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BRIGADIER ROBERT HENRY THOMAS, C.S.I., D.S.O.
SURVEYOR GENERAL OF INDIA, 1928-33.

SURVEY OF INDIA

GENERAL REPORT

1933



From 1st October 1932
To 30th September 1933

PUBLISHED BY ORDER OF
BRIGADIER H. J. COUCHMAN, D.S.O., M.C.
SURVEYOR GENERAL OF INDIA.

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PREFACE

THE HISTORY AND WORK OF THE SURVEY OF INDIA.

The first authoritative map of India was published by D'Anville in 1752, when the exploration of the then unknown India was still largely in French hands. It had been compiled from routes of solitary travellers and rough charts of the coast.

The Survey of India may be said to have been founded in 1767—ten years after the battle of Plassey—when Lord Clive formally appointed Major James Rennell the first Surveyor General of Bengal, at that time the most important of the East India Company's possessions, though there were earlier settlements in Madras and Bombay.

Rennell's maps were originally military reconnaissances and latterly chained surveys based on astronomically fixed points, and do not pretend to the accuracy of modern maps of India based on the rigid system of triangulation commenced at Madras in 1802 and since extended over and beyond India. Even now however the *relative* accuracy of these old maps makes them valuable in legal disputes, as for instance in proving that the holding of a Bengal landowner was a river area at the time of the Permanent Settlement of 1793, so that he is debarred from its benefits.

From these beginnings, this department has gradually become primarily responsible for all topographical surveys, explorations and the maintenance of geographical maps of the greater part of Southern Asia, and also for geodetic work.

Geodesy means the investigation of the size, shape and structure of the earth, and the geodetic work of the department consists of primary (or geodetic) triangulation, latitude, longitude and gravity determinations. From these the exact "figure" of the earth is obtained, whereby points fixed by triangulation can be accurately located on its curved surface. This system of fixed points holds together all topographical and revenue surveys, and the existence of such a system from the early days of the department has obviated the embarrassments caused in other countries where isolated topographical surveys have been started without a rigid framework, with the inevitable result that they could not be fitted together.

A geodetic framework is therefore essential in any large survey, but there are a number of other activities, all of them ultimately utilitarian, which can be suitably combined with its execution, and the following are some of those which are carried out in India:

- Precise levelling for the determination of heights;
- Tidal predictions and publication of Tide Tables for fortyone ports between Suez and Singapore;
- The Magnetic survey;
- Observation of the direction and force of gravity;
- Astronomical observations to determine latitude, longitude and time;
- Seismographic and meteorological observations at Dehra Dūn.

Indian geodesy has disclosed by far the largest known anomalies of gravitational attraction in the earth's crust, which have recently led to a reconsideration of the whole theory of isostasy.

Topographical Surveys.—In the past this department used to carry out the large scale revenue surveys for most of India, and was still conducting this work for Central and Eastern India and Burma in 1905.

Though revenue survey is primarily a record of individual property boundaries and is unconcerned with the surface features, ground levels and exact geographical position essential to a topographical survey, it was on the whole found economical to carry out both surveys together.

By 1905 however all the Provinces had taken over the revenue surveys, for which they had always paid, and the Survey of India was enabled to concentrate its energies on a complete new series of modern topographical maps in several colours on the 1-inch to 1-mile scale.

This new series had been rendered necessary by the natural demand for more detailed information to be shown on maps, especially as regards the portrayal of hill features by contours, proper classification of communications and—more recently—air traffic requirements.

It was intended that this 1905 survey should be completed in twentyfive years, and then revised periodically every thirty years. Owing however to the war and more recent retrenchments, only two thirds of the programme had been completed by 1932, in spite of a reduction of scale for the less important areas.

Although new surveys covering from thirty to sixty thousand square miles—an area comparable to that of England—are carried out every year, the maps of a large part of the country are still over 50 years old, printed mostly in black only, and have hill features shown by roughly sketched form lines or hachures; such changes in town sites, canals and communications as have been embodied in them have not been surveyed on the ground, but entered from outside information.

Owing to the serious financial situation in 1931, the establishment of the department was severely cut down and its annual expenditure halved, in consequence of which the modern survey of India cannot now be completed before 1950.

The obsolescence of the present series of modern maps of India is shown in the second index map at the end of this report.

Large Scale Surveys.—Surveys and records of international, state and provincial boundaries have always formed an important item of topographical work, and in recent years numerous Guide Maps have been published of important cities and military stations where the 1-inch to 1-mile scale is inadequate.

Miscellaneous.—While expending on topographical and geodetic work all funds allotted by Imperial Revenues, the department is prepared to undertake or aid local surveys, on payment by those concerned, such as

Forest and cantonment surveys;

Riverain, irrigation, railway and city surveys;

Surveys of tea gardens and mining areas, with such control levelling as is necessary for these operations.

Administrative assistance is also given, and executive officers lent, in aid of the revenue surveys of various Provinces and States.

The Printing Offices at Calcutta and Dehra Dūn also carry out work for other Government departments, such as special maps, illustrations for Reports and all diagrams for patents.

The Mathematical Instrument Office of this department assists all Government departments, as well as non-officials, by maintaining a high standard of instrumental and optical equipment and by manufacturing and repairing instruments which would otherwise have to be imported from abroad.

Military Requirements and Air Survey.—The department is also responsible for all survey operations required by the army, and is in a position to meet the rapidly increasing complexity of modern military requirements, especially in air survey.

In view of its high military importance, air survey work for civil purposes is receiving all possible encouragement and assistance, and the latest methods of mapping from photographs taken from the ground are being studied experimentally.

The flying and photography for air mapping done by this department are at present carried out by the Royal Air Force or the Indian Air Survey Company, a commercial firm with headquarters at Dum Dun.

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 four Directors, one for the Map Publication and other technical offices at Calcutta, and three for three of the five Survey of India Circles into which the country is divided; the other two Circle areas (covering Burma and South India) are administered personally by the Surveyor General.

Of the three Circle Directors, one also administers the Geodetic Branch at Dehra Dūn in addition to his topographical survey Circle.

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GLOSSARY.

Scales are referred to as follows:—

- (i) by their representative fraction, e.g. "1/25,000".
- (ii) for scales which are multiples of 1/1,000,000—"1/M scale", "1/6M scale" &c., which mean "1/1,000,000 scale" &c., "1/6,000,000 scale" &c.,
- (iii) for scales smaller than 4 miles to one inch—"50-mile scale", "8-mile scale" &c., which mean "scale of 50 miles to one inch" "scale of 8 miles to one inch" &c.,
- (iv) for scales of and larger than 4 miles to one inch—"¼-inch scale", "½-inch scale", "4-inch scale", "16-inch scale" &c., which mean "scale of ¼ inch to one mile" &c., &c.

Serial numbering of Survey of India maps. The system of numbering will be evident by a reference to the Indexes at the end of this report, e.g.

Sheets 65, 78 &c. are sheets on the 1/M scale;

Sheets 65K, 78F &c. are ¼-inch sheets;

Sheets 65K/N.W., 78F/S.E., &c. are ½-inch sheets;

Sheets 65K/1, 78F/16 &c. are 1-inch sheets.

Abbreviations.—U. S. S. denotes Upper Subordinate Service.

L. S. S. denotes Lower Subordinate Service.

U. S. Officer denotes Upper Subordinate Officer.

L. S. Officer denotes Lower Subordinate Officer.

P. L. O. denotes Photo.-Litho. Office (Calcutta).

P. Z. Section denotes Photo.-Zinco Section (Dehra Dūn).

D. O. denotes Drawing Office.

SURVEY OF INDIA

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INTRODUCTION AND SUMMARY.

1. **Annual Reports** will be published, with effect from this report of 1933, in two separate volumes as follows:—

Geodetic Report.

General Report.

Both of these reports are for the survey year ending 30th September, with the exception of *Part 4* of the *General Report* (Map Publication and Office Work) which is for the financial year up to 31st March.

The Geodetic Report includes full details of all scientific work.

This General Report only gives brief abstracts of the *Geodetic Report* (*vide Part 2* in the Table of Contents), but gives complete reports of the survey operations of the ordinary field parties and detachments. Abstracts II and IV (*vide* Table of Contents) summarize these latter reports and enable the reader to look up such portions as may concern him.

The first Index Map appearing at the end of this Report shows the progress of modern topographical surveys and compilation. Maps of sorts are of course available for all parts of the Indian Empire, but some of them are very old, and all previous to 1905 were based on the old longitude of 1815 (which was over 2 miles out) and are therefore excluded from the Index Map.

Part 4 (Map Publication and Office Work), with the last five INDEX MAPS at the end of this report, shows the progress of map publication on all scales, and contains 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 obsolescence of the modern maps of India is shown in the second INDEX MAP at the end.

2. **General.** Brigadier R. H. Thomas, C.S.I., D.S.O., made over charge of the office of Surveyor General to Colonel H. J. Couchman, D.S.O., M.C., and proceeded on leave preparatory to retirement for 6 months, from the 1st April 1933.

The post of Assistant Surveyor General was filled by Major H. R. C. Meade, I.A., throughout the year.

3. The total cost of the Department for the past financial year ending 31st March 1933, as compared with that of previous years, was as follows:—

	1930-31	1931-32	1932-33	REMARKS.
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>	
Gross actual cost ...	60,98,804(a)	49,86,863(b)	34,62,329 †	(a) Including Rs. 2,99,160 for English Charges (High Commissioner) on Stores, and loss or gain by exchange. (b) Including Rs. 1,80,760 for do. do.
Deduct receipts and credits	29,31,369	14,50,965	13,80,459 †	
Nett actual charges ...	37,67,435	35,35,898	20,81,870 †	† These figures are not final.
Total area of survey of all kinds completed during the year.	Square miles.	Square miles.	Square miles.	
	61,678*	37,924*	43,683*	* Vide page 15.

4. **Organisation.** The retrenched organisation described in para. 4 of last year's General Report was introduced with full effect during the year.

All the Indian Army Officers in the department, who were previously borne on the Supernumerary List, were restored to the Active List with effect from 27th July 1933. In future they will be required to qualify for army promotion.

The arrangements hitherto existing between the Survey of India and the Government of Assam, under which the latter paid one-fourth of the salary of the Director, Eastern Circle, in return for his supervision of local revenue surveys as Director of Surveys, Assam, were discontinued from the 18th May 1933.

Until 31st March 1936, when the new arrangements will be reconsidered, the Government of Assam will pay a contribution of Rs. 1,500 a year to the Survey of India for technical advice given by the Director to the Officer in Charge, Assam Traverse Party and Drawing Office, who will be responsible to the local Government for the conduct of provincial survey work.



Photo. by Capt. G. H. Osburnston, M.C., R.E.

LEONAK (SUKIM)
SOUTH EAST FACE OF THE "FLATTENED PEAK" (LEONAK PEAK).

The services of Mr. H. H. Creed were transferred to the Government of Assam from 1st May 1933, with a view to his appointment as Officer in Charge, Assam Traverse Party and Drawing Office.

From the 1st October 1932, the Officer in Charge, No. 5 Party, relinquished charge of the post of the Assistant Director of Surveys Central Provinces, and Rai Sahib N. C. Puri, B.A., (Class II), has been permanently transferred to serve as Survey Officer, Central Provinces. The Upper Subordinate Officer who was serving as Assistant Survey Officer to the local Government has also reverted to this department.

Henceforth the Officer in charge of the Survey of India Party working in the Central Provinces, or the Director concerned, will carry out general inspection of the local revenue surveys only when specially requested by the local Government.

5. Notable events of the Survey year.

Boundary Survey.—

CUTCH-MORVI BOUNDARY.—Mr. A. F. Murphy (Class II), No. 1 Drawing Office, and Surveyor Najmul Husain and 8 Khalasis from No. 1 Party proceeded to Rajkot on the 18th February 1933, in connection with the settlement of a boundary dispute between the States of Morvi and Cutch.

11 square miles of the disputed area were triangulated and surveyed on the 4-inch scale and traces sent to the Agent to the Governor General, Western India States, by the 14th May, on which date the party was disbanded.

TRIPURA STATE BOUNDARY.—Captain Osmaston surveyed and marked the positions of pillars of 31 miles of the undemarcated boundary between Tripura State and Chittagong Hill Tracts of Bengal. The civil authorities on both sides accepted the boundary demarcated (para. 89).

Exploration.—

Captain Osmaston, accompanied by three companions, made an expedition to North Sikkim whilst on a month's leave. The party left Gangtok on 3rd October 1932 and returned there on 24th. Captain Osmaston climbed to nearly 20,000 feet, obtained some new information about little known passes, and checked parts of survey sheet 77 D and 78 A and Marcel Kurzi's map of the Kanchenjunga *massif*, made during the international expedition of 1930. His results will be incorporated in the next edition of the above sheets.

Dr. deTerra has furnished results of the surveys carried out by Khan Sahib Afraz Gul Khān in Kashmir and Jammu in 1932, and these are being mapped.

The period of deputation of Surveyor Muhammad Ayub Khān, who accompanied Sir Aurel Stein in November 1931 in connection with his explorations in the Punjab and South Persia, has been extended by one year with effect from the 4th May 1933. This surveyor's ¼-inch reconnaissance in South Persia in 1932-33 is being incorporated in the maps of that area.

The results of Mr. H. St. J. B. Philby's compass traverse of 1932 in the Rub al Khāli were received from the Royal Geographical Society and are being incorporated in the 1/2M map of South-East Arabia.

The revised edition of "The Geography and Geology of the Himālaya" by Sir Sidney Burrard and Dr. A. M. Heron, was published (para. 26). The first edition of 1907 had been rendered out of date by recent explorations.

Khan Sahib Afraz Gul Khān, who retired on the 26th July 1933, was awarded in 1933 the Gill Memorial, for frontier and trans-frontier exploration and survey, by the Council of the Royal Geographical Society.

Surveys in Tribal Territory.—

A survey detachment, consisting of Mr. Muzaffar Husain, C.H., (U. S. S.) and 7 khalasis, accompanied the column operating in the Lower Mohmand country. The detachment was disbanded after 2 months' work on 3rd October 1933.

The following appreciation of the services of Mr. Muzaffar Husain was received from the Brigade Commander:—

"I have formed a very high opinion of him. He gets about the country in a marvellous way with a minimum of fuss or bother. He has never given the slightest trouble to me or my staff. On the contrary, he has always been most helpful to us and has given us much valuable information from time to time".

Two surveyors of No. 10 Party surveyed 753 square miles of unexplored Nāga tribal territory between Burma and Assam. Their relations with the inhabitants were excellent throughout, and their Military Police escorts were withdrawn at the end of January (para. 104).

Exercises and Manœuvres.—

Captain Angwin, R.E., took part in the Western Command War Game, 29th to 31st March 1933. Whilst the War Game was devoted mainly to the functions of the higher Command, survey problems were encountered and discussed and the employment of the survey organisation received consideration.

Air Survey.—

Air photography of 74 square miles of Tripura State, already surveyed last winter, was carried out as an experiment to find out, by the preparation of a comparative map, whether such photographs could be used to quicken up the field work in this very intricate and densely afforested country.

The accordance of the air survey with the ground survey proved so complete as regards outline, that it is intended to survey the outline of next season's work in Tripura State by air methods, leaving ground surveyors to enter hill features on the air survey compilations (para. 56).

Research was continued by No. 18 (Air Survey) Party, with a view to improving the accuracy of the determination of ground heights from air photographs (para. 56).

Tentative designs of air survey instruments have been constructed by the Mathematical Instrument Office among which are a tilt-recorder, a rigid head stereoscope and simple parallax-measurer (para. 57).

Deputation of Officers.—Owing to financial stringency, India withdrew from the International Union of Geodesy and Geophysics, and no official representatives of India were sent to the Lisbon conference of September 1933. Dr. deGraaff Hunter, C.I.E., M.A., sc.D., and Lt.-Col. Mason, M.C., R.E., of this Department, who were on leave pending retirement, attended the conference.

Lectures.—Major Glennie, D.S.O., R.E., while on leave in England, read a paper on "Crustal warping" at the Geophysical Meeting of the Royal Astronomical Society on 25th November 1932.

• *Adventures and Casualties.*—

The Surveyor General deeply regrets to announce the death of the following officers:—

Lieut. R. P. Buchanan, R.E., who died of cholera on the 4th May 1933 in his camp at Mahadeb Bāri in Tripura State.

Mr. G. B. Scott, C.I.E., who died at Bournemouth on the 20th November 1932. He spent 38 years of very distinguished service in the Survey of India, mostly on the North-West Frontier and in Afghānistān, and was also an authoritative writer on the tribes among whom he worked.

Mr. Rohini Kumar Talapatra, B.A., Sub-Assistant Superintendent, attached to No. 4 Party, who was killed at Loimora in Bāmra State on the 15th April 1933 by a wounded tiger which he was following up.

Mr. Shashi Bhushan Shome, late Head Geodetic Computer, on the 9th November 1932. He retired in 1904.

23 Lower Subordinates and 8 inferior servants died during the year under report.

Wild elephants interrupted No. 12 Party's field work in Tripura State, and the camp of the Director, Eastern Circle, was demolished one night and two khalasis injured. (para. 91).

Distinguished visitors.—Brigadier the Viscount Gort, V.C., C.B.E., D.S.O., M.V.O., M.C., Director Military Training, Army Headquarters and Group Captain B. E. Sutton, D.S.O., O.B.E., M.C., Commanding No. 1 (Indian) Group, Royal Air Force, visited the Office of No. 18 (Air Survey) Party at Peshāwar on the 15th March 1933.

6. Appreciations and Awards.

His Majesty the King, Emperor of India, has been graciously pleased to appoint Dr. J. deGraaff Hunter, M.A., sc.D., F.Inst.P. to be a Companion of the Most Eminent Order of the Indian Empire.

Major Glennie, D.S.O., R.E., has been elected a fellow of the Royal Astronomical Society of London.

In connection with the work of the "Afghān Boundary Party", the formation and disbandment of which was noticed in paragraph 5 of last year's General Report, the following is an extract from a confidential letter from Captain W. R. Hay, I.A., Officer on Special Duty (Foreign

and Political Department), to the Chief Secretary to Government, North-West Frontier Province:—

“Captain D. R. Crone, R.E., was in charge of the survey party and was ably assisted by Subedar Fateh Mohammad Khan.”

* * * * *

“Captain Crone and Subedar Fateh Mohammad Khan worked at high pressure to get the boundary maps ready in time and were busy till 3 A.M. on the night of July the 10/11th.”

In connection with the work of the three surveyors of No. 6 Party, whose deputation to foreign service in ‘Irāq was noticed in paragraph 5 in last year’s General Report, His Majesty’s Minister at Baghdād has written to the Government of India:—

“The ‘Irāq Government further desire that their thanks be conveyed to the Government of India for the loan of these surveyors and for the excellent work done by them, particular mention being made of the helpful work of Surveyor M. Ghulam Mohiuddin.”

The Municipal Board of Jhānsi have specially acknowledged the valuable work of a detachment of No. 20 (Cantonment) Detachment in connection with a large scale survey of Jhānsi City during last field season.

The United States Coast and Geodetic Survey have adopted and acknowledged a system of preparing star programmes for Talçott latitude observations which was devised by Mr. R. B. Mathur, B.A., of the Geodetic Branch. The system is described in Geodetic Report, Vol. VII.

Mathematical Instrument Office.—At the request of the Government of ‘Irāq, one of their employees, Mr. Abdul Sattar, received training for about 6 months in the Mathematical Instrument Office in the repairs of optical instruments generally and in No. 7 Dial Sights in particular.

Captain A. F. F. Thomas, D.A.D.O.S. (P), visited the Mathematical Instrument Office in January 1933 and discussed the stock of mathematical instruments and repair programme, in so far as it relates to supplies to the Army in India.

The grinding of accurate spirit level bubbles has been undertaken in the Mathematical Instrument Office with satisfactory results, and the scope of this work is now being extended with a view to reducing Home Indents.

The Director of Artillery and the Inspector of Guns, Cossipore, visited the Mathematical Instrument Office in December 1932 and discussed the manufacture and repair of instruments.

Four survey pattern clinometers have been adapted, at the instance of Captain Gemmell, in order to check bubble adjustment by means of reverse readings. This greatly simplifies the process of bubble setting, but is no check on angle readings. They are being tested during the 1933-34 field season.

A tilt indicator attachment for the F. 8 Camera, designed by Captain Crone, is under construction. The object of this is to photograph two small portions of the horizon on opposite edges of the same negative as the vertical photograph.

7. Personnel.—Casualties, retirements, &c., were as follows:—

Class I Officers.—Brigadier R. H. Thomas, C.S.I., D.S.O., Dr. J. de Graaff Hunter, C.I.E., M.A., Sc.D., F.Inst.P., Lt.-Col. R. Foster, I.A., and Lt.-Col. A. H. Gwyn, I.A., were granted leave preparatory to retirement.

Lt.-Col. L. C. Thuillier, I.A., and Mr. H. B. Simons retired.

Lt.-Col. Campbell, D.S.O., R.E., confirmed as Director and promoted to the rank of Colonel.

Major Mason, M.C., R.E., promoted to be Lieut.-Colonel.

Messrs. P. Simpson and C. H. Tresham, V.D., confirmed as Superintendents.

Mr. D. K. Rennick, M.B.E., appointed as temporary Superintendent.

Lieut. R. C. N. Jenney, R.E., confirmed as Assistant Superintendent.

Lieut. R. P. Buchanan, B.A., R.E., died of cholera in the field.

Class II Officers.—Messrs. F. B. Kitchen, Munshi Lal, B.A., C. O. Picard, H. H. P. Butterfield, A. V. Dickson, D. N. Vasudeva, B.A., S. M. Murtaza, B.A., and Khan Sahib Afraz Gul Khan retired.

Mr. H. H. Creed was transferred to Assam Government and Rai Sahib N. C. Puri to Central Provinces Government.

Four Probationers in Class II service were confirmed.

Miscellaneous appointments.—Messrs. A. Francis and Sadiq Ali, C.H., retired and Mr. A. R. Mukherji and Staff Sergeant A. Couzens died.

Upper Subordinate Officers.—Khan Sahib Md. Husain Khan, and Messrs. Md. Husain, Sajawal Khan, C.H., V. R. E. Nayadu, M. L. Roy, and Qadir Dad retired.

Messrs. P. S. Venguswami and G. P. Rao, M.A., died.

Mr. R. K. Talapatra, B.A., was killed by a tiger.

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

8. The prime duties of the Survey of India are geodetic, topographical and geographical, but the department is also developing co-operation with local survey agencies, with a view to mutual economy, and is now doing a considerable amount of miscellaneous outside work on payment, besides advising and assisting Provincial Governments with local and settlement surveys as required.

The following abstract shows the nature and *locale* of the field operations actually carried out by the Department during the past year, grouped under the following sub-heads:

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

9. N. W. F. Province.

Air survey in Tirāh and Mohmand Tribal territory, in Dir Swāt and Chitrāl Agency and in Kohāt and Peshāwar districts (pp. 37, 38).

10. Baluchistān.

Topographical surveys. Revision surveys in Bolān Pass, Loralai, Quetta-Pishin. Sibi and Zhob districts and in Kalāt State. (pp. 35, 36).

11. Punjab, Punjab States and Delhi.

Topographical surveys in Delhi Province, in Gujrāt, Gurgaon, Hissār, Jhelum, Kāngra, Montgomery, Multān, Muzaffargarh and Rohtak districts and Bahāwalpur, Chamba, Dujāna, Jind and Lohāru States. (pp. 34, 39).

Correction surveys in Attock, Dera Ghāzi Khān, Gujrānwala, Gujrāt, Jhelum, Muzaffargarh and Shāhpur districts (p. 34).

Town surveys in Lahore (p. 34).

Framework. Triangulation to control traversing in Karnāl district and Patiāla State. (p. 39).

Triangulation in Bahāwalpur State (p. 35).

Rectangulation to 3,000 acres in Hissār, Karnāl and Rohtak districts and in Jind and Patiāla States. Rectangulation to 25 acres in Delhi Province, in Gurgaon, Hissār and Rohtak districts and in Dujāna and Jind States (p. 39).

Levelling. Secondary levelling for the Bhakra Dam Irrigation Project in the Ambāla, Karnāl, and Rohtak districts and in Jind, Kalsia, Nābha and Patiāla States (p. 55).

Tertiary levelling in Delhi Province, in Gurgaon, Hissār and Rohtak districts and in Dujāna, Jind and Lohāru States (p. 40).

12. Rājputāna Agency, Ajmer-Merwāra and Bikaner.

Topographical surveys in Ajmer-Merwāra Province and in Bikaner, Jaipur, Jodhpur, Kishangarh, Shāhpura and Udaipur States (p. 41).

Framework. Triangulation in Būndi, Jhālāwār, Jodhpur, Kotah, Shāhpura, Sirohi and Udaipur States (p. 41).

Triangulation in Bikaner State (p. 35).

Levelling. High precision levelling to connect the new Standard Bench Mark (Type P) at Bikaner with the old Indian level net (p. 13).

13. Central India Agency and Gwalior.

Framework. Triangulation in Indore and Mandasor States (p. 41).

14. United Provinces.

Air surveys. Re-survey in Bahraich and Sitapur districts (page 67, para 117).

Cantonment and City surveys. Re-survey of Jhānsi and Meerut Cantonments and original survey of Jhānsi Municipal area. (p. 42).

Framework. Traversing for cantonment surveys of Allahābād and Fyzābād (p. 43).

Levelling for cantonment surveys of Allahābād and Fyzābād (p. 43).

15. Central Provinces.

Topographical surveys in Bhandāra, Chānda and Drug districts (p. 47).

Forest surveys. Some reserved forests in Bhandāra and Chānda districts were included in the ordinary survey (p. 47).

Framework. Triangulation and Traverse in Bhandāra, Drug and Raipur districts (p. 47).

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

Boundary surveys in Cutch and Morvi States (pp. 3, 41).

17. Eastern States Agency

Topographical surveys in Athmallik, Bāmra, Bastar, Baud, Bonai, Daspalla, Kānker, Nāndgaon, Narsinghpur, Pāl-Lahara, Rairākhola and Sonpur States (pp. 45, 47) and in Bastar State (p. 52).

Forest surveys in Bastar State (p. 52).

Framework. Triangulation and Traverse in Bastar, Kānker and Nāndgaon States (p. 47).

18. Madras.

Topographical surveys in East Godāvāri and Vizagapatam districts (p. 52).

Framework. Triangulation in Vizagapatam district (p. 47).

19. Bihar and Orissa.

Topographical surveys in Angul and Sambalpur districts (p. 45).

Framework. Triangulation in Sambalpur district (p. 47).

20. Bengal Presidency and Sikkim.

Air Surveys in Tripura State (pp. 4, 38).

Exploration in Sikkim (p. 3).

Topographical surveys in Chittagong Hill Tracts, Tippera district and in Tripura State (p. 48).

Cantonment surveys. Re-survey of Jālāpahār Cantonment (p. 42).

Framework. Triangulation in Chittagong district and Chittagong Hill Tracts (pp. 48 & 49).

Levelling. Levelling of precision to connect the levelling in Burma to the Indian level net *via* Chittagong (p. 13).

21. Assam.

Topographical surveys in Cāchār and Sylhet districts (p. 48, 49) and in Manipur State (p. 54).

Framework. Triangulation in Lushai Hills (pp. 48 and 54).

22. Burma.

Topographical surveys in the Chin Hills, Pakokku and Upper and Lower Chindwin districts (p. 54).

Geodetic. Latitude and longitude at 44 stations (p. 12).

Geodetic. Re-measurement of Mergui base and measurement of bases at Amherst and Kalemio, and their connection with Primary Triangulation (p. 13).

Framework. Triangulation in the Chin Hills, Pakokku and Upper and Lower Chindwin districts (p. 54). Triangulation in the Chin Hills (p. 49).

Traversing in the Shwebo and Upper Chindwin districts (p. 54).

Levelling. Levelling of Precision to connect the levelling in Burma to the Indian level net *via* Akyab and Minbu (p. 13).

PART 2.—GEODETIC WORK.

III.—ABSTRACT OF GEODETIC OPERATIONS.

DIRECTOR:—{Dr. J. de Graaff Hunter, M.A., Sc.D., F. Inst. P., C.I.E., to 25-11-32.
Colonel R. H. Phillimore, D.S.O., from 26-11-32.

23. General.—Besides geodetic work, the Director, Geodetic Branch, administers at Dehra Dūn *No. 2 Drawing Office*, the *Forest Map Office*, a *Printing Section* and a *Photo-Zinco. Section*, whose work is reported in *Part 4* of this 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. 107*;

Topographical Survey carried out by *No. 1 Party* (paras 64-67);

• • *Cantonment Surveys* (paras 68-71);

Training School (in abeyance at present).

24. 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 41 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 of 1933 which contains complete index maps and detailed results.

No gravity observations were made during the current year, the geophysical party being employed on observations of latitude and longitude.

25. Observatory Section.—Bi-weekly time observations were continued, and a record of the longitude of Dehra Dūn maintained by the reception of wireless time signals from Bordeaux and Rugby. An electric drive has been installed on one of the larger transits, and an experimental method of observation, devised by Dr. J. de Graaff Hunter, has been in regular use on the other. Both instruments have been working satisfactorily.

On the completion of three years' work the observations for variation of latitude have been discontinued. The variation found at Dehra Dūn has been much greater than those found at the international stations. This is attributed to abnormal refraction, arising from meteorological causes, and it is hoped that light will thereby be thrown on the cause of anomalies which have been found at other stations.

The invar wires of the base-measuring detachment were standardised at the beginning and end of the field season. Instability in the lengths of the wires has caused anxiety.

The usual magnetic, seismographic and meteorological observations have been undertaken. Measuring tapes and other instruments have been standardised and overhauled. Instruction in the use of instruments has been given to various officers.

26. Computing Section.—The Computing Section has been largely employed on the computation and adjustment of minor triangulation in the North-West Frontier and trans-frontier areas. Sheet 34 has been completed, and work in sheet 35 is in progress.

All triangulation records of the Central Circle have been lodged in the Computing Section. Adjustment of minor triangulation in sheets 45 F, G, I, J & K was carried out in connection with the programme of No. 1 Party.

The computations of the Dālbandin Meridional series, observed in 1931-32 by No. 15 Party, were completed, and the series was adjusted between its terminal sides in the Kalāt Longitudinal and Makrān Longitudinal series.

The revised edition of the *Geography and Geology of the Himālaya Mountains & Tibet* by Sir Sidney Burrard and Dr. Heron has been edited at Dehra Dūn and printed by the Government Press at Calcutta.

The *Geodetic Report Vol. VIII*, and the *Handbook of Topography, Chapter XII (Air Surveys)* have been edited and printed at Dehra Dūn.

Two Indian triangulation pamphlets and addenda to 13 others have been compiled. Two Persian triangulation pamphlets and the addenda to 7 Indian triangulation pamphlets and 5 levelling pamphlets have been printed. Two Indian triangulation pamphlets have been reprinted and 21 secondary levelling pamphlets reproduced by Gestetner.

27. Tidal Section.—Tide-tables of the Indian Ocean for 69 ports for the year 1934 were completed, and advance predictions for 14 ports were despatched in December 1932 to the Admiralty and to the Hydrographic departments of the United States and Japan. Two new ports, Shortt Island and Chāndbāli on the Orissa Coast, were included in these tables for the first time.

It has been decided to discontinue prediction for Basra from January 1934. The riverain conditions there are such that the usual system of prediction has never given satisfactory results, and the port authorities have found that they can obtain better results by applying corrections, based on local experience, to the Admiralty predictions of the tides at the mouth of the river.

Automatic registrations were continued at Aden, Bombay, Colombo, Karāchi, Kidderpore (Calcutta), Madras, Rangoon and Trincomalee. The despatch of tidal diagrams from Basra has been discontinued. Observations of high and low water on tide-poles during daylight only were continued at Akyab, Bhaunagar and Chittagong. The tidal observatories at Bombay, Kidderpore and Rangoon have been inspected by the port authorities.

28. Latitude and Longitude.—(No. 14 Party).—Observations for latitude and longitude were made at 44 stations spaced along a line across Burma from the Chin Hills through the Lower Chindwin, Sagaing and Kyaukse districts and the Southern Shan States to the Mekong river at the tri-junction of Burma, Siam and French Indo-China.

These observations provide an accurate section of the geoid in Burma and it is to be hoped that the Siamese and Indo-China survey departments will continue the work into their countries. This section still has to be connected to work previously done in India, by observa-

tions between the Lushai Hills and Calcutta.

Observations for latitude and local time were made with the prismatic astrolabe, the observer's personal equation being obtained by comparative observations with a portable transit (with impersonal micrometer eye-piece) at every fourth station. Greenwich time was obtained from the Rugby and Nauen time signals. Geodetic position was obtained by theodolite resection from existing triangulated points. The observer was Captain G. Bomford, R.E.

Longitude was observed at Kēng Tung, completing the observations necessary for a Laplace station there.

29. Triangulation and Base-measurement.—(No. 15 Party).—During 1932-33 the Mergui Base, originally measured in one direction only with Colby bars in 1882, was remeasured in both directions. New bases were also measured in the Amherst and Kalembo districts and connected to primary triangulation, the former to the Burma Coast series, and the latter to the Manipur Meridional series.

All the bases were measured with two pairs of invar wires, one pair in each direction.

30. High Precision Levelling.—(No. 15 Party).—During 1932-33 no high precision levelling was carried out for the new level net.

As buildings were encroaching on the old site of the standard bench mark at Bikaner, the Revenue Minister, Bikaner State, asked for the stone monolith to be moved and re-erected in a better site. Accordingly a detachment was despatched in 1930-31, which carried out the necessary check-levelling before the removal of the bench mark, selected a suitable site for its re-erection, and left bench marks in the vicinity of new site. The stone was re-erected last year and, on completion of the Bhakra Dam work, in February 1933, No. 2 detachment undertook the necessary two miles of fore-and-back levelling to re-connect it.

31. Precise Levelling.—In Bengal and Burma precise levelling was carried out in the Chittagong, Akyab, Kyaukpyu and Minbu districts for the Indo-Burma connection (485 miles). This consisted of simultaneous double levelling of higher precision than that employed for normal secondary work, and is identical with the procedure employed for the levelling of the old Indian level net.

Reports of secondary levelling will be found under Section IX of this report (para. 107).

PART 3.—TOPOGRAPHICAL WORK.

IV.—ABSTRACT OF TOPOGRAPHICAL WORK.

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

Tables A & B. The figures in Tables A and B published prior to 1930-31 were found to be incorrect owing to unsystematic treatment in the past, alterations in circle boundaries, and accidental omissions of surveys by one circle in an adjoining circle's area.

In order to make information readily available to the public regarding areas of modern surveys completed and published, the two tables have been recast and the areas are now given *by scales and not, by circles*, the latter being of purely departmental interest.

It has not been found possible to calculate the figures for each scale for each quinquennium between 1905 and 1930, and consolidated figures are therefore given. The figures which were entered in the report for 1930-31 have been found inaccurate on re-examination, and revised figures have been entered in Table A.

Tables C I and C II supersede Tables C and D of General Reports published prior to 1930-31 and have been introduced to facilitate a more accurate assessment of cost rates for all varieties of survey. The new Tables are divided into two sections, C I for survey in the field and C II for mapping in recess.

A reference to these and to the map publication cost rates, ascertainable from the Director, Map Publication, should allow of a complete estimate for producing any map.

33. Progress. It was hoped in 1905 that modern maps on the 1-inch scale would be available for the whole Indian Empire within 25 years, but the work has been greatly 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 these reductions of scale to scales of $\frac{1}{2}$ -inch and $\frac{1}{4}$ -inch to 1 mile, about half the work may be regarded as completed by 1925.

There is however a tendency to revert to the 1-inch scale in special cases owing to the pressing requirements of geologists and engineers, and in accordance with the modern military view that this is the smallest scale suitable for tactical operations. Moreover some areas already surveyed on smaller scales have had to be resurveyed on a larger scale.

Revision of modern surveys has also become necessary in certain frontier tracts and is badly needed in some other areas. The area revised during 1932-33 is given in Table B.

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

Table A.—Progress of Topographical Surveys since 1905.

Survey years.	1-inch and larger scales.	$\frac{3}{4}$ and $\frac{1}{2}$ -inch scales.	$\frac{3}{8}$ and $\frac{1}{4}$ -inch scales.	TOTALS.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>	<i>Sq. miles.</i>
1905-30 ...	861,728	156,125	17,986	1,035,834
1930-32 ...	63,204	22,115	7,943	93,262
1932-33 ...	25,512	9,138	.....	34,650
Totals to 1933 ...	950,439	187,378	25,929	1,163,746
<i>Balance remaining</i>	<i>approximately 350,000</i>	<i>approximately 260,000</i>	<i>approximately 110,000</i>	<i>720,941</i>
Total programme				1,884,687

Table B.—Revision and Resurvey of above work during the year.

1932-33 ...	9,033	Nil	Nil	9,033
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TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1932-33.

PARTY AND LOCALITY.		Degrees. Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	REMARKS.
Character of country.	Scale.							Description of Survey.	Sq. m.	Rs.	Sq. m.	Rs.
"A" Company.—Punjab and Rajputana Agency.							
Plains and open wooded hills	1-inch	Triangulation	1,600	2·3	1,600		
Punjab plains	1-inch	Original survey ...	4,660	8·1	4,660	67,748	
Medium hills, with broken ground and scrub.	1-inch	Re-survey ...	252	(d)			
Plains and open wooded hills	1-inch	Revision survey	250	12·9			
Special surveys	4-inch	Revision survey	82(a)	47·0	584		(a) Lahore Guide map.
	1-inch	Correction survey	7,796	1·2			(b) For ½' revision in 39 J.
	½-inch	Correction survey	381(b)	0·6			(c) 110 miles of metre gauge Kangra Valley Railway inserted.
	1-inch	Correction survey	(c)	.....	8,177		(d) Training Camp.
"E" Company.—Baluchistan.							
High rugged hills	1/50,000	Triangulation	1,460(c)	6·3	1,460	53,238	(e) Covering intersected points and excluding 440 sq. miles area of G. T. Triangles.
Rugged hills and rolling plateaux with sparse vegetation and intermittently cultivated upland and lowland plains.	1-inch	Revision survey					(f) The different scales of revision survey were intimately interconnected and the revision programme has therefore been treated as a whole and a combined cost rate computed.
	2-inch	Revision survey	7,161	6·2(f)	7,161		

**FRONTIER
CIRCLE.**

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1932-33.

PARTY AND LOCALITY.		Degree Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	REMARKS.
Character of country.	Scale.		Sq. m.	Rs.	Sq. m.	Rs.	
No. 18 (Air Survey) Party.—North-West Frontier Province and Kashmir.							
<i>Open medium hills</i>	... 1-inch	38 O	80	0·7	80	40,895	FRONTIER CIRCLE.—<u>Contd.</u>
	Planetable control (air survey).	...					
<i>Steep partly wooded mountains (3,000—11,000 feet).</i>	1½-inch	38 K & O	301	49	451		
	Original air survey.	...					
<i>Medium hills with open cultivated valleys.</i>	1½-inch	38 N	150	92	451		
	Original air survey.	...					
<i>Open plains and low broken hills.</i>	3-inch	38 N	332	26	780		
	Revision air survey.	...					
<i>Ditto</i>	1½-inch	38 O	448	6·4	780		
	Revision air survey.	...					
<i>Plains and low foot hills</i>	... 1-inch	38 K	317	13	317		
	Ground revision	...					
<i>Plains and low broken hills</i>	1½-inch	38 O	498	0·2	498		
	Accessory ground work.	...					
<i>Medium hills with open cultivated valleys.</i>	1-inch	38 N	90	3·3	90		
	Rapid air survey	...					

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1932-33.

PARTY AND LOCALITY.		Description of Survey.	Degree Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate persq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	REMARKS.
Character of country.	Scale.							
No. 23 Party.—Punjab.								
<i>Flat cultivated plains interspersed with scrub, long grass and trees.</i>	4-inch	Original Irrigation survey.	44 O & P, 53 C, D & H.	Sq. m. 1,479	Rs. 26.49	Sq. m. 1,479	Rs. 2,54,635(c)	FRONTIER CIRCLE.— Conclid. (a) Including computations. (b) Including cost and embodiment of marketous. (c) Excluding expenditure on secondary levelling by No. 15 Party.
		Triangulation to control traversing(a).	53 B & C ...	577	3.69	577		
		Traversing and rectangulation to 3,000 acres(a) (b).	53 C & G ...	2,804	14.08	2,804		
		Rectangulation to 25 acres(b).	44 O, 53 C, D, G & H.	2,051	77.15	2,051		
		Tertiary levelling	44 O & P, 53 C, D & H.	1,328	19.39	1,328		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1932-33.

PARTY AND LOCALITY.		Degree Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	REMARKS.
Character of country.	Scale. Description of Survey.						
No. 1 Party.—Rajputana and Central India Agencies, and Ajmer-Merwara.							
<i>Open flat and low sand hills</i>	$\frac{1}{2}$ -inch Original survey	45 F, I, J & K...	4,510	6.5		1,12,991	<u>GEODETIC</u> <u>BRANCH.</u>
<i>Open flat and low hills, fairly well wooded.</i>	1-inch Original survey	45 G & K ...	1,435	12.9			
<i>Covered with numerous small hills, comparatively unforested.</i>	1-inch Original survey	45 G & K ...	443	2.7	6,388		
<i>Partly hilly and partly undulating plains.</i>	$\frac{1}{2}$ -inch Triangulation	45 K, O & P ...	6,471	1.9			
<i>Partly the high Aravalli range and partly undulating plains.</i>	1-inch Triangulation	45 G ...	1,885	2.8	8,356		

TABLE C I. FIELD WORK.—Areas and Cost rates of Surveys, 1932-33.

PARTY AND LOCALITY.		Scale.	Description of Survey.	Degree Sheet No.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of this unit.	REMARKS.	
Character of country.	PAKTY AND LOCALITY.									
No. 20 (Cantonments) Detachment.—										
United Provinces and Bengal.										
Plains Cantonments	...	16-inch	Traversing	...	63 G & J	...	Sq. m. 9,308 acres. (169 L. miles.)	Rs. 0·4 per acre	43,494	GEODETIC BRANCH. <i>Contd.</i> Allahābād and Fyzābād Cantonments.
Ditto	...	64-inch	Traversing	...	63 G & J	...	21 acres (3·3 L. miles.)	10·4 per acre.		Allahābād and Fyzābād Bāzars.
Congested city area	...	132-inch	Traversing	...	54 K	...	378 acres (26 L. miles.)	3·2 per acre	9,707 acres	Jhānsi City.
Plains Cantonments	...	16-inch	Levelling	...	63 G & J	...	9,308 acres. (89 L. miles.)	0·1 per acre	9,308 acres	Allahābād and Fyzābād Cantonments.
Hills Cantonments	...	16-inch	Re-survey	...	73 A	...	32 acres.	13·1 per acre.		Jalapahār Cantonment.
Ditto	...	64-inch	Re-survey	...	73 A	...	5 acres.	59·0 per acre		Jalapahār Bāzars.

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1932-33.

PARTY AND LOCALITY.		Degree Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	REMARKS.
Character of country.	Scale. Description of Survey.						
<p>No. 20 (Cantonments) Detachment.— United Provinces and Bengal.—<i>Concl'd.</i></p>							
<i>Cantonments (undulating ground).</i>	16-inch Re-survey	54 K ...	6,254 acres.	2'3 per acre	Sq. m.	Rs.	GEODETIC BRANCH.— <i>Concl'd.</i>
<i>Cantonment bāzārs</i>	64-inch Re-survey	53 G & H, 54 K ...	354 acres.	28'3 per acre	Sq. m.	Rs.	Jhānsi Cantonment.
<i>Cantonments, flat and fairly open, but congested in parts.</i>	16-inch Re-survey	53 G & H ...	9,596 acres.	0'9 per acre	Sq. m.	Rs.	Meerut and Jhānsi Bāzārs. Meerut Cantonment.
<i>Congested city area</i>	132-inch Original Survey	54 K ...	379 acres.	8'4 per acre	16,619 acres	Rs.	Jhānsi City.

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1932-33.

PARTY AND LOCALITY.		Degree Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate persq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	REMARKS.
Character of country.	Scale.	Description of Survey.	Sq. mi.	Rs.	Sq. in.	Rs.	
No. 4 Party.—Bihar & Orissa.							
<i>Jungle clad hills and plains, with occasional cultivation in the low-lying areas.</i>	1-inch	Original	4,511	18'6	5,546	1,04,612 ^(a)	(a) Includes Rs. 1,832 for training of pupils and expenditure on Calcutta Revision Survey and Chandipur Artillery Range Survey.
<i>Ditto.</i>	1-inch	Supplementary	1,035	18'4			
No. 5 Party.—Central Provinces.							
<i>Low jungle covered hills</i>	1-inch	Triangulation	3,095	6'6	3,095	97,410 ^(c)	
<i>Plains, mostly open and cultivated.</i>	1-inch	Traversing	3,517	2'6	3,517		(b) Includes 329 sq. miles completed by men under training.
<i>Low jungle covered hills and plains.</i>	1-inch	Original survey	3,328 ^(b)	16'8	3,328		(c) Includes cost of men under training, Rs. 17,660.

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1932-33.

PARTY AND LOCALITY.		Degree Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate persq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	REMARKS.
Character of country.	Scale.	Description of Survey.	Sq. m.	Rs.	Sq. m.	Rs.	
No. 12 Party.—Assam, Bengal, and Tripura State.							
<i>Medium and high jungle clad hills in Chittagong Hill Tracts and Lushai Hills.</i>	$\frac{1}{2}$ -inch	Triangulation	84 B ... 4,398	4.7	4,398	94,654 ^(a)	EASTERN CIRCLE. <i>Concl'd.</i> (a) Includes Rs. 830 on account of cost of training and Rs. 1,727 on account of 32 linear miles of supplementary traversing.
<i>Low intricate hills covered with dense jungle (mostly bamboo) with occasional cultivation, in Tripura State.</i>	1-inch	Original survey ...	79 M ... 1,506	43.7			
<i>Medium hills covered with dense jungle, mostly heavy timber, in Cūchūr district of Assam.</i>	1-inch	Original survey ...	83 H ... 52	107.5	1,558		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1932-33.

PARTY AND LOCALITY.		Scale.	Description of Survey.	Degree Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	REMARKS.
Character of country.	Party.								
No. 10 (Burma) Party.—Upper Burma.									
<i>Jungle covered hills up to about 4,000 feet.</i>		$\frac{1}{2}$ -inch	Triangulation	84 F	2,970	2.15		2,34,655	
<i>Jungle covered hills below 4,000 feet.</i>		1-inch	Triangulation	84 I & J	2,130	10.16	5,100		
<i>Jungle covered hills with patches of cultivation.</i>		1-inch	Traverse	84 I	1,138	14.59	1,138		
<i>Hills up to about 4,000 feet. Dense jungle.</i>		$\frac{1}{2}$ -inch	Original Survey	83 K	753	6.79			
<i>Low jungle covered hills (traversing).</i>		1-inch	Original Survey	83 L, 84 I & J	307	54.52			
<i>Low jungle covered hills with some cultivation (traversing and resection).</i>		1-inch	Original Survey	83 L, 84 I & J	1,631 ^(a)	33.68			(a) Includes 29 square miles of revision survey.
<i>Jungle covered hills up to 3,000 feet.</i>		1-inch	Original Survey	84 I & J	1,342	26.62	4,019 ^(b)		(b) Excludes 14 square miles reported in excess in General Report for 1931-32.

INDEPENDENT PARTIES.

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1932-33.

PARTY AND LOCALITY. Class of Work.	Degree Sheet Nos.	Area. Sq. m.	Cost rate per sq. mile.	Total expenditure on recess work.	REMARKS.
"A" Company.—Punjab & Rājputana Agency.			Rs.	Rs.	FRONTIER CIRCLE.
1 inch triangulation ...	39 O, 44 C & G	700	'82	574	
Adjustment and compilation for Lambert Grid Pamphlets of pre-1925 triangulation.	43 A, D, E, F	.....	.....	2,003	
Graphical adjustment and compilation of post-1925 triangulation.	38 M, N & O, 37 P, 42 D & H, 43 A, B, E, F.	.....	.....	3,006	
Supplying of triangulation data for field camps, 6 D. O. and D. G. B.	39 O, 44 P & J, 52 D, 38 K.	.....	.....	485	
Resection Stations on the Indo-Afghan boundary.	38 M	.....	.....	253	
Miscellaneous	.....	.....	.....	469	
Original ...	43 G, 38 H, 39 N & O, 44 B & F.	5,137	5'0	25,932	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1932-33.

PARTY AND LOCALITY. (Class of Work.)	Degree Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure on recess work.	REMARKS.
"A" Company.—Punjab & Rajputana Agency <i>(Concid.)</i>					
Original ... 3-inch Fair mapping ...	42 H, 43 I ...	7,563	1.0	7,526	FRONTIER CIRCLE.—Contd.
Lahore (Guide Map) ... 4-inch Fair mapping ...	44 I ...	82	25	2,028	
Miscellaneous Drawing ... ..	.....	.....	.....	3,110	
"E" Company.—Baluchistan.					
Revision ... 1½-inch Fair mapping ...	34 I, J, M & N.	1,318	5.1 ^(a)	6,709	(a) Includes complete re-drawing of some sheets and heavy corrections to others. (b) As this was commenced in 1931 and not yet completed, owing to reduction in personnel, cost rate cannot be computed. (c) Excludes 440 sq. miles of G. T. triangles.
Original ... 1½-inch Fair mapping ...	34 L, 34 P ...	1,566	(b)	.....
Original ... 3-inch Fair mapping ...	35 I ...	2,113	(b)	.....
1/50,000 Triangulation ...	34 E, I, J ...	1,460 ^(c)	1.8	2,591	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1932-33.

PARTY AND LOCALITY. Class of work.	Degree Sheet Nos.	Area. Sq. m.	Cost rate per sq. mille.	Total expenditure on recess work.	REMARKS.
No. 18 (Air Survey) Party.—N. W. F. P.					
Original ... 1½-inch Fair mapping ...	38 K, M & O.	650	10'0	6,473	FRONTIER CIRCLE.—Concl'd.
Peshāwar Guide Map ... 6-inch Fair mapping ...	38 N & O ...	25	1570	3,988	
No. 23 Party.—Punjab.					
(Completion of original 4-inch P. T. Sections for reproduction	44 O & P, 53 C, D & H.	1,479	11'76	16,728 ^(a)	(a) Excluding D. O. costs.
4-inch contour sheets ...	44 O & P, 53 C, D & H.	1,479	9'26	13,174 ^(a)	
Reproduction and printing of 4-inch maps and spot level charts.	44 I, J, M & N	1,524	6'07	8,903	
Tertiary levelling computations and compilation of spot level charts.	44 O & P, 53 C, D & H.	1,328	10'66	13,610 ^(a)	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1932-33.

PARTY AND LOCALITY. Class of work.		Degree Sheet Nos.	Area. Sq. m.	Cost rate per sq. mile.	Total expenditure on recess work.	REMARKS.
No. 1 Party.—Rājputana and Central India Agencies, and Ajmer-Merwāra.						
Original	... 1½-inch	45 G & K ...	1,878	9·8	46,224	GEODETIC BRANCH.
Original	... 1-inch	45 F, I, J & O	6,381	2·7		
Triangulation	... 1-inch	45 G ...	1,885	0·3		
Triangulation	... ½-inch	45 K, O & P ...	6,471	0·9		
No. 20 (Cantonments) Detachment.—United Provinces and Bengal.						
Traverse	... 16-inch	63 G & J ...	9308 acres	0·3 per acre.	3,013	Allahābād and Fyzābād Cantonments.
Traverse	... 64-inch	63 G & J ...	21 acres	17·6 per acre.	369	Allahābād and Fyzābād Cantonments.
Traverse	... 132-inch	54 K ...	378 acres	1·2 per acre.	434	Jhānsi City.
Re-survey	... 16-inch	53 G, H & O, 54 K, 78 A.	9491 acres	1·4 per acre.	13,376	Meerut, Rānīkhet, Jhānsi, Lebong and Jalapahār Cantts.
Re-survey	... 64-inch	53 G, H & O, 54 K, 78 A.	251 acres	14·7 per acre.	3,699	Meerut, Rānīkhet, Jhānsi and Jalapahār Cantts.

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1932-33.

PARTY AND LOCALITY. CLASS OF WORK.	Degree Sheet Nos.	Area. Sq. m.	Cost rate per sq. mile.	Total expenditure on recess work.	REMARKS.
No. 4 Party. Bihar & Orissa.			Rs.	Rs.	<u>EASTERN CIRCLE.</u>
1-inch	Fair mapping ...	4,714 ^(a)	8·7	40,977	(a) 832 square miles drawn by No. 12 Party (E. C.) excluded.
No. 5 Party.—Central Provinces and Eastern States Agency.					
1-inch Triangulation	Computations ...	2,540 ^(b)	0·6	} 32,357	(b) Excludes computation of 555 sq. miles remaining for completion.
1-inch Traverse	Computations ...	3,517	0·7		
Original 1-inch	Fair mapping ...	3,328	8·6		
No. 12 Party.—Bengal, Assam, Bihar & Orissa and Tripura State.					
1-inch Triangulation	Computations ...	4,398	1·3	} 42,069	(c) Includes 3 sheets (832 sq. miles) drawn for No. 4 Party (E. C.)
1-inch	Fair mapping ...	2,554 ^(c)	12·8		
1-inch	Fair mapping ...	1,153	3·1		

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1932-33.

PARTY AND LOCALITY. Class of Work.	Degree Sheet Nos.	Area. Sq. m.	Cost rate per sq. mile.	Total expenditure on recess work.	REMARKS.
<u>INDEPENDENT PARTIES.</u>					
No. 6 (South India) Party.—Bombay, Central Provinces, Madras and Mysore.					
Original 1-inch ...	65 F, J, K & O	4,783	8'0		
Original (a) 2-inch ...	65 F ...	22	2'5		
1/2-inch ...	48 M, N & O, 58 I, M & N, 65 F & J.	20,880	0'6		(a) Original plane-table completed as fair-sheet.
1/2-inch ...	48, 57, 58, 65 & 66.	32,480	0'5	71,331	
Colour Patterns ...	*	52 Sheets	26'6 (b)		(b) per sheet.
1-inch Triangulation ...	65 N, 74 B ...	4,000	0'8		

TABLE C II.—RECESS WORK.—Cost rate for Computations and fair mapping, 1932-33.

PARTY AND LOCALITY. Class of Work.	Degree Sheet Nos.	Area. Sq. m.	Cost rate per sq. mile.	Total expenditure on recess work.	REMARKS.
No. 10 (Burma) Party.—Upper Burma.					
Original ...	... ½-inch	... Triangulation	84 F ...	2,970	Rs. 4,136
Original ...	... 1-inch	... Triangulation	84 I & J ...	2,130	Rs. 1,204
Original ...	... 1-inch	... Traversing ...	84 I ...	1,138	Rs. 780
Original sheets	... 1-inch	... Fair mapping ...	83 L, 84 I & J	3,280	Rs. 31,424
Compiled sheets	... 1-inch	... Fair mapping ...	85 N ...	659	Rs. 2,131
Compiled sheets	... ½-inch	... Fair mapping ...	83 K, I, P, N, 93 A, 96 N.	8,841	Rs. 15,992
Compiled sheets	... ½-inch	... Fair mapping ...	94 D, 96 N ...	9,234	Rs. 3,730
Colour Patterns	... ..	... ..	.....	29,124	Rs. 3,914
Office copy corrections and Miscellaneous Work	... ..	... ..	.....	.....	Rs. 14,169

V.—SURVEY REPORTS, FRONTIER CIRCLE.

DIRECTORS:— { Colonel H. J. Couchman, D.S.O., M.C., to 23-10-32.
 „ S. W. Sackville Hamilton, D.S.O., from 24-10-32.

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

35. Training.—One Class I Officer on probation who joined 'A' Company in May received training in air survey in addition to his ordinary training in that unit.

Three Soldier Surveyors were under training in 'A' Company during the field season, of whom one was reverted to his regiment.

36. Special.—The Officer Commanding 'E' Company took part in the Western Command War Game held at Quetta at the end of March. The advantages of maintaining the nucleus of a survey company permanently at Quetta has become increasingly apparent.

During the year the Western Command Intelligence Course Class, the Intelligence Liaison Officers' Class and the Staff College senior students visited the office of 'E' Survey Company for brief lectures and demonstration of map making and reproduction.

Further details of the military training carried out in 'E' Company are given in para. 49.

37. The Field work of units was as follows:—

'A' Survey Company. Topography on the 1-inch scale in sheets 39 N and O, 43 H, 44 B and F and 52 D.

Revision of Lahore Guide Map on the 4-inch scale in sheet 44 I.

Correction of existing 1-inch maps in sheets 43 D and H.

Verification of certain corrections on the 1-inch scale in sheets 43 P and 52 D, and on the $\frac{1}{2}$ -inch scale in sheet 39 J.

Triangulation in sheets 39 O, 44 C, D and G.

'E' Survey Company. Revision surveys on the 2-inch, $1\frac{1}{2}$ -inch and 1-inch scales in sheets 34 I, J, M, N and O.

No. 18 (Air Survey) Party. Compilation of original air surveys in sheets 38 K, N and O, and revision surveys in sheets 38 N and O.

Ground revision on the 1-inch scale in sheet 38 K.

No. 23 (Irrigation Surveys) Party.—Special topographical survey on the 4-inch scale in sheets 44 O and P and 53 C, D and H.

Triangulation in sheets 53 B and C.

Traversing and rectangulation to 3,000 acres in sheets 53 C and G.

Tertiary levelling in sheets 44 O and P and 53 C, D and H.

Rectangulation to 25 acres in sheets 44 O and 53 C, D, G and H

'A' Survey Company.

Officer Commanding.— { Major T. M. M. Peuncy, R.E., to 20-11-32.
 Lt.-Col. C. G. Lewis, O.B.E., R.E., from 21-11-32 to 23-3-33.
 Lieut. R. H. Sams, B.Sc., R.E., from 24-3-33 to 24-9-33.
 Major O. Slater, M.C., R.E., from 25-9-33.

38. General.—The field head-quarters of the Company moved to Peshāwar and occupied the same building as No. 18 Party, opening on the 20th October 1932 and closing on the 13th April 1933.

The whole Company recessed at Murree, as there was no summer programme this year.

Most of the Company was employed on 1-inch original survey in the Punjab plains around Multān and south of Montgomery.

Due to extensive irrigation projects, this area is now on the whole highly cultivated. There are however many large tracts of land in the area which are still wholly or partly undeveloped. Colonisation of the area is proceeding in conjunction with the building of the canal systems, so that in a few years time the whole country will be fully developed.

Thirtyone 1-inch sheets of correction survey was also carried out in Bhaun, Jhelum and Shāhpur districts.

The training camp this year carried out resurvey on the 1-inch scale in the Kāngra valley.

39. Personnel. The average strength of the Company during the year was one Class I, 2 Class II and 5 U. S. officers, 26 surveyors, 4 draftsmen, 5 computers, 3 clerks and 3 soldier surveyors.

Mr. Chiragh Shah, on his return from the field, was transferred to 'E' Company in May 1933.

Mr. E. R. Wilson, B.A., joined 'A' Company from No. 6 Party in July 1933.

40. Areas Surveyed.

4,660 sq. miles of 1-inch original survey ;

252 sq. miles of 1-inch resurvey ;

250 sq. miles of 1-inch revision survey ;

82 sq. miles of 4-inch revision survey.

41. Field work. The field season started with three camps employed mostly on original 1-inch survey, with headquarters at Multān, Lahore and Miān Channun, the camp officers being Lieut. R. H. Sams, Mr. W. H. Strong, M.B.E., and Rai Sahib Chuni Lal Kapur respectively.

In January Rai Sahib Chuni Lal Kapur was recalled to Peshāwar to take charge of the Drawing section, and the surveyors of his camp were allotted to the other two camps.

In all, 18 surveyors were employed and completed eighteen 1-inch sheets in Muzaffargarh, Multān and Montgomery districts and in Bahāwalpur State in sheets 39 N and O, 44 B and F.

Two surveyors under Mr. W. H. Strong, M.B.E., carried out correction surveys in thirtyone 1-inch sheets.

Mr. W. H. Strong, M.B.E., also carried out the revision survey of the Lahore Guide Map on the 4-inch scale, and also a revision survey of sheet 43 H/9 on the 1-inch scale.

One surveyor under Lieut. R. H. Sams, B.Sc., R.E., carried out 381 sq. miles of ½-inch correction survey of the Indus River in Muzaffargarh and Dera Ghāzi Khān districts.

Mr. Bashirullah Khan surveyed 110 miles of the Kāngra Valley Railway on six 1-inch sheets.

Mr. Chiragh Shah had charge of the training camp of three surveyors. He was assisted by Mr. Bashirullah Khan, who took charge of this camp during a period of 3 months spent by Mr. Chiragh Shah in triangulating in Bahāwalpur and Bikaner States.

Triangulation. Mr. Chiragh Shah carried out the triangulation of 1,600 sq. miles in sheets 39 O, 44 C and G in Bahāwalpur and Bikaner States.

He also did a further reconnaissance to ascertain the reliability of Colonel G. C. Depree's triangulation of 1878-80 in sheet 44 G.

42. Office work. During the field season Rai Sahib Chuni Lal Kapur was in charge of the Drawing section in Peshāwar. On the return of the surveyors to recess at Murree, the fair mapping was organised in three sections as follows to conform to the personnel of the field camps.

No. I Section, with Mr. W. H. Strong, M.B.E., in charge, assisted by Mr. Mohammad Akbar and 11 Lower Subordinates, completed 6 sheets during recess.

No. II Section, with Rai Sahib Chuni Lal Kapur in charge, assisted by Mr. Bashirullah Khan and 8 Lower Subordinates, completed 8 sheets during recess.

No. III Section, with Mr. E. R. Wilson in charge, assisted by Mr. Sardar Khan and 8 Lower Subordinates, completed 8 sheets during recess.

Computations. Mr. S. I. Ahmad was in charge of the computing section, consisting of 3 computers during the winter. Computer Abdul Aziz joined from No. 18 Party at the commencement of recess, in order to deal with the graphical adjustment of pre-1925 with post-1925 triangulation.

The section continued the adjustment and compilation of old data lying in sheets 43 A, D, E and F.

'E' Survey Company.

Officer Commanding.—Captain J. B. P. Angwin, R.E.

43. General.—The field and recess headquarters were at Quetta.

In view of the prevailing financial stringency it was decided to confine the field work to correction of existing topographical maps. The area covered was that most required by the army for training purposes and by the department for new small scale maps.

44. Personnel.—The average strength during the year was 2 Class I, 1 Class II and 2 Upper Subordinate Officers and 13 Lower Subordinates (excluding 4 clerks and 16 reproduction section personnel).

Mr. Abdul Rashid (U. S. S.) proceeded on leave in April, and on expiry of his leave was replaced by Mr. Chiragh Shah (U. S. S.).

Mr. V. D. Chopra (U. S. S.) joined the Company in September.

45. Areas Surveyed. 7,161 square miles, covering the major portion of thirtytwo 1-inch sheets, were revised.

46. Field Work was carried out in three separate periods, in the high hills northwest of Quetta from October to the end of December, in the Sibi and Bolān Pass area during January and February, and in the lower hills north and northeast of Quetta during spring and early summer.

The number of surveyors employed in the field varied slightly according to the locale and the season.

Lieut. R. C. N. Jenney, assisted by Mr. Abdul Rashid (U. S. S.), was camp officer for the second period and Mr. H. M. Critchell (Class II), assisted by Mr. Khushal Khan (U. S. S.), was camp officer for the first and third periods.

Connection between spirit levelling and G. T. triangulation. During August Mr. Chiragh Shah, C.H., made a connection from two G. T. S. Bench marks to one G. T. station and five minor stations of the North Baluchistān Series.

Nature of area surveyed. The terrain varied between high rocky hills and rolling uplands to the northwest of Quetta, the cultivated plains of Quetta and Sibi, and the arid hills in the neighbourhood of the Bolān Pass. Vegetation is sparse and water scanty everywhere, and minor communications indifferent at best.

Surveyors worked particularly well during the colder months, under rigorous conditions.

47. Office Work. Owing to shortage of personnel, ordinary fair mapping was almost entirely suspended during the field season. Those surveyors, who were free at intervals from field work, were employed on the 1/25,000 map of Quetta, extra-departmental drawing (paid for work) and miscellaneous departmental work.

Recess work. Owing to the late ending of the field season, recess work did not get into full swing until early July when personnel was organised as follows:—

No. 1 Section, with Lieut. R. C. N. Jenney, R.E., in charge and 5 surveyors and draftsmen, fair mapped 3 sheets of revision survey and 4 trial grid data charts.

No. 2 Section, with Mr. H. M. Critchell in charge, assisted by Mr. Chiragh Shah and 7 surveyors, fair mapped 4 sheets of revision survey, and completed four arrear sheets and the four sheets of the Quetta 1/25,000 map.

Lieut. Jenney also supervised generally reproduction and miscellaneous work for the army and Mr. Critchell carried out office copy corrections and miscellaneous drawing.

48. Reproduction Section. This section, under Mr. Sadiq Ali (until his departure on leave pending retirement) and subsequently under Litho. Draftsman Shahabuddin, was employed mainly in paid for work and in preparing drawing blue prints of revision surveys. Charts of the Khairpur and Suttlej Valley irrigation schemes were also printed.

During the year part of the office was reconstructed to form a photo section and a 25-inch lens was installed. A duffing room was also built.

49. Military Training. Arrangements were completed for No. 2 Indian Field Survey Company, at war strength (less the Reproduction Section and Air Survey Section), to take part in the 2nd Indian Divisional exercise in October 1932, but unfortunately the exercise was not held owing to prevalence of cholera in the Quetta area.

Captain Angwin, R.E., and Lieut. Jenney, R.E., took part in the Staff and Signal Exercise from 22nd to 24th May. The experience gained was useful and there can be no doubt that the participation of survey officers in exercises of this nature is of value to all concerned.

Captain Angwin, R.E., took part in the Western Command War Game held at Quetta from 29th to 31st March. Whilst the war game was devoted mainly to the functions of the higher command, survey problems were encountered and discussed and the employment of the survey organisation received consideration.

A skeleton company took part in 2nd Indian Division night operations on the 14th and 15th July and carried out triangulation and fixation of R. A. Brigade bearing pickets under active service conditions. Many lessons were learnt and the work of the unit was favourably commented on by G.O. C. 2nd Indian Division at a conference held subsequently, at which all officers who took part attended.

Training of a skeleton company in carrying forward ground control rapidly was carried out in early September and culminated on September 20th and 21st in an attack, in co-operation with 1st Fd. Bde. R.A.

Full details and reports on above training will be found in the technical supplement 1932-33.

One U. S. Officer and 9 Lower Subordinates suitable for mounted duties in a Field Survey Company, underwent a short riding course with the 16th Light Cavalry during the summer.

Miscellaneous. A new store godown was built.

No. 18 (Air Survey) Party.

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

50. General.—Recess and field headquarters have remained at Murree and Peshāwar respectively, the latter opening on 14th October 1932 and closing on 3rd April 1933.

Close liaison has been maintained with the Royal Air Force, and the standard of survey photography shows continuous and steady improvement.

A large number of the Officers of No. 1 (Indian) Group, Royal Air Force, visited the Party office in Peshāwar and had the methods of air survey and reproduction briefly demonstrated to them. The Northern Command Annual Intelligence Course also had the work of the party demonstrated to them in Murree, as usual.

51. Personnel. The average strength was 2 Class I, 2 Class II and 4 U. S. Officers, and 20 Lower Subordinates (excluding clerks and reproduction section personnel).

Lieut. C. A. K. Wilson, R.E., was transferred to No. 5 Party on 6th April 1933 and Lieut. J. S. O. Jelly, R.E., joined the party on 8th May 1933.

52. Areas Surveyed.

2,310 square miles photographed.

1,230 square miles compiled.

650 square miles fair mapped.

53. Field Work. No. 1 (Indian) Wing Station, Royal Air Force supplied vertical photographs of 1,414 square miles of tribal territory in sheets 38 G and H for original air survey and of 498 square miles in Kohāt District in sheet, 38 O for revision survey.

No. 2 (Indian) Wing Station supplied vertical photographs of 38 square miles of tribal territory in sheet 43 B for original air survey and of 360 square miles in Peshāwar District in sheet 38 N for revision survey.

Tests of a 20-inch lens for long distance oblique photography were also carried out during the year.

Test strips of vertical and oblique photographs were taken with the Wild Air Camera and the plates sent to Switzerland for plotting in the Wild Autograph.

Lieut. C. A. K. Wilson, R.E., carried out revision surveys in sheets 38 K/5, 6, 7 and 11 during November and December 1932.

Surveyor Manawar Khan carried out the additional ground work after revision air survey of sheets 38 O/3 and 7 and also fixed numerous clinometer heights in tribal territory in sheet 38 O/2 from stations on the Sipāh Ghār range.

54. Compilation.—Revision survey of sheets 38 O/3 and 7 was completed during the year by correction of combined black prints on the 1½-inch scale.

Revision survey of sheets 38 N/7, 8, 11 and 12 was completed during the year on blue print enlargements of the previous surveys. Areas for original air survey were completed *for detail only* pending the production of a simple and accurate method of height finding from the photographs.

55. Training.—Lieut. Jelly continued training in the compilation of oblique air photographs.

56. Methods of Survey.—Research in order to find a simple and accurate method of height finding was continued during the year.

Experimental work in long distance survey from oblique photographs was carried out during recess.

The Wild Photo-theodolite was fitted with an infra-red light filter and various test exposures made with very satisfactory results, one of which will be seen in the Appendix of this Report.

An area of 74 square miles in Tripura State of Bengal was photographed by the Indian Air Survey Company, Dum-Dum, and surveyed as a test of proposed methods for a survey by air and ground methods used in conjunction.

57. Instruments.—One model each of Barr and Stroud Z. D. 13 and 14 Stereoscopes were received during the year.

The Z. D. 13 Stereoscope is a precision stereoscope on the same general principle as the Z. D. 10 model, except that it is fitted with electric light for viewing transparencies by transmitted light and is provided with a switch to enable the photographs to be examined pseudoscopically when required. The model was modified at the Mathematical Instrument Office during recess 1933.

The Z. D. 14 Stereoscope is a rigid semi-precise stereoscope reading through a magnifying arm to 0.1 m. m. Certain minor defects were rectified by the Mathematical Instrument Office.

The Mathematical Instrument Office constructed during the year experimental models of

- (i) a new pattern head stereoscope of aluminium, with stainless steel mirrors.

- (ii) a parallax measuring board reading by vernier to 0·1 m. m.
- (iii) a parallax measuring rule with vernier reading to 0·1 m. m.
- (iv) a tilt recorder, for attaching to the 7-inch lens cone of the F-8 camera, by which it is hoped to photograph two small portions of the horizon on opposite edges of the same negative as the vertical photograph.

58. Reproduction Section.—The section was kept moderately employed during the year on miscellaneous work, details of which are given in para. 123.

No. 23 (Irrigation Surveys) Party.

Officer in Charge.—Mr. C. H. Tresham, v. D.

59. General.—This party, which works for the Punjab Government, continued the survey of the area covered by the Bhakra Dam Irrigation Project. The recess and field headquarters were at Solon and Rohtak respectively, the latter opening on 19th October 1932 and closing on 18th April 1933.

60. Personnel.—The average field strength of the party apart from the Officer in Charge, was 4 Class II and 4 Upper Subordinate officers and 131 Lower Subordinates.

61. Areas surveyed.—

1,479 square miles of special topographical survey on the 4-inch scale.

1,328 square miles of tertiary levelling.

2,051 square miles of 25-acre rectangulation.

577 square miles of triangulation to control traversing, in sheets 53 B & C.

2,804 square miles of traversing and 3,000-acre rectangulation, in sheets 53 C & G.

62. Field work.—

Camp (1).—Mr. O. D. Jackson (Class II), assisted by Mr. Ghulam Hasan (U. S. S.) and 20 surveyors, completed 1,479 square miles of special topographical survey on the 4-inch scale in Delhi Province, Gurgaon, Hissār and Rohtak districts and Dujāna, Jind and Lohāru States, in sheets 44 O & P and 53 C, D & H.

Camp (2).—Mr. Jiya Lal Sahgal (Class II) with 31 Lower Subordinates completed 1,114 square miles of 25-acre rectangulation in Delhi Province, Gurgaon, Hissār and Rohtak districts and Jind State in sheets 44 O and 53 C, D, G & H.

Camp (3).—Mr. Mahammad Najamuddin, B.A. (Class II) with 19 Lower Subordinates completed 2,804 square miles of traversing and 3,000-acre rectangulation in Hissār, Karnāl and Rohtak districts and Jind and Patiāla States in sheets 53 C & G, and 577 square miles of triangulation in Karnāl district and Patiāla State in sheets 53 B & C.

Camp (4).—Mr. B. N. Murthy, B.sc. (Class II), assisted by Mr. N. M. Bopaiāh (U. S. S.) up to 6th February, and 31 Lower Subordinates, completed 937 square miles of 25-acre rectangulation in Delhi Province, Gurgaon, Hissār, and Rohtak districts and Dujāna and Jind States in sheets 44 O and 53 C & D.

Camp (5).—Mr. N. D. Joshi, B.A. (U. S. S.), assisted by Mr. N. M. Bopaiah (U. S. S.) from 7th February, and 15 Lower Subordinates, completed 1,328 square miles of tertiary levelling in Delhi Province, Gurgaon, Hissār and Rohtak districts and Dujāna, Jind and Lohāru States in sheets 44 O & P and 53 C, D and H.

The country surveyed consists of flat cultivated plains, interspersed with scrub, long grass and trees, particularly round villages and along roads and canals. In the south and south-west it is open, sandy and undulating.

Drawing Section.—Mr. M. L. Kohli (U. S. S.) and 8 Lower Subordinates completed the reduction to the 4-inch scale of 4,222 village musamis of Rohtak district, 150 of Gurgaon district and 650 of Delhi Province.

63. Recess duties.—The fair mapping and computations of the field work were completed during recess. The work was supervised by Messrs. O. D. Jackson, Jiya Lal Sahgal, Md. Najamuddin, B. N. Murthy, Ghulam Hasan, N. D. Joshi and M. L. Kohli, assisted by Mr. N. M. Bopaiah.

VI.—SURVEY REPORTS, GEODETIC BRANCH.

No. 1 Party.

Officer in charge.— { Lt.-Colonel R. Foster, I.A., to 4-11-32.
 { Captain H. W. Wright, R.E., from 5-11-32.

64. General.—The party continued work in Ajmer-Merwāra Province, Rājputāna and Central India Agencies and Gwalior State, in sheets 45 F, G, I, J, K, O and P.

Shortly after the party had taken the field the programme had to be changed, as Jaipur State asked that the survey of a certain area of the state should be postponed. The surveyors were transferred into Jodhpur State after some discussion as to the areas considered most important.

Both Jaipur and Jodhpur States contributed at the full rate for surveys carried out for them; Būndi State made a very small contribution.

By personal discussion with state officials, the Officer in charge obtained offers of further contributions from some of the States, and there are signs that most of the States are beginning to appreciate the value of accurate modern maps.

The field headquarters of the party opened in Ajmer on the 7th November 1932 and closed on the 7th April 1933, at the conclusion of the field work.

Personnel.—The strength of the party, excluding the Officer-in-charge, was 4 Class II & 4 U. S. officers and 37 Lower Subordinates, including 5 soldier surveyors under training.

65. Areas surveyed.—4,510 square miles of $\frac{1}{2}$ -inch original survey in Ajmer-Merwāra Province and Bikaner, Jaipur, Jodhpur, Kishangarh and Udaipur States.

1,878 square miles of 1-inch original survey in Ajmer-Merwāra Province and Jodhpur, Shāhpura and Udaipur States.

8,356 square miles of triangulation in Būndi, Gwalior, Indore, Jhālāwār, Jodhpur, Kotah, Mandasor, Shāhpura, Sirohi and Udaipur States.

66. Field work was organised as follows:—

Camp (1).—Mr. A. A. Graham (Class II), with one U. S. officer and 15 surveyors, completed the original survey of 4,242 square miles on the $\frac{1}{2}$ -inch scale in sheets 45 F, I and J.

The country consisted mostly of monotonous sand-hills, covered partly by trees. Near the Sāmbhar salt lake there were low ridges of hills.

Camp (2).—Mr. T. M. C. Alexander (Class II), with 1 senior surveyor as instructor and 7 surveyors, completed the original survey of 1,074 square miles on the 1-inch scale in sheets 45 G and K.

One first class surveyor was transferred at short notice in February to assist in boundary operations in Cutch and Morvi States of the Western India States Agency.

Camp (3).—Mr. Jugāl Behari Lal (Class II), with 1 senior surveyor as instructor and 8 surveyors, completed the original survey of 268 square miles on the $\frac{1}{2}$ -inch and 804 square miles on the 1-inch scale in sheet 45 K.

The area of both *Camps (2) and (3)* lay across the northern end of the Arāvalli range, which is much broken with steep and intricate detail, but falls away to flat plains to the east and west.

Triangulation.—Mr. J. C. Ross (Class II) triangulated 1,885 square miles in sheet 45 G, Mr. B. P. Rundev (U. S. S.) 2,163 square miles in sheet 45 P, Mr. Z. A. Qureshi (U. S. S.) 2,154 square miles in sheet 45 O and Mr. M. W. Kalappa (U. S. S.) 2,154 square miles in sheet 45 K.

67. Recess duties.—Fair mapping was divided into 3 sections under Messrs. A. A. Graham, T. M. C. Alexander and Jugal Behari Lal, and 13 sheets were mapped during recess.

Mr. M. W. Kalappa was responsible for the completion of computations.

No. 20 (Cantonments) Detachment.

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

68. General.—The detachment resurveyed cantonments and cantonment bāzars, on the 16-inch and 64-inch scales respectively, in accordance with the programme approved by the Engineer-in-Chief and the Army Department.

The special survey of the Jhānsi City area for the Municipality on the 132-inch scale, which was commenced last season, was completed.

The field season commenced at Meerut on 13th October 1932. The field headquarters remained at Meerut till 14th March 1933 and was then moved to Dehra Dūn, which will be the recess quarters of the Detachment in future.

Personnel.—The field strength, which had to be considerably increased to cope with the programme, consisted of 2 U. S. officers and 40 Lower Subordinates, including 5 draftsmen and 3 computers employed at field headquarters and 9 surveyors engaged for the field season as a temporary measure. Six of the latter were discharged on termination of field work and three retained to bring the recess strength up to cadre.

69. Areas surveyed.—

16-inch re-survey.

Meerut Cantonments	...	...	9,596 acres.
Jhānsi	„	(including detached Fort area)	4,884 „
Jhānsi Civil Station	...	...	1,370 „
Jālāpahār Cantonments (part)	...	...	32 „

1,370 acres of the Jhānsi Civil Station adjoining Cantonments were surveyed to meet the special requirements of the military authorities.

The above areas include overlaps.

64-inch re-survey.

Meerut Bāzārs	...	...	315 acres.
Jhānsi	„	...	39 „
Jālāpahār	„	...	5 „

The Meerut Bāzārs area includes a small area of 20 acres adjoining the Sadar Bāzār, which was surveyed to meet requirements of the military authorities.

132-inch original (special) survey.

Jhānsi City	378 acres.
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70. Traversing and Levelling.—26 linear miles were traversed for the current season's 132-inch survey of Jhānsi City.

172 linear miles of traversing and 89 linear miles of levelling were completed for next season's survey. In addition 20 linear miles of levelling was carried out in Meerut at the special request of the C. R. E. to provide 26 new Bench marks at selected points.

Ten rangefinding points were fixed at Jālāpahār and 9 at Allahābād at the request of the military authorities.

The loss of traverse stations in cantonments owing to road repairs and other engineering operations is a serious difficulty, which recurs whenever a cantonment is under revision or re-survey. It necessitates traversing the whole area afresh and causes difficulties in making use of the old work, even in places where details have not changed materially since the previous survey. Since 1931-32 therefore, a number of traverse stations have been laid down as permanent marks, consisting of stone or cement pillars about 2 feet in length, eighteen inches being rectangular and embedded in the ground, and the upper six inches being triangular and above ground, with a circle and dot to mark the position of the station. These pillars are placed under the charge of the M. E. S. authorities and will be of considerable value for future revision.

71. Recess duties.—Fair mapping was allotted to two main sections under Messrs. J. A. Cabral and Bakhshi Harnam Singh and to a separate small section of 5 draftsmen under Draftsman Latafat Husain, which dealt with arrears of mapping.

Seven sheets on the 16-inch scale and 3 sheets on the 64-inch scale of Almora, Jālāpahār, Lansdowne, Lebong and Roorkee cantonments and bāzārs were completed and sent for publication.

The computations of the traversing and levelling carried out in the field were also completed during recess.

VII.—SURVEY REPORTS, EASTERN CIRCLE.

DIRECTOR:—{ Lt.-Colonel C. M. Thompson, I.A., to 21-10-32.
Colonel J. D. Campbell, D.S.O., from 22-10-32.

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

The Director, Eastern Circle, also acted as the Director of Surveys, Assam, under the Local Government. This entailed the administration of the Assam Traverse Party, Assam Drawing and Reproducing Offices at Shillong, and the Assam Survey School at Jhālukbāri (Gauhāti). This arrangement ceased from 18th May 1933, and from that date he acted as technical adviser to the Government of Assam.

He also acted as technical adviser to the Government of Bengal up to 31st March 1933, from which date this arrangement ceased to operate.

73. The field work of parties comprised thirty-nine 1-inch sheets partly or wholly surveyed as follows:—

No. 4 Party.—Topography, 5,546 square miles on the 1-inch scale in sheets 73 C and D.

No. 5 Party.—Topography, 3,328 square miles on the 1-inch scale in sheet 64 D.

No. 12 Party.—Topography, 1,558 square miles on the 1-inch scale in sheets 79 M and 83 H.

74. Training. No pupils were recruited during the year under report.

No. 4 Party.

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

75. General.—Original and Supplementary surveys of 5,546 square miles on the 1-inch scale were carried out in sheets 73 C and D in Bihār and Orissa.

The field headquarters opened at Sambalpur on 14th November 1932, and closed on 10th May 1933 on completion of field work.

76. Personnel.—The field strength of the party was 1 Class I, 3 Class II and 6 Upper Subordinate Officers, 1 Upper Subordinate Probationer, 44 Lower Subordinates and 6 soldier surveyors in their second period of extra training.

Mr. B. T. Wyatt proceeded on leave out of India at the end of the field season and Mr. M. M. Ganapathy on two months' leave.

Mr. P. C. Mitra, B.A. (Class II), joined the party on the 1st May 1933.

77. Areas surveyed.—

1-inch original survey	...	...	4,511 square miles.
1-inch supplementary survey	...	...	1,035 „ „

78. Field work

 was distributed as follows:—

Camp (I).—Mr. B. T. Wyatt, V.D. (Class II), with one U. S. Officer and 9 surveyors, completed the original survey of 674 square miles in sheet 73 D/9 and parts of sheets 73 D/10, 13 and 14 falling in

Athmallik, Baud, Daspalla and Narsinghpur States of the Eastern States Agency and supplementary survey of 439 square miles in parts of sheets 73 D/10, 13 and 14 in the Angul district of Orissa.

The country consists of hills ranging from 200 to 2,500 feet, densely wooded with miscellaneous forest growth and with dense bamboo jungle in the south-east. The Mahānadi River flows from west to east through high steep hills in the southern part of the area. The country is sparsely populated, but there is some cultivation in the valleys in the immediate vicinity of villages.

The Cuttack-Sambalpur Road passes through the northern portion, and there are a few motorable fair-weather roads.

Camp (II).—Mr. M. M. Ganapathy, B.A. (Class II), with one U. S. Officer and 10 surveyors, completed 868 square miles of original survey in 73 C/9 and in parts of sheets 73 C/1, 2, 5 and 6 falling in Bāmra, Bonai and Gāngpur States of the Eastern States Agency and supplementary survey of 513 square miles in parts of sheets 73 C/1, 2, 5 and 6 in the Sambalpur district.

In the eastern half, the country consists of steep and densely wooded hills with some villages and cultivation in occasional jungle clearings in the valleys. In the west, the country is open, cultivated and well-inhabited. There are several motorable fair-weather roads.

Camp (III).—Mr. Abdul Ahad, B.sc. (Class II), with one U. S. Officer and 8 surveyors, completed the original survey of 1,113 square miles in sheets 73 D/1, 2, 5 and 6 in Athmallik, Baud, Rairākhhol and Sonpur States of the Eastern States Agency and Angul district.

In the vicinity of the Khondmāls-Baud State boundary the hills are high and densely wooded. The Mahānadi River runs from west to east through the middle of the area. South of the river the country is open, fairly intensively cultivated and well-inhabited. North of the river the country consists mostly of flat sāl jungle, with villages and their cultivated lands interspersed between, and steep isolated hills rising abruptly out of the plain.

Camp (IV).—Mr. R. K. Talapatra, B.A. (U. S. S.), with one U. S. Officer and 9 surveyors, completed the original survey of 1,107 square miles in sheets 73 C/10, 11, 14 and 15 in Bāmra, Bonai, Pāl Lahara, Rairākhhol and Tālcher States of the Eastern States Agency.

The country consists of densely wooded parallel ranges of hills with wide, cultivated and well inhabited valleys. Some fair-weather roads radiate from Deogarh, the capital of Bāmra State, and there is a good all-season motor road connecting Deogarh with Bāmra Railway Station (Gobindpur).

Camp (V).—Mr. S. C. Chatterjee, B.sc. (U. S. S.), with one U. S. Probationer and 7 surveyors, completed the original survey of 749 square miles in parts of sheets 73 C/4, 7, and 8 falling in Athmallik, Bāmra, Rairākhhol and Sonpur States of the Eastern States Agency, and the supplementary survey of 83 square miles in parts of sheets 73 C/4 and 7 in the Sambalpur district.

The country in the north consists of high wooded hills and in the south of low hills and flat sāl forest with a few villages and patches of cultivation. The Sambalpur-Cuttack road passes through this area.

Triangulation and Traverse.—*Nil.*

Special Surveys.—Mr. U. D. Mamgain, B.sc. (U. S. S.) relaid accurately the artillery range at Chandipur in Balasore district.

79. Miscellaneous.—The Eastern States Agency area in Orissa is very malarious, as evidenced by the bad health of the party generally during the field season. At least 90 per cent. of the men suffered from an attack or two of malaria. For sickness other than malaria four surveyors had to be sent on medical leave.

The loss of time due to sickness was equivalent to the loss of over 20 surveyors for a whole month.

During the second half of February the weather was stormy, with many wet days. March and April were hot and dry with occasional dust and thunder-storms, and the water in some localities became scanty and bad.

Wild animals are very numerous in the forest areas, chiefly tiger, leopard and bear. There are also elephants in some localities.

Mr. R. K. Talapatra, B.A. (U. S. S.) was killed while following a wounded tiger in the Bāmra State jungles on the 15th April 1933.

One surveyor died just before the party arrived in the field and another, who was sent on medical leave from the field, died of tuberculosis on the 19th May 1933.

One khalāsi died of fever and one of beri-beri during the field season.

At the end of the field season the party field headquarters were removed from Sambalpur to Gulzarbāgh (Patna), in the party's new area.

80. Forest Surveys.—Various reserved forests in the Eastern States Agency and Sambalpur district of Orissa were surveyed in the normal programme and on the 1-inch scale.

81. Recess duties.—The fair mapping was divided amongst four sections under Messrs. P. C. Mitra, M. M. Ganapathy, Abdul Ahad and S. C. Chatterjee. Mr. Mohabat Ali held charge of Mr. Ganapathy's section while the latter was on leave.

All the fair mapping was completed during recess.

No. 5 Party.

Officer in charge.—
 { Major L. H. Jackson, I.A., to 19-10-32.
 { Captain G. F. Heaney, R.E., from 20-10-32 to 14-6-33.
 { Lieut. C. A. K. Wilson, R.E., from 15-6-33 to 25-9-33.
 { Lieut. I. H. R. Wilson, R.E., from 26-9-33.

82. General.—The Party continued surveys on the 1-inch scale in the eastern part of the Central Provinces and Eastern States Agency in sheet 64 D. Field headquarters at Nāgpur opened for the field season on 2nd November 1932 and closed again on completion of field work on 22nd April 1933.

Personnel.—The field strength consisted of 3 Class I (2 under training), 4 Class II (2 under training) and 3 U. S. (1 under training) officers, 24 surveyors, 3 traversers, 4 computers, 3 clerks and one storekeeper.

83. Areas Surveyed.—

1-inch original survey of 3,328 square miles in sheet 64 D.

Triangulation and traversing, for 1-inch surveys, of 3,095 and 3,517 square miles respectively in sheets 64 G, H and K.

84. Field work.—The 12 sheets under survey were allotted to three camps of four sheets each. Three traversers and 3 triangulators worked directly under party headquarters.

Camp (I).—Mr. P. C. Mitra (Class II) with 8 surveyors carried out original surveys of 1,112 square miles in Bhandāra and Chānda districts and Nāudgaon State of the Eastern States Agency in sheets 64 D/1, 2, 5 and 6.

Except for occasional areas of cultivation, the country was covered with jungle, open in the plains but fairly dense in the hills. About half the area was afforested.

Mr. P. C. Mitra went sick during the first month of the field season and thereafter this camp was combined with *camp (II)*.

Camp (II).—Mr. M. A. Khan (Class II) and 9 surveyors carried out original surveys of 1,100 square miles in Chānda and Drug districts in sheets 64 D/3, 4, 7 & 8. The country was similar to that of *camp (I)*.

Camp (III).—Mr. R. N. Hastir (U. S. S.) and 11 surveyors (including 1 Class I, 2 Class II, 1 U. S. officer and 1 traverser under training) carried out original surveys of 1,116 square miles in Chānda and Drug districts and in Bastar and Kānker States in sheets 64 D/11, 12, 15 & 16.

This area was much wilder than that of the other two camps but not more difficult for survey, as it was more hilly. The inhabitants are all Gonds, who live in temporary villages and have little permanent cultivation.

Triangulation was carried out by Lieuts. J. S. O. Jelly (555 square miles) and R. P. Buchanan (1,270 square miles) and Mr. I. H. Naqvi (U. S. S.) (1,270 square miles) in country similar to that of the plane-tableing camps.

Lieut. Jelly, R.E., triangulated in Raipur district of the Central Provinces and in Sambalpur district of Orissa in sheets 64 K/12 & 16.

Lieut. Buchanan, R.E., triangulated in Drug and Raipur districts of the Central Provinces and Kānker and Bastar States of the Eastern States Agency in sheets 64 H/2, 3, 6, 7 & 8.

Mr. I. H. Naqvi triangulated in Raipur district of the Central Provinces and Kānker and Bastar States of the Eastern States Agency and in Vizagapatam district of Madras Presidency in sheets 64 H/10, 11, 12, 14, 15 & 16.

Traversing.—In the north of the area the country was flat and wooded, and triangulation had to be supplemented by traversing.

Traversing of 1,387 linear miles was carried out for controlling the detail survey of 3,517 square miles in sheets 64 G/4, 7, 8, 11, 12, 15 & 16 and 64 H/1, 2, 5, 6, 9, 10, 13 & 14.

85. Miscellaneous.—There was a great deal of malaria early in the season and few officers or surveyors escaped it. After mid-January there was a marked improvement in health.

In the latter half of February thunder showers were of nearly daily occurrence and these continued to occur at intervals to the end of the field season. This weather, which is unusual in the Central Provinces, rendered the last two months of field work much pleasanter than usual.

86. Recess duties.—Fair mapping was divided into three sections under Mr. F. C. Pilcher, Lieut. C. A. K. Wilson, R.E., and Mr. R. N. Hastir. On Lieut. Wilson's taking over charge of the Party, his section was supervised by Mr. G. H. Khan (Class II), and later by Mr. M. A. Khan (Class II) on his return from leave.

Mr. K. C. Gosain (Class II) was in charge of the computing section.

The 12 sheets surveyed during the field season were fair drawn and all computations completed during recess.

No. 12 Party.

Officer in charge.— { Mr. P. C. Mitra, B.A., up to 28-10-32.
 { Captain G. H. Osmaston, M.C., R.E., from 29-10-32.

87. General.—The main work of the party this season was the continuation of the 1-inch survey of Tripura State, Bengal. A small detachment was also employed in finishing a difficult area of 1-inch survey in the forest clad hills of the Cāchār district of Assam, started last year.

Triangulation for future survey was carried out in the Chittagong Hill Tracts district of Bengal and in the Lushai Hills district of Assam.

The field headquarters of the party opened at Comilla on 17th November 1932 and closed on 20th May 1933.

Personnel.—The strength of the party was 1 Class I, 3 Class II, 4 Upper Subordinate officers, and 41 Lower Subordinates including 32 surveyors.

88. Areas surveyed.—Owing to sickness and the intricate nature of the country, only about two-thirds of the proposed programme was completed, the areas actually surveyed being

1-inch original survey	...	...	1,558 square miles;
Triangulation for ½-inch survey	...	...	4,398 " "

89. Field work was organized as shown below:—

Camp (1) Mr. H. H. Creed (Class II) with 13 surveyors carried out 544 square miles of 1-inch original survey in sheets 79 M/5 and 9.

Mr. Creed proceeded on leave from 5th April, and the surveyors of this camp were then transferred to *Camps (2)* and *(5)*.

Camp (2) was formed from the 16th February under Mr. F. M. Hawley (Class II), who had previously been planetabling. Surveyors were transferred to this camp as they finished their work in *Camp (1)* and 273 square miles of 1-inch original survey was completed in sheet 79M/6.

Camp (3) Mr. K. L. Dhawan, B.A. (Class II) with 12 surveyors carried out 545 square miles of 1-inch original survey in sheets 79 M/13 and 14.

Camp (4) Mr. H. K. Kar (U. S. S.) and 1 surveyor completed 52 square miles of 1-inch original survey to complete sheet 83 H/2 started last season. This work was finished early in April and the personnel were then transferred to *Camp (5)*.

Camp (5) was formed from 1st April under Lieut. R. P. Buchanan, B.A., R.E., transferred from No. 5 party. Surveyors were attached to

this camp as they finished work in Camps (1) and (4), and 144 square miles of 1-inch original survey was carried out to complete sheet 79 M/7 started last season.

Triangulation.—Messrs. G. C. Aggarwala, O. P. Anand, S. K. Guha and Hari Singh (U. S. S.) completed the triangulation of sheets 84B/NW, SW, NE and SE respectively.

Special Survey.—A special traverse was made by Captain Osmaston of the undemarcated boundary between Tripura State and Chittagong Hill Tracts, falling in sheet 79 M/14.

Altogether 31 miles of the boundary was surveyed, and the positions for 7 boundary pillars were chosen and marked on the ground, in consultation with the officials of Tripura State and Chittagong Hill Tracts who accompanied the survey. There were no disputes.

90. Description of Country.—The area surveyed by Camps (1), (2), (3) and (5) fell entirely in Tripura State, except for some small portions of Tippera and Sylhet districts in the west and Chittagong Hill Tracts in the east.

Tripura State borders on the Bengal delta in the west, where considerable areas of flat cultivated land exist between the low jungle covered ridges. Elsewhere in the State there is very little flat cultivation except close to the main rivers, and the whole country is covered with dense jungle.

A series of ranges, running north and south, divide the country into broad parallel valleys and seriously hamper communication from east to west. These ranges are so far apart and the country between them, consisting of a confused tangle of low jungle covered hills and tortuous streams, is so complicated, that accurate survey was extremely slow.

Under the circumstances the survey of the main valleys was carried out almost entirely by traversing, adjusted to occasional fixings wherever these could be made.

The country is traversed everywhere by perennial streams, which form the only communications other than jungle paths.

Although the country is so heavily wooded, villages are fairly numerous over the whole area. The inhabitants live on the crops grown in *jhūms*, which are merely forest clearings cultivated for a year and then abandoned.

In the process of *jhūming*, these areas are naturally deforested, and bamboo jungle springs up and stifles all other vegetation a year or two later. Much of the State, which used to be valuable forest, is now covered with nothing but bamboo.

New *jhūms* are cleared each February and burnt about the end of March. There is considerable danger of these fires spreading to the villages and surrounding country. Two surveyors had their camps completely burnt down in this way and others had narrow escapes.

The country surveyed by Camp (4) lay almost entirely in the Reserved Forests to the west of the Barāk river in Cāchār district of Assam, in sheet 83H/2.

The area includes both slopes of the Bhuban range which runs parallel to and a few miles west of the river, and rises in places to over 2,000 feet.

The forests are dense and undeveloped and very few paths exist, communication in general being up and down the stream beds. To avoid very heavy clearing the survey was carried out almost entirely from fixings on *machāns* or platforms at the top of the highest trees, supplemented by traversing up the main streams. Some of the men became very expert at making these *machāns* and, by sending building parties ahead, this method of survey proved economical in time and labour. In all 80 *machāns* were occupied by the two surveyors employed this season, the highest being 116 feet above the ground.

91. Miscellaneous.

Health.—Low jungle areas are seldom healthy, and the party suffered a good deal from malaria during the season, the average amount of sickness amongst the surveyors being equivalent to one-tenth of the strength.

Epidemics of cholera, small pox and other diseases are common in Tripura State, especially after February, but this season only one or two minor outbreaks of cholera were reported, and special precautions were promptly taken by inoculating all personnel in the vicinity.

It was a grave disaster that, within a fortnight of the end of the field season, Lieut. Buchanan should have contracted cholera and died in his camp 34 hours later, before full medical aid could reach him. A mahout and two khalāsis developed cholera a few days later, but by then proper treatment was available and they all recovered.

Weather.—The party took the field on 17th November, by which date the rainy season is not usually finished and it is a particularly unhealthy time of year.

The weather remained fine till April. During April and the first half of May thunder storms and heavy showers were frequent, but these rather improved conditions of survey by cooling and clearing the air, and they seldom lasted long enough seriously to delay the work.

Conditions after the 10th May are uncertain, and heavy rain is usual.

Fauna.—Game birds are fairly numerous in Tripura State and include green and imperial pigeon, *kalij* pheasant, snipe, jungle fowl and a few duck.

A considerable variety of big game was encountered including elephant, tiger, bison, bear, wild boar, panther, sambhar and barking deer.

Wild elephant are numerous and often interrupted surveyors at work, but only once was any serious damage done.

On a moonlight night during the Director's tour of inspection his camp was attacked by a large rogue elephant, which had evidently been following one of the tame female baggage elephants. After demolishing a bamboo shelter containing some khalāsis, it charged over and razed three tents, including those of the Director and Officer in charge, and then drove away the tame elephant into the jungle. There was no warning whatever of the attack and the occupants of the camp were

mostly caught asleep in their tents. Two men were fairly seriously injured, but it might have been a much worse accident. The party elephant was recovered two days later.

92. Recess Duties. The party was organized in 3 drawing sections and a computing section under Messrs. F. J. Grice, F. M. Hawley and K. L. Dhawan (Class II) and G. C. Aggarwala (U.S.S.) respectively.

The 7 sheets surveyed on the 1-inch scale, as well as three 1-inch sheets surveyed by No. 4 Party and the $\frac{1}{2}$ -inch compilation of one sheet surveyed last season, were fair-mapped, and triangulation computations were completed, by the end of recess.

VIII.—SURVEY REPORTS, INDEPENDENT PARTIES.

93. Nos. 6 (South India) and 10 (Burma) Independent Parties were administered directly by the Surveyor General. Their mapping and survey areas were approximately the same as those of the recently abolished Southern and Burma Circles respectively.

No. 6 (South India) Party.

Officer in charge.—Major W. J. Norman, M.C., R.E.

94. General. The party continued the topographical programme in Bastar State and in the Vizagapatam and East Godavari Districts of Madras. Field head-quarters opened at Waltair on the 15th November and closed on 19th April.

In addition to the field work a permanent drawing section was employed on compiled mapping in Bangalore.

95. Personnel. The strength of the party during the field season was 1 Class I, 5 Class II and 5 Upper Subordinate Officers and 62 Lower Subordinates.

One Class II Officer left the party at the end of the field season.

96. Areas surveyed. A total of 4,805 square miles of original survey was carried out in sheets 65 F, J, K & O, thus completing the modern survey of these sheets.

Of this, 4,783 square miles was surveyed on the 1-inch scale, and 22 square miles was special forest survey on the 2-inch scale carried out for Bastar State.

An area of 563 square miles was triangulated in November and December, for detail survey the same season.

97. Field work was organized as follows:—

A Camp under Mr. Natesan (Class II), with Mr. Wilson (Class II) and Messrs. Mustafa and Fernandez (U. S. S.) and 33 surveyors, surveyed 1,062 square miles in sheets 65 K/13 and 65 O during November and December, after which all these men moved inland to more malarious districts.

No. 1 Camp under Mr. Natesan, with Messrs. Mustafa and Fernandez (U. S. S.) and 15 to 18 surveyors, surveyed 1,691 square miles on the 1-inch scale. This camp started work in January.

No. 2 Camp under Mr. Nair (Class II), with Mr. Wilson (Class II), and 13 to 18 surveyors, surveyed 1,384 square miles on the 1-inch scale and 22 square miles on the 2-inch scale. This camp also started work in January.

No. 3 Camp under Mr. Azim, I.D.S.M., (U. S. S.) with 5 to 6 surveyors surveyed 646 square miles on the 1-inch scale. This camp started work in November.

Triangulation. Mr. Nair during November and December supplemented the triangulation in 65 F/5 and 6 while Mr. Shamanna was doing original triangulation in 65 F/1 and 2. These sheets were plane-tabled during the same season.

Triangulation was also carried out for the re-survey of Kallyār Tea Estate.

98. The country surveyed included a portion of the coastal plain, but most of it was on the plateau to the West of the Eastern Ghāts. The country was usually so thickly wooded as to make survey work difficult. The Bailādila Range in Bastar State, also included in the programme, is a narrow ridge rising about 2,500 feet above the surrounding country. It contains iron, and a great deal of the country round is magnetically disturbed.

99. The health of the party was not good and nearly every surveyor had malaria.

Before taking the field all the men had an anti-malarial course, and entry into the malarious districts was delayed as long as possible. Bamber oil was issued in large quantities and surveyors were given prophylactic doses of plasmoquine. But in spite of all precautions the incidence of the disease was not diminished, although possibly it was not so prevalent as in former years till later in the field season.

100. Recess duties. Nineteen 1-inch sheets and one 2-inch sheet of the current programme were mapped during recess by 3 drawing sections under Messrs. Natesan, Nair and Azim. Compiled mapping was carried out throughout the year by 2 sections under Messrs. Drake, D.C.M., and Nangia (Class II) who also dealt with all the party's colour patterns. The arrears of compiled mapping were considerably reduced and should be completely eliminated by the end of recess 1934.

101. Map Sales have continued very poor due doubtless to the general depression. Mr. Clarke continued his agency until his death on the 27th July 1933, after which the Map Sales agency was taken over by No. 6 Party.

No. 10 (Burma) Party.

Officer in charge.— $\left\{ \begin{array}{l} \text{Captain G. F. Heaney, R.E., to 5-10-32.} \\ \text{Mr. J. McCracken, M.B.E., from 6-10-32 to 3-11-32.} \\ \text{Major L. H. Jackson, I.A., from 4-11-32.} \end{array} \right.$

102. General.—The party continued surveys on the 1-inch and $\frac{1}{2}$ -inch scales in Upper Burma and Assam in sheets 83 K and L and in 84 I and J. The field headquarters opened at Mawlaik on 21st November and closed on 8th May.

Personnel.—The field strength was one Class I, 3 Class II and 4 U. S. Officers, 30 surveyors, 4 traversers and 1 computer. In addition, a Drawing Section under Mr. McCracken, consisting of 1 U. S. Officer and 15 surveyors and draftsmen, remained in Maymyo to carry on with the compiled mapping of the party.

103. Areas surveyed.—

3,251 square miles of 1-inch original survey and 29 square miles of 1-inch revision survey in sheets 83 L, 84 I and J;

753 square miles of $\frac{1}{2}$ -inch original survey in sheet 83 K;

5,100 square miles of triangulation in sheets 84 F and J;

1,138 square miles of traversing in sheet 84 I.

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

104. Field work was organized as follows:—

Camp (1).—Mr. D. N. Saha (Class II) with 12 surveyors completed 816 square miles on the 1-inch scale (including 29 square miles of revision of modern 4-inch surveys) and 753 square miles on the $\frac{1}{2}$ -inch scale in sheets 83 K/NE and SE, 83 L/16 and 84 I/1 and 5 in the Chin Hills and Upper Chindwin districts, in Manipur State and in tribal territory in the Naga Hills.

The country surveyed consists of densely wooded hills and plains, with poor communications.

The $\frac{1}{2}$ -inch survey in tribal territory was carried out by surveyors S. M. Bukari and Shiromani Sharma. They were supplied with ~~Survey~~ Police escorts up to the end of January 1933 but, in order to complete the work, they were obliged to remain in the area up to the middle of February. The inhabitants were friendly and no untoward incidents occurred.

Late in the field season, 9 surveyors were transferred from this Camp to Camp (3).

Camp (2).—Mr. F. W. Smith (Class II) with 12 surveyors completed 1,368 square miles on the 1-inch scale in sheets 84 I/2, 3 and 4 and 84 J/1 and 2 in the Chin Hills, Upper Chindwin and Pakokku districts.

The country surveyed consists for the most part of densely wooded hills, with small areas of flat country covered with impenetrable kyne grass. Communications are fair.

Camp (3).—Mr. C. P. E. Davenport (Class II), assisted by Mr. P. C. Sen Gupta and 5 surveyors, 4 traversers and 1 computer, completed 1,096 square miles on the 1-inch scale in sheets 84 I/7 and 8 and 84 J/5 and 6 in the Upper and Lower Chindwin districts. Late in the field season, this camp was reinforced by 9 surveyors from Camp (1).

The country surveyed consists chiefly of densely wooded hills with poor communications, except along the Chindwin River. This Camp also completed the traverse of 1,138 square miles in sheets 84 I/11, 12, 15 and 16 in the Upper Chindwin and Shwebo districts.

Triangulation.—Messrs. P. C. Sen Gupta, Khan Muhammad, A. K. Talapatra, On Ba and surveyor Iqbal Muhammad completed the triangulation of 5,100 square miles in sheets 84 F/NW and NE, 84 J/1, 2, 3, 5, 6 and 7 in the Chin Hills, Upper and Lower Chindwin and Pakokku districts of Burma and in the Lushai Hills district of Assam.

105. Recess duties.—Fair mapping was divided into three sections under Messrs. F. W. Smith, C. P. E. Davenport and D. N. Saha. The Computing Section was under Mr. Khan Muhammad. All surveys were fair mapped and all computations completed by the end of recess.

The Drawing Section, under Mr. J. McCracken, carried out compiled mapping during the whole year.

IX.—MISCELLANEOUS SURVEY REPORTS.**No. 15 Party (Triangulation and Levelling).**

Officer in charge.—Lieut. I. H. R. Wilson, R.E.

106. Levelling of Precision and High Precision done by this party is described in paras 30 and 31.

107. Secondary Levelling was carried out for the Bhakra Dam Irrigation Project (349 miles) in the Punjab States and Punjab and Delhi Provinces.

PART 4.—MAP PUBLICATION AND OFFICE WORK.

From 1st April 1932 to 31st March 1933.

X.—INTRODUCTION AND PERSONNEL.

108. Index maps Nos. 3 to 7, at the end of this Report, form the most important adjunct to *Part 4*, as they show the progress of publication to date for all standard series of modern maps, excluding transfrontier work.

109. Letter press. Apart from *Sections X* (Introduction) and *XIV* (annual report of the Mathematical Instrument Office), *Part 4* is divided into three main Sections:—

Section XI shows all publications and map issues for the year.

Section XII shows all the fair drawing, whether completed for publication or still in hand, carried out by the various drawing offices and field parties.

Section XIII describes the work of the printing and miscellaneous offices, excluding that of the Computing and Tidal Party, whose work is of a geodetic character and is published in full in the annual Geodetic Report.

110. Personnel.

Calcutta. Director, Map Publication.

Colonel R. H. Phillimore, D.S.O., to 7-4-32.

Lt.-Col. F. J. M. King, R.E., from 8-4-32 to 31-10-32.

Colonel H. J. Couchman, D.S.O., M.C., from 1-11-32 to 30-3-33.

Lt.-Col. C. G. Lewis, O.B.E., R.E., from 31-3-33.

Chief Draftsman—Mr. Amar Krishna Mitra, R.S., to 6-6-32 and from 7-2-33.

“ “ “ F. H. Grant, from 7-6-32 to 6-2-33.

No. 1 Drawing Office.

O.C. Mr. E. B. West.

II “ F. H. Grant, to 6-6-32.

“ “ C. S. McInnes.

“ “ J. C. St. C. Pollett.

“ “ A. F. Murphy.

“ “ Dharendra Nath Banerjee, L.C.E.

“ “ Duni Chand Puri.

“ “ Bhupendra Nath Saha, M.Sc.

“ “ Abdul Rashid Quraishi, B.A.,
from 7-4-32.

U.S. “ K. G. Mandanna.

“ “ Girija Sanker Bagchi.

“ “ Atul Chandra Maulick.

“ “ Nirmal Chandra Sen.

Engraving Office.

Mr. A. R. J. Dalziel, Head Engraver.

Photo.-Litho. Office.

O.C. Captain G. W. Gemmell, I.A.

Managers & Assistant Managers.

Mr. S. Colquhoun, Manager, Litho.

“ C. F. Oddy, “ Photo, to 5-5-32.

“ F. R. Vandyke, “ “ from 6-5-32.

“ F. R. Vandyke, *Asstt.* Manager, Photo,
to 5-5-32.

“ J. B. Chorlton, “ “ Litho.
to 29-11-32.

“ W. S. Armitt, “ “ Photo.
to 20-9-32.

“ L. J. Vallis, “ “ Photo.
from 21-9-32.

“ L. H. Mordue, “ “ Litho.
from 3-3-33.

Map Record and Issue Office.

O.C. Capt. G. H. Osmaston, M.C., R.E.,
to 1-10-32.

“ Mr. E. A. Meyer, from 2-10-32.

Mathematical Instrument Office.

Mr. S. Woodhouse, Superintendent in charge.

“ E. C. Malcolm, F.R.M.S., F.R.Met., Soc.,
Asst. Supdt.

“ A. Lacamp, Asst. Supdt.

Dehra Dūn. Director, Geodetic Branch.

Dr. J. deGraaff Hunter, M.A., Sc.D., F.Inst. P., C.I.E., to 25-11-32.

Colonel R. H. Phillimore, D.S.O., from 26-11-32.

No. 2 Drawing Office.

- O.C. Major H. R. C. Meade, I.A., to 21-4-32.
 " Lt.-Col. A. H. Gwyn, I.A.,
 from 22-4-32 to 19-7-32.
 " Mr. V. W. Morton, from 20-7-32.
 II " A. A. Graham, to 27-4-32.
 " " M. M. Muzaffar Ansari, B.A.
 " " N. S. Harihara Iyer, from 28-4-32.
 U.S. Mr. L. D. Joshi, to 11-7-32.
 " " A. A. S. Matlub Ahmad, from 11-7-32.
 " " Abdul Ghani Qureshi.
 " (Probationer) Mr. Tara Singh, to 24-4-32.

Forest Map Office.

- C.D. Mr. O. N. Pushong.
 U.S. " B. B. Shome, from 13-10-32.

Computing & Tidal Party.

- O.C. Lt.-Col. A. H. Gwyn, I.A., to 24-5-32 and
 from 20-7-32 to 12-11-32.
 " Captain Bomford, R.E.,
 from 25-5-32 to 19-7-32.

Photo.-Zinco. Section.

- Mr. A. Francis, to 22-10-32.
 " S. C. Aratoon, from 23-10-32.

Letterpress Printing Section.

- Mr. H. H. Williams.

Simla. Director, Frontier Circle.Colonel H. J. Couchman, D.S.O.,
M.C., to 23-10-32." S. W. S. Hamilton, D.S.O.,
from 24-10-32.**No. 6 Drawing Office.**

- O.C. Lt.-Col. F. B. Scott, I.A.
 SURVEY SECTION.
 II Mr. H. T. Hughes, to 17-4-32.
 " " M. M. Mudaliar, M.A., from 20-5-32.
 " " Chowdhuri Mohd. Aslam, B.A.,
 from 8-4-32.
 U.S. " Imam Din, (Retired from 1-7-32).
 " " H. Narasimhamurti Rao, B.A.
 " " Vidya Dhar Chopra.
 " " Lalbir Singh, C.H.

ARMY SECTION.

Lieut. T. A. Whitmarsh.

Shillong. Director, Eastern
Circle.Lt.-Col. O. M. Thompson, I. A.,
to 21-10-32.Colonel J. D. Campbell, D.S.O.,
from 22-10-32.**No. 5 Drawing Office.**

- O.C. Mr. P. Simpson.
 II " C. T. Hurley, from 1-10-32.
 U.S. " Janam Raj Chibbar, from 15-11-32.
 " " Rohini Kumar Talapatra, B.A.,
 to 28-8-32.
 " " Muhammad Muzaffar Shah.
 " " Sardar Bhagwant Prakash Mathur, B.Sc.,
 to 30-9-32.

Bangalore. No. 6 (South India)
Party.

- O.C. Major W. J. Norman, M.C., R.E.
 II Mr. A. J. A. Drake, D.C.M.
 " " E. N. Natesan, B.A.
 " " M. D. Nangia, B.A.
 " " M. R. Nair, B.A.
 " " E. R. Wilson, B.A.
 U.S. " Muhammad Abdul Azim, I.D.S.M.
 " " K. B. Muthanna.
 " " Muhammad Mustafa.
 " " A. Shamanna.
 " " C. H. Fernandez.

Maymyo. No. 10 (Burma) Party.

- O.C. Captain G. F. Heaney, R.E., to 20-7-32 and
 from 22-8-32 to 5-10-32
 " Mr. J. McCracken, M.B.E., from 21-7-32 to
 21-8-32 and from 6-10-32 to 3-11-32.
 " Major L. H. Jackson, I.A., from 4-11-32.
 II Mr. J. McCracken, M.B.E.
 " " F. W. Smith.
 " " C. P. E. Davenport from 3-6-32.
 " " D. N. Saha.
 U.S. " P. C. Sen Gupta, B.Sc.
 " " Khan Muhammad, C.H.
 " " A. K. Sen Gupta.
 " " A. K. Talapatra, B.A.
 " " On Ba.

No. 7 Drawing Office
(abolished 9th July 1932).

- O.C. Lt.-Col. R. Foster, I.A., to 9-7-32.
 U.S. Mr. Muhammad Kudratullah Khan,
 to 30-6-32.

XI.—PUBLICATIONS AND ISSUES.

111. **Publications.**—The publications of the Department for the year are shown in the following three tables, of which Table I shows map publications at the various presses, Table II shows the progress made in publication of modern topographical maps, and Table III shows the more important letterpress publications.

Table I (a)—Maps published at Calcutta, during the year 1932-33.

Class of maps.	Scale.	New publications.	Revised editions, new editions and reprints.	Number of copies printed.	Value. Rs.
GENERAL MAPS.		<i>Departmental.</i>			
Maps of India	Various	1	2	5,354	8,989
GEOGRAPHICAL MAPS.					
India and Adjacent Countries Series	1:1 million	1	9	6,158	9,362
La Carte Internationale du Monde	1:1 million	...	2	600	1,200
TOPOGRAPHICAL MAPS.					
Quarter-inch, Modern	1" = 4 miles	16	18	17,785	27,371
" (Provl.)	Ditto	...	16	6,201	6,921
Half-inch, Modern	1" = 2 miles	42	25	36,961	77,206
One-inch, Modern	1" = 1 mile	141	113	161,458	2,52,058
" (Prel.)	Ditto	4	17	14,493	22,900
" (Provl.)	Ditto	...	3	828	828
Old style maps	Various	...	25	4,555	6,400
SPECIAL MAPS.					
Manœuvre and Radius maps	1" = 1 mile	...	1	2,000	4,375
City & Town Guide maps	Various	1	4	5,316	11,982
Provincial maps	Ditto	...	1	2,000	3,281
Index maps	Ditto	1	142	85,941	6,770
Miscellaneous maps	Ditto	42	59	70,472	13,852
Total ... ..	.....	249	437	370,122	4,53,490
		<i>Extra-departmental.</i>			
Maps	Various	380	32	136,418	41,817
Plans and diagrams	Ditto	197	22	61,327	7,517
Illustrations ... ..	.....	110	...	20,092	4,437
Miscellaneous ... ..	.....	42	12	25,062	1,959
Total ... ..	.....	729	66	242,899	55,730
Grand Total ... ..	.....	978	503	613,021	5,09,220

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

Class of maps.	Scale.	New publica- tions.	Reprints and new editions.	Number of copies printed.	Value. Rs.
<i>Departmental.</i>					
Cantonment maps ...	Various	15	29	3,528	5,209
Forest maps ...	"	4	28	1,673	2,627
Miscellaneous ...	"	47	55	49,720	16,850
Total ...	...	66	112	54,921	24,686
<i>Extra-departmental.</i>					
Maps ...	Various	34	5	40,320	7,974
Plans and diagrams ...	"	98	...	19,341	11,085
Charts ...	"	...	10	4,732	738
Forest maps ...	"	49	...	4,418	5,808
Total ...	...	181	15	68,811	25,605
Grand Total ...	...	247	127	123,732	50,291

Table I (c)—Maps published at Quetta.

Class of maps.	Scale.	New publica- tions.	Reprints and new editions.	Number of copies printed.	Value. Rs.
<i>Departmental.</i>					
Maps ...	Various	44	4	405	620
Plans and diagrams ...	"	18	...	3,111	278
Charts } Forms }	"	36	...	3,606	999
Total ...	...	98	4	7,122	1,897
<i>Extra-departmental.</i>					
Maps ...	Various	26	10	5,423	1,303
Plans and diagrams ...	"	32	8	8,548	989
Charts } Forms }	"	23	2	4,750	1,516
Total ...	...	81	20	18,721	3,808
Grand Total ...	...	179	24	25,843	5,705

Table I (d)—Maps published at Murree and Peshawar.

Class of maps.	Scale.	New publica- tions.	Reprints and new editions.	Number of copies printed.	Value. Rs.
<i>Departmental.</i>					
Plans and diagrams ...	Various	...	...	6,591	5,077
Total ...	...	...	...	6,591	5,077
<i>Extra-departmental.</i>					
Maps ...	Various	...	...	1,622	840
Plans and diagrams } Charts ... } Forms ... }	"	...	...	1,000	228
Total ...	...	...	...	2,622	1,077
Grand Total ...	...	...	...	9,213	6,154

Table II.—Abstract of Modern Topographical Maps.

	One-inch maps.	Half-inch maps.	Quarter-inch maps.
Topographical maps published in 1932-33	141	42	16
Do. do. published in previous years	3,210	871	299
Total published ...	3,351	913	315
Number of sheets in India ...	6,218	1,630	450

NOTES.—

Calcutta.—In addition to the work shown in Table I(a), 122,488 copies of 330 maps were gridded during the year.

Dehra Dūn.—In addition to the work shown in Table I(b), 2,987 prints of 635 originals, consisting of plane-table sections, triangulation charts and pamphlets, and forest maps were printed.

Bangalore.—On the abolition of the Southern Circle on 13th April 1932, the publication of maps ceased in Bangalore. In previous years these were shown in Table I(c).

Table III.—Letterpress publications.

(a) PUBLISHED AT CALCUTTA.

1. General Report of the Survey of India, 1930-31. (450).*
2. Map Publication and Office Work Report, 1930-31. (250).
3. Handbook of Topography Chapter I (5th Edition). (750).
4. Departmental Paper No. 15. (180).

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

Table III (Concl'd.).

(a) PUBLISHED AT CALCUTTA.—Concl'd.

5. List of maps published,—issued monthly. (5,700).
6. Alphabetical Index to names on Calcutta and Howrah Town Guide Map—Tape Indicator Edition. (100).
7. Survey of India Notes,—issued monthly. (3,000).
8. Correction slips to Handbooks of Topography, Type Table, Border Specimen, Conventional Signs, etc. (67,423).
9. Government of India and Circular Orders and Circular Memos. (1,900).
10. Calendar for 1933. (2,100).

(b) In hand at Calcutta.

1. *General Report of the Survey of India, 1931-32.*
2. *Map Publication and Office Work Report, 1931-32.*
3. *Handbook of Topography Chapter V (4th Edition).*
4. *Index to Annual Reports of the Survey of India 1904-05 to 1926-27 compiled by Lt.-Col. A. H. Gwyn, I.A.*
5. *Price list of maps.*
6. *Correction to Handbook of Topography, Conventional Signs, &c.*
7. *Government of India and Circular Orders.*

(c) PUBLISHED AT DEHRA DŪN.

1. Geodetic Report Vol. VII. (850).*
2. Record Vol. XXIII. (Report on No. 24 Party Sind Rectangulation). (350).
3. Auxiliary Tables, Part V. (200).
4. Tide Tables for the Indian Ocean, 1933. (1,500).
5. do. Bombay 1933. (1,000).
6. do. Rangoon 1933. (950).
7. do. Hooghly 1933. (175).
8. do. Hooghly (Signals, Lights, &c.) 1933. (900).
9. Addendum to Special Publication No. 2. (200).
10. Departmental Paper No. 14. (150).
11. Professional Paper No. 27 (on Gravity). (350).
12. Annual Provision and Maintenance return of 25 Districts. (2,500).
13. Pamphlets for the use with medicine chest. (200).
14. Lists of Bench marks and Schedule of bearings. (8).
15. Correction slips to Routes in Western Himālaya, Levelling Pamphlets, F. M. O. Catalogue, &c. (2,580).
16. Triangulation Pamphlets. (2,000).
17. Miscellaneous. (316,231).

(d) In hand at Dehra Dūn.

1. *Geodetic Report Vol. VIII.*
2. *Handbook of Topography Chapter XII.*
3. *Tide Tables for the Indian Ocean, 1934.*
4. *Annual Provision and Maintenance return of 23 Districts.*
5. *Addendum to Routes in Western Himālaya.*
6. *Addendum to Levelling Pamphlets.*
7. *Addendum to Triangulation Pamphlets.*

112. Map Issues. Table IV infra shows the total number of maps issued by the Survey of India during the year. Following this table is a diagram showing the progress of map sales during the last six years. The total number of copies sold by the entire Department during the past year was 540,635, value Rs. 3,10,456, against 559,432, value Rs. 3,72,024, sold during the previous year.

The total number of departmental maps sold during the year by the Map Record and Issue Office was 184,551. This represents a decrease of

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

3,901 or about 2% on the previous year's figures. Considering the present allround economic depression, this slight fall is negligible. The number of copies issued to the Army and Royal Air Force increased by 7,857 and sales to the public by 13,412. Accordingly sales of departmental maps show an increase of Rs. 8,914.

As regards extra-departmental maps, the total number of copies sold during the year by the Map Record and Issue Office was 238,030. The number of copies issued to Government Officials (including the Army and Royal Air Force) was 171,452, being an increase of 36,832 over the previous year's sales. Sales to the public, however, decreased appreciably. This also is attributable to the prevailing trade depression.

Strict economy was observed in the free issue of complimentary copies of maps. The total number of free issues of departmental maps during the year was 14,031 against 21,250 issued during the previous year. This shows a reduction of about 34% in the course of a single year.

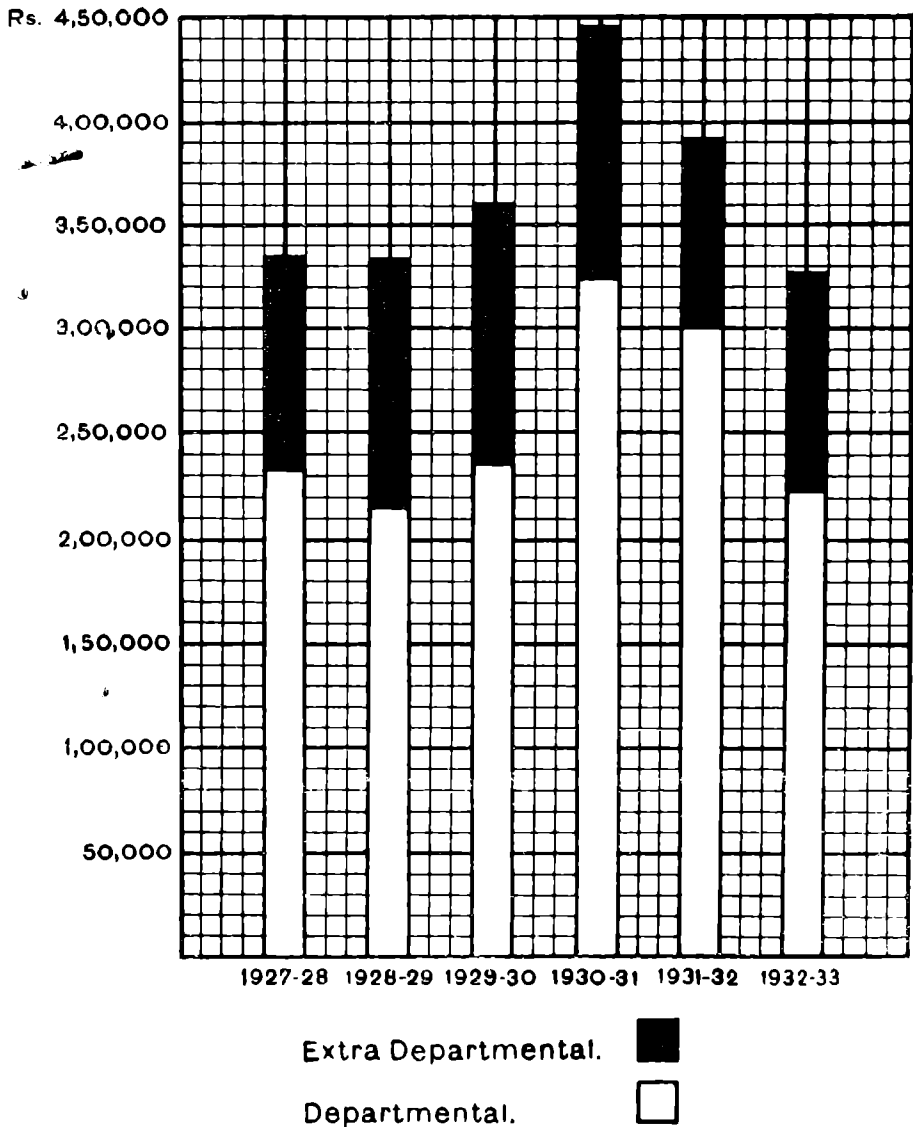
32,571 copies of maps, value Rs. 51,946, were transferred to the Circles for stock and issue.

Table IV.—Maps issued by Survey units.

		SALES.								FREE ISSUES. Number of copies.
		GOVERNMENT OFFICIALS.		ARMY AND ROYAL AIR FORCE.		PUBLIC.		TOTAL		
		Number of copies.	Sale Value. Rs.	Number of copies.	Sale Value. Rs.	Number of copies.	Sale Value. Rs.	Number of copies.	Sale Value. Rs.	
Calcutta	D	17,832	22,086	125,883	1,32,902	40,836	48,361	184,551	2,03,349	14,031
	X	155,048	45,201	16,404	4,407	66,578	8,494	238,030	58,102	3,756
Dehra Dūn	D	2,320	5,373	2,571	4,340	1,101	2,143	5,992	11,865	15,661
	X	30,776	17,615	65,300	3,788	4,133	6,042	100,209	27,445	.....
Simla	D	47	92	.....	.....	147	287	194	379	723
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Murree ("A" Company)	D	57	128	120	223	131	298	308	649	.....
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Quetta ("E" Company)	D	80	192	976	1,116	106	306	1,162	1,616	270
	X	3,225	456	829	441	1,069	117	5,123	1,014	.....
Peshāwar (No. 18 Party)	D	.....	.....	.....	.....	.....	.....	.....	.....	.....
	X	.....	.....	2,566	954	56	33	2,622	987	6,591
Bangalore	D	12	18	.....	.....	7	7	19	25	.....
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shillong	D	257	407	15	20	156	323	428	750	1,359
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Maymyo	D	595	1,459	1,114	2,352	288	464	1,997	4,275	169
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Totals		210,249	93,027	215,778	1,50,554	1,14,608	66,875	540,635	3,10,456	42,580

PROGRESS OF MAP SALES

1927-33



The above diagram represents the aggregate sales of the whole Department.

113. Map Record and Issue Office.—The most important function of the Map Record and Issue Office is to be able to supply maps correctly and expeditiously. To be in a position to do so, it is most important that this office should not be caught out-of-stock of any published map. For this reason a constant verification is being carried out almost continuously throughout the year, and any discrepancy between actual stocks and ledger figures is immediately adjusted.

The Army is still the largest customer of this office. From a classification of sales carried out during the year under review, it has been ascertained that the Army accounts for 52% of all sales, other government departments 26% and the public 22%.

A rearrangement of the Map Store Room was carried out and a chart showing the location of the various sheets was prepared for easy reference.

The map mounting machine worked very satisfactorily. The total number of maps mounted during the year was 63,464 which represents a saving of roughly Rs. 31,732 over the cost of hand mounting. Most of the maps supplied to the Army are now machine mounted on cloth.

The maximum speed of the map mounting machine has increased to 325 copies an hour. Further improvements to the machine are being investigated with a view to increasing the speed.

The new Catalogue has become very popular and a large number of up-to-date copies are being issued every month.

Messrs. Sifton Praed & Co., the Map House, London, were appointed agents for the sale of the Survey of India maps during the year. Several new agents were also appointed in various parts of India and they have been instrumental in further popularizing Survey of India maps.

A list of agents for the sale of maps will be found among the loose-leaf notices in this report.

PUBLICATIONS AND ISSUES

Table V. Stock of Maps. This table gives the stock of maps as it stood on 31st March 1933.

Class of maps.	CALCUTTA.		DEHRA DŪN.		SHILLONG.		SIMLA.		MURREE.		QUETTA.		MAYMYO.		BANGALORE.		TOT
	Number of copies in stock.	Present Face Value Rs.	Number of copies in stock.	Present Face Value Rs.	Number of copies in stock.	Present Face Value Rs.	Number of copies in stock.	Present Face Value Rs.	Number of copies in stock.	Present Face Value Rs.	Number of copies in stock.	Present Face Value Rs.	Number of copies in stock.	Present Face Value Rs.	Number of copies in stock.	Present Face Value Rs.	Number of copies in stock.
1/2M Southern Asia Series ...	8,262	19,803	118	266	1,075	2,150	56	134	20	44	59	118	...	...	24	60	9,614
1/M India and Adjacent Countries ...	38,563	63,462	1,575	2,554	...	...	354	551	224	346	152	228	398	597	417	701	41,683
1/M Carte Internationale du Monde	4,467	8,948	328	656	177	266	38	76	2	6	18	45	...	...	46	92	5,076
Two-inch maps ...	10,862	31,938	7,496	14,568	351	623	...	...	...	...	...	...	...	...	15	23	18,724
One-inch maps ...	1,248,363	18,79,828	50,492	75,813	22,973	34,460	2,516	3,806	3,002	4,503	1,340	1,800	22,493	33,675	3,602	5,368	1,354,781
Half-inch maps ...	352,175	7,01,167	11,991	23,652	4,690	9,380	752	1,514	678	1,356	530	750	3,747	5,621	934	1,846	375,497
Quarter-inch maps ...	261,945	3,83,718	7,988	11,054	3,142	4,713	1,077	1,636	763	1,145	763	1,000	3,033	4,550	332	498	279,043
General maps of India ...	16,682	34,913	458	521	64	204	54	122	3	36	12	20	...	...	54	186	17,327
Provincial and District maps of India	5,522	23,108	267	582	665	1,165	39	142	5	9	...	...	...	...	37	142	6,535
Cantonment and Town maps (Special and Guide).	44,165	1,15,480	11,542	24,526	304	763	292	1,857	160	318	24	101	171	463	384	768	57,042
Manœuvre and Radius maps ...	6,381	13,130	128	264	...	...	20	44	66	139	...	...	...	...	...	...	6,595
Miscellaneous maps ...	79,736	59,231	12,276	14,174	188	196	43	216	17	25	70	140	...	...	149	324	92,479
TOTALS ...	2,077,123	33,34,726	104,659	1,68,630	33,629	53,920	5,241	10,098	4,940	7,927	2,968	4,202	29,842	44,906	5,994	10,008	2,264,396

XII.—WORK OF DRAWING OFFICES.

114. Tables VI to VIII give an abstract of new maps, reprints and new editions completed for publication as well as those in hand during the year, for the whole department.

115. **No. 1 Drawing Office, Calcutta.**—The Engraving Section was separated from No. 1 Drawing Office from 1st April 1932 and formed into an independent office under the Director, Map Publication.

Extra-departmental maps prepared during the year included, an 8-mile road map of Hyderābād for the Hyderābād Government, 16-mile Province maps for the Rail-Road Enquiry Committee, Census maps on various scales for the 1931 Census and a 32-mile wall map of India for the Imperial Council of Agricultural Research, for display at the World's Grain Exhibition, Canada.

116. **The Engraving Office, Calcutta.**—From the 1st April 1932 this office ceased to form a Section of No. 1 Drawing Office and was reconstituted as a separate unit under the Director, Map Publication.

The Copper Plate Printing Section, which had been separated from the Engraving Office in 1928 and placed under the control of the Photo.-Litho. Office, was retransferred to the control of the Head Engraver. This reorganisation is due to a reversal of the policy initiated in 1928, by which it had been proposed to substitute brush drawing for engraving.

Two experiments have been carried out with success.

- (i) The preparation of the negative for a section paper plate by the ruling of lines on powder-coated glass supplied by the Photo.-Litho. Office.
- (ii) Instead of tracing the work from a pattern on to celluloid and transferring it by hand to the copper plate, the pattern is now transferred by a modified helio process in the Photo.-Litho. Office, which ensures an exact reproduction, not possible by the old method, and a considerable saving in time and labour.

117. **No. 2 Drawing Office, Dehra Dūn.**—Since the abolition of the Central Circle and No. 3 D. O., this office has been responsible for the compiled mapping of the old Central Circle area, less the area allotted to No. 5 Party, which was transferred to the Eastern Circle.

Besides the normal mapping in Persia, Tibet and the Andaman Islands, which is reported in Tables V to VII, the office completed the last $\frac{1}{4}$ -inch sheet of Nepāl. The 8-mile map of Nepāl, commenced in 1930, is nearing completion and will replace the preliminary edition published in 1928.

A work that was new to the draftsmen was the revision of sheets 63 A/6, 10, 11 and 14 from the air photographs taken by the Indian Air Survey and Transport Company for 16-inch settlement maps. The detail required for mapping was inked up on unrectified contact prints on a scale of about 6 inches to a mile. These were then reduced by pantagraph and proportional compass direct on to a projected sheet on the $1\frac{1}{2}$ -inch scale, on which all ground control points had been plotted, and the reduction inked up in colours formed the original compilation.

For the revision of sheet 63 E/2 a different method was employed. Unrectified prints were inked up and bleached; photographic reductions of these, printed on celluloid on approximately the 1-inch scale, were rectified individually to plotted control points on a 1½-inch plot sheet and the detail drawn by means of a rectifier designed by Major H. R. C. Meade, I.A., and constructed by the Geodetic Branch workshops.

To save time and labour the compilation of sheet 63 E/14 is being carried out as follows. The contact prints are inked up, bleached and pinned up on a board in groups of uncontrolled mosaics. Each mosaic is limited to about 50 photographs, or about 29 square miles, so that they can be fitted together by marginal detail. These are then reduced by photography to the 1½-inch scale and mosaicked to fit the control of a projected and plotted sheet. Drawing blue prints are made from this, one of which is inked up in colours to serve as a permanent compilation sheet.

Contour charts were prepared for the Bahāwalpur area of the Sutlej Valley Project, where the levelling had to be revised. Twenty charts out of 63 were completed and sent for publication to 'E' Company at Quetta during the year.

118. The Forest Map Office, Dehra Dūn.—This office continues to work for all Local Governments except Assam, Bihār and Orissa. The main work of this office was the fair drawing of working plans for various forest officers and upkeep of their office copies. During the year stock ledgers of all forest maps were completed.

119. No. 6 Drawing Office, Simla.—*Survey Section.* The following work was done in addition to that reported in Table III:—

Indexes.—A large number of miscellaneous indexes were prepared.

General.—The Frontier Circle records were received, arranged and indexed.

Army Section.—During the past year, the Army Section has dealt with the compilation, drawing and reproductions of maps and plans (mostly Secret and Confidential) for staff purposes, internal security, Staff College instruction for Army Headquarters, Commands and various other Government Departments.

The Establishment consists of:—

1 head draftsman.

5 permanent draftsmen and personnel of the lithographic printing presses.

During the year the output has far exceeded that of previous years, and work of this section is steadily increasing.

In addition to the normal routine work, 7 British other ranks were trained as draftsmen for employment by the army.

The various Departments for whom work was executed include:

General Staff and Commands, A. G's Branch, Q. M. G's Branch, M. G. O., Foreign and Political, Government of India Press and the Survey of India.

L.				ACCESSORY.						MISCELLANEOUS.						OFFICE COPIES.	
Forest.		Cantonment.		Gridding.		Shading.		Colour Patterns.		Indexes.		Charts.		Various.		New.	Old, corrected.
..	...	...	...	182	5	224	52	98	2	6	...	...	...	38	3	562	3,795
..	...	...	...	4	3	...	...	33	4	...	...	60	49	103	...	51	338
..	...	15(<i>g</i>)	18(<i>h</i>)	...	...	...	...	...	...	...	...	...	...	5	...	...	...
..	...	...	...	18	4	...	...	59	13	...	...	...	...	...	...	282	330
..
..	...	...	...	21	...	...	...	37	2	...	...	...	...	...	...	93	17
..
..	...	...	...	4	...	...	...	81	4	...	...	...	...	...	...	49	53
..	...	...	...	1	1	...	...	46	2	...	...	1(<i>k</i>)	...	1022	...	227	228
)	...	...	...	...	...	...	...	...	...	...	...	...	...	156	16	359	680
)	...	15	18	230	13	224	52	354	27	6	...	61	49	1324	19	1623	5441
.....
.....

4-inch five sheets and 16-inch thirteen sheets.
 ombay, Delhi and Lucknow guide maps.
 4-inch map of Indaw mining lease area.
 4-inch boundary plot for the Forest Department.
 Office copy correction for the Land Records Department
 and Military.
 4-inch Benares guide map.
 4-inch Bidar Fort guide map on scale 400 feet to 1 inch.
 4-inch Gulbarga Fort guide Map.

O (Burma) Party—

4 sheets examined and corrected	...	...	14
computed for Forest Department	...	...	4
mounting (Booklets)	...	...	313
printing sheets for Military training	...	...	30

WORK OF DRAWING OFFICES

Table VI.—New maps.

Figures in italics denote work in hand.

	TOPOGRAPHICAL.								GEOGRAPHICAL.								GENERAL AND SPECIAL.						ACCESSORY.						MISCELLANEOUS.			OFF COPIES												
	1-inch.		½-inch.		¼-inch.		⅛-inch.		1/M.		CARTE INTERNATIONALE.		1/2 M.		Guide.	Special.	Province.	India.	Forest.	Cantonment.	Gridding.	Shading.	Colour Patterns.	Indexes.	Charts.	Various.	New.																	
	Helio.	En-graved.	Helio.	En-graved.	Helio.	En-graved.	Helio.	En-graved.	Helio.	En-graved.	Helio.	En-graved.																																
No. 1 Drawing Office including Engraving Office.	12	6	4	1(a)	2(a)	1(a)	10(a)	4(b)	...	2(c)	1(a)	1	...	1(d)	5(e)	...	1(f)	182	5	224	52	98	2	6	38	3	562
No. 2 Drawing Office Geodetic Branch parties	...	7	2	5	5	14	...	3	...	7	2	3(i)	4	3	33	4	60	49	103	...	51		
No. 5 Drawing Office Eastern Circle parties	3	...	14	13	3	9	18	4	59	13	282			
No. 6 Drawing Office Frontier Circle parties	1	3	21	37	2	93			
No. 6 (S. I.) Party	18	12	2	7	1(n)	1(o)	4	81	4	49				
No. 10 (Burma) Party	10	2	14	4	2	3	1(j)	1	1	46	2	1(k)	...	1022	...	227			
Forest Map Office	156	16	359			
Total	113	26	66	42	12	37	...	3	1	9	1	10	...	4	...	4	1	1	5	7	2	1	...	5	...	1	9	...	15	18	230	13	224	52	354	27	6	...	61	49	1324	19	1623	
Total to date	...	3,496	1,000	327	81	23	1	18	1	15			
Total for India	...	6,218	1,630	450	104	104	41	22			

References.

Scales:— <i>x</i> -inch means <i>x</i> inches to 1 mile.	(a) Revised editions, new compilation.	(h) 64-inch five sheets and 16-inch thirteen sheets.
<i>x</i> -mile " 1 inch to <i>x</i> miles.	(b) Includes two revised editions, new compilation.	(i) Bombay, Delhi and Lucknow guide maps.
1/M means 1:1 million or 1·014 inches to 16 miles.	(c) Includes one revised edition, new compilation.	(j) 4-inch map of Indaw mining lease area.
1/2M " 1:2 million or 1·014 " " 32 "	(d) Calcutta & Howrah Guide Map, scale 3 inch = 1 mile (Revised edition).	(k) 4-inch boundary plot for the Forest Department.
	(e) Baluchistān; Punjab; Kashmir and Jammu; U. P. and Delhi; Burma.	(l) Office copy correction for the Land Records Department and Military.
	(f) 128-mile India, engraved edition.	(m) 6-inch Benares guide map.
	(g) 64-inch one sheet and 16-inch fourteen sheets.	(n) Bidar Fort guide map on scale 400 feet to 1 inch.
		(o) 8-inch Gulbarga Fort guide Map.

Table VII.—Miscellaneous.

No. 1 Drawing Office—	Forest Map Office—	No. 10 (Burma) Party—
Originals corrected against press order proofs ... 153	Standard indices completed ... 42	Party sheets examined and corrected ... 14
Mosaics (congregated rough maps prepared for photography) ... 97	Maps hand coloured for issue ... 93	Area computed for Forest Department ... 4
Grid originals scrutinized and corrected ... 82	Areas extracted, No. of sheets ... 37	Map mounting (Booklets) ... 313
Grid cutting points on originals drawn or checked ... 92	Originals corrected ... 19	Gridding sheets for Military training ... 30
Miscellaneous cases ... 319	No. of sheets passed for publication ... 171	
Extra-departmental maps prepared ... 34	No. 6 Drawing Office—	
No. 2 Drawing Office—	Party sheets examined and corrected ... 22	
Originals corrected against press order proofs ... 5	" " Special Map ... 1	
Published charts corrected by hand ... 3,000	" " Guide Map ... 1	
Party sheets examined, corrected and submitted for publication ... 36		
Mosaics (congregated rough maps prepared for photography) ... 3		

Table VIII.—Re-issues

Reprints—No changes in map. New editions—Slight alterations. Revised editions—Considerable changes.

	MODERN MAPS INCLUDING PRELIMINARY EDITIONS.								OLD-STYLE, INCLUDING PROVI- SIONAL ISSUES.			GENERAL AND SPECIAL.							
	TOPOGRAPHICAL.				GEOGRAPHICAL.				1-inch.	½-inch.	¼-inch.	Various.	RAIL- WAY.	FOREST.	CANTONMENT.				
	1-inch.	½-inch.	¼-inch.	¼-inch.	1/M. Helio.	1/M. En- graved.	1/M. Carte Internationale.	1/2 M.					67-mile.	2-inch & 4-inch.	16-inch.	32-inch.	64-inch.		
No. 1 Drawing Office including Engraving Office—																			
Reprints ... ..	...	...	...	...	...	1	...	...	...	...	...	2	...	...	...	...	...	...	...
New editions	66	11	22	...	...	...	...	...	23	1	13	1	1	...	...	...	...	...
Revised „ ... ..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
No. 2 Drawing Office—																			
Reprints ... ..	...	...	...	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
New editions ... ..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
No. 5 Drawing Office—																			
New editions ... ..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Revised „ ... ..	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
No. 6 Drawing Office—																			
New editions ... ..	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Revised „ ... ..	...	2	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
No. 10 (Burma) Party—																			
New editions ... ..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Revised „	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Forest Map Office—																			
Reprints ... ..	...	...	...	...	...	...	...	...	...	...	...	...	...	4	...	...	...	...	...
New editions ... ..	...	...	...	...	...	...	...	...	...	...	...	...	...	18	...	...	...	...	...
Revised „ ... ..	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...
Totals ...	67	13	30	14	...	1	...	...	23	1	13	3	1	23	...	...	...	...

XIII.—PRINTING AND MISCELLANEOUS.

120. The Photo.-Litho. Office, Calcutta.—The second offset machine and offset press from Dehra Dūn were received and erected during the year. One Hoe flat-bed machine (26 inches × 19 inches) purchased in 1902 was sold to make room for the machine.

A new engraved 45° single-line screen, 40 inches × 32 inches, was imported at the beginning of the year. It was manufactured by Messrs T. E. Brown & Co. Ltd., Leicester, to the order of Messrs Hunter Penrose Ltd. The use of this screen has improved all tints and layers, particularly in work exceeding 24 inches × 22 inches. Previously, diagonal-line screens were prepared by photographing a cross-ruled Levy screen with a suitable narrow oblong stop placed between the lens combination. Though results were satisfactory up to 24 inches × 22 inches, beyond this size it became impossible to cut out entirely the image of the crossing diagonals and the resultant lines on the negative were uneven. Good cross-lined screens have been prepared by the powder process from this new diagonal-line screen.

Some drawing blue prints have been supplied towards the end of the year from lithographically combined mosaics. An improvement in accuracy and out-turn has been obtained by replacing the single crossed-line diaphragms of the McLeod Bar microscopes by double crossed-line diaphragms, the lines of which are .03 inches apart.

Cost and out-turn of Photo.-Litho. Office are given in the following table. Out-turn compares favourably with past years. There is a considerable drop in expenditure on account of retrenchment and the curtailment of capital expenditure on replacement of obsolescent plant. Value of work done is less than the previous year on account of smaller press orders.

COST AND OUT-TURN OF PHOTO.-LITHO. OFFICE.

Expenditure.	Value of out-turn at office rates.	Negatives prepared.	Zinc plates prepared.	MAPS PRINTED.			Impressions pulled.
				Departmental.	Extra-departmental.	Copies printed.	
Rs.	Rs.						
3,17,760	3,98,352	6,332	7,779	1,011	2,674	594,810	3,892,609

INDEPENDENT OUT-TURN OF THE PROCESS ENGRAVING AND TYPE PRINTING SECTIONS.

PROCESS ENGRAVING SECTION.					TYPE PRINTING SECTION.		
HALF-TONE WORK.		LINE WORK.		PHOTO-GRAVURES.			
Blocks prepared.	Impressions pulled.	Blocks prepared.	Impressions pulled.	Plates prepared.	Items or pages published.	Copies printed.	Impressions pulled.
125	20,490	120	13,700	1	2,129	722,012	1,323,911

**121. OUT-TURN OF ENGRAVING OFFICE COPPER PLATE
PRINTING SECTION.**

IMPRESSIONS PULLED.

Photogravures.	Chromo Paper.	Transfer.	Miscellaneous.	Total.
1,079	365	104	2,891	4,439

122. Photo.-Zinco.-Section, Dehra Dūn.—One electric whirling machine for coating and drying helio plates was received and erected to replace the old hand arrangement. The new machine is working very satisfactorily and a greater out-turn of sensitised plates is now obtained. Owing to retrenchment of establishment, two rotary offset machines and one duplicating press were transferred to the Photo.-Litho. Office, Calcutta, and one rotary machine and one duplicating press with electric plant to "E" Company, Quetta.

One new graining machine was received and is now in use in the Graining Section. The remaining rotary machine and duplicating press, together with three flat-bed hand presses, have all been kept busy during the year printing Forest and Cantonment maps, diagrams, the Bhakra Dam Project Sheets and Indexes and Charts for the Geodetic report.

123. No. 18 (Air Survey) Party, Peshāwar and Murree.—The reproduction section was employed on miscellaneous work for Northern Command Headquarters and on normal reproduction work for air survey compilation.

One special map was produced for Headquarters Peshāwar District and one for Headquarters No. 1 (Indian) Group, Royal Air Force, in connection with operations.

124. 'E' Company, Quetta.—The reproduction section has been regularly employed throughout the year. The volume of extra-departmental work has somewhat decreased, but there has been an increase in departmental work. Extra-departmental work is mainly from local sources but work has been received from such distant places as Lahore and Mysore.

A good deal of the work has been printed on the rotary offset machine which was installed last year and is working very satisfactorily. During the year part of the office has been re-designed to form a large plan room and camera room capable of taking a 48-inch lens. At present the only lens available is a 25-inch Cooke Process lens by Taylor and Hobson. These improvements will increase the photographic scope of the unit very considerably.

Reproduction of originals received :—

In one colour	...	...	...	122
In two colours	...	...	...	23
In three ..	...	...	...	47
In four ..	...	...	...	2
			TOTAL	194
Vandyke and Helio plates prepared	...	...	...	827
Prints pulled	...	...	...	20,259

XIV.—MATHEMATICAL INSTRUMENT OFFICE.

125. Besides regular repair and manufacture, the following special works were carried out in the Mathematical Instrument Office:—

(a) Repairs of—

1000 Binoculars	...	} For the Army Department.
1986 Monoculars	...	
93 Clinometers	...	
55 Directors	...	
400 Prismatic and Pocket Com- passes.	...	
308 Range-finders	...	
100 Sight Dials	...	
17 Odometers	...	
158 Telescopes	...	
17 Distance Recorders	...	
625 Watches	...	
60 Speedometers	...	
1 Duboscq's Colorometer	...	For the Chemical Examiner for Customs and Excise Calcutta.
57 Microscopes	...	For the Medical Department.
4 Ophthalmoscopes	...	For the Medical Stores Depart- ment, Lahore Cantt.
1 Spirometer	...	For the All India Institute of Hygiene and Public Health Calcutta.

The grinding of accurate spirit level bubbles has been undertaken in the Mathematical Instrument Office with satisfactory results and the scope of this work is now being extended with a view to diminishing Home Indents.

(b) Manufacture of:—

7 Sounding Chains, 60 ft.	...	For the Engineer-in-Chief, Har- bour Construction, Vizaga- patam.
24 Wire gauze eye-shades	...	For the Superintendent, Medical College Hospitals, Calcutta.
2 Magnetic Indicators	...	For the Superintendent, G. & S. Factory, Cossipore.
6 Cyclone circle charts	...	For the Bengal Pilot Service, Calcutta.
4 Hook Gauges 20" long	...	} For the Irrigation Research Laboratory, Lahore.
2 " " 10" "	...	
4 Pointer Gauges 20" long	...	
2 " " 10" "	...	

- | | | | |
|-----|---|---|---|
| 1 | Minor Control Scaler to carry out the adjustment of plotted strips to a slightly different scale expeditiously. | } | For the O. C., No. 18 (Air Sy.) Party. |
| 12 | Air Survey Instruments, graduated L squares in opaque celluloid. | | |
| 5 | sets of optically flat stainless steel mirror. | } | For quintants and sextants. |
| 140 | Glass jars 20 fluid oz. ... | } | For the Excise Department. |
| 1 | Die suitable for sealing meter in connection with one of the Public Supply Stations. | } | For the Sub-divisional Officer, Lahore. |
| 7 | Ampoule fillers and Ampoule holders. | | |
| | | } | For the Office of the Bacteriophage Inquiry, Public Health Laboratories, Bankipore. |

In the optical section considerable progress was made in the renovation of prisms and lenses resulting in economy in Home Indents. During the year under review 2000 prism surfaces, and 637 lenses and object glasses were re-worked, polished and re-figured where necessary and 1623 lenses and object glasses re-balsamed. Prisms to the number of 170, 450 lenses, 775 colour glasses, 750 diaphragm glasses and graticules, 107 reflecting mirrors have been made up. About one hundred stereoscopes, head pattern, have been fitted with reflecting mirrors.

- (c) The Superintendent, Mathematical Instrument Office received thanks from a number of officials in all parts of India for the efficiency of the repairs carried out on optical instruments submitted by them.
- (d) Training given to outsiders:—
At the request of the Financial Secretary to H. E. the High Commissioner for 'Irāq, Mr. Abdul Sattar, an instrument repairer of the 'Irāq Government, was under training in the repairs of optical instruments generally and in the No. 7 Dial Sight in particular, for a period of 6 months from November 1932.
- (e) Monthly fire drill was held and the fire appliances inspected regularly. The Inspector of Calcutta Fire Brigade personally attended the fire drill held in December 1932.
- (f) Army surplus and obsolescent instruments *viz.* binoculars, Telescopes, &c., to the value of about Rs. 4,290 were sold, on behalf of the Director of Contracts, Simla, to the best advantage of Government. A sum of about Rs. 3,000 has been realised from the sale of surplus and obsolescent stores and scrap materials belonging to the Mathematical Instrument Office.

(g) The following Officers visited the Mathematical Instrument Office:—

Brigadier J. Morrison, I.A., Director of Artillery, on 9-12-32 to discuss prospects of more repair work coming to the Mathematical Instrument Office.

The Factory Inspector, on 12-12-32.

Capt. A. F. F. Thomas, D.A.D.O.S., (P.), on 16-1-33 with a view to discuss the stock and repair programme of mathematical instruments at the Mathematical Instrument Office in so far as it relates to supplies to the Army in India.

(h) Every endeavour has been made to curtail the expenditure as much as possible, resulting in a prospective saving of about Rs. 19,000 in the cost of establishments, due principally to retrenchments and short-time work. Steps have also been taken to reduce the expenditure on printing, stationery, stamps and books to the minimum.

The following comparative table shows that the total value of sales during the year under review has considerably decreased, due to an abnormal fall in demands for instruments, resulting in a large but unavoidable drop in manufacture. The total value of repairs carried out is approximately the same as the last five years, the figure for the past year being exceptionally good.

	1930-31.	1931-32.	1932-33.
	<i>Rs.</i>	<i>Rs.</i>	<i>Rs.</i>
1. Total value of stores issued ...	3,78,291	1,71,700	1,39,422
2. " " " repairs carried out to orders ...	2,13,906	3,16,950	2,49,705
3. " " " instruments &c. returned to stores ...	48,547	30,534	23,154
4. <i>Book value of stock in—</i>			
(a) Serviceable store ...	4,54,147	4,56,869	4,07,531
(b) Repairable " ...	1,28,331	1,44,197	1,59,494
(c) Material " ...	2,06,718	1,90,888	1,80,725
5. <i>Value of new instruments—</i>			
(a) Manufactured in workshop ...	1,62,717	85,065	44,105
(b) Purchased locally ...	45,930	16,222	13,264
(c) Imported through the Stores Department, London ...	1,47,130	36,085	8,410
6. Total value of work done in the workshop ...	4,67,145	4,89,189	3,52,141
7. Value obtained by sale of obsolescent and condemned stores ...	2,625	687	3,350
8. <i>Employees—</i>			
(a) Average numbers in workshop ...	463	438	424
(b) Cost of employees in workshop including pension contribution	1,94,262	1,89,812	1,55,878

APPENDIX.

The two photographs in Plates II and III show the great improvement in definition obtained by the use of an infra-red plate and filter (Plate II), as compared to one taken with the usual panchromatic plate and orange filter (Plate III).

The photographs were taken from Bāriān, Murree Hills (7,210 ft.) looking north-east across the Jhelum valley and Kashmir. The snow peak in the right centre of the landscape is Nanga Parbat (26,620 ft.), 115 miles distant, and the hill marked Qāfir Khān (11,515 ft.) on the watershed forming the horizon, is 31 miles from the camera.

A comparison of the two photographs shows the utility of infra-red photography for ground photo survey.

At present infra-red plates are comparatively slow, their speed⁴ being about one-third the speed of a fast panchromatic plate with suitable light filter. This restricts their use in the air, owing to Camera vibration, to subjects requiring brief exposures such as distant mountain ranges.

NOTICES

- I. **Work done by the Survey of India.**
- II. **How to obtain maps and other publications.**
- III. **List of Agents for the sale of maps.**

I. WORK DONE BY THE SURVEY OF INDIA

APPLICATION FOR SURVEYS OF ANY KIND, whether for private or Government purposes, should be made to the following officers :

The Director, Frontier Circle,* Survey of India, Simla. (Tel. "Surfrontier").
 " " Geodetic Branch,* " " Dehra Dūn. (Tel. "Surtrig").
 " " Eastern Circle,* " " Shillong. (Tel. "Sureast").
 " O. C. No. 6 (South India) " " Bangalore. (Tel. "Surfield Six").
 " " Party,*
 " " No. 10 (Burma) " " Maymyo. (Tel. "Surfield Ten").
 " " Party,*

FOREST AND CANTONMENT SURVEYS, LEVELLING, TRIANGULATION AND TIDE TABLES. Advice in regard to these, and on scientific questions, is obtainable from the *Director, Geodetic Branch, Survey of India, Dehra Dūn*, who undertakes a good deal of levelling and similar work for municipalities and engineering projects, on payment. (Telegrams "Surtrig").

MAPS AND ILLUSTRATIONS can be printed by the *Director, Map Publication, Survey of India, 13 Wood Street, Calcutta*, for Government Departments only, and special maps can also sometimes be prepared, on payment.

THE MATHEMATICAL INSTRUMENT OFFICE, Survey of India, 15 Wood Street, Calcutta, is a well equipped Government Factory which supplies, manufactures and repairs all kinds of Surveying, Drawing, Optical, Meteorological and Medical instruments. It also manufactures special instruments for experimental purposes and receives back surplus instruments on valuation, from all Government Departments, whether Imperial or Provincial.

The Price List, Rules and Regulations and Forms for Indents, Repairs and Deposits are supplied gratis on application. (Telegrams "Swinst").

GENERAL ENQUIRIES should be addressed to the Assistant Surveyor General, 13 Wood Street, Calcutta. (Telegrams "Surveys"), as the Surveyor General of India is on tour during most of the year.

* Provinces and States in each Survey Circle.

- | | | |
|---|---|--|
| <p>1. FRONTIER Circle
 Kashmir and Jammu
 N. W. F. Province
 Baluchistan
 Punjab and Delhi
 Punjab States
 Bikaner and States of
 W. Rājputāna.
 Part of Bombay†
 Cutch.</p> | <p>2. GEODETIC Branch
 United Provinces
 Central India
 Gwalior
 Ajmer-Merwāra
 E. Rājputāna States
 Baroda
 Part of Bombay†
 States of Western
 India (less Cutch).</p> | <p>3. No. 6 (South India) Party.
 Madras Presidency
 Madras States
 Hyderabad
 Mysore and Coorg
 Part of Bombay†</p> <p>4. EASTERN Circle
 Central Provinces
 (including Berār).
 Bihār and Orissa
 Bengal Presidency
 Assam and Sikkim.
 States of Eastern India.</p> |
| <p>5. No. 10 (Burma) Party.
 Burma.</p> | | |

† *Bombay Presidency*—Sind is in the Frontier Circle: Northern Div. in Geodetic Branch, remainder in No. 6 (South India) Party.

II. HOW TO OBTAIN MAPS

AND OTHER PUBLICATIONS

SURVEY OF INDIA MAPS are obtainable from the Map Office, 13 Wood Street, Calcutta (*Tel. "Surmaps"*). Also to some extent from the Agents detailed overleaf and from the Directors of Survey Circles. A **MAP CATALOGUE**, which itself forms a useful atlas of India and surrounding countries, can be obtained for *Re. 1/- (post free)*.

FOREST AND CANTONMENT MAPS are obtainable from the Map Office, Survey of India, Dehra Dūn. (*Tel. "Surtrig"*).

GEOLOGICAL MAPS are prepared by and can be obtained from the Director, Geological Survey, Calcutta.

SURVEY PUBLICATIONS OTHER THAN MAPS are obtainable through the Director, Geodetic Branch, Survey of India, Dehra Dūn, who will supply *gratis* a full *Catalogue* of the following :

- (a) *Trigonometrical data.* Triangulation pamphlets, each covering one square degree, giving descriptions, positions, and heights of triangulated points and other data, with chart. Levelling pamphlets, each covering $4^{\circ} \times 4^{\circ}$, giving descriptions and heights of Bench-marks, with chart.
- (b) *Tidal Predictions*, published annually in advance as *Tide Tables of the Indian Ocean*. These tables contain predictions for about 40 Indian and Burmese ports, and for about 25 other ports in various parts of the world.
- (c) *Geodetic works of Reference*—The G.T.S. series of twenty-one large quarto volumes describing in detail the geodetic operations of the Great Trigonometrical Survey from 1800. Detailed accounts are given of the Base-line measurements, of the reduction of the Geodetic Triangulation treated in five portions, of the early Pendulum observations, of Telegraphic Longitude and Astronomical Latitude operations, of Tidal observations, and of Levelling of high precision.
- (d) *Historical, and General Reports*, including the "Memoirs on Indian Surveys" by Sir Clements Markham and C.E.D. Black: also Annual Reports, Narrative Reports, Record Volumes, and the annual Geodetic Reports.
- (e) *Miscellaneous.* Papers on Geodesy, Exploration, etc.

(The Catalogue is also included in the Annual Geodetic Report.)

III. LIST OF AGENTS FOR THE SALE OF MAPS

- OUT OF INDIA.**
- England.* 1. Secretary to the High Commissioner for India. (General Department), India House, Aldwych, London, W. C. 2.
2. Sifton Praed & Co. Ltd., The Map House, 67 St. James's Street, London, S. W. 1.
- America.* 3. C. S. Hammond & Co., 30 Church Street, Hudson Terminal, New York, and 75 State Street, Boston, Mass.
- Germany.* 4. Dietrich Reimer, Berlin, S. W. 48.
- INDIA.**
- Āgra.* 1. English Book Depot, Tāj Road.
2. Indian Army, Book Depot, Dayal Bagh.
- Allahābād.* 3. North India Christian Tract and Book Society.
- Ambāla.* 4. Ram Chander & Sons.
- Bangalore.* 5. Higginbothams Ltd.
- Bombay.* 6. Thacker & Co.
7. D. B. Taraporevala Sons & Co.
8. King & Co., 213-215 Badri Mahal, Hornby Road.
- Calcutta.* 9. W. Newman & Co., 3 Old Court House Street.
10. Automobile Association of Bengal, 40 Chowringhee.
11. City Map Agency, Govt. Book Depot, 8 Hastings St.
12. Oxford Book & Stationery Co., 37/39 Park St.
13. Standard Book & Map Agency, Ballygunge.
14. S. K. Khana & Co., B. 45 Municipal Market.
15. Thacker Spink & Co., 3 Esplanade East.
- Cawnpore.* 16. Advani Brothers.
- Dacca.* 17. Provincial Library.
- Darjeeling.* 18. Oxford Book and Stationery Co.
- Delhi.* 19. Oxford Book and Stationery Co., Kashmere Gate.
20. Romesh Book Depot and Stationery Mart.
21. J. M. Jaina & Brothers, Mori Gate.
22. Bhawani & Sons, Connaught Place.
- Ferozapore.* 23. English Book Depot, Wazir Ali Buildings.
- Jhānsi.* 24. English Book Depot.
- Karāchi.* 25. Hoosenbhoy Karimji & Sons, Napier Road.
26. Keale & Co., Book Corner, Elphinstone Street.
- Kasauli.* 27. Ram Chander & Sons.
- Kashmīr.* 28. Cockburns Agency, Srīnagar.
29. Beckett & Co., Srīnagar.
30. D. G. Smith & Co., Srīnagar.
- Lahore.* 31. Punjab Religious Book Society, Anarkali.
32. Standard Book Depot.
33. Oxford Book & Stationery Co.
- Lucknow.* 34. Davy & Co.
- Madrās.* 35. Higginbothams Ltd.
- Meerut.* 36. Oxford Book & Stationery Co.
- Murree.* 37. J. Ray & Sons, The Mall.
- Mussoorie.* 38. The Mussoorie Book Society.
39. Davy & Co.
- Muzaffarpur.* 40. Burman & Co.
- Nagpur.* 41. Superintendent, Govt. Printing, Book Depot.
- Peshāwar.* 42. Northern India Book Depot.
43. Sham Lal & Sons.
- Quetta.* 44. Standard Book Stall, Club Corner.
- Rangoon.* 45. The Curator, Government Book Depot, Burma.
- Rawalpindi.* 46. J. Ray & Sons, 43 K & L, Edwardes Road.
- Simla.* 47. Oxford Book & Stationery Co.

NOTICES

- I. Work done by the Survey of India.
- II. How to obtain maps and other publications.
- III. List of Agents for the sale of maps.