undulating country.

Special surveys.—Surveyors Dhondi Masku Banker and Bal Kishan Lal carried out surveys of the Sānchi Tope, Raisen Fort, Cuttack Buddhistic Caves, Gulbarga and Warangal Forts on 125 feet to 1 inch and larger scales, as well as revision and supplementary work for the Bidar guide map.

102. Recess duties.—Fair-drawing was arranged in 3 sections under Messrs. Natesan and Davenport and the Officer in charge of the party. The fair-mapping of 28 one-inch, 6 half-inch and 9 two-inch sheets was completed. 8 special sheets of Buddhistic Cave areas were also drawn and submitted. Mr. Abdul Ahad, Class II probationer, surveyors Mohkam Chand and A. Narasingha Rao and 2 computers completed the computations of the triangulation.

103. Map sales.—A fairly large business was done during the year with the military authorities, official departments of the Hyderābād State and private individuals.

No. 7 Party.

Officer in charge.— { Captain G. W. Gemmell, I.A., to 9-3-30.
Mr. S. S. McA'Fee Fielding from 10-3-30.

104. General.—The party continued topographical surveys in the North Kanara and Dhārwār districts of Bombay, the Bellary district of Madras, the Chitaldrug, Kadūr and Shimoga districts of the Mysore State, and the Raichūr district of the Hyderābād State. The unsurveyed areas of the Hyderābād and Mysore States were completed during the season.

The field season commenced on the 25th November with head-quarters at Shimoga, and closed on the 20th April.

Personnel.—The field strength was 1 Class I and 4 Class II officers including one probationer, 4 Upper Subordinate officers, and 43 surveyors, etc.

105. Areas surveyed.—A total of 6,353 square miles was surveyed, comprising 653 square miles original, and 5,700 square miles supplementary survey on the scale of 1 inch to a mile, and 4,865 acres or 7 square miles on scales of eight and twentysix inches to a mile.

106. Field work was organized as follows:—

Camp (1), Mr. F. C. Pilcher (Class II) with one Class II probationer and 10 surveyors completed 1,754 square miles in sheets 48 J and N.

Camp (2), Mr. N. S. Harihara Iyer (Class II) with 12 surveyors completed 2,014 square miles in sheets 48 M and N.

Camp (3), Mr. K. G. Mandanna (U. S. S.) with 12 surveyors completed 2,008 square miles in sheets 48 M and N.

Camp (4), consisting of Mr. I. K. Ponnappa (U. S. S.) and 4 surveyors directly under the supervision of the Officer in charge of the party, completed 577 square mile in sheet 48 O.

The country surveyed consisted chiefly of open undulating plain in the Bellary district, wooded plateau in Mysore, and heavily forested hills running down to the sea coast in the North Kanara district of Bombay.

The well-known Jog (Gersoppa) falls, 829 feet in height, fell in the area surveyed.

Triangulation and traversing.—Messrs. B. N. Murthi (Class II), P. S. Vengusvami and Mohabat Ali (U. S. S.) carried out supplementary triangulation over an area of 4,684 square miles in Belgaum, Dhārwār, Bijāpur and North Kanara districts, Kolhāpur and Savanūr States and Southern Marātha Jāgirs of Bombay, and Raichūr district of Hyderābād, in sheets 48 J, M and N which had been previously triangulated during 1875—1903. Mr. B. N. Murthi completed 41 linear miles of theodolite traversing to provide heights in sheet 48 J/13.

Special surveys.—Two surveyors were employed on the survey of two private estates covering an area of 4,865 acres in the Hassan and Kadūr districts of Mysore.

107. Recess duties.—Fair-mapping of the 22 one-inch and 2 half-inch sheets, and of the 3 estate maps was completed under Messrs. Pilcher, Harihara Iyer, Mandanna and Murthi. A section under Mr. Vengusvami completed the computations of the triangulation.

No. 8 Party.

Officer in charge.—Mr. E. M. Kenny.

108. General.—The party opened its field head-quarters at Cuddalore on 21st November, and continued topographical surveys in the South Arcot, Tanjore and Trichinopoly districts of Madras, and the French territories of Pondicherry and Kārikāl. Triangulation in advance was carried out in the Salem, South Arcot, and Trichinopoly districts, and the survey of some private estates was also undertaken in the Coimbatore and Nilgiri districts and in the Travancore State.

Personnel.—The field strength, excluding the Officer in charge, was 3 Class II, 4 Upper Subordinate and 36 Lower Subordinate officers and 12 pupil surveyors.

109. Areas surveyed.—A total of 3,507 square miles was surveyed comprising.—

3,467 square miles original and supplementary surveys on the scale of 1 inch to a mile.

8 square miles town survey on the scale of 8 inches to a mile.

20,229 acres or 32 square miles on the scale of 16 inches to a mile.

110. Field work was organized as follows :—

Camp (2).—Mr. M. S. Ganesa Aiyar (Class II) with Mr. Sheikh Alauddin (U. S. S.) and 10 surveyors completed 158 square miles of original and 1,283 square miles of supplementary survey on the scale of 1 inch to a mile in sheet 58 M.

Camp (3).—Mr. S. R. Kelkar, B.Sc., (Class II) with 10 surveyors completed 61 square miles of original and 1,383 square miles of supplementary survey on the scale of 1 inch to a mile in sheets 58 M and N.

Camp (4).—Mr. Syed Budhan (U. S. S.) with 10 pupil surveyors completed 582 square miles of 1-inch original survey in sheet 58 M.

The country varied from the low lying paddy fields along the coast to the higher undulating country at the foot of the Kalrāyan hills on the west.

Triangulation.—Mr. Muhammad Mustafa (U. S. S.) triangulated 2,363 square miles in sheet 58 I.

Special surveys.—*Camp (1)*, Mr. B. T. Wyatt (Class II) with Mr. H. Murthi Rao (U. S. S.) and 12 surveyors triangulated and surveyed 20,229 acres of private estates on the scale of 16 inches to a mile in sheets 58 A, B, C, F and G.

The town of Pondicherry and surrounding country, comprising 8 square miles, was surveyed on the scale of 8 inches to a mile by camp (2).

A survey of a rifle range on the scale of 48 inches to a mile and a sectional and route survey of a proposed transmission line on a scale of 1 inch to 240 feet were also undertaken.

111. *Miscellaneous.*—The French authorities were most courteous, and gave all assistance required to surveyors working in French territories. The health of the party was good.

112. Recess duties.—Fair-mapping was divided into 4 sections under Messrs. Wyatt, Ganesa Aiyar, Kelkar and Nair. The mapping of all field work was completed during the year, also the drawing of three

half-inch sheets, of which two had been partly completed in the previous season. The Pondicherry Town Guide map was drawn on the 8 inches to 1 mile scale for publication on the 6-inch scale.

Mr. Syed Budhan was in charge of a training section and the pupils of the party were given further instruction in plane-tabling.

Mr. Muhammad Mustafa completed the computations of his own triangulation.

VIII.—SURVEY REPORTS, EASTERN CIRCLE.

DIRECTOR:—{Lt.-Colonel J. D. Campbell, D.S.O., R.E., up to 10-3-30.
{Lt.-Colonel L. C. Thuillier, I.A., from 11-3-30.

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.

In addition, as technical adviser to the Governments of Bengal and Bihār & Orissa, the Director, Eastern Circle, visited the Bengal Survey School at Maināmati near Comilla.

114. *The field work* of parties comprised 54 one-inch and half-inch sheets partly or wholly surveyed, as follows:—

No. 4 Party.—Topography, 4,103 square miles on the scale of 1 inch to 1 mile in sheets 72 H and 73 M.

No. 9 Party.—Topography, 3,612 square miles on the scale of 1 inch to 1 mile in sheets 73 H, 74 A and E.

No. 12 Party.—Topography, 3,973 square miles on the scales of 1 inch and ½ inch to 1 mile in sheets 78, A, B, E and F.

Training.—The majority of 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.—{Major F. B. Scott, I.A., up to 20-10-29.
{Lieut. J. B. P. Angwin, R.E., from 21-10-29.

115. General.—Supplementary survey was carried out on the scale of 1 inch to 1 mile in sheet 72 H in Bihār and Orissa, and original and supplementary survey on the same scale in Bengal in sheet 73 M. The field head-quarters were at Burdwān.

Personnel.—The field strength of the party was 1 Class I officer, 4 Class II officers, (1 on probation), 2 Upper Subordinate officers (1 on probation), and about 47 Lower Subordinate officers.

Lieut. Angwin took over charge from Major Scott at the commencement of the field season and Mr. M. M. Ganapathy, B.A., (Class II probationer) took charge of Camp I towards the end of the field season, when Mr. S. F. Norman proceeded on leave.

116. Areas surveyed.—

One-inch original survey 1,085 square miles.

One-inch supplementary survey 3,018 square miles.

4-inch *forest boundary* survey 25·65 linear miles.

Traversing.—5,490 square miles.

Levelling.—155 linear miles.

117. Field work was organized as follows:—

Camp (1).—Mr. S. F. Norman (Class II) with 7 surveyors completed supplementary survey of 1,351 square miles on the scale of 1 inch to 1 mile. The area lay in the heavily wooded rocky hills which form the northern limit of the Chota Nāgpur plateau, and in the open cultivated

plains and isolated hills of Gaya, Patna, Monghyr and Hazāribāgh districts, in sheets 72 H/5, 9, 10, 13 and 14. Mica mines abound in the hills. Four-inch boundary surveys were also made of the Chatkari, Dubaur, Meghatāri and Bishunpur protected forests, and of part of the Kodarma reserved forest.

Camp (2).—Mr. P. C. Mitra, B.A., (Class II) with 8 surveyors and 4 pupils carried out original survey on the scale of 1 inch to 1 mile of 763 square miles, and supplementary survey on the same scale of 356 square miles in the Bīrbhūm and Burdwān districts of Bengal, and the Santāl Parganas district of Bihār and Orissa, in sheets 73 M/1, 5, 6 (part), 9 and 10. The area comprised open rolling country, and thickly populated flat cultivated land, well wooded.

Camp (3).—Mr. A. R. Quraishi, B.A., (Class II) with 9 surveyors carried out original survey on the scale of 1 inch to 1 mile of 322 square miles, and supplementary survey on the same scale of 1,311 square miles in the Burdwān and Bānkura districts of Bengal in sheets 73 M/3, 4, 7, 8, 11 and 12. The area included undulating country and flat cultivation, with patches of thick low sal jungle.

Traverse Camp.—Mr. N. C. Ray (U. S. S.) with 6 traversers and 1 leveller carried out traversing and levelling in the Burdwān, Bīrbhūm, Murshidābād, Bānkura, Hooghly, Howrah and Midnapore districts of Bengal, in well wooded, cultivated areas, partly undulating, partly flat. Later in the season, work was also carried out in the south-eastern part of the area which had been flooded earlier. The area covered sheets 73 M/13, 14, 15, 16 and 73 N (complete). Sheets 73 M/13 and 14 were traversed by Mr. M. M. Ganapathy, B.A.

118. Recess duties.—Fair-mapping was organized into three sections under Mr. P. C. Mitra, B.A., Mr. A. R. Quraishi, B.A., Mr. M. M. Ganapathy, B.A., and Mr. Iltifat Husain as available. Mr. U. D. Mamgain, B.Sc., (U. S. probationer) was in charge of the typing section.

The fair-mapping of all the sheets surveyed was completed during recess.

Computations were completed by mid September by a section under computer Ajudhia Prasad Gupta.

No. 9 Party.

Officer in charge.—Mr. V. W. Morton.

119. General.—Original survey was carried out on the scale of 1 inch to 1 mile in sheets 73 H, 74 A and 74 E 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, (one on probation), 5 Upper Subordinate officers, (one on probation), and 38 Lower Subordinate officers.

120. Areas surveyed.—Original survey of 3,612 square miles on the scale of 1 inch to 1 mile.

Triangulation.—4,249 square miles.

121. Field work was organized as follows:—

Camp (1).—Mr. Priya Nath Sur (Class II) with 10 surveyors and 1 pupil, carried out original surveys on the scale of 1 inch to 1 mile of

1,046 square miles in the Puri district, Rānpur Feudatory State of Orissa, and Ganjām district of Madras. The country surveyed consisted of densely wooded as well as barren hills terminating at the western and northern shores of the Chilka lake, and low-lying arable areas of rice-land extending to the sea coast.

Camp (2).—Mr. Bhupendra Nath Saha, M.Sc., (Class II), with 1 Class II probationer, 10 surveyors and 3 pupils carried out original surveys on the scale of 1 inch to 1 mile of 1,395 square miles in the Cuttack and Puri districts, and Athgarh, Barāmba, Dhenkānāl, Hindol, Khandpara, Narsinghpur and Tigiria Feudatory States of Orissa. The country surveyed comprised the densely wooded hills and narrow valleys in the Feudatory States sloping down to the Mahānadi river, and the highly cultivated deltaic areas which are subject to inundation.

Camp (3).—Mr. Rohini Kumar Talapatra, B.A., (U. S. S.), with 1 Upper Subordinate probationer and 10 surveyors carried out original surveys on the scale of 1 inch to 1 mile of 1,171 square miles in the Puri district, Barāmba, Daspalla, Khandpara, Narsinghpur, Nayāgarh and Rānpur Feudatory States of Orissa and Ganjām district of Madras. The country varies from densely wooded hills to flat open cultivated areas.

Triangulation.—Messrs. Atul Chandra Maulick, Hiranya Kumar Kar and Nirmal Chandra Sen, U. S. officers, triangulated in the Angul district of Bihār and Orissa, Ganjām district of Madras and Rairākhol, Sonpur, Athmallik, Tālcher, Baud, Narsinghpur, Khandpara, Daspalla and Nayāgarh Feudatory States of Orissa. The country is traversed by the Mahānadi river towards the north and consists of vast ranges of forest-clad hills with well-watered and highly cultivated valleys. The area is particularly noted for its malarious climate, and both triangulators and *khalāsis* suffered a great deal from this cause.

Forest surveys.—The area of one-inch survey included several Government reserved and protected forests in the Puri district and State forests in the Feudatory States.

City surveys.—One surveyor was attached to the Map Publication Office at Calcutta and employed on the revision of the 6-inch and 8-inch Guide Maps of Calcutta & Howrah, and Dum-Dum respectively.

122. Miscellaneous.—Malarial fever was very prevalent in the low-lying country around the Chilka Lake and in the Feudatory States of Orissa. Several surveyors and *khalāsis* suffered throughout the season. One *khalāsi* died of cerebral malaria and another was drowned while bathing in the sea at Puri.

The famous temple of Jagannāth in Puri town, the caves and rock sculptures at Khandgiri and Udayagiri, the Lingarāj temple and other remains at Bhubaneswar and the Asoka inscriptions at Dhauli Hill in the Khurda sub-division are of archæological interest.

123. Recess duties.—The fair mapping of the area surveyed was divided into two sections under Messrs. Sur and Saha, assisted by 2 U. S. officers and was completed before the end of recess.

A computing section under Mr. A. C. Maulick (U. S. S.) with 4 computers completed the triangulation computations.

No. 12 Party.

Officer in charge.— Major H. R. C. Meade, I.A., from 1-10-29 to 4-4-30.
Mr. J. McCraken, from 5-4-30 to 21-4-30.
Lt.-Colonel C. M. Thompson, I.A., from 22-4-30.

124. General.—Original survey was carried out on the scales of ½ inch and 1 inch to 1 mile in sheets 78 A, B and F in Bengal, Bhutān, Sikkim and Nepāl. Original survey for the Darjeeling Guide Map on the scale of 6 inches to 1 mile in sheets 78 A 4, A/8 and B/5 was also commenced. Supplementary survey on the scale of 1 inch to 1 mile in sheets 78 B and F in Bengal was carried out. Triangulation and traversing were undertaken in sheets 78 A and B, 79 M, 83 D and H, and 84 A.

The field head-quarters were at Jalpaiguri.

Personnel.—The field strength of the party was 2 Class II, 6 Upper Subordinate officers and about 35 Lower Subordinate officers.

125. Areas surveyed.—

½-inch original survey 553 square miles.

1-inch original survey 1,273 square miles.

6-inch original survey of Darjeeling, 2·6 square miles.

1-inch supplementary survey 2,147 square miles.

Triangulation.—6,095 square miles.

The area includes 2,506 square miles reported as triangulated, but really only reconnoitred in 1928-29.

Traversing.—270 square miles (116 linear miles).

126. Field work was organized as follows:—

Camp (1).—Mr. J. McCraken (Class II), with an average strength of 20 surveyors, carried out original surveys on the scales of ½ inch and 1 inch to 1 mile and supplementary surveys on the scale of 1 inch to 1 mile of 1,908 square miles in the Jalpaiguri and Darjeeling districts of Bengal and in Bhutān and Sikkim. The portion of this camp's area falling in the plains comprised the Bengal Duārs and consisted entirely of Government forests and tea gardens. The Himālayan foot-hills in Bhutān, which are very rugged, rise from 800 feet at the frontier to over 12,000 feet above the sea-level in less than 15 miles.

Camp (2).—Mr. H. H. Creed (Class II), with an average strength of 14 surveyors, carried out original and supplementary surveys on the scale of 1 inch to 1 mile of 891 square miles in the Jalpaiguri and Darjeeling districts of Bengal and in Bhutān, Sikkim and Nepāl. Survey for the Darjeeling Guide map was also commenced on the scale of 6 inches to 1 mile and 2·6 square miles completed. The area of this camp's work comprised both hills and plains, covered by tea gardens and Government forests.

Camp (3).—Mr. Moti Lal Roy, (U. S. S.), with an average of 13 surveyors carried out supplementary surveys on the scale of 1 inch to 1 mile of 1,174 square miles in the Jalpaiguri and Rangpur districts and Cooch Behār State, Bengal. The camp's area consisted entirely of highly cultivated plains.

Triangulation.—Triangulation in sheets 78 A/4, A/8, A/12 and A/16 in the Darjeeling district of Bengal and Sikkim, Bhutān and Nepāl States was carried out by Mr. Creed (Class II), Mr. S. C. Mukherjee, (U. S. S.), and

surveyors Muhammad Rashiduddin and Hari Datta II and points provided by the end of January for the plane-tabling carried out in the same season. Triangulation in sheets 78 B/1 and B/5 in the Darjeeling and Jalpaiguri districts of Bengal was carried out by surveyors Muhammad Rashiduddin and Abdus Salam. Triangulation in sheets 79 M/9, M/10, M/13 and M/14 in Tripura State of Bengal was carried out by Mr. Hari Singh, (U. S. S.). Triangulation in sheets 83 D/4, D/8, D/12 and D/16 and 83 H/3, H/4, H/7 and H/8 in Tripura State of Bengal, Cāchār district, Lushai Hills and Manipur State of Assam and in the Chin Hills of Burma, was carried out by Mr. S. C. Chatterjee, (U. S. S.). Triangulation in sheets 84 A/1, A/2, A/5 and A/6 in Tripura State and Chittagong Hill Tracts of Bengal and Lushai Hills of Assam was carried out by Mr. Hari Singh, (U. S. S.) and surveyor Ilahidad Khan.

Traversing.—One traverser *viz*:—Raja Ram Panday carried out 116·4 linear miles of traversing in sheets 78 B/4 and B/8 in the Dinājpur district of Bengal, and Purnea district of Bihār and Orissa.

Forest surveys.—No 4-inch surveys were carried out owing to lack of funds. 4-inch enlargements of the 1-inch surveys however may be supplied to the Forest Department, provided funds are allotted for the purpose. The 1-inch survey included 546·9 square miles of reserved forests in the Jalpaiguri and Darjeeling districts of Bengal.

Miscellaneous.—By the courtesy of the Nepāl, Bhutān and Sikkim *Durbārs* our plane-tablers were able to enter their territories and map a large area (1,039 square miles) of little known country.

Conditions in the area of survey were very diverse. In the jungle areas of the plains, work was held up at times by wild animals, one surveyor having his camp demolished by a rogue elephant. In the higher hills of the Nepāl, Bhutān and Sikkim portions, unusually severe weather conditions retarded the work considerably.

The supplementary surveys were carried out on blue prints of the preliminary editions of about 1922-25, which were themselves compiled from Revenue maps 30 or 40 years old. The blue prints however were found to be of very little help and these surveys, though classed as supplementary, partook of the nature of original surveys.

The health of the party in general was bad during the months of November, December and January owing to malaria in the Bengal Duārs' area and, later on, much trouble was caused by frostbite at the higher altitudes of the Himālayan foot-hills. One U. S. officer and one surveyor had to return to recess owing to illness which rendered them unfit for field work. There were three deaths from pneumonia and malaria, and one case of insanity among the *khalāsis*. Several of the latter deserted owing to the cold climatic conditions in the hills.

127. Recess duties.—Fair-mapping consisting of eleven 1-inch sheets and one ½-inch sheet was divided into two sections under Messrs. McCraken and Creed, assisted by Messrs. Suresh Chandra Chatterjee, Moti Lal Roy, Muhammad Siddik and Hari Singh, and was completed before the end of recess.

Mr. S. C. Mukherjee 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.

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

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

No. 10 Party.—Topography on the scales of 1 inch and 4 inches to a mile in sheets 83 P and 85 I; triangulation and traversing in advance.

No. 11 Party.—Topography on the scales of ½ inch and 1 inch to a mile in sheets 83 N, 85 O, and 85 P; triangulation and traversing in advance.

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

130. *Training.*—One probationer in the Class II Service was transferred from the Southern Circle in May 1930, and received training in No. 11 Party. Ten new pupils were entertained during the year, four pupils were discharged as unlikely to become efficient surveyors.

No. 10 Party.

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

131. General.—After working down the Arakan coast and in the Irrawaddy Delta for 6 years, the party again moved to Upper Burma and resumed the work in the basin of the Chindwin, abandoned in 1923. Eight sheets, however, had still to be surveyed in Lower Burma to complete the programme there.

A total area of 3,600 square miles was surveyed in the Upper Chindwin, Katha, Minbu, Myitkyina, Sandoway and Thayetmyo districts, in sheets 83 P and 85 I.

Field head-quarters were in Banmauk, Katha district; field work commenced about the 15th November and closed during the first week in May.

The programme consisted of 1,367 square miles of original survey and 2,230 square miles of revision survey on the scale of 1 inch to a mile; also 0·5 square miles of original and 2·5 square miles of supplementary forest survey on the scale of 4 inches to a mile. The original surveys were in sheet 83 P, and the revision and forest surveys in sheet 85 I. 533 miles of linear traverse for 1-inch and ½-inch surveys were run in the Upper Chindwin district in sheets 83 P and O, and 1,200 square miles were triangulated for ½-inch survey in the Upper Chindwin and Myitkyina districts in sheet 83 O.

132. Field work.—The field strength of the party was 2 Class II, 5 Upper Subordinate and 33 Lower Subordinate officers. The work was distributed as under:—

Camp (1).—Mr. F. E. R. Calvert (Class II), with 2 Upper Subordi-

nate officers, 14 surveyors and 4 pupils carried out 2,233 square miles of revision survey on the scale of 1 inch to a mile. 3 pupils were also attached from No. 21 Party and No. 7 Drawing Office for instruction.

Camp (2).—Mr. H. M. Critchell (Class II), with 1 Upper Subordinate officer, 8 surveyors and 1 pupil carried out 1,367 square miles of original survey on the scale of 1 inch to a mile.

The areas surveyed were covered with dense jungle, with occasional small patches of cultivation. In sheet 85 I, the south-west portion of the work lay across the main ridge of the Arakan Yomas, over 4,000 feet above sea level, but the greater part of the work in this area was among hills little over 1,000 feet in height. Till the end of January a great deal of clearing was necessary and progress was slow, but with the falling of leaves and lengthening of the days in the spring, work became much more rapid, and the out-turn of camp (1) during March was twice that during December. In sheet 83 P there were hills to the N.E. and S.W. of the area, but the remainder was flat or consisted of low hills, and much plane-table traversing was necessary.

Camp (3).—Mr. A. K. Sen Gupta (U.S.S.), with 5 traversers and 1 computer, ran 553 linear miles of traverse south-west of Homalin and in the entirely unsurveyed and practically unknown area between the Uyu and the Chindwin rivers, north-east of Homalin. Work was greatly hampered by the absence of any exact information about the latter area. Part of it had to be triangulated while traversing was going on, and until the triangulator had completed his reconnaissance, it was impossible to give definite orders to the traversers.

133. Miscellaneous.—The Mindon and Pani Chaung valleys of Thayetmyo district lived up to their reputation of being exceedingly unhealthy. During the first two months of the season there was a great deal of malaria, especially amongst *khalāsis*. In the pupils' camp, at one time it was only possible to collect enough men out of five squads to enable one pupil to work; and every pupil had at least one bad attack of fever. Camp head-quarters had eventually to be moved from Mindon. After January, when the country had dried up, there was little sickness anywhere.

Surveyors' squads each consisted of two Hazāribāgh *khalāsis* and three Kachins. Traversers were provided with squads of Kachins for transport. In camps (2) and (3) the Kachins were troublesome and unsatisfactory. This is attributable to the enlistment of a poor type from round Myitkyina rather than men from the hills. Surveyors in camp (2) were supplied with mule transport, but as roads were better and supplies more plentiful than anticipated, this was found an unnecessary expense and the muleteers were paid off after the minimum time allowed by contract.

134. Recess duties.—The party was organised into three drawing sections and a computing section, under Messrs. Munshi Lal (Class II), Critchell (Class II), A. K. Sen Gupta (U.S.S.) and Calvert (Class II), respectively. The whole area of 1-inch survey was fair-mapped on the scale of 1½ inches to a mile; the 4-inch forest work was fair-drawn on the scale of survey.

No. 11 Party.

Officer in charge:— Major O. Slater, M.C., R.E., to 1-11-29.
Mr. G. E. R. Cooper, from 2-11-29 to 27-11-29.
Lt.-Colonel F. J. M. King, R.E., from 28-11-29.

135. General.—Field head-quarters opened at Rangoon on the 26th November and surveys were continued in the Bassein, Hanthawaddy, Insein, Ma-ubin, Myaungmya, Pyapon and Tharrawaddy districts of Burma.

Triangulation and traverse operations were carried out in advance in the Bassein, Henzada, Insein, Ma-ubin and Tharrawaddy districts to provide data for the surveys mentioned above.

Triangulation and traverse operations for next season's work were carried out in the Henzada, Pegu, Prome, Tharrawaddy, Thayetmyo and Toungoo districts.

136. *Personnel.*—The strength of the party at the beginning of the field season was 3 Class II, 4 Upper Subordinate and 30 Lower Subordinate officers.

Of the above, Mr. M. R. Nair (Class II) was taken ill at the beginning of the field season and had to be sent on leave with a view to transfer to a better climate; he was temporarily replaced by Mr. L. M. Ganguli (U. S. S.) from No. 7 Drawing Office.

The party had the great misfortune to lose Mr. G. E. R. Cooper (Class II), a most capable and energetic officer with a long experience of Burma, who died of jaundice and heart-failure on March 11th: he was replaced later by Mr. P. A. Thomas (Class II) from the Frontier Circle.

137. Areas surveyed.—A total area of 5,067 square miles of *revision* survey was completed on the scale of 1 inch to 1 mile.

138. Field work.—The party was organized as follows:—

Camp (1).—Mr. G. E. R. Cooper (Class II), with 12 surveyors completed 2,513 square miles of 1-inch revision survey in sheets 85 O and P.

On the death of Mr. Cooper, camp (1) was taken over by Mr. A. F. Murphy (Class II) from camp (2).

Mr. P. A. Thomas (Class II) joined the party towards the end of the field season and was posted to camp (1) as assistant camp officer.

The country surveyed consisted, for the most part, of flat deltaic alluvium, intensively cultivated with paddy and intersected by numerous creeks and rivers; the north-east part of the area, however, included a portion of the western slopes of the Pegu Yoma, consisting mainly of densely forest-clad hills.

Transport, at the beginning of the season, was mainly by *sampan* and the steamers of the Irrawaddy Flotilla Co., Ltd., while the camp officer was provided with a Government launch; later on, however, when the country dried up, cart transport was utilised.

Camp (2).—Mr. A. F. Murphy (Class II), with 12 surveyors completed an area of 2,554 square miles of 1-inch *revision* survey in sheets 85 O and P.

Mr. Hayat Muhammad, K.S., (U. S. S.) took over charge of this camp on the transfer of Mr. Murphy to the charge of camp (1).

The country surveyed was flat paddy land similar to that already described; the camp officer was provided with a Government launch for the first part of the season.

Surveyor Narayan Singh carried out ½-inch original survey of 150 square miles in sheet 83 N, while accompanying an expedition in the Nāgā Hills.

139. *Triangulation and Traversing.*—An area of 1,700 square miles was triangulated and traversed by Messrs. Hayat Muhammad, K.S., (U. S. S.), P. C. Sen Gupta (U. S. S.), Khan Muhammad (U. S. S.) and A. K. Talapatra (U. S. S.) in sheet 85 O for work during the season under report.

For next season's work an area of 5,224 square miles was triangulated and traversed by the above 4 U. S. S. officers together with Mr. L. M. Ganguli (U. S. S.) and surveyor Ikbal Muhammad in sheets 85 N and O, while 27 linear miles of traverse for 4-inch forest survey, and 17 linear miles of forest boundary traverse were completed by surveyor Bishan Dutt.

Progress on triangulation and traversing was not as rapid as was hoped, and both camp officers were considerably harassed by having to do computations in addition to carrying on their own work. Mr. Hayat Muhammad, K.S., moreover had to be taken off triangulation to take charge of camp (2) after Mr. Cooper's death, while haze continually hampered the rest of the work; notwithstanding these difficulties more than sufficient work has been completed for next field season.

140. *Special Survey.*—A special survey of the Twante, Twante Ridge and Wanetchaung rubber estates belonging to the Burma Rubber Estates, Ltd., was carried out on payment. The area amounted to 3,215 acres, and the scale adopted was 8 inches to 1 mile with contours at 10 ft. vertical interval.

141. Recess duties.—The fair-mapping was divided into two sections under Messrs. Murphy and Thomas. The whole area surveyed, comprising 18 sheets, was fair-mapped on the scale of 1½ inches to a mile.

A computing section under Mr. P. G. Burby (Class II), who joined the party at the beginning of recess, completed the triangulation and traverse computations.

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's work lay in degree sheets 83 L, O and P.

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

Mr. L. B. Fitz-Gibbon (Class II), triangulating, and in charge of the traverse camp of 5 traversers and 2 computers.

Mr. G. A. Norman, M.B.E., (Class II), *Camp (1)*, with one U. S. officer and 8 surveyors.

Mr. A. V. Dickson, (Class II), *Camp (2)*, with 10 surveyors.

Mr. Bhamba Ram (U. S. S.), *Camp (3)*, with 5 surveyors.

Mr. G. S. Bagchi (U. S. S.) and 1 surveyor traversing in sheet 83 P, from the end of February.

144. Areas surveyed.—The party surveyed a total area of 288 square miles on the scale of 4 inches to 1 mile in the Mansi Division of the Northern Forest Circle, and the Upper Chindwin Division of the Chindwin Forest Circle.

145. Field work.—*Camps (1) and (3)* under Messrs. G. A. Norman and Bhamba Ram respectively, worked in the Mansi Forest Division, and surveyed 142 square miles of the Nankyin and Uyu reserves.

Camp (2) under Mr. A. V. Dickson worked in the Upper Chindwin Forest Division and surveyed 138 square miles of the Thawun and Thaungdut reserves together with 8 square miles of unclassed area near the reserves.

The exclusion boundary of the Mode Reserve was inserted on the map of this reserve published in 1922, by plane-table traverse.

4 surveyors of camp (1) and the whole of camp (3) were transferred to camp (2) by the 25th March.

146. The area surveyed by camp (1) lay on the north-western slopes of the watershed carrying the common boundary of the Upper Chindwin and Kathā districts. The country consisted of precipitous hills, ranging from 500 to 3,500 feet, all densely forested with no communications within the reserve.

The area surveyed by camp (2) lay on the eastern slopes of the watershed between the Chindwin and Kabaw valleys. The country varied from the low, heavily forested foot-hills, to the steep and less densely wooded crest of the range, between altitudes of 400 and 4,500 feet.

The area surveyed by camp (3) was on the southern slopes of the Taungthonlon group in the apex formed by the northern limit of the Kathā district boundary, and consisted of long spurs descending southwards to the Chaunggyi, a main tributary of the Uyu river. The whole area was densely jungle-clad and lay between altitudes of 600 and 3,000 feet.

147. *Triangulation.*—An area of 275 square miles was triangulated by Mr. L. B. Fitz-Gibbon in degree sheets 83 L and P, including observations at 29 stations. This triangulation was a continuation of that done in 1928-29, and completed the Thaungdut reserve; its main purpose was to tie down the theodolite traverses. The area triangulated lay chiefly in the southern portion of the Thaungdut reserve on the eastern side of the watershed between the Chindwin and Kabaw valleys; the country comprises densely wooded, low undulating and high precipitous ground, rising from 400 to over 3,500 feet.

This triangulation was extended across the Chindwin river to the Paungbyin reserve on its east bank and also continued further inland to the Sanda reserve, to provide connections there for the theodolite traversing.

Some supplementary triangulation in the Thawun and Thaungdut reserves, in the area triangulated by the party in 1928-29, was carried out by Mr. A. V. Dickson to fix additional points for surveyors doing the detail survey.

All the triangulation is based on the Manipur Longitudinal Series and falls in the Chindwin Forest Circle.

148. *Traversing.*—175 linear miles of forest boundary theodolite traversing and 153 linear miles of interior and connection traversing were carried out by the traverse camp in the Thaungdut, Thaungdut Extension, Paungbyin, Sanda and Sanda Extension reserves, to provide data for the ensuing field season. The area traversed falls in sheets 83 L and P in the Upper Chindwin Division of the Chindwin Forest Circle.

In addition to the above, 43 linear miles of forest boundary theodolite traversing and 31 linear miles of interior and connection traversing were carried out in the Namma reserve of the Mansi Division of the Northern Forest Circle. This work was begun about the end of February.

149. *Miscellaneous.*—The party took the field very early in November and head-quarters opened at Homalin on the 15th of the same month. Camps (1) and (3) took the field during the last week of October, marching to their respective areas from Indaw (Burma Railways). They had arrived in their areas by the 15th November. Camp (2) and the traverse camp which accompanied the head-quarters reached their areas 10 days or so later.

The whole of the Kachin personnel marched from Indaw to Homalin.

The health of the party was satisfactory. The Hazāribāgh *khalāsis* were inoculated against cholera at Calcutta prior to embarkation for Burma, and the Kachins were medically examined at Myitkyinā at the time of recruitment, and inoculated against cholera soon after. These precautions were successful in preventing any outbreak of the disease amongst the inferior establishment on the long journey to the field.

The party had only 2 deaths during the season. One Hazāribāgh *khalāsi* died from epileptic fits and one Kachin of typhoid fever. In March and April, there were some cases of malaria. During the dry season the water in the Thaungdut reserve was scanty and bad. Forest fires were also frequent and added much to the discomfort of surveyors.

150. Recess duties.—The fair-mapping was divided between two sections under Messrs. G. A. Norman and A. V. Dickson.

The computation work was under Mr. L. B. Fitz-Gibbon. The fair-mapping and computations of all the field work were completed during the year.

X.—MISCELLANEOUS SURVEY REPORTS.

151. 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 8-10-29 and from 28-10-29.
,, L. Williams, M.B.E., from 9-10-29 to 27-10-29.

152. The high precision levelling done by this party is described in para. 32. In future all tertiary levelling required in connection with irrigation and other projects will be carried out by the topo. circle concerned.

Secondary levelling (*a*) for the E. I. Railway was carried out along certain sections (totalling 644 miles) in the Howrah, Dinapur and Asansol Divisions, and (*b*) for the Commissioners for the Port of Calcutta from Uttarpāra to Kālna (61 miles) along the west bank of the Hooghly river.

Training School, Dehra Dūn.

Officer in charge.—Mr. L. Williams, M.B.E.

153. *Class I probationers.*—Lieut. R. C. N. Jenney, R.E., joined the Training School on first appointment on the 2nd January 1930. His course of instruction in the field consisted of plane-tabling on the scales of 1 inch and 2 inches to a mile, theodolite traversing and a triangulation programme including observations at 9 hill stations.

The recess was devoted to instruction in fair-mapping, computations, levelling and astronomical work.

He was also attached for short periods to the various units of the Geodetic Branch in order to acquire a knowledge of the work being done by the different field parties and offices.

154. *Class II probationers* (first year).—Six probationers were appointed in the third week of November 1929 and a seventh on the 14th January 1930. They were put through a course of plane-tabling during which they completed an area of 4 square miles on the scale of 4 inches to a mile, and about 10 square miles on the scale of 2 inches to a mile. Each probationer also observed at about half a dozen stations in connection with the triangulation programme.

During the recess they were instructed in all branches of survey work.

MODERN TOPOGRAPHICAL SURVEYS AND COMPILATION

on scales ranging from 4 inches to 1 mile to $\frac{1}{8}$ inch to 1 mile.