SURVEY OF INDIA

GENERAL REPORT

1931 TO 1932

From 1st October 1931
To 30th September 1932

PUBLISHED BY ORDER OF

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

SURVEYOR GENERAL OF INDIA.

Printed at the Photo.-Litho. Office,
Survey of India,
CALCUTTA,
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Price One Rupee or One Shilling and Nine Pence.

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PREFACE

THE WORK OF THE SURVEY OF INDIA

This department is primarily responsible for all topographical surveys and explorations, for the maintenance of geographical maps of the greater part of Southern Asia, and also for geodetic work, which includes

The main trigonometrical framework, extending in some cases far beyond the frontiers of India, and control networks of precise levelling based on tidal observatories;

Tidal predictions, and the publication of tide tables for forty ports between Suez and Singapore;

The magnetic survey;

Astronomical, seismographic, and meteorological observations at Dehra Dūn;

Geodetic investigations of an international character, for which India, by its position between the greatest highlands of the world and a deep ocean extending to the Antarctic, enjoys a unique advantage.

Indian geodesy has disclosed by far the largest known anomalies of gravitational attraction in the earth's crust, which have led to some of the most important developments of modern geodetic research. The Great Trigonometrical Survey of India enjoys an international reputation for contributions to estimates of the size and exact shape of the earth, on which depend ultimately the calculations of astronomy and some important data in physics.

Survey programme.—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.

In 1905 however all revenue surveys were handed over to the Provinces concerned, in order to concentrate the energies of the department on a complete new series of modern topographical maps on the 1-inch to 1 mile scale, which it was hoped to complete by 1930.

Owing to retrenchment and the war however, little more than half this programme has been completed, in spite of the reduction of the scale of survey for the less important areas.

New surveys covering an area about equal to that of England are carried out every year, but the maps of nearly half the country are still very old and revised only roughly from information rather perfunctorily supplied by local officials; these old maps are also about two miles out in geographical position, being based on a longitude of Madras determined in 1815.

Owing to the serious financial situation of the country last year, drastic economy and reorganisation of the Survey of India was enforced, in consequence of which the completion of the first modern survey of the whole of India will not now be possible before 1950.

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 for important cities and military stations have been published, where the 1-inch to 1 mile scale is quite inadequate.

Miscellaneous. While expending on topographical and geodetic work all funds allotted by Imperial Revenues, the department is steadily developing the policy of aiding local surveys on payment by those concerned, such as

Forest and cantonment surveys;

Riverain, irrigation, railway, and city surveys;

Surveys of tea gardens, mining areas, &c., 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 do much work for other Government departments, such as printing special maps, illustrations for Archæological 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 equipment, especially optical, and by manufacturing and repairing instruments which would otherwise have to be imported from abroad.

Military. 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.

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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SURVEY OF INDIA

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INTRODUCTION AND SUMMARY.

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

General Report.

Geodetic Report.

Map Publication and Office Work Report.

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

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

The Geodetic Report includes full details of all scientific work.

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

The Index Map appearing at the end shows the progress of modern topographical surveys and compilation. Maps of sorts are of course available for all parts of the Indian Empire, but some 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.

2. General. Brigadier R. H. Thomas, D.S.O., on return from 3 months' leave, resumed charge of the office of Surveyor General from Colonel R. H. Phillimore, D.S.O., on 22nd November 1931.

His Majesty's Secretary of State for India has been pleased to sanction, as a special case, the extension of the service of Brigadier Thomas, D.S.O., as Surveyor General of India up to the 31st March 1933.

The post of Assistant Surveyor General was filled by Major R. S. Wauchope, O.B.E., I.A., upto 3rd May 1932, and thereafter by Major H. R. C. Meade, I.A.

3. The total cost of the Department for the past financial year ending 31st March 1932, as compared with that of previous years, was as follows:

	1929-30	1930-31	1931-32	REMARKS.
	Rs.	*Rs.*	*Rs.*	
Gross actual cost ...	65,06,835(*a*)	60,98,804(*b*)	48,06,113†	(*a*) Including Rs. 4,44,690 for English Charges (High Commissioner) on Stores, and loss or gain by exchange. (*b*) Including Rs. 2,99,160 for do. do.
Deduct receipts and credits	24,79,158	23,31,369	14,50,966†	
Nett actual charges ...	40,27,177	37,67,435	33,55,147†	†These figures are not final.
Total area of survey of all kinds completed during the year.	Square miles.	Square miles.	Square miles.	
	61,107	61,678*	37,924*	* *Vide* page 27.

4. Organization. The whole area of India and Burma has been re-divided for the purposes of the Survey of India into three Circles and two independent parties, the latter under the direct control of the Surveyor General. The limits of these as revised are shown by blue lines on the index map at the end of the book.

In order that civil administrations and the public may know which Director to address on survey matters, a list of Provinces and States comprised in each Circle is given in the loose slip containing Survey Notices.

Retrenchment.—Prior to the economy campaign the Department was administered by the Surveyor General, assisted by the Assistant Surveyor General and seven Directors in administrative charge of (*a*) five topographical Circles (*b*) the Geodetic Branch and (*c*) Map Publication Branch.

When the severity of the financial crisis was realised, it was found necessary to curtail severely the expenditure of the Department, and the

retrenchments effected as a result of the proposals advanced by the Surveyor General were as follows:—

Directorate.	Units controlled by Director before retrenchment.	Changes under retrenchment proposals.
Frontier Circle, Simla.	"A" Company, "E" Company, No. 23 Party, No. 18 Party and No. 6 Drawing Office.	No change.
Central Circle, Mussoorie.	Nos. 1 and 5 (Topographical) and 20 (Cantonment) Parties and No. 3 Drawing Office.	Circle together with its directorate and Drawing Office abolished. Nos. 1 and 20 (Cantonment) Parties transferred to the Geodetic Branch, and No. 5 Party to the Eastern Circle.
Eastern Circle, Shillong.	Nos. 4, 9 and 12 (Topographical) Parties and No. 5 Drawing Office.	No. 9 Party abolished and replaced by No. 5 Party transferred from Central Circle.
Southern Circle, Bangalore.	Nos. 6, 7 and 8 (Topographical) Parties and No. 4 Drawing Office.	Circle, directorate and units abolished, excepting No. 6 Party retained under the administration of the Surveyor General.
Burma Circle, Maymyo.	Nos. 10 and 11 (Topographical) and No. 21 (Forest) Parties and No. 7 Drawing Office.	Circle, directorate and units abolished, excepting No. 10 Party retained under the administration of the Surveyor General.
Geodetic Branch, Dehra Dūn.	Nos. 13, 14, 15, 17, 19, Computing and Tidal Parties, No. 2 Drawing Office and No. 16 Party (which included the Photo.-Zinco. Office).	Nos. 13, 16, 17 and 19 Parties abolished. Photo.-Zinco. Office transferred to Computing and Tidal Party. No. 1 Party and No. 20 Party (reduced to the status of a Detachment) transferred from Central Circle.
Map Publication Office, Calcutta.	No. 1 Drawing Office, the Photo.-Litho. Office and the Map Record and Issue Office, the Engraving Office under the direct control of the Director, and the Mathematical Instrument Office under a specialist officer.	No change.

The following changes have therefore taken place:—

(1) Circle Directors and Drawing Offices are reduced from six to three.

The office of the Director, Central Circle, was amalgamated with that of the Geodetic Branch, with effect from 1st March 1932, the post of Director being kept in abeyance and Lt.-Col. A. H. Gwyn, who was officiating in that post, reverting to his substantive appointment of Superintendent.

The posts of Directors, Burma and Southern Circles have been held in abeyance with effect from the 1st and 13th April 1932, respectively, the latter from the date of Lt.-Col. L. G. Crosthwait's proceeding on leave out of India. Lt.-Col. R. Foster, who was officiating as Director, Burma Circle, reverted to his substantive appointment of Superintendent from 1st April 1932.

The Drawing Offices attached to the Burma, Central and Southern Circles were abolished.

(2) Topographical Parties have been reduced from ten to six.

(3) No. 21 Burma Forest Party has been abolished.

(4) No. 20 (Cantonments) Party has been reduced to the status of a Detachment.

(5) Geodetic Parties have been reduced from six to three.

Retrenchment of personnel.—Establishment cadres have been reduced as follows:—

	Sanctioned cadre.	*Reduced strength.*
Class I—directly recruited officers (military officers and Dr. J. deGraaff Hunter).	52	30
Class I—promoted from Class II ...	11	6
Miscellaneous gazetted appointments (technical).	7	7
Class II	80	56
Upper Subordinate Service	113	64
Geodetic Computers	12	6
	Approximate Original strength.	*Approximate Reducd strength.*
Lower Subordinate Service	2100	1550
Inferior Servants	6100	3250

The above changes in organisation are based on the scheme of retrenchment adopted by the Government of India subject to the sanction of the Secretary of State. Under that scheme, which will come into full operation with effect from the 1932-33 budget, the nett expenditure of the Survey of India has been limited to Rs. 21½ lakhs against the sanctioned grant of Rs. 41½ lakhs nett for 1931-32.

The above figures show how hard the economy campaign has hit the Survey of India, harder perhaps than any other Department in India, leaving it practically only on a maintenance basis. The Surveyor General feels that most deserving of sympathy are the many individual Government servants with family responsibilities, who have spent many years in Government service, and have now to be retired compulsorily for no specific fault of their own.

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

Triangulation.—The ray from Mālik Surindra H. S. to Choto-i-jik H. S. (80 miles) observed this year by No. 15 Party in the Dālbandin Meridional Series, is the longest ray in the annals of Indian primary triangulation. The triangle Mālik Surindra—Salāmbek—Choto-i-jik has an area of 2,000 square miles and a spherical excess of 26″.

Boundary Survey.—

THE PERSO-BALUCH BOUNDARY PARTY was formed in February 1932 with the following personnel for special survey work on the Perso-Baluch Frontier:—

Captain Bomford, R.E., Superintendent in charge.

Mr. Khushal Khan, Sub-Assistant Superintendent.

Surveyors Muhammad Akram and Mian Muhammad.

The Party was under the direct administration of the Surveyor General and was disbanded from the 25th May.

1,900 square miles of practically unsurveyed country were triangulated and 2,880 square miles surveyed on the $\frac{1}{4}$-inch scale, and copies of the map were supplied to the Persian Government by October 1932.

THE AFGHĀN BOUNDARY PARTY was formed under the administrative control of the Director, Frontier Circle from the 23rd June, for survey work entailed by the demarcation of the Indo-Afghān boundary in the vicinity of Arnawai, Chitrāl, and consisted of:—

Captain Crone, R.E.

Surveyor Fateh Muhammad Khan.

15 Survey Khalasis.

They left Peshāwar on the 24th June and proceeded by the Lawarai Pass to Arnawai, and met the Afghān Boundary Commission there on the 1st July.

$2\frac{1}{2}$ square miles of boundary survey on the 4-inch scale and 264 square miles of reconnaissance and ground photography for photo-survey on the 1-inch and 2-inch scales were completed by the 11th July, and the Boundary Party returned to Murree and was disbanded on the 16th July.

Thanks to the courtesy of the Afghān delegates, Captain Crone was able to visit Busar Gāt, a point 11,700 feet high in Afghān territory west of the Kunar river, and to proceed down the Kunar Valley as far as Nāri; this enabled him to link up his survey work with that carried out by Colonel (later Sir Thomas) Holdich in 1895.

SYRIA-TRANS-JORDANIA BOUNDARY.—At the request of the Government of 'Irāq three surveyors were placed on deputation with them for about seven months from December 1931, for work in connection with the survey of the frontier between Syria and Trans-Jordania.

The Government of 'Irāq have expressed their appreciation of the excellent work done by them.

SWĀT BOUNDARY.—Surveyor Ghulam Muhammad, who retired from the Department on 1st November 1931, was re-employed by the Deputy Commissioner, Hazāra, in carrying out a survey of the disputed boundary between the territory of the Hasanzais and the Wali of Swāt near Bayosar.

The officer on special duty under the Deputy Commissioner, Hazāra, writes:—

> "Ghulam Muhammad accompanied me to the Tribal Territory "and has done splendidly".

TRIPURA STATE BOUNDARY (page 67).—The settlement of the Gaurangala Sibpur boundary dispute between Tripura State and Tippera district of Bengal was carried out by Mr. G. C. Aggarwala, B.A., Sub-Assistant Superintendent, who ran a traverse line along the boundary and prepared a plot on the 16-inch=1 mile scale for relaying in accordance with Mr. Roe's award map of 1850.

The boundary was accepted by the representatives of British India and Tripura State and it was arranged that pillars should be erected on the line demarcated.

Exploration.—

Surveyor Muhammad Ayub Khan accompanied Sir Aurel Stein on his latest archæological exploration through Persian Baluchistān from the Makrān Coast to Kermān. Before proceeding to Persia, Sir Aurel Stein carried out some archæological work in the neighbourhood of Jhelum and established the site, at Jalālpur, 30 miles south-west of Jhelum, of the grave of Bucephalus the famous horse of Alexander the Great.

Khan Sahib Afraz Gul Khan, who was on leave pending retirement from the department, was permitted to join Dr. de Terra's expedition to Eastern Ladākh in May 1932, during which he surveyed approximately 4,600 square miles on the ½-inch scale in sheets 52 J, K, N and O.

THE BRITISH KĀMET EXPEDITION of 1931 succeeded, in addition to reaching the summit of Kāmet (25,447 ft.), in reconnoitring 86 square miles of partly unexplored country in the Arwa valley on the half-inch scale, which has now been incorporated in the new maps of that area.

This reconnaissance was not carried out by trained surveyors, and portions of it differ so radically from the existing surveys, carried out in 1878, that in ordinary times it would have been incumbent on all concerned to settle the matter by a deliberate survey, a course which financial stringency unfortunately does not permit at present.

Surveys in Tribal Territory.—

"A" Company's summer field season during 1931 in North-West Frontier Province Tribal Territory and the Gilgit Agency brings to a close the sixth successive season in the mountainous country on the North-West Frontier. The country surveyed during 1930-31 included many peaks of over 23,000 feet, amongst them Nanga Parbat 26,620 ft. Most of the officers and surveyors have served in these areas throughout the whole period, under unusually trying conditions.

Two surveyors of No. 10 Party, working on the Upper Chindwin River, were able to penetrate the tribal territory of headhunting Nāgās, lying on the Assam-Burma boundary, and survey on the ½-inch scale 540 square miles of previously unmapped country (page 71).

Exercises and Manœuvres.—Captain Angwin, R.E., attended the Western Command Staff and Signal Exercise in May 1932.

The Western Command Divisional Exercise of October 1932, with which "E" Company were to have co-operated, had unfortunately to be cancelled owing to the prevalence of cholera.

Air survey.—Two methods of mapping from air photographs, recently evolved and developed in India, are described in the appendices of this Report. The first is specially applicable to mountainous inaccessible areas and the second to deliberate large-scale surveys in flat country.

In addition to the air survey by No. 18 Party (pages 52-53), an area of 951 square miles in the United Provinces was resurveyed from air photographs on the 1-inch scale (page 11).

Deputation and instruction of officers.—

Dr. J. deGraaff Hunter, M.A., Sc.D., F.Inst.P., was placed on deputation as delegate to the 2nd Conference of Empire Surveyors held in England in July 1931, at which the following papers from officers of the Survey of India were read:—

(1) "The lay-out of geodetic triangulation and the intervals between base-lines and Laplace points", by Dr. J. deGraaff Hunter, M.A., Sc.D., F.Inst.P.

(2) "Cadastral surveys by air photography in India", by Colonel R. H. Phillimore, D.S.O.

(3) "Rectangulation surveys for irrigation projects", by Lt.-Colonel J. D. Campbell, D.S.O., R.E., and Lt.-Colonel A. H. Gwyn, I.A.

(4) "Map reproduction in the tropics", partly contributed by Major T. M. M. Penney, R.E.

Dr. Hunter submitted a report on the Conference to the India Office, and the following is an extract from the letter of acknowledgment addressed by the Under Secretary of State for India, Economic and Overseas Department, to Dr. Hunter:—

"The Secretary of State desires me to convey to you his "appreciation of the valuable services rendered by you as "delegate".

Major H. R. C. Meade, I.A., during his leave visited the War Office and Southampton Ordnance Survey Offices in August and September 1931, and his "Notes on air survey and map publication in England in 1931" were published later as a Departmental Paper, with a foreword and additions incorporating Indian experience by Captain Crone, R.E., Officer in charge, No. 18 (Air survey) Party.

Captain D. R. Crone, R.E., was placed on deputation during his home leave in 1931-32, and visited the War Office and Southampton Ordnance Survey Offices and various instrument &c. makers in England, as well as the Survey Institute at Flums, Switzerland, with a view to studying the latest air survey developments.

Lectures.—At the request of Western Command, Captain Angwin, R.E., delivered a lecture on "Surveys" to the Command Intelligence Course at Quetta on the 23rd April, about 25 officers being present.

At the request of O. C. 31 Squadron, R. A. F., Captain Angwin, R.E., delivered a lecture on "Surveys and Maps" to about 60 R. A. F. Officers and men at Quetta on the 23rd July.

Adventures and Casualties.—The Surveyor General records with deep regret the death of the following officers:—

Captain D. M. Burn, R.E., formerly in the Survey of India, who was killed climbing in Kashmir on 12th August, 1932.

Captain W. A. J. Coldstream, I.M.S., who was the son of Colonel W. M. Coldstream, C.I.E., R.E., late of the Survey of India, and who served as Medical Officer to "A" Company during the Dīr, Swāt and Chitrāl Surveys, and was murdered at Peshāwar on 22nd July, 1932.

Two deaths occurred in No. 12 Party among the khalasis, one from cholera and the other from dysentery (page 68).

For the first time, khalasis recruited in Hazāribāgh were repatriated from Burma after the 1931-32 field season overland *vid* Manipur, instead of by sea *vid* Rangoon and Calcutta, with a considerable saving to Government (page 72).

As the result of a dug-out capsizing in a rapid in the Upper Chindwin River on 2nd June, one khalasi was drowned and three surveyors of No. 10 Party lost the whole of their kit (page 72).

During the field season No. 12 Party had to work in the very unsettled area near Comilla in East Bengal. Progress was held up considerably, but the only untoward incident was the theft on the 11th April of the whole of a squad's monthly pay (page 68).

Distinguished visitors.—Lt.-General H. H. Maharaja Sir Bhim Sham Shere Jung Bahadur Rana, G.C.S.I., G.C.M.G., K.C.V.O., Prime Minister and Commander-in-Chief of Nepāl, visited the headquarters offices in Calcutta on the 7th January 1932. His Highness subsequently wrote a very courteous letter to the Surveyor General expressing his appreciation of the visit and requesting that his hearty thanks be conveyed to Colonel Phillimore and the other officers.

Mr. George Phillips of George Phillips & Sons, publishers of Atlas maps, visited the Map Publication Offices at Calcutta on the 22nd January 1932.

6. Appreciations.—The following is an extract from para. 11 of the Administration Report by the Chief Engineer, Irrigation Works, Punjab, for the year 1930-31 :—

> "The Survey of India continued to make very satisfactory "progress on the surveys in connection with Bhakra Dam "project."

Mathematical Instrument Office.—The Superintendent received the thanks of the Bridge Engineer, Bengal-Nāgpur Railway, for manufacturing two Rotary Recording Deflectometers of an entirely new type for bridge-testing.

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

Class I Officers.—Major G. Lennox, I.A., Messrs. S. S. McA'Fee Fielding, H. P. D. Morton, J. H. Williams and P. A. T. Kenny retired.

Captain W. G. Irvine-Fortescue, M.C., R.E., reverted to military employ.

Lt.-Colonels L. C. Thuillier, I.A., L. G. Crosthwait, I.A., Major Kenneth Mason, M.C., R.E., and Mr. H. B. Simons were granted leave preparatory to retirement.

Major Mason took up the appointment of Professor of Geography, Oxford University, a newly created chair, from 2nd May, 1932.

Miscellaneous Gazetted Officers.—Mr. C. F. Oddy, Manager, Photo., Photo.-Litho. Office, was invalided.

Class II Officers.—Messrs. S. F. Norman, J. C. C. Lears, J. H. Johnson, R. C. Hanson and Abdul Karim, B.A., retired.

Mr. D. H. Luxa died.

Mr. D. D. Aggarwala, probationer, was discharged.

Messrs. A. M. Talati, L.C.E., A. B. Hunter, E. M. Kenny, P. N. Sur, L. B. Fitzgibbon, F. B. Kitchen, Munshi Lal, C. O. Picard, H. T. Hughes, H. H. P. Butterfield, G. A. Norman, M.B.E., M. S. Ganesa Aiyar, A. V. Dickson, S. R. Kelkar, S. R. Gupta, S. M. Murtaza, Khan Sahib Afraz Gul Khan, and D. N. Vasudeva, were granted leave preparatory to retirement.

Upper Subordinate Officers.—Rai Sahib Ram Prasad and Messrs. Imam Din, U. Pe, A.T.M., K.S.M., C.H., Bansi Ram, C. C. Biswas, Saiyid Budhan, Baldeo Bihari Lal and Shadi Lal Dube retired.

Mr. P. B. Roy died.

Khan Sahib Md. Husain Khan and Messrs. P. S. Vengusvami, Md. Husain, S. C. Mukherji, L. D. Joshi, D. R. Vohra, R. Bhamba Ram, C.H., Sajawal Khan, C.H., Jagannath, V. R. E. Nayadu, Abdul Majid, D. S. Gandhi, Abdul Karim I, M. L. Roy, Md. Siddik, Iltifat Husain, Ahmadullah Khan, L. M. Ganguli, R. C. Ray, S. N. Mitra, D. M. Das, T. N. Sharma, B.A., Md. Kudratullah Khan, R. K. Bhattacharji, B.A., K. N. Joarder, B.A., Quadir Dad and Hakdad Khan were granted leave preparatory to retirement.

Ten probationers recruited in 1928 were confirmed, and eight probationers recruited in 1930 were discharged.

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

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

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

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

9. N. W. F. Province.

Air surveys in Tīrāh and Mohmand Tribal territory (p. 53).

Topographical surveys in the Peshāwar and Hazāra districts (p. 51).

Framework. Triangulation in the Peshāwar district (p. 51).

10. Baluchistān.

Topographical surveys. Guide map of Quetta on 1/25,000 scale (pp. 51, 52).

City surveys. Corrections to the 16-inch map of Quetta Civil Station (pp. 51, 52).

Geodetic. Fourteen stations of Primary Triangulation were observed in Baluchistān (Dālbandin Meridional Series) (p. 15).

11. Punjab, Punjab States and Delhi.

Topographical surveys in Lahore, Ferozepore, Lyallpur, Montgomery, Multān, Jhang and Rāwalpindi districts (pp. 50, 51); and in Faridkot and Kalsia States (pp. 53, 54).

Revision surveys. In Delhi Province and in Gurgaon and Rohtak districts (pp. 56, 57).

Framework. Triangulation in Delhi Province, in Hissār, Karnāl and Rohtak districts and in Dujāna, Jind and Patiāla States (p. 54).

Traversing and rectangulation in Delhi Province, in Gurgaon, Hissār and Rohtak districts and in Dujāna, Jind, Lohāru and Pataudi States (p. 54).

Levelling. Tertiary levelling in Ferozepore, Hissār and Ludhiāna districts and in Faridkot and Kalsia States (pp. 53, 54).

Secondary levelling for the Bhakra Dam Irrigation Project in Delhi Province, in Hissār, Rohtak, Ferozepore, Karnāl, Ambāla and Ludhiāna districts and in Jind, Patiāla and Nābha States (p. 74).

Tertiary partal levelling from N. to S. and check-levelling of single tertiary lines from E. to W. in Bahāwalpur State (p. 74).

12. Rājputāna Agency, Ajmer-Merwāra and Bīkaner.

Topographical surveys in Ajmer-Merwāra Province and in Būndi, Jaipur, Jodhpur, Kishangarh, Lāwa, Shāhpura, Tonk and Udaipur States (pp. 56, 57).

Framework. Triangulation in Ajmer-Merwāra Province and in Bīkaner, Jaipur, Jodhpur, Kishangarh, Shāhpura and Udaipur States (p. 57). Traversing in Jodhpur State (p. 57).

Levelling. Tertiary levelling in Jodhpur State (p. 57).

13. Central India Agency and Gwalior.

Geodetic. Gravity at one station (p. 15).

14. United Provinces.

Air surveys. Resurvey in Hardoi, Kheri and Sitapur districts (page 14 of 1931-32 Map Publication Report).

Topographical revision surveys in Aligarh, Bulandshahr and Meerut districts (pp. 56, 57).

Cantonment surveys in Almora, Lansdowne, Rānīkhet and Roorkee (p. 58).

City surveys in Jhānsi (pp. 57, 58).

Geodetic. Gravity at thirteen stations (p. 15).

Framework. Theodolite and plane-table height traverse in Ballia district (p. 64).

15. Central Provinces.

Topographical surveys in Bālāghāt, Bhandāra, Bilāspur, Drug, Mandla and Raipur districts, and in Kawardha, Khairāgarh, Chhuikhadān and Nāndgaon States (pp. 65, 66).

Forest surveys. Some reserved forests in the South Mandla, North Raipur and Bilāspur Forest Divisions were included in the ordinary survey (pp. 65, 66).

Geodetic. Gravity at eleven stations (p. 15).

Framework in Chānda, Drug, Bilāspur, and Raipur districts and in Kawardha, Nāndgaon, Raigarh, Sakti, Sārangarh, Kānker and Bastar States (p. 66).

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

Topographical surveys in North Kanara district and Goa (pp. 59, 60).

Geodetic. Gravity at five stations (p. 15).

Levelling. Secondary levelling for the Lloyd Barrage Irrigation Project at Sukkur (p. 14).

17. Hyderābād.

Geodetic. Gravity at two stations (p. 15).

18. Madras Presidency and Madras States.

Topographical surveys in East Godāvari and Vizagapatam districts (p. 59).

Geodetic. Gravity at four stations (p. 15).

Framework. Triangulation in Ganjām and Vizagapatam districts (p. 60).

19. Bihār and Orissa.

Topographical surveys in Balasore district and in Mayūrbhanj State (p. 63).

Special Forest surveys. Several reserved forests in Sambalpur district (p. 64).

Geodetic. Gravity at six stations (p. 15).

Framework. Triangulation for connection of boundary traverse of reserved forests in Sambalpur district (pp. 63, 64).

Theodolite and plane-table height traverse in Gaya, Muzaffarpur, Patna, Sāran and Shāhābād districts (p. 64).

Levelling. Secondary levelling for the Bihār and Orissa Flood Area Irrigation Project in Balasore, Cuttack and Puri districts (p. 74).

20. Bengal Presidency and Sikkim.

Topographical surveys in Midnapore and Howrah districts (p. 63), in Tippera and Noākhāli districts and in Tripura State (p. 66).

Cantonment surveys in Jālāpahār and Lebong (p. 58).

Geodetic. Gravity at four stations (p. 15).

Miscellaneous. Boundary of Tripura State (p. 67).

Fixing of wireless mast at Chittagong (p. 67).

21. Assam and Bhutān.

Topographical surveys in Cāchār, Sylhet and Lushai Hills districts and in Manipur State (p. 66).

Forest surveys. Some reserved forests in the Cāchār and Lushai Hills Forest Divisions were included in the ordinary survey (p. 68).

Cantonment surveys. Revision survey of Shillong Cantonment (p. 62).

Framework. Triangulation in Lushai Hills district (pp. 67-68).

22. Burma.

Topographical surveys in Chin Hills district (p. 66), and in Upper Chindwin district and tribal area (pp. 70, 71).

Framework. Triangulation in Chin Hills district (p. 70), and in Upper Chindwin and Shwebo districts (pp. 70, 71, 72).

Traversing in Upper Chindwin district (pp. 70, 71).

II.—ABSTRACT OF GEODETIC OPERATIONS.

DIRECTOR:—{Lt.-Colonel F. J. M. King, R.E., from 1-10-31 to 20-10-31.
{Dr. J. de Graaff Hunter, M.A., Sc.D., F. Inst. P., from 21-10-31.

23. General.—Besides geodetic work, the Director, Geodetic Branch, administers at Dehra Dūn *No. 2 Drawing Office*, the *Forest Map Office* and a *Printing and Photo-Zinco Office*, whose work is reported in the annual Map Publication and Office Work Report, and also the following survey operations which are reported in other parts of the General Report:—

Levelling carried out in aid of special engineering projects, *vide* paras 124-125;

Topographical Survey carried out by *No. 1 Party* (paras. 69—73);

Cantonment Surveys (paras. 74—77 and 94) carried out by No. 20 Detachment.

Training School (now in abeyance).

No. 1 Party and No. 20 Detachment were transferred to Geodetic Branch from 1st March 1932.

The Publication and Stores Office was amalgamated with Computing and Tidal Party from 1st March 1932.

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;

Prediction of tides at 40 eastern ports between Suez and Singapore.

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

Geodetic Operations for 1931-32.

25. Observatory Section.—Bi-weekly time observations with the bent transit were continued, and a record of the longitude of Dehra Dūn was maintained by the reception of wireless time signals from Bordeaux and Rugby.

Experiments have been made with the Transit and Astrolabe in the hope of eliminating the personal equations of the observers. An electric drive for one Transit has been ordered from Messrs. Cook Troughton and Simms.

The latitude variation programme has been continued, the first year's results having indicated that a satisfactory degree of accuracy is being maintained.

The usual magnetic, seismographic and meteorological observations were undertaken.

Measuring tapes and other instruments have been standardized and overhauled.

Observations of the heights of certain snow peaks have been made from Mussoorie, in continuation of observations made 25 years ago by Mr. Shaw, with the intention of detecting any changes of height. The results show no evidence of a systematic change in the height of the peaks.

26. Computing Office.—The adjustment of the revised Mong Hsat series, observed in 1929-31, and its further extension to the Great Salween series has been completed between its terminal stations in the Mandalay Meridional and Great Salween series.

The rough graphical adjustment of minor triangulation in 1/M sheet 39 has been completed and that of sheet 34 and Synoptical Vol. I/A is in progress.

The triangulation from India and Burma through the Malay Peninsula to the Dutch East Indies and Philippine Islands has been examined to gauge the possibilities of a junction with Australia.

Editorial work of a revised edition of "Himālayan Geography and Geology" has been undertaken by Sir Sidney Burrard and Dr. A. M. Heron, and it is now under publication by the Government Press.

The following publications have been printed at Dehra Dūn :—

(*a*) Geodetic Report, Vol. VII.
(*b*) Professional Paper No. 27.
(*c*) Triangulation Tables of Auxiliary Tables, Part IV.
(*d*) Trig. Handbook (Part I), Geodetic Triangulation.
(*e*) Departmental Paper No. 14.
(*f*) One Persian and 19 Indian triangulation pamphlets have been compiled. Five new triangulation pamphlets have been published and addenda to 5 existing pamphlets have been reprinted. Addenda to 10 levelling pamphlets and 18 lists of protected primary bench-marks have been compiled and published.

As a measure of economy, the number of geodetic computers has been reduced from 12 to 6, one of whom is attached to the Frontier Circle.

27. Tidal Section.—Automatic registrations were continued at Aden, Basra, Karāchi, Bombay, Madras, Kidderpore, Rangoon, Trincomalee and Colombo. In addition, observations on tide-poles were continued during the year at Bhāvnagar, Chittagong and Akyab, and at Pilakāt or Deserters' Creek (Rangoon River) up to 31st March 1931.

The tidal observatories at Kidderpore and Karāchi were inspected by the Port authorities in August and December 1931 respectively. The observatory at Kidderpore was closed at its present site on 1st March 1932 and reopened at Garden Reach about 1 mile down stream on 17th March 1932.

The day and night hourly visual observations at Chāndbāli and Shortt Island on the Orissa coast, taken by the Port Officer for one year from 1st May 1931, have been reduced by the method of harmonic analysis and tide-tables for these ports will be published for the first time in 1934.

The "Tide-Tables of the Indian Ocean" for 1933 for 68 ports were completed, advance copies of which for certain Indian ports had been

despatched in December 1931 to the Admiralty and the Hydrographic Departments of the United States and Japan.

The prediction curves of the 40 Indian ports from Aden to Singapore for 1934 were run off on the predicting machine by February 1932.

28. Gravity Observations.—(No. 14 Party).—Observations to determine the force of gravity were made at one station in Central India Agency, thirteen stations in the United Provinces, eleven stations in the Central Provinces, five stations in the Bombay Presidency, two stations in Hyderābād, four stations in Madras Presidency, six stations in Bihār and Orissa and four stations in the Bengal Presidency.

A greatly increased out-turn was obtained by the use of motor transport.

29. Triangulation.—(No. 15 Party).—The programme consisted of the observation of the Dālbandin Meridional series, which connects the Kalāt Longitudinal and Makrān Longitudinal series in longitude 65°.

Twelve new stations were built and 14 stations observed at. Astronomical azimuths were observed at 5 stations and latitudes at 7 stations. Work started at Dālbandin on November 2nd and observations were completed on January 14th, the weather being excellent throughout.

Wild Precision Theodolite No. 59 was used. It had been returned to the maker and thoroughly adjusted by them, and was in excellent order. The average triangular error was 0″·71.

The ray between Mālik Surinda and Choto-i-jik stations (80 miles) is the longest ray in the Indian primary triangulation, and was observed without any difficulty.

30. High Precision Levelling (No. 15 Party).—During 1931-32 no high precision levelling was carried out.

III.—ABSTRACT OF MAP PUBLICATION AND OFFICE WORK.

31. Full Reports of the work of all drawing, printing, and miscellaneous offices of the department, with *Index Maps* showing the progress and present state of map publication on various scales have been published separately in the *Map Publication and Office Work Report* for the financial year ending 31st March 1932.

The following extracts from the full Report show the progress of publications, issues, manufacture and sales.

Table I *(a)*—Maps published at Calcutta, during the year 1931-32.

Class of maps.	Scale.	New publications.	Revised editions, new editions and reprints.	Number of Copies printed.	Value. Rs.
		Departmental.			
GENERAL MAPS.					
Maps of India	Various	2	4	7,822	11,026
GEOGRAPHICAL MAPS.					
Southern Asia Series ...	1:2 million	1	2	970	2,342
India and Adjacent Countries Series	1:1 million	2	20	7,940	13,373
Carte Internationale du Monde	1:1 million	...	1	500	1,000
TOPOGRAPHICAL MAPS.					
Quarter-inch, Modern ...	1″=4 miles	16	34	23,358	35,586
,, (Prely.) ...	Ditto	1	16	7,445	11,783
,, (Provl.) ...	Ditto	...	5	1,436	2,104
Half-inch, Modern ...	1″=2 miles	39	22	31,205	63,157
One-inch, Modern ...	1″=1 mile	160	132	189,069	2,91,144
,, (Prely.) ...	Ditto	5	6	12,231	20,063
,, (Provl.) ...	Ditto	...	9	2,586	3,055
Old-style maps	Various	...	60	12,630	18,053
SPECIAL MAPS.					
Manœuvre and Radius maps ...	1″=4 miles	4	7	12,335	26,387
City & Town Guide maps ...	Various	2	4	3,108	6,986
Provincial maps	Ditto	...	6	2,990	10,366
Index maps	Ditto	131	11	82,600	11,260
Miscellaneous maps ...	Ditto	51	62	67,035	8,221
Total ...	.....	**414**	**401**	**465,260**	**5,35,856**
		Extra-departmental.			
Maps...	Various	223	26	120,960	41,642
Plans and diagrams ...	Ditto	49	30	40,694	2,548
Illustrations	.....	66	2	81,102	7,220
Miscellaneous	.....	24	21	37,173	3,381
Total ...	.....	**362**	**79**	**279,929**	**54,791**
Grand Total ...	.....	**776**	**480**	**745,189**	**5,90,647**

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

Class of maps.	Scale.	New publications.	Reprints and new editions.	Number of copies printed.	Value. Rs.
		Departmental.			
Cantonment maps ...	Various	14	74	5,469	6,709
Forest maps ...	,,	...	160	7,449	10,100
Miscellaneous ...	,,	...	35	14,609	4,186
Total ...	...	**14**	**269**	**27,527**	**20,995**
		Extra-departmental.			
Maps	Various	14	91	46,800	10,281
Plans and diagrams ...	,,	113	20	11,457	2,416
Charts	,,	214	...	9,583	6,813
Forest maps ...	,,	4	67	6,408	7,281
Total ...	...	**345**	**178**	**74,248**	**26,791**
Grand Total ...	...	**359**	**447**	**1,01,775**	**47,786**

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

Class of maps.	Scale.	New publications.	Reprints and new editions.	Number of copies printed.	Value. Rs.
		Departmental.			
Guide maps (Madura, Tanjore and Kumbakonam).	3″=1 mile	3	...	300	.....
Total ...	...	**3**	...	**300**	.....
		Extra-departmental.			
Forest maps, Hyderābād	2″=1 mile	38	...	.....	836
Forest maps, Mysore ...	Various	16	1	1,045	762
Private Estates ...	,,	13	...	151	2,174
Plans and diagrams ...	,,	10	1	3,076	1,000
Total ...	...	**77**	**2**	**4,272**	**4,772**
Grand Total ...	...	**80**	**2**	**4,572**	**4,772**

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

Class of maps.	Scale.	New publications.	Reprints and new editions.	Number of copies printed.	Value. Rs.
		Departmental.			
Maps	Various	62	8	1,535	1,659
Plans and diagrams ...	,,	11	...	613	164
Charts / Forms	,,	10	1	178	66
Total ...	...	**83**	**9**	**2,326**	**1,889**
		Extra-departmental.			
Maps	Various	19	9	3,895	758
Plans and diagrams ...	,,	11	4	3,941	297
Charts / Forms	,,	75	...	17,735	6,095
Total ...	...	**105**	**13**	**25,571**	**7,150**
Grand Total ...	...	**188**	**22**	**27,897**	**9,039**

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

Class of maps.	Scale.	New publications.	Reprints and new editions.	Number of copies printed.	Value. Rs.
		Departmental.			
Maps	Various	...	...	3,236	2,947
Plans and diagrams ...	,,	...	...	159	115
Charts / Forms	,,	...	...	18 3,672	35 756
Total ...	...	...	...	**7,085**	**3,853**
		Extra-departmental.			
Maps	Various	...	...	3,271	1,288
Plans and diagrams ...	,,	...	...	12	7
Charts / Forms	,,	...	...	...	.....
Total ...	...	...	...	**3,283**	**1,295**
Grand Total ...	...	...	...	**10,368**	**5,148**

Table II.—Abstract of Modern Topographical Maps.

	One-inch sheets.	Half-inch sheets.	Quarter-inch sheets.
Topographical maps published in 1931-32	160	39	16
Do. do. published in previous years.	3,050	832	283
Total published ...	**3,210**	**871**	**299**
Number of sheets in India ...	**6,218**	**1,630**	**450**

32. Notes.—*Calcutta.*—In addition to the work shown in Table I(*a*), 64,735 copies of 223 maps were gridded during the year.

33. *Dehra Dūn.*—In addition to the work shown in Table I(*b*), 48,208 prints of 710 originals, consisting of plane-table sections, triangulation charts and pamphlets, and forest maps were printed.

Table III.—Letterpress publications.

(*a*) Published at Calcutta.

1. General Report of the Survey of India, 1929-30. (500).*
2. Confidential Supplement to the Survey of India General Report for 1929-30. (160).
3. New Catalogue of the Survey of India maps. (2,000).
4. Survey of India Notes,—issued monthly. (4,550).
5. List of maps published,—issued monthly. (9,960).
6. List of F. O. U. O. maps published,—issued quarterly. (800).
7. Correction slips to Handbooks of Topography, Type Table, Border Specimen, Conventional Signs, etc. (70,065).
8. Government of India and Circular Orders and Circular Memos., etc., (2,400).
9. Calendar for 1932. (2,100).
10. Miscellaneous. (4,800).

(*b*) *In hand at Calcutta.*

1. *General Report, Survey of India, 1930-31.*
2. *Confidential Supplement to the Survey of India Reports, 1930-31.*
3. *Map Publication and Office Work Report, 1930-31.*
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. *Handbook of Topography Chapter I (5th Edition).*
6. *Price list of maps for 1931.*

(*c*) Published at Dehra Dūn.

1. Geodetic Report Vol. VI. (450).*
2. Supplement to Geodetic Report, Vol. VI. (100).
3. Tide Tables of the Indian Ocean 1932. (2,500).
4. do. Bombay 1932. (1,000).
5. do. Rangoon 1932. (970).
6. do. Hooghly 1932. (275).
7. do. Hooghly (Port Commissioners). (1,000).
8. List of Publications (corrected upto 31-12-30). (100).
9. Levelling Pamphlets 54, 56 and 72. (590).

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

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

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

10. Addendum to Levelling Pamphlets 54 and 63. (350).
11. Triangulation Pamphlets. (1,900).
12. Auxiliary Tables, Parts, II and IV. (660).
13. Departmental Paper No. 10. (250).
14. Triangulation Handbook. (375).
15. Lists of bench-marks and Schedule of bearings. (8).
16. Calendar for 1932. (300).
17. Correction slips to Triangulation Pamphlets, Handbooks of Topography, etc. (6,230).
18. Miscellaneous. (262,591).

(d) In hand at Dehra Dūn.

1. *Report on No. 24 Party.*
2. *Auxiliary Tables, Part V.*
3. *Tide Tables for Indian Ocean for 1933.*
4. *Addendum to Special Publication No. 2.*
5. *Departmental Paper No. 14.*
6. *Professional Paper No. 27.*
7. *Geodetic Report, Vol. VII.*
8. *List of Publications (corrected upto 31-12-31).*
9. *Triangulation Pamphlets.*

34. Map Issues.—Table IV shows the total issues of maps by the Survey of India during the year.

The new headings under which these are divided for the first time this year show clearly that the Government and Military Services are at present the main purchasers of maps.

In value, the Army accounted for roughly 50% of all sales, other Government Departments 30%, and the public 20%.

Sales to the general public have not hitherto been separated, but a steady increase is evident, and should continue as the general utility of maps for travel and reference becomes more widely understood.

The number of departmental maps sold during the year by the Map Record and Issue Office totalled 188,452, a decrease of 50,681 on the previous year's figures; payments for these maps however were only Rs. 30,854 less. Incidentally last year's figures included large numbers of maps required for military operations at Peshāwar.

A certain decrease in total sales is only to be expected during the present financial crisis, and the diagram showing *progress of sales* from year to year shows that the decrease, taken over the whole department, has been remarkably small.

Comparing the sales from other units with those of the previous year, a general falling off is apparent, except in the case of the Burma Circle, where sales have been extraordinarily high owing to the military operations.

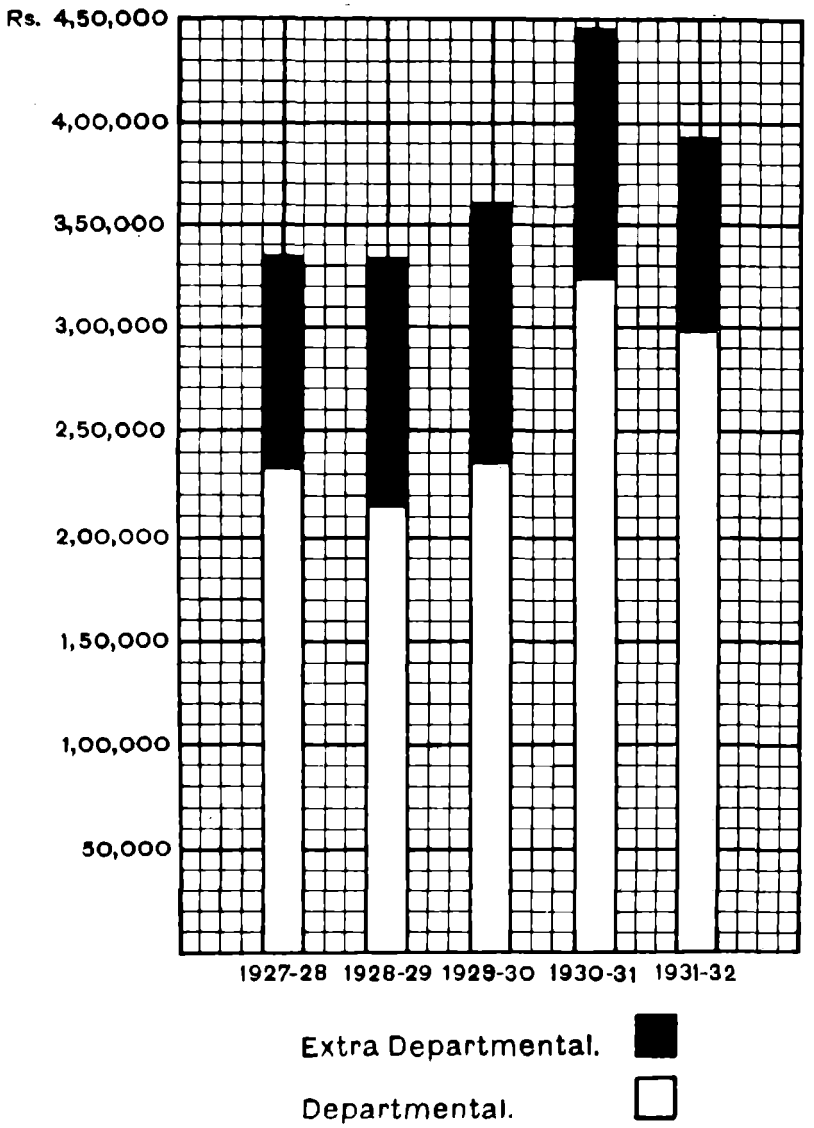
Table IV. Maps issued by Survey units.

D=Departmental. X=Extra-departmental.		SALES.								FREE ISSUES.
		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.	Number of copies.
Calcutta	D	43,002	52,143	118,026	1,34,516	27,424	37,831	188,452	2,24,492	21,250
	X	124,096	32,518	10,524	4,229	145,176	19,866	279,796	56,613	2,208
Dehra Dūn & Mussoorie	D	3,713	10,238	4,380	6,842	715	1,348	8,808	18,428	14,858
	X	29,325	24,816	1,773	443	4,089	2,975	35,187	28,734	.....
Simla	D	.....	.....	.....	.....	129	227	129	227	792
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Murree ('A' Company)	D	97	153	43	70	37	60	177	283	.....
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Quetta ('E' Company)	D	27	50	37	45	14	23	78	118	762
	X	18,810	6,268	2,538	586	4,223	296	25,571	7,150	.....
Peshāwar (No. 18 Party)	D	.....	.....	.....	.....	.....	.....	.....	.....	.....
	X	.....	.....	3,258	1,239	10	16	3,268	1,255	7,199
Bangalore	D	760	1,109	.....	.....	3,234	5,049	3,994	6,158	.....
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Shillong	D	374	626	53	53	195	417	622	1,096	1,170
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Maymyo	D	1,514	3,959	11,557	22,672	279	799	13,350	27,470	447*
	X	.....	.....	.....	.....	.....	.....	.....	.....	.....
Totals	...	221,718	1,31,880	152,189	1,70,697	185,525	68,907	559,432	3,72,024	48,686

* Though shown as free issues the cost is covered by the contribution towards the survey.

PROGRESS OF MAP SALES

1927—32



This diagram represents the aggregate sales of the entire Department. The diagram in the previous year's Report showed the sales by the Map Record and Issue Office only.

35. Map Record and Issue Office. The rearrangement of original records and planetable sections in the new steel racks was completed during the year, this has resulted in one room becoming available for the storage of departmental office forms.

Map mounting is now carried out in one wing of the building, but for want of space hand-mounting has still to be done on the floor of the verandah.

The map mounting machine worked well, and the total number of sheets machine-mounted was 74,406, which is the largest number ever mounted in a single year and is an increase of about 28% on last year's figures. This method of mounting maps on thin linen is rapidly gaining in popularity owing to its cheapness.

The Despatch Section has been moved from the centre of the building to the west wing, near the main gate, where it is more conveniently situated for handling heavy packages.

The new Map Catalogue was published in December. It appears to be satisfactory for departmental use and more intelligible to the general public than the former catalogue. The procedure for keeping it revised works well, and up-to-date copies are always available.

Book-sellers in important centres have been encouraged to take up agencies for the sale of Survey of India maps. The sales effected through these agencies amounted to Rs. 14,387 which is rather more than one-third the value of departmental maps sold to the public during the year.

A leading steamship company has kindly consented to carry a stock of maps of India for sale to passengers. The success of this experiment will not be known until next year, but it is hoped that this will result in further popularizing Survey of India maps.

36. Stock of Maps. The table below gives the stock of maps as it stood on 31st March 1932.

Class of maps.	CALCUTTA.		DEHRA DŪN.		SHILLONG.		SIMLA.		PESHĀWAR AND MURREE.		QUETTA.		MAYMYO.		BANGALORE.		TOTAL.	
	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.	Present Face Value Rs.
1/2M Southern Asia Series ...	8,530	19,874	146	320	...	...	54	135	39	94	20	44	...	...	20	49	8,809	20,5
1/M India and Adjacent Countries	40,853	65,735	1,261	1,971	...	...	475	687	257	389	93	143	435	646	428	692	43,802	70,2
1/M Carte Internationale du Monde	4,599	9,214	431	862	155	233	39	78	11	22	...	...	...	...	46	92	5,281	10,5
Two-inch maps	11,054	32,507	8,060	16,875	...	...	...	...	...	...	...	...	...	...	...	...	19,114	49,3
One-inch maps	1,184,205	17,82,741	51,253	76,799	19,180	28,770	2,578	3,886	4,135	6,203	920	1,350	24,805	31,205	3,643	5,738	1,290,719	19,36,6
Half-inch maps	331,036	6,58,905	11,476	22,882	5,009	10,018	1,182	2,376	1,118	2,236	251	358	3,947	7,400	753	1,465	354,772	7,05,6
Quarter-inch maps	267,478	4,25,017	7,575	11,291	2,936	4,404	1,928	2,914	1,253	1,880	286	329	3,692	5,144	382	480	285,530	4,51,4
General maps of India ...	19,273	37,668	590	795	64	204	52	152	5	7	...	...	...	...	48	196	20,032	39,0
Provincial and District maps of India	7,985	27,830	738	1,160	672	1,193	25	87	...	...	...	...	89	161	48	208	9,557	30,6
Cantonment and Town maps (Special and Guide).	41,943	1,20,038	12,103	25,431	171	403	344	2,295	129	214	16	44	111	235	181	362	54,998	1,49,0
Manœuvre and Radius maps ...	8,087	16,804	120	238	...	...	11	26	...	...	...	...	...	...	...	...	8,218	17,0
Miscellaneous maps	53,302	60,967	13,675	19,989	270	542	29	87	2	2	8	16	...	...	256	557	67,542	82,1
TOTAL ...	1,978,345	32,57,300	107,428	1,78,613	28,457	45,767	6,717	12,723	6,949	11,047	1,594	2,284	33,079	44,791	5,805	9,839	2,168,374	35,62,3

37. Mathematical Instrument Office. The demands on this office for the supply of instruments show a marked decrease. The total repairs done in the Workshops during the year under review has been exceptionally good in comparison with those of the previous years. The manufacture out-turn has decreased considerably owing to there being no demand for new instruments, but the decrease has been more than covered by the repair work out-turn.

	1929-30.	1930-31.	1931-32.
	Rs.	*Rs.*	Rs.
1. Total value of stores issued ...	4,20,131	3,78,291	**1,71,700**
2. ,, ,, ,, repairs carried out to orders	2,21,510	2,13,906	**3,16,950**
3. ,, ,, ,, instruments, &c., returned to store	44,921	48,547	**30,534**
4. *Book Value of stock in—*			
(*a*) Serviceable store	4,10,839	4,54,147	**4,56,869**
(*b*) Repairable ,, ...	1,06,575	1,28,331	**1,44,197**
(*c*) Material ,, ...	2,00,288	2,06,718	**1,90,688**
5. *Value of New Instruments—*			
(*a*) Manufactured in Workshop ...	1,79,842	1,62,717	**85,065**
(*b*) Purchased locally	28,363	45,930	**16,222**
(*c*) Imported through the Stores Department, London ...	2,31,128	1,47,130	**36,085**
6. Total value of work done in the workshop	5,25,686	4,67,145	**4,89,189**
7. Value obtained by sale of obsolescent and condemned stores ...	1,148	2,625	**687**
8. *Employees—*			
(*a*) Average number	490	463	**438**
(*b*) Cost of employees including pension contribution ...	2,02,734	1,94,262	**1,89,812**

IV.—ABSTRACT OF TOPOGRAPHICAL WORK.

38. 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.

39. Progress. It was hoped in 1905 that maps on the scale of 1 inch to 1 mile would be available for the whole Indian Empire within 25 years, but the work has been greatly 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, we may regard about half the work 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 some important frontier tracts and is badly needed in some other areas. The figures for this work are given in italics in Table B.

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

Table A.—Progress of Topographical Surveys since 1905.

Survey years.	1-inch and larger scales.	¾ and ½-inch scales.	⅜ and ¼-inch scales.	TOTALS.
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Sq. miles.*
1905-10 ...				
1910-15 ...				
1915-20 ...	861,723	156,154	17,986	1,035,863
1920-25 ...				
1925-30 ...				
1930-31 ...	38,525	11,995	7,943	58,463
1931-32 ...	**24,679**	**10,097**	.....	**34,776**
Totals to 1932 ...	**924,927**	**178,246**	**25,929**	**1,129,102**
Balance remaining	*379,212*	*268,182*	*108,191*	*755,585*
Total programme	**1,304,139**	**446,428**	**134,120**	**1,884,687**

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

Up to 1930 ...	*8,071*	*Nil*	*Nil*	*8,071*
1930-31 ...	*2,901*	*314*	*Nil*	*3,215*
1931-32 ...	**2,834**	**314**	**Nil**	**3,148**
Total Revision and Resurvey.	*13,806*	*628*	*Nil*	*14,434*

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	Remarks.
				Sq. m.	Rs.	Sq. m.	Rs.	**FRONTIER CIRCLE.**
"A" Company.—Punjab and North-West Frontier Province.								
Low hills and plains ...	4-inch	**Triangulation**	38 N & O ...	130	.....	**130**	**1,34,260**	
Punjab plains ...	**1-inch**	Original survey ...	44 B & F ...	4098	.....			
Medium hills partly wooded	**1½-inch**	Re-survey ...	43 G ...	64(b)	.....	**4,233**		(b) Training area.
Special Surveys.								
Low hills and plains ...	**4-inch**	Original survey ...	38 N & O ...	71	.....			
"E" Company.—Baluchistan.								
Rugged hills and open plains and environs of Quetta.	**1/25,000**	Re-survey ...	34 J & N ...	129	.....	**129**	**9,051(c)**	(c) Includes Rs. 2,112 spent in survey year 1930-31 for correction of fair sheets not yet completed.
City area (Quetta Civil Station).	16-inch	Corrections ...	34 N ...	3(d)	.....			(d) Incorporated in 1/25000 map of Quetta.

TABLE C I.—FIELD WORK.—Areas and Cost rates of surveys, 1931-32.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	Remarks.
No. 18 (Air Survey) Party.—Punjab and North-West Frontier Province.				Sq. m.	Rs.	Sq. m.	Rs.	**FRONTIER CIRCLE.—*Contd.***
Open Medium hills ...	**1-inch**	Plane-table control (air survey).	38 O ...	100	0·6	**100**	**38,522**	
Rugged mountainous country (5,000—11,000 feet).	**1½-inch**	Original air survey.	... ...	Gaps	.....			
Steep partly wooded mountains (3,000—11,000 feet).	**1½-inch**	Original air survey.	38 K & O ...	121	.....			
Steep partly wooded mountains (4,000—15,000 feet).	**1½-inch**	Original oblique air survey.	38 K ...	220	20·7	**1,030**		
Steep partly wooded mountains (3,000—11,000 feet).	**1-inch**	Original provisional air survey.	38 O ...	143	59·8(e)			(e) Includes cost of fair drawing. Costs do not include cost of flying time or photographs. In the case of Tirāh, R. A. F. cost rates are approximately Rs. 15 per square mile for vertical photography and Rs. 3 per square mile for oblique photography.
Medium hills with open cultivated valleys.	**1-inch**	Original provisional air survey.	38 N ...	380	32·8(e)			
Ditto.	**1½-inch**	Original air survey.	38 N ...	.....	.....			
Open plains and low broken hills.	**3-inch**	Revision air survey.	38 N ...	116	24·2			
Open plains low broken hills	**1½-inch**	Revision survey	38 O ...	50	3·4			

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	Remarks.
No. 23 Party.—Punjab.				Sq. m.	Rs.	Sq. m.		**FRONTIER CIRCLE.—** *Concld.*
SPECIAL SURVEYS.								
Flat cultivated plains interspersed with trees, scrub and sand hills.	4-inch	Original Irrigation survey.	44 I, J, M & N ...	1,524	27·8	**1,524**	**Rs. 3,53,968 (Total cost of party for all kinds of work done on the Bhakra Dam, Muzaffargarh and Haveli Projects).**	
		Triangulation to control traversing (including computations).	53 C, D & H ...	863	7·5	**863**		
		Traversing and rectangulation to 3000 acres (including computations and cost and embedding of markstones).	44 P, 53 C, D, G & H.	2,920	16·3	**2,920**		
		Rectangulation to 25 acres (including cost and embedding of markstones).	44 O & P, 53 C & D.	1,269	125·6	**1,269**		
		Tertiary levelling (including computations and compilation of spot level charts).	44 J, N, O & P ...	1,242	29·6	**1,242**		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	Remarks.
No. 1 Party.—(Geodetic Branch).				Sq. m.	Rs.	Sq. m.	Rs.	**GEODETIC BRANCH.**
Open flat and low hills ...	**1-inch**	Original survey	45 N/4, 8 & 45 O/1, 2, 5, 6.	1,607	20·41		**73,710**	
Open flat with low sand hills	**½-inch**	Original survey	45 M/3, 4, 7, 8, 45 N/1, 2, 3, 5, 6, 7, 11, 12, 15, 16 & 45 O/9, 10, 13, 14.	4,797	5·34			
Dense with high grass and babul trees.	**1-inch**	Revision survey	534* ...	150	12·1	**6,554**		*Along Jumna River bank only.
Open flat and sandy ...	**8-inch**	Original survey	Part of 45 C/1 (In Pachbhadra Salt Source only).	32·33	104·5	**3,233**		Special survey.
Partly hilly and Partly undulating plains.	1-inch	**Triangulation**	45 G/15, 45 K/1, 2, 5, 6, 9, 10, 13, 14.	2,414	1·34			
Undulating ground with low sandy hills.	½-inch	**Triangulation**	45 I/9, 10, 11, 12, 16.	1,322	3·1	**3,736**		
Open flat and sandy ...	8-inch	**Traversing** ...	Part of 45 C/1, (In Pachbhadra Salt Source only).	75 L. miles.	25·5	**75 L. miles.**		
Ditto ...	8-inch	**Levelling** ...	Do.	117 L. miles.	6·2	**117 L. miles.**		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

PARTY AND LOCALITY. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	REMARKS.
No. 20 Party.—(Cantonments) Detachment. United Provinces and Bengal.				Sq. m.	Rs.	Sq. m.	Rs.	**GEODETIC BRANCH.—**
								Contd.
Hill Cantonments ...	16-inch	**Traversing** ...	53. O, 78. A & 53. K.	54 L. miles.	36·9 per linear mile.		**44,850**	Almora, Lebong, Jālāpahār and part of Lansdowne.
Ditto ...	64-inch	**Traversing** ...	78. A & 53. K ...	3 L. miles.	64·5 per linear mile.			Jālāpahār and part of Lansdowne.
Plains Cantonments ...	16-inch	**Traversing** ...	53. G & H & 54. K & M.	264 L. miles.	36·9 per linear mile.			Roorkee, Meerut, Jhānsi and Shāhjahānpur Cantonments.
Ditto ...	64-inch	**Traversing** ...	Do.	36 L. miles.	64·5 per linear mile.			Ditto.
City area	132-inch	**Traversing** ...	54. K ...	29 L. miles.	61·3 per linear mile.	**386 L. miles.**		Jhānsi City (Special survey).
Hill Cantonments ...	16-inch	**Levelling** ...	53. O & 78. A ...	27 L. miles.				Almora, Lebong and Jālāpahār Cantonments.
Plains Cantonments ...	16-inch	**Levelling** ...	53. G & 54. M ...	42 L. miles.	6·7 per linear mile.			Roorkee and Shāhjahānpur Cantonments.
Hill Cantonments ...	16-inch	**Spot-Levelling**	53. O ...	79 L. miles.		**148 L. miles.**		Rānīkhet and Almora Cantonments.

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	Remarks.
No. 20 Party.—(Cantonments) Detachment. United Provinces and Bengal.—*Concld.*				Sq. m.	Rs.	Sq. m.	Rs.	**GEODETIC BRANCH.—*Concld.***
Hill Cantonments ...	**16-inch**	Re-survey ...	53. O ...	4,924 Acres.	2·9 per acre.			Rānīkhet Cantonment.
Ditto ...	**64-inch**	Re-survey ...	Do. ...	98 Acres.	16·3 per acre.			Rānīkhet Cantonment Bāzārs.
Ditto ...	**16-inch**	Revision survey	53. K & O & 78. A.	2,724 Acres.	2·1 per acre.			Lansdowne, Almora, Lebong and Jālāpahār Cantoments.
Ditto ...	**64-inch**	Revision survey	53. K ...	23 Acres.	26·5 per acre.			Lansdowne Cantonment Bāzārs.
Plains Cantonments ...	**16-inch**	Revision survey	53. G ...	2,366 Acres.	2·1 per acre.			Roorkee Cantonment.
Ditto ...	**64-inch**	Revision survey	Do. ...	12 Acres.	26·5 per acre.			Roorkee Cantonment Bāzārs.
Ditto ...	**132-inch**	Original Survey	54. K ...	122 Acres.	22·3 per acre.	**10,269 Acres.**		Jhānsi City (Special survey).

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

Party and Locality. Character of country	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	Remarks.
No. 6 (South India) Party.—Bombay, Madras and Goa.				Sq. m.	Rs.	Sq. m.	Rs.	**SOUTHERN CIRCLE.**
Coastal plains, forest clad hills and open rolling country.	1-inch	Original ...	48 J/1 ...				**1,42,187**	
		Re-survey ...	65 J/7, 8, 9, 10, 11, 12, 13, 14, 15, 16.					
			65 K/1, 2, 3, 4, 5, 9, 10, 11, 14, 15.	5,332	22·3	**5,332**		
Ditto.	1-inch	**Triangulation**	65. N & O, 74. B	6,381	3·6	**6,381**		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	Remarks.
				Sq. m.	Rs.	Sq. m.	Rs.	**EASTERN CIRCLE.**
No. 4 Party.—Bengal and Bihār & Orissa.								
Low hills in plains		**Triangulation**	64. O, 73. C ...	277	9·5	**277**	**87,134**	For traverse connection only.
Cultivated plains		**Traverse** ...	72. C, G ...	1,607	3·5			
Low jungle clad hills		**Traverse** ...	64. O, 73. C ...	15	83·5	**1,622**		For 4-inch forest survey.
Low jungle clad hills, portions intersected by canals.		Planetable Height **Traverse.**	72. C, G ...	2,689	1·6	**2,689**		
Cultivated plains densely inhabited with small areas of sal jungle and wooded villages.	**1-inch**	Original survey ...	73. N ...	236	18·7			Excludes Rs. 5,175 for training of pupils and Rs. 1,344 being the pay etc. of inferior servants employed for Calcutta revision survey.
Ditto ditto	**1-inch**	Supplementary survey.	73. N, O ...	3,915	17·3			
Low jungle clad hills ...	**4-inch**	Forest survey ...	64. O, 73. C ...	4	245	**4,155**		This Survey was closed down before it was completed.

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	Remarks.
				Sq. m.	Rs.	Sq. m.	Rs.	**EASTERN CIRCLE.—** *Contd.*
No. 5 Party.—Central Provinces.								
Densely wooded hills ...	1-inch	**Triangulation**	64. D, K, L, & H	5,696	5·9	5,696	1,17,667(*d*)	
Cultivated plains ...	1-inch	**Traverse** ...	64. K ...	1,987	4·3	1,987		
Densely wooded hills up to 3,000 ft.	**1-inch**	Original survey ...	64. F & G ...	1,300(*a*)	23·5			(*a*) Includes 460 sq. miles by men under training.
Cultivated plains ...	**1-inch**	Original survey ...	64. F & G ...	2,945(*b*)	10·3			(*b*) Includes 1,021 sq. miles by men under training.
Densely wooded hills up to 3.000 ft.	**1-inch**	Supplementary survey.	64. F & G ...	446	3·4	4,691(*c*)		(*c*) Includes 1,481 sq. miles by men under training.
								(*d*) Includes cost of men under training.
No. 12 Party.—Assam, Bengal, Burma and Tripura State.								
Low jungle-clad Hills in Tripura State (Bengal).	1-inch	**Triangulation**	79. M ...	122	36·3		1,37,954	Excludes Rs. 5,781 being the cost for men under training.
Jungle-clad hills in Lushai Hills, Assam and Chin Hills, Burma.	½-inch	**Triangulation**	84. E ...	2,183	5·9	2,305		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	Remarks.
No. 12 Party.—Assam, Bengal, Burma and Tripura State.—*Concld.*				Sq. m.	Rs.	Sq. m.		**EASTERN CIRCLE.—** *Contd.*
Low jungle-clad hills in Tripura State, Bengal and Assam.	1-inch	**Traverse** ...	83. H & 79. M ...	254 L. miles.	27·7 per L.M.	**254 L. miles.**		
Low and high junge-clad Hills.	**1-inch**	Original survey ...	79. M, 83. D & 83. H.	1,063	51·7			
Cultivated and densely populated plains.	**1-inch**	Supplementary survey.	79. M ...	853	23·3	**4,281**		
Low and high jungle-clad Hills.	**½-inch**	Original survey ...	83. D & 83. H ...	2,365	16·3			
Cultivated plains area with small jungle-clad Hills.	16-inch	plot and **Traverse** of Gaurangala Sibpur boundary.	79. M ...	3 L. miles.	94 per L.M.	**3 L. miles.**		

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

Party and Locality. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	Remarks.
No. 5 Drawing Office.—Assam.				Sq. m.	Rs.	Sq. m.	Rs.	**EASTERN CIRCLE.—** *Concld.*
Special Survey.								
Shillong Cantonment ...	.....	**Traversing** ...	78 O/14 ...	5·63 L. miles or 495·27 acres.	3·6 per acre.	**495·27 acres.**	**5,735**	
Ditto ...	**64-inch**	Supplementary survey.	78 O/14 ...	19·6 acres.	38·7 per acre.	**Supplementary survey 465·64 acres.**		
Ditto ...	**32-inch**	Supplementary survey.	78 O/14 ...	24·6 acres.	2·6 per acre.			
Ditto ...	**32-inch**	Original survey ...	78 O/14 ...	4·03 acres.	1·4 per acre.	**Original survey 29·63 acres.**		
Ditto ...	**16-inch**	Supplementary survey.	78 O/14 ...	421·44 acres.	2·6 per acre.			
Ditto ...	**16-inch**	Original survey ...	78 O/14 ...	25·60 acres.	15·3 per acre.			

TABLE C I.—FIELD WORK.—Areas and Cost rates of Surveys, 1931-32.

PARTY AND LOCALITY. Character of country.	Scale.	Description of Survey.	Sheet Nos.	Areas in sq. miles (or acres) of each description of work.	Cost rate per sq. mile (or acre) of each description of work excluding pupils and men under training.	Total.	Total cost of the field work of the unit.	REMARKS.
No. 10 Party.—Upper Burma.				Sq. m.	Rs.	Sq. m.	Rs.	**BURMA CIRCLE.**
Jungle covered hills up to over 4,000 feet.	½-inch	**Triangulation**	84 E/NE, SE NW & SW.	3,980	1·68		**2,84,700**	
Jungle covered hills below 4,000 feet.	1-inch	**Triangulation**	83 L/16 & P/4. 84 I/1, 2, 3, 4, 5, 7, 8.	2,380	8·66	**6,360**		
Low hills covered with very thick jungle.	½-inch	**Traverse** ...	83 O/NE, NW, & SW.	950	14·69			
Jungle covered hills with patches of cultivation.	1-inch	**Traverse** ...	83 L/16, 84 I/9, 10, 13, 14.	740	15·63	**1,690**		
Low hills dense jungle (traversing country).	**½-inch**	Original survey ...	83 O/NW, SW & NE. 83 K/SE.	2,311	24·09			
Hills up to over 4,000 feet. Dense jungle.	**½-inch**	Original survey ...	83 O/SW, NW, NE. 83 K/NE, 83 N/SW.	1,004	7·90			
Low jungle covered hills (Traversing).	**1-inch**	Original survey ...	83 P/3, 4. 84 I/6, 9, 10, 13, 14. 83 L/11, 12, & 15.	1,543	35·36			
Low jungle covered hills with some cultivation (traversing and fixing).	**1-inch**	Original survey ...	83 L/11, 12, & 15	332	63·88			
Jungle covered hills up to 3,000 feet.	**1-inch**	Original survey ...	83 L/11, L/12. 83 P/4. 84 I/6.	412	49·91			
Low hills and dense jungle	**4-inch**	Original survey ...	84 I/10 & 14 ...	16	363·93	**5,618**		

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1931-32.

Party and Locality. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure on recess work.	Remarks.
		Sq. m.	Rs.	Rs.	**FRONTIER CIRCLE.**
"A" Company Punjab & N. W. F. P.					
Computation of Nowshera and Khajuri Plain **Triangulation**	38. N & O ...	130	2·4	308	
Miscellaneous computation of various nature	.....	.....	.....	1,793	
Adjustment of Chitrāl Circuit ... **Triangulation**	37. P, 42. D, H, 43. A & E.	5 sheets	66·4 per sheet	332	
Adjustment, classification and compilation in duplicate of old topo. data for Lambert Pamphlets.	38. J, K, N, O, F, G, H, L, P & M.	10 sheets	485·1 per sheet	4,851	
Original **1½-inch** ... ... Fair mapping	43 F/9, 10, 13, 43 E/16, 43 I/4; 44 I/5, 9, 13 (partly). 43 B/13; 43 F/1, 5; 38 H/10, 13; 44 B/1, 2, 5, 6, 9, 10, 13, 14; 44 F/1, 2, 5, 6, 9, 10, 13, 14.	5,800 approx.	6·4	37,305	
Original **1-inch** ... ... Fair mapping	38 O/1, 38 K/5, 6, 9, 10, 7 & 13.	1,735	2·2	3,901	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1931-32.

Party and Locality. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure on recess work.	Remarks.
"A" Company.—Punjab & N. W. F. P.—*(Concld.)*.		Sq. m.	Rs.	Rs.	**FRONTIER CIRCLE.—*Contd.***
Original ... ¾-inch Fair mapping ...	43 A/NE, 43 A/NW.	1,940	2·8	5,528	
Special maps ... 1/20,000 scale Fair mapping ...	Bannu Guide Map.	62	23·5	1,454	
Do. ... do. Fair mapping ...	Nowshera Artillery Practice Camp.	71	4·9	350	
"E" Company (F. C.).—Baluchistan and Sind.					
Original ... ¾-inch **Triangulation**	Portions of 34. L, 35. I, J, M, N, O.	7,580	0·53(*a*)	4,048(*b*)	(*a*) Previously reported 0·3 per sq. mile. Cost of completion under estimated in 1931.
Original ... **1-inch** Fair mapping ...	34 L/9, 10; 34 P/1, 2, 5, 6, 34 L/13, 14 (*c*).	2,088	.....	11,103	(*b*) Includes Rs. 2,663 spent in 1930-31. (*c*) Commenced in 1931, not yet completed owing to retrenchment cost rate cannot therefore be computed.
Original ... ½-inch Fair mapping ...	35 I/NW, SW(*c*)	2,113	.....	3,635	(*d*) Field work carried out in 1930-31.
Special Work.					(*e*) Excludes about Rs. 500 which it is estimated will be expended in 1932-33.
Corrections to 16-inch map of Quetta Cantonment ...	Quetta ...	22(*d*)	87	1,915	
1/25,000 Guide map ... Fair mapping ...	Quetta ...	150	90·8	13,614(*e*)	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1931-32.

Party and Locality. Class of work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure on recess work.	Remarks.
		Sq. m.	Rs.	Rs.	**FRONTIER CIRCLE.—*Concld.***
No. 18 (Air Survey) Party.—N. W. F. P.					
Original ... **1-inch** Fair mapping ...	38 O/5 ...	.....	.....	.....	
SPECIAL WORK.					
Peshawar Guide Map ... **6-inch** Fair mapping ...	38 N/8, 12; 38 O/5 & 9.	25	300	7,517	
No. 23 Party.—Punjab.					
Completion of original 4-inch P. T. Sections for reproduction	44. I, J, M, & N.	1,524	26·1	38,199(*f*)	(*f*) Excludes reproduction charges. No D. O. costs.
Reductions from 4-inch **1-inch** Compiled mapping Haveli survey.	Falling in 39. N & O.	1,430	2·3	3,229(*g*)	(*g*) Includes reproduction charges. No D. O. costs.

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1931-32.

Party and Locality. Class of work.				Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure on recess work.	Remarks.
No. 1 Party.—Geodetic Branch.					Sq. m.	Rs.	Rs.	GEODETIC BRANCH.
Original	...	1½-inch	Fair mapping ...	45 N/4, 8, O/1, 2, 5, 6.	1,607	9·5	15,297	
Original	...	¾-inch	Fair mapping ...	45 N/SW, N/SE, N/NW, 45 M/SW, O/NE.	5,332	5·8	30,962	
Bombay Guide Map	...	1/20,000 scale	Fair mapping ...	Bombay Guide Map (a).	79(a)	9·2(a)	7,142	(a) Including 701 sq. miles of insets on scale 1/160,000.
Pachbhadra Salt Source		8-inch	Fair mapping ...	1, 2, 3, 4 & 5	32	101·6	3,254	
Original	...	1-inch	Computations ...	45 G/15 and 45 K/1, 2, 5, 6, 9, 10, 13, 14.	2,414	1·4	3,323	
Original	...	½-inch	Computations ...	45 I/9, 10, 11, 12, 16.	1,322	1·4	1,846	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1931-32.

Party and Locality. Class of work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure on recess work.	Remarks.
No. 20 Party.—(Cantonments) Detachment United Provinces and Bengal.		Sq. m.	Rs.	Rs.	**GEODETIC BRANCH.—*Concld.***
16-inch ... ... **Traverse** ...	53. G, H, O, 54. K & M, 78. A & 53. K.	318 Linear miles.	36·9 per linear mile.	4,197	Roorkee, Meerut, Almora, Jhānsi, Shāhjahānpur, Lebong, Jālāpahār and part of Lansdowne Cantts.
64-inch ... ... **Traverse** ...	53. G, H, K, 54. K & M, & 78. A.	39 Linear miles.	64·5 per linear mile.	878	Roorkee, Meerut, Jhānsi and Shāhjahānpur Cantts.
132-inch ... ... **Traverse** ...	54. K ...	29 Linear miles.	61·3 per linear mile.	989	Jhānsi City.
Cantonment plans ... **16-inch** Fair mapping ...	53. F, O, K & G.	6,711 acres.	1·7 per acre.	11,921	Chakrāta, Almora, Lansdowne and Roorkee Cantts.
Bāzār plans ... **64-inch** Fair mapping ...	53. F, K, G ...	58 acres.	33·0 per acre.	2,010	Chakrāta, Lansdowne and Roorkee Cantts. Bāzārs.
City plans ... **132-inch** Fair mapping ...	54. K ...	56 acres.	.....	.....	Jhānsi City.

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1931-32.

Party and Locality. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total Expenditure on recess work.	Remarks.
		Sq. m.	Rs.	Rs.	**SOUTHERN CIRCLE.**
No. 6 (South India) Party.—Bombay, Madras and Goa.					
Original 1-inch ... ... **Triangulation**	65. F, N, O. 74. B.	2,700	1·0	2,808	
1-inch ... ... Fair mapping ...	48. J, 65. J & K.	5,242	5·5	26,730*	*Excludes cost of miscellaneous work due to abolition of Southern Circle &c., Rs. 2,000.
½-inch ... ... Fair mapping ...	48. M, N, O. 58. I, M, N. 65. D, F.	11,400	0·80	11,072	
¼-inch ... ... Fair mapping ...	57. 65 ...	9,000	0·20		
Colour patterns	48, 57, 58, 65, 66.	48 Sheets	70 per sheet.	3,360	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping 1931-32.

Party and Locality. Class of work.			Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure on recess work.	Remarks.
No. 4 Party.—Bengal and Bihar & Orissa.				Sq. m.	Rs.	Rs.	**EASTERN CIRCLE.**
1-inch sheets	Fair mapping	...	73. N, O ...	4,151	8·4	34,896	
Triangulation (forest survey) ...	Computations	...	64. O, 73. C ...	277	·7	188	Computations were completed in the field.
Traverse	do.		72. C, G ...	1,607	3·9	6,349	Do. do.
Do. (forest survey) ...	do.		64. O, 73. C ...	15	11·9	178	Do. do.
Planetable height **Traverse** ...	do.		72. C, G ...	2,689	·3	752	
No. 5 Party.—Central Provinces.							
Original 1-inch **Triangulation** ...	Computation	...	64. D, H, K & L.	5,696	1·6	9,153	
Original 1-inch **Traverse** ...	Computation	...	64. K ...	1,987	1·6	3,200	
1-inch	Fair mapping	...	64. F & G ...	4,691	5·5	25,696	
½-inch	Compiled mapping		63. P & 64. J	1,200	4·8	5,703	
Benares Guide Map **6-inch**	Fair mapping	...	.....	20	56	1,120	
1-inch sheets—Men under training	Fair mapping	...	.....	.....	.....	1,505	

TABLE C II.—RECESS WORK.—Cost rate for Computations and fair mapping, 1931-32.

Party and Locality. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure on recess work.	Remarks.
No. 12 Party.—Assam, Bengal, Burma and Tripura State.		Sq. m.	Rs.	Rs.	**EASTERN CIRCLE.** —*Concld.*
Original 1-inch **Triangulation** ... Computation ...	79. M ...	122	16·3	1,992	
Do. ½-inch **Triangulation** ... do.	84. E ...	2,183	1·1	2,399	
Do. 1-inch **Traverse** ... do.	79. M & 83. H	254 L. miles.	5·6 per L.M.	1,414	
1-inch ... ... Fair mapping ...	79. M & 83. D, H.	1,892	15·7	29,692	
½-inch ... ... Fair mapping ...	83. H ...	2,115	4·3	9,243	
No. 5 Drawing Office.—Assam.					
Shillong Cantonment.—					
Original **Traverse** ... ... Computation ...	78 O/14 ...	495·27 acres.	1·4 per acre.	717	
Original **64-inch** ... ... Fair mapping ...	78 O/14 ...	19·6 acres.	13·0 per acre.	256	
Original **32-inch** ... ... Fair mapping ...	78 O/14 ...	28·63	3·5 per acre.	102	
Original **16-inch** ... ... Fair mapping ...	78 O/14 ...	447·04	1·1 per acre.	495	

TABLE C II.—RECESS WORK.—Cost rate for Computations and Fair mapping, 1931-32.

Party and Locality. Class of Work.	Sheet Nos.	Area.	Cost rate per sq. mile.	Total expenditure on recess work.	Remarks.
		Sq. m.	Rs.	Rs.	**BURMA CIRCLE.**
No. 10 Party.—Upper Burma.					
Original ½-inch ... ... **Triangulation**	84 E/N.E., S.E., N.W. & S.W.	3,980	0·69	2,775	
Do. 1-inch ... ... **do.**	83 L/16, & P/4. 84 I/1, 2, 3, 4, 5, 7, 8.	2,380	1·06	2,539	
Original ½-inch ... ... **Traverse** ...	83 O/N.E., N.W. & S.W.	950	1·19	1,135	
Do. 1 inch ... ... **do.**	83 L/16, 84 I/9, 10, 13, 14.	740	1·38	1,025	
Original ½-inch sheets ... Fair mapping ...	83 O/N.W., S.W. & N.E.	3,154	2·80	9,277	
Do. 1-inch do. ... ... do.	83 P/3, 4; 84 I/6, 9, 10, 13, 14; 83 L/11, 12, 15.	2,287	17·05	40,946	
Do. 4-inch do. ... ... do.	84 I/10 & 14.	16	210·06	1,361	

V.—SURVEY REPORTS, FRONTIER CIRCLE.

DIRECTOR:—Lieut.-Colonel S. W. Sackville Hamilton, D.S.O., R.E., to 17-10-31.
" F. B. Scott, I.A., from 18-10-31 to 28-10-31.
" F. J. M. King, R.E., from 29-10-31 to 28-3-32.
Colonel H. J. Couchman, D.S.O., M.C., from 29-3-32.

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

41. Training.—Two Class I Officers on probation, who joined 'A' Company in May, received training in air survey in addition to their ordinary training in that unit.

Seven soldier surveyors were under training in 'A' Company during the field season, of whom three were reverted to their regiments and four transferred to the Geodetic Branch in May.

Officers of the R. A. F. paid occasional visits to No. 18 Party to study methods of air photo compilation.

42. Special.—The Officer Commanding, 'E' Company took part in the Western Command Signal Exercise held near Quetta at the end of May.

43. Field work of units was as follows:—

'A' Survey Company. Topography on scales of 4 inches, 1½-inches and 1-inch to 1 mile in sheets 38N and O, 43G, 44 B and F, and triangulation in sheets 38N and O.

'E' Survey Company. Topographical re-survey on the scale of 1/25,000 for the preparation of a Guide Map of Quetta and environs, in sheets 34J and N, and corrections to the 16-inch map of Quetta Civil Station.

No. 18 (Air Survey) Party. Compilation of air surveys in North-West Frontier Province in sheet 38O.

No. 23 (Irrigation Surveys) Party.—Special topographical survey on the scale of 4-inches to 1 mile in sheets 44I, J, M and N; triangulation in sheets 53C, D and H; traversing and rectangulation in sheets 44O and P, and 53C, D, G and H; and tertiary levelling in sheets 44J, N, O and P.

'A' Survey Company.

Officer Commanding.—Mr. W. H. Strong, M.B.E., to 13-10-31.
Major T. M. M. Penney, R.E., from 14-10-31.

44. General.—The field head-quarters of the Company moved to Peshāwar and occupied the same building as No. 18 Party. The whole Company recessed in Murree as there was no summer programme this year.

It was hoped at one time to complete the survey of the small area on the south-west slopes of the Black Mountain remaining over from last year's work, but the necessary political arrangements could not be made.

A small portion of disputed boundary between the territory of the Hassanzais and the Wali of Swāt was demarcated.

The major portion of the Company was employed on 1-inch original survey in the Punjab plains round Montgomery.

Most of this country is now very highly developed and areas which only a few years ago were bare sandy desert are now richly cultivated. Twenty years ago it was possible to ride or drive in any direction from Montgomery chasing black buck and partridge, but now movement is confined to a few roads and all game has disappeared.

The site of the ruins of the ancient cities of Harappa was included in this season's programme. Here the Archæological Department has unearthed well preserved remains indicating a civilization 5,000 years old and dating from the same period as the more famous remains recently excavated at Mohenjo Daro in Sind. Seals and other objects found here bear a close resemblance to similar remains of the Sumerian period discovered at Ur.

During the period prior to 1,000 B.C. of which remains are found, this part of the Punjab was evidently covered with dense jungle and overrun by wild animals. There is evidence to show that it dried up later while later remains indicate that after another 1,000 years it again became habitable. After this later civilization, as the result apparently of a further period of desiccation, the land again reverted to sandy desert and is only now becoming once more extensively cultivated, as a result of modern irrigation.

The training camp this year was first employed in carrying out a 4-inch survey in the neighbourhood of Nowshera to provide a practice camp map for the Artillery. Since the agreement made with the Afridis last year, many of the bad characters who previously found refuge in tribal territory have had this sanctuary denied them. Consequently many of them now haunt that part of the country which lies between Peshāwar and Nowshera on both sides of the Grand Trunk Road. Except however for one case of a soldier surveyor being fired at, work in this area proceeded without interference, but as a precaution the surveyors were made to camp inside the villages at night.

45. Personnel.—The average strength of the Company during the year was 1 Class I officer, 2 Class II officers, 5 U. S. officers, 32 L. S. officers and 7 soldier surveyors under training (the latter were transferred from the Company in May).

Lieut. R. P. Buchanan, B.A., R.E. and Lieut. J. S. O. Jelly, R.E., joined the Company in May, and the latter received training in air survey in addition to his ordinary training in this Company.

46. Field work.—R. S. Chuni Lal Kapur (Class II) assisted by Mr. Sardar Khan (U. S.) with Mr. Rustam Khan (U. S. Probationer) and 18 surveyors surveyed 4,098 sq. miles on the scale of 1-inch to 1 mile in Lahore, Ferozepore, Lyallpur, Montgomery, Multān and Jhang districts of the Punjab (sheets 44 B & F), and carried out verification of new topographical detail in 44 A and 44 K.

Training Camp.—K. S. Afraz Gul Khan (Class II), Mr. Sajawal Khan and Mr. Chiragh Shah, the lastnamed being assisted by Mr.

Bashirullah Khan (U. S. S.), in turn had charge of the Training Camp of seven soldier surveyors and one lithodraftsman from No. 18 Party, who was receiving training as a surveyor.

This camp first surveyed an area of 71 sq. miles on the 4-inch scale in the Peshāwar District of the N. W. F. P. in sheets 38N & O, Mr. Bashirullah Khan carrying out a subsidiary triangulation of 130 sq. miles to supply the necessary framework.

In March the Camp moved to the Murree hills (sheet 43 G) and resurveyed 64 sq. miles on the 1½-inch scale in the Hazāra district of the N. W. F. P. and the Rāwalpindi district of the Punjab.

47. Areas surveyed.—A total area of 4,233 square miles was surveyed, as follows:—

4,098 square miles of original survey on the scale of 1-inch to 1 mile in sheets 44 B & F.

64 square miles of resurvey on the scale of 1½-inches to 1 mile in sheet 43 G.

71 square miles of original survey on the scale of 4-inches to 1 mile in sheets 38 N & O.

48. Office work.—Mr. W. H. Strong, M.B.E., (Class II), assisted by Mr. Muhammad Akbar (U. S. S.), was in charge of the Drawing Section which worked in Peshāwar throughout the winter and which formed No. 1 Section during recess. This section completed 26 fair sheets, and its average strength was 9.

R. S. Chuni Lal Kapur and Lieut. R. P. Buchanan, B.A., R.E., assisted by Mr. Sardar Khan, were in charge of No. 2 Section during recess and completed 16 fair sheets. The average strength of this section was 21.

Mr. D. M. Das, and after him Mr. S. I. Ahmad (U. S. S.), was in charge of the computing section. This section consisted of 4 and 2 computers in winter and summer respectively and continued the adjustment and compilation of old data in sheets 38 and 43.

'E' Survey Company.

Officer Commanding.—{ Major E. O. Wheeler, M.C., R.E., to 16-3-32.
Captain J. B. P. Angwin, R.E., from 17-3-32.

49. General.—The field and recess head-quarters were at Quetta. Owing to retrenchment, the only field work carried out was the re-survey on 1/25,000 scale of the vicinity of Quetta, and corrections to the Quetta 16-inch Civil Station maps. These surveys, with the corrections to the Quetta 16-inch Cantonment map carried out in 1930-31, were incorporated in the final compilation of a 1/25,000 guide map of Quetta and its environs.

Personnel.—The average strength during the field season was 1 Class I officer, 1 Class II officer, 1 Upper Subordinate officer and 8 Lower Subordinate officers (excluding clerks and reproduction section).

50. Field work.—As far as possible surveyors awaiting transfer to other units were utilized in correcting the 16-inch map, surveyors to be retained in the unit being employed on the 1/25,000 re-survey. The re-survey of the southern and heavier half of the 1/25,000 map and

correction on the ground of the 16-inch map were completed by Christmas 1931 and drawing was commenced. Re-survey of the northern half was started in the middle of March and completed in the middle of May. Mr. F. J. Grice (Class II), assisted by Mr. Abdul Rashid (U. S. S.), was in charge of the field work.

51. Areas surveyed.—Re-survey of 129 sq. miles on the scale of 1/25,000, and correction of 3 sq. miles on the scale of 16-inches to 1 mile. Owing to discrepancies found in the Quetta municipal boundary, the traverse of 5 linear miles was also carried out.

Nature of area surveyed.—The 1/25,000 work varied from rugged hills to open plain. In order to economise as far as possible, the more rugged areas were not surveyed and the headings and tables of references in the published map will be arranged to cover the spaces unsurveyed.

The 16-inch portions corrected were thickly populated city areas.

52. Office work.—Fair-drawing was carried on throughout the year, under the charge of Mr. F. J. Grice (Class II), until relieved by Mr. Critchell (Class II), and under Lieut. Jenney assisted by Mr. Khushal Khan and Mr. Abdul Rashid (U. S. S.). Owing to the amount of work entailed in the preparation of the Quetta guide map, as well as corrections to the 16-inch map, miscellaneous work and extra-departmental drawing (paid-for work), and owing to the much reduced establishment of the company due to retrenchment, it was necessary to delay the completion of some outstanding mapping.

53. Reproduction section.—This section, under Litho Draftsman Shahabuddin upto his transfer on the 7th April 1932, and thereafter under Mr. Sadik Ali, worked mainly on paid-for work throughout the year. The volume of extra-departmental work obtained was somewhat adversely affected by the universal economic depression.

During the year a Rotary offset machine and a duplicating and reversing press were installed in the office of the Company at Quetta.

54. Military Training.—Captain J. B. P. Angwin, R.E., took part in the Western Command signal exercise held near Quetta at the end of May. Useful experience was gained in methods of co-operation between the survey company and military formations and in methods of procedure when rapid progress of ground control is the primary object.

No. 18 (Air Survey) Party.

Officer in charge.—Captain D. R. Crone, R.E., till 6-12-31, from 14-4-32 to 22-6-32, and from 16-7-32.
Lieut. C. A. K. Wilson, R.E., from 7-12-31 to 13-4-32 and from 23-6-32 to 15-7-32.

55. General.—Recess and field headquarters have remained at Murree and Peshāwar respectively. Close liaison with the Royal Air Force has been maintained and the standard of the photographs received shows a steady improvement. Photography has in general followed the demands of air operations and as a result photography for revision surveys is temporarily in abeyance.

56. Personnel.—The strength of the party was increased from 1 Class I, 1 Class II, 1 Upper Subordinate and 17 Lower Subordinate officers to 2 Class I, 2 Class II, 4 Upper Subordinate and 26 Lower Subordinate officers during the year. On this expansion, the party was reorganized into 2 survey sections, one fair mapping section and one computing section.

57. Field work.—No. 2 Wing Station R. A. F. supplied photographs of 870 sq. miles of tribal territory in 38 N, and No. 1 Wing Station supplied photographs completing gaps in all previous surveys. Surveyor Fateh Muhammad Khan fixed numerous points with plane-table and clinometer in sheets 38 O/6, 10 and 14 from the Kohāt Pass road and the administrative border, for the control of the air survey compilation.

58. Compilation. *Tirāh.*—The rigorous survey of tribal territory in sheet 38 O/5 was completed.

59. Methods of survey.—A graphical method of surveying from oblique photographs (*vide* Appendix I) was devised and employed for mapping 220 square miles of country. The method was easily learnt by the surveyors and the errors were of the order anticipated.

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

61. Publications.—Captain Crone produced a draft for Topographical Hand Book Chapter XII "Air Surveys" during the year.

No. 23 (Irrigation Surveys) Party.

Officer in charge.—Mr. C. H. Tresham.

62. 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 head-quarters were at Solon and Ferozepore respectively.

Personnel.—The average field strength of the party, apart from the Officer in charge, was 4 Class II officers, 5 Upper Subordinate officers and 128 Lower Subordinates.

63. Field work.—

Camp (1).—Mr. C. O. Picard (Class II) up to 29th February 1932, and Mr. B. N. Murthy, B.Sc., (Class II) thereafter, with 24 Lower Subordinates completed 624 square miles of 25-acre rectangulation in Hissār and Rohtak districts and Jind and Lohāru States, in sheets 44 O & P and 53 C & D.

Camp (2).—Mr. H. H. P. Butterfield (Class II) assisted by Mr. Ghulam Hasan (U. S. S.) with 20 surveyors completed 1,524 square miles of special topographical survey on the scale of 4 inches to 1 mile in Ferozepore district and Faridkot and Kalsia States in sheets 44 I, J, M and N.

Camp (3).—Mr. Jiya Lal Sahgal (Class II) with 16 Lower Subordinates completed 1,242 square miles of tertiary levelling in Ferozepore, Hissār and Ludhiāna districts and Faridkot and Kalsia States, in sheets 44 J, N, O and P.

Camp (*4*).—Mr. Mohd. Najamuddin, B.A., (Class II) assisted by Mr. M. L. Kohli (U. S. S.) and 24 Lower Subordinates completed

2,920 square miles of traversing and rectangulation to 3,000 acres in Delhi, Gurgaon, Hissār and Rohtak districts and Dujāna, Jīnd and Pataudi States, in sheets 44 P and 53 C, D, G and H;

863 square miles of triangulation in Delhi, Hissār, Karnāl and Rohtak districts and Dujāna, Jīnd and Patiāla States, in sheets 53 C, D and H;

30 square miles of rectangulation to 25 acres in Rohtak district in sheet 53 D.

Camp (*5*).—Khan Sahib Mohd. Hussain Khan (U. S. S.) assisted by Mr. Quadir Dad (U. S. S.) and 24 Lower Subordinates completed 615 square miles of rectangulation to 25 acres in Hissār and Rohtak districts and Jīnd State, in sheets 44 O & P and 53 C & D.

Drawing Section.—Mr. N. D. Joshi, B.A., (U. S. S.) with 10 Lower Subordinates completed the fairmapping of three 1-inch compiled sheets of the Haveli Irrigation Project and the reduction to the 4-inch scale of 4,942 village musavis of Hissār district, 17 of Ferozepore district and 1,318 of Faridkot State.

64. Areas surveyed.—

1,524 square miles of special topographical survey on the scale of 4 inches to 1 mile in Ferozepore district and Faridkot and Kalsia States, in sheets 44 I, J, M & N.

1,242 square miles of tertiary levelling in Ferozepore, Hissār and Ludhiāna districts and Faridkot and Kalsia States, in sheets 44 J, N, O & P.

1,269 square miles of rectangulation to 25 acres in Hissār and Rohtak districts and Jīnd and Lohāru States, in sheets 44 O & P and 53 C & D.

2,920 square miles of traversing and rectangulation to 3,000 acres in Delhi, Gurgaon, Hissār and Rohtak districts and Dujāna, Jīnd and Pataudi States, in sheets 44 P and 53 C, D, G and H.

863 square miles of triangulation in Delhi, Hissār, Karnāl and Rohtak districts and Dujāna, Jīnd and Patiāla States, in sheets 53 C, D & H.

The country surveyed consists for the most part of flat cultivated plains, interspersed with trees and scrub and very sandy in the western portion.

65. Recess duties.—The fair mapping and computations of all the field work were completed during the year. The work was supervised by Messrs. O. D. Jackson, Jiya Lal Sahgal, Mohd. Najamuddin, B.A., B. N. Murthy, B.Sc., Ghulam Hasan and N. D. Joshi, B.A., assisted by Messrs. M. L. Kohli and N. M. Bopaiah.

VI—SURVEY REPORTS, CENTRAL CIRCLE* to 29-2-32, GEODETIC BRANCH from 1-3-32.

DIRECTOR:—{Lt.-Col. J. D. Campbell, D.S.O., R.E., to 28-10-31.
Lt.-Col. A. H. Gwyn, I.A., from 29-10-31 to 29-2-32.
Dr. J. de Graaff Hunter, M.A., Sc.D., F.Inst.P., from 1-3-32.

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

On completion of their work, Khairpur and Air Survey Traverse Detachments were disbanded from 1st September and 1st October 1931 respectively and their personnel distributed amongst the other units of the Circle.

No. 5 Party was transferred to the administrative control of the Director, Eastern Circle, from 1st February 1932 and its Report will be found among the Eastern Circle survey reports (pages 65 and 66).

As a measure of retrenchment, the Central Circle directorate was closed and Nos. 1 and 20 Parties transferred to the control of the Director, Geodetic Branch, with effect from 1st March 1932. No. 3 Drawing Office was amalgamated with No. 2 Drawing Office from the 21st January 1932.

No. 20 (Cantonments) Party was reduced to the status of a detachment from 1st April 1932.

The Castle Hill Estate, the property of the Survey of India at Mussoorie, has been transferred for maintenance to the Public Works Department (Central Division, Dehra Dūn) from 1st February 1932.

67. Training—Two Class II officers were confirmed in their appointments. A batch of four U. S. officers on probation was transferred from the Geodetic Branch to No. 1 Party for training at the commencement of the field season. Two of them have since been retrenched.

Out of the six soldier surveyors under second period of training in No. 1 Party, one was reverted to his regiment as unlikely to become a 1st Class surveyor and draftsman, and the remaining five were recommended for retention in the department. Two more soldier surveyors were posted to No. 1 Party for training during field season 1931-32, but both of them were found unsuitable and reverted to their respective units.

68. Field work of parties was as follows:

No. 1 Party.—Topography on the scales of $\frac{1}{2}$, 1 and 8 inches to 1 mile in sheets 45C, M, N and O, and 53H. Triangulation in 45G, I and K. Traversing and levelling in advance.

No. 5 Party.—Transferred to Eastern Circle from 1-2-1932. For details of work see pages 65 and 66.

No. 20 Party.—Large scale surveys of cantonments and bāzārs of four cantonments in the U. P. and two in Bengal. Special survey of the civil area in Jhānsi. Traversing and levelling in advance.

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* The Central Circle was incorporated with the Geodetic Branch from 1-3-32.

No. 1 Party.

Officer in charge.—Lt. C. A. K. Wilson, R.E., to 6-10-31.
Mr. A. M. Talati, L.C.E., from 7-10-31 to 17-3-32.
,, L. Williams, M.B.E., from 18-3-32 to 28-4-32.
Capt. H. W. Wright, R.E., from 29-4-32 to 27-7-32.
Lt.-Col. R. Foster, I.A., from 28-7-32.

69. General.—The party continued operations in the Rājputāna Agency, Ajmer-Merwāra, Delhi, Punjab and United Provinces, partly by special arrangements with Jaipur State and the Northern India Salt Revenue Department, in sheets 45C, G, I, K, M, N, O and 53H.

The field headquarters of the party were at Ajmer.

Personnel.—The strength of the party, including a section left at Dehra Dūn but excluding the officer in charge, was 7 Class II officers, 2 Class II officers on probation, 2 Upper Subordinates, 4 Upper Subordinates on probation and 55 Lower Subordinates and soldier surveyors.

70. Areas surveyed.—4,797 square miles of ½-inch original survey in sheets 45M, N and O;

1,607 square miles of 1-inch original survey in sheets 45N and O, in Ajmer-Merwāra and states of the Rājputāna Agency;

150 square miles of 1-inch revision survey in sheet 53H in Delhi, Punjab and United Provinces;

32 square miles of 8-inch original survey in 45C in Jodhpur State of the Rājputāna Agency.

Triangulation.—3,736 square miles in sheets 45G, I and K in Ajmer-Merwāra and the Rājputāna Agency.

Traversing and levelling.—75 linear miles of traversing and 117 linear miles of tertiary levelling were carried out in sheet 45C in Jodhpur State.

71. Field work was organized as follows:

Camp (1).—Mr. N. S. Harihara Iyer (Class II) with 1 instructor, 2 Upper Subordinate probationers and 7 surveyors, of whom 6 were under instruction, completed 533 square miles of ½-inch original survey in sheet 45N in Ajmer-Merwāra and in Jaipur and Kishangarh States and 803 square miles of 1-inch original survey in sheets 45N and O in Ajmer-Merwāra and in Jaipur, Kishangarh and Shāhpura States.

The area, mostly under light cultivation, was flat and dry, with occasional small hills.

Camp (2).—Mr. M. M. Mudaliar (Class II) with 2 Class II probationers, 1 Upper Subordinate officer, 2 Upper Subordinate probationers and 3 surveyors, completed 804 square miles of 1-inch original survey in sheet 45O in Ajmer-Merwāra and the states of Būndi, Jaipur, Shāhpura and Udaipur.

The area was mainly flat with a range of hills in the south.

Camp (3).—Mr. T. M. C. Alexander (Class II) with 8 surveyors, completed 2,123 square miles of ½-inch original survey in sheets 45M and N in the states of Jaipur, Jodhpur and Kishangarh.

The area was flat and dry and included a portion of the Sāmbhar Salt Lake.

Camp (*4*).—Mr. Jugal Behari Lal (Class II), with 1 Class II officer and 9 surveyors, completed 2,141 square miles of original ½-inch survey in sheets 45N and O in the states of Būndi, Jaipur, Tonk and the Chiefship of Lāwa of the Rājputāna Agency.

The area was flat and dry, drained by the Banās river, with a range of hills in the south.

Camp (*5*).—First Class surveyor Najmul Husain with 4 surveyors completed 75 and 117 linear miles of traversing and levelling and 32 square miles of 8-inch original survey in sheet 45C in Jodhpur State.

This work covered the Pachbhadra Salt Source, consisting of a dry sandy area, cut up by numerous salt pits.

Revision.—Two surveyors carried out 150 square miles of 1-inch revision survey along 115 miles of the Jumna river in sheet 53H in Delhi, Punjab and United Provinces. They were inspected in the field by Mr. N. S. Harihara Iyer (Class II).

Mr. Jugal Behari Lal (Class II) proceeded to Bombay for about a month to collect information from local authorities for bringing up to date the 1923 4-inch map of Bombay and Salsette.

Triangulation.—Mr. S. M. Murtaza (Class II) triangulated 1,322 square miles in sheet 45I in the states of Bīkaner, Jaipur and Jodhpur. The country was chiefly dry and barren with undulating sand hills.

Mr. B. B. Kuttappa (U. S. S.) triangulated 2,414 square miles in sheets 45G and K of hilly country in Ajmer-Merwāra and the states of Kishangarh, Jodhpur, Shāhpura and Udaipur.

Field season mapping.—Mr. O. D. Jackson (Class II) and 10 surveyors remained at Dehra Dūn employed on fair drawing, as a measure of economy.

72. Recess duties.—Fair mapping was divided into 4 sections under Messrs A. A. Graham, T. M. C. Alexander, Jugal Behari Lal and 1st Class surveyor Najmul Husain.

Mr. B. B. Kuttappa was responsible for the completion of computations.

73. Reorganization.—On 1-3-32 the party was transferred to the Geodetic Branch, on the disbandment of the Central Circle.

No. 20 Detachment (Cantonments).

Officer in charge.— Mr. J. H. Williams, to 31-3-32.
Lt.-Col. A. H. Gwyn, I.A., from 1-4-32 to 29-4-32.
Mr. L. Williams, M B E., from 30-4-32.

74. General.—The party, which was reduced to the status of a detachment from 1-4-32, carried out revision surveys and re-surveys of cantonments on the scale of 16 inches to 1 mile, and of cantonment bāzārs on the scale of 64 inches to 1 mile, as required by the Engineer-in-Chief and Army Department. A special large scale survey of the civil area in Jhānsi was also taken up for the Jhānsi municipality.

The field season commenced on 12-10-31, with field headquarters at Rānikhet. The headquarters were transferred to Dehra Dūn on 21-3-32 and moved to recess in Mussoorie on 9-5-32.

Personnel.—The field strength, excluding the officer in charge, was 2 U. S. officers and 20 L. S. officers. A drawing section of 4 draftsmen and a computing section of 3 computers were maintained at field headquarters, under the supervision of the officer in charge.

75. Areas surveyed.—Details of the survey completed by both camps are as follows:—

	16-inch re-survey.		
Rānīkhet Cantonments	...	...	4,924 acres.
	64-inch re-survey.		
Rānīkhet Bāzārs	...	...	98 acres.
	16-inch revision survey.		
Almora Cantonments	...	...	385 acres.
Jālāpahār ,, (part)	...	...	365 ,,
Lebong ,,	...	...	340 ,,
Lansdowne ,,	...	...	1,634 ,,
Roorkee ,,	...	...	2,366 ,,
	64-inch revision survey.		
Lansdowne Bāzārs	...	...	23 acres.
Roorkee ,,	...	...	12 ,,
	132-inch original survey.		
Jhānsi civil area	...	...	122 acres.

The above areas include overlaps.

76. Field work was organized as follows:

Camp (1).—Headquarters Rānīkhet. Mr. Jagannath (U. S. S.) with 7 surveyors, 1 traverser up to 31-12-31 and 1 computer as leveller were employed in Almora, Rānīkhet, Lebong and Jālāpahār cantonments.

Camp (2).—Headquarters Roorkee. Mr. Bakhshi Harnam Singh (U. S. S.) with 4 surveyors, increased by 3 surveyors transferred from Camp (1) on 30-4-32, and 5 traversers, including 1 transferred from Camp (1), were employed in Lansdowne, Roorkee, Meerut, Jhānsi and Shāhjahānpur cantonments and in Jhānsi civil area.

Traversing and levelling.—386 linear miles of traversing and 69 linear miles of levelling were carried out, the latter to control 5-foot contour intervals in plains and 20-foot contour intervals in hill cantonments. Of this, 123 linear miles of traversing and 52 linear miles of levelling were computed for this season's survey, the remainder being advance work for next season's survey.

In addition to the above, 79 linear miles of spot levelling of 176 positions in Rānīkhet and 101 positions in Almora were carried out for the M. E. S. for a special scheme of drainage and water supply.

Four positions were fixed by triangulation in Lansdowne cantonment for the purpose of range-finding.

77. Recess duties.—Fair mapping was supervised by the officer in charge up to 13-6-32, after which date it was placed under Mr. Bakhshi Harnam Singh (U. S. S.) as section officer.

Five sheets on 16-inch scale and 1 sheet on 64-inch scale of Chakrāta cantonment and bāzār were completed and sent for publication.

VII.—SURVEY REPORTS, SOUTHERN CIRCLE.

DIRECTOR:—Lieut.-Colonel L. G. Crosthwait, I.A., upto 13th April 1932.

78. Summary. Southern Circle Office, together with No. 4 Drawing Office, Nos. 7 and 8 Parties, was abolished during the year as a measure of retrenchment. All the records of the Circle Office were taken over by No. 6 Party, the only unit of the old Circle which is to continue in existence, redesignated No. 6 (South India) Party.

No. 4 Drawing Office.

Officer in charge.—Mr. E. A. Meyer, upto 29th February 1932.

79. No. 4 Drawing Office was abolished, as a measure of retrenchment, from 1st March 1932 and the arrears of compiled mapping were taken over by No. 6 Party.

No. 7 Party.

Officer in charge.—Captain G. W. Gemmell, I.A., upto 29th February 1932.

80. This party was employed during the field season on compiling work for the Frontier Circle, and abolished as a measure of retrenchment from 1st March 1932.

No. 8 Party.

Officer in charge.— { Major W. J. Norman, M.C., R.E., upto 21st October 1931.
Mr. H. B. Simons, from 22nd Oct. upto 14th December, 1931.

81. This party did not take the field and was abolished as a measure of retrenchment, from 15th December 1931.

No. 6 Party.

Officer in charge.— { Mr. E. M. Kenny, upto 22nd October 1931.
Major W. J. Norman, M.C., R.E., from 23rd October, 1931.

82. General.—On the disbandment of the Southern Circle in April 1932, No. 6 Party became responsible for all surveys as well as for all the compiled mapping in the south of India.

The party took the field in November 1931 with increased strength, as Nos. 7 and 8 Parties were being abolished. Party Headquarters opened in Waltair on the 23rd November 1931 and closed on the 20th April 1932.

The programme consisted of topographical surveys in the East Godāvari and Vizagapatam districts of Madras, as well as a small area in the Kanara district of Bombay and Goa adjoining last year's work of No. 7 Party, which was required to complete the compiled mapping. The programme had to be curtailed owing to the prevalence of fever amongst the members of the party.

83. Personnel. The field strength of the party was 3 Class I Officers, 4 Class II Officers, 1 Class II Probationer, 10 Upper Subordinates and 53 Lower Subordinates.

The recess strength was 1 Class I Officer, 4 Class II Officers, 1 Class II Probationer, 5 Upper Subordinates and 73 Lower Subordinates.

84. Area surveyed.—A total of 5,332 square miles was surveyed on the scale of 1-inch to 1 mile, comprising 5,220 square miles of original survey and 112 square miles of re-survey, in sheets 48J and 65J and K.

85. Field work was organized as follows:—

No. 1 Camp under Mr. P. S. Venguswami (U. S. S.), with 6 to 8 surveyors, surveyed 593 square miles.

No. 2 Camp under Mr. C. P. E. Davenport (Class II), with Mr. K. B. Muthanna (U. S. S.) and 10 to 12 surveyors, surveyed 914 square miles.

No. 3 Camp under Lieut. R. H. Sams, R.E., with 5 to 8 surveyors, surveyed 566 square miles.

No. 4 Camp under Mr. E. N. Natesan, B.A. (Class II), with Mr. Muhammad Mustafa (U. S. S.), one Class II Probationer, 3 Upper Subordinates and 10 to 14 surveyors, surveyed 1,347 square miles.

No. 5 Camp under Mr. M. D. Nangia, B.A. (Class II), with 5 to 7 surveyors, surveyed 607 square miles.

No. 6 Camp under Mr. Muhammad Abdul Azim, I.D.S.M. (U. S. S.), with Mr. Muzaffar Husain (U. S. S.) and 8 to 10 surveyors, surveyed 1,126 square miles.

A detachment of 2 surveyors in Bombay and Goa surveyed 179 square miles.

86. *Triangulation.* An area of 6,381 square miles was triangulated in advance, for detail survey in future years, by Lieut. Jenney, R.E., Mr. Nair, B.A. (Class II), Mr. Alauddin (U. S. S.), Mr. Shamanna (U. S. S.) and surveyor Narasingha Rao.

87. The country surveyed included a portion of the coastal plain, but most of it was on the Eastern Ghāts. These hills rise in places to 5,000 feet and, though parts of the Jeypore Estate are cleared for cultivation, many of the hills are covered with thick virgin jungle.

88. The health of the party was not good, and the programme suffered in consequence. Many of the men had been working in feverish areas the previous year and nearly all these suffered relapses. The area of this year's work is notoriously unhealthy and an effort was made to protect the surveyors by supplying them with prophylactic doses of plasmoquine. Unfortunately the drug arrived late and its quantity proved insufficient for the Party's requirements. The fever area was also larger than anticipated.

Although fever was not avoided this year to any large extent, it is fairly certain that some measure of protection is possible.

89. Recess Duties. The 21 one-inch sheets of the current programme were mapped during recess by 4 drawing sections under Messrs. Natesan, Nangia, Azim and Muthanna. These sections also completed the colour patterns of the previous year's work of Southern Circle.

The compiled mapping was carried out by a section under Mr. Drake, D.C.M. (Class II).

Triangulation computations were carried out by a section under Mr. Nair.

90. Map Sales. As an experimental measure Mr. Clarke, who had been employed for the last 5 years by the department to take charge of the sale of maps, was appointed Map Sales Agent with effect from 1st March, when he ceased to be an employé of the department. The stock of maps in Bangalore was considerably reduced when this new arrangement came into force. The sales during the year amounted to Rs. 4,132.

VIII.—SURVEY REPORTS, EASTERN CIRCLE.

DIRECTOR:—{Colonel H. J. Couchman, D.S.O., M.C., upto 20-3-32.
Lt.-Colonel C. M. Thompson, I.A., from 21-3-32.

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

No. 9 Party did not take the field during the year under report, but was kept in abeyance as a retrenchment measure, pending orders from the Government of India regarding its disbandment.

No. 5 Party was transferred from the Central Circle to Eastern Circle with effect from the 1st February 1932.

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

In addition, as technical adviser to the Governments of Bengal and Bihār and Orissa, the Director, Eastern Circle, visited the *Bengal Drawing Office* at Alipore (Calcutta) and the *Bihār and Orissa Drawing Office* at Gulzarbāgh (Patna). The existing arrangement by which the Director acts as technical adviser to the Government of Bihār and Orissa ceased with effect from 1st April 1932.

92. The field work of parties comprised 53 one-inch sheets partly or wholly surveyed and other miscellaneous work, as follows:—

No. 4 Party.—Topography, 4,155 square miles on the scales of 1-inch and 4-inches to a mile in sheets 73 C, N and O.

No. 5 Party.—Topography, 4,691 square miles on the scale of 1-inch to a mile in sheets 64 F and G.

No. 12 Party.—Topography, 4,763 square miles on the scales of 1-inch and ½-inch to a mile in sheets 79 M, 83 D and H.

No. 5 Drawing Office.—Shillong Cantonment Survey.

Theodolite traverse	5·63	Linear miles
16-inch original survey	25·6	acres
16-inch supplementary survey ...	421·44	,,
32-inch original survey	4·03	,,
64-inch supplementary survey ...	19·6	,,
32-inch supplementary survey ...	24·6	,,

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

94. Shillong Cantonment Survey.—An original and supplementary survey of 495·27 acres of the cantonment area of Shillong was carried out by 2 traversers and 5 surveyors under the supervision of Mr. Rohini Kumar Talapatra, B.A. (U.S.S.) and the Officer in charge, No. 5 Drawing Office.

The work was transferred to the Eastern Circle by No. 20 (Cantonments) Detachment. The fair mapping was also completed by arrangement with the Director, Geodetic Branch.

No. 4 Party.

Officer in charge.— { Captain J. B. P. Angwin, R.E., up to 4-3-32.
Mr. D. K. Rennick, M.B.E., from 5-3-32.

95. General.—Original and Supplementary surveys of 4,151 square miles on the 1-inch scale were carried out in Bengal and Bihār and Orissa, consisting of original survey of 236 square miles in sheet 73 N and supplementary survey of 3,915 square miles in sheets 73 N and O.

Personnel.—The field strength of the party was 1 Class I, 4 Class II, 1 Class II Probationer, 4 Upper Subordinate and 59 Lower Subordinate Officers.

96. Areas surveyed.—

Original survey on the 1-inch scale	...	236 square miles.
Supplementary survey on the 1-inch scale	...	3,915 ,, ,,
Forest survey on the 4-inch scale	...	4 ,, ,,
Traverse (theodolite) ...	...	899 linear miles.
Traverse (theodolite) forest boundaries	...	79 ,, ,,
Traverse (plane-table height)	...	829 ,, ,,
Triangulation for 4-inch Forest Survey	...	277 square miles

97. Field work was organised as follows:—

Camp (1).—Mr. B. T. Wyatt, V.D. (Class II), with Mr. Iltifat Husain as assistant camp officer, 1 Class II Probationer, 1 U. S. S. Probationer and 7 pupils under training, and 5 surveyors, completed the supplementary survey of 1,046 square miles in the low-lying, densely populated coastal country of the Midnapore district of Bengal and the Balasore district of Bihār and Orissa, in sheets 73 O/1, 2, 3, 5 and 6.

Camp (2).—Mr. Abdul Rashid Quraishi, B.A. (Class II), with 13 surveyors, completed the supplementary survey of 1,218 square miles in country similar to that of Camp (1), in the Midnapore district, in sheets 73 N/6 and 12 and O/9, 10, 13 and 14.

Camp (3).—Mr. M. M. Ganapathy, B.A. (Class II), with 11 surveyors completed 236 square miles of original survey in sheet 73 N/15 and 826 square miles of supplementary survey in sheets 73 N/7, 8 and 11, in the low-lying and densely populated country of the Midnapore and Howrah districts. Mr. Mohabat Ali (U. S. S.) joined this camp in March on transfer to the party.

Camp (4).—Mr. Abdul Ahad, B.Sc. (Class II), with 7 surveyors completed the supplementary survey of 825 square miles in sheets 73 N/2, 3 and 4 in the Midnapore district, in country ranging from flat low-lying paddy land to gently undulating dry laterite ground with patches of *sāl* forest.

The camp areas generally range from densely populated low-lying rice lands from the coast in the south to undulating dry laterite country with occasional *sāl* jungle in the north. The villages are thickly wooded, with groves of bamboo and miscellaneous trees and numerous tanks, which are the usual water supply away from the rivers.

Triangulation.—An area of 277 square miles was triangulated by Mr. D. D. Aggarwala (Class II Probationer) in sheets 64 O/14 and 73 C/2 and 3 in the Sambalpur district of Bihār and Orissa. This was done to

provide connections for the traverse for the 4-inch survey of reserved forests.

Traverse.—Two U. S. Officers, Messrs. U. D. Mamgain, B.Sc., and S. K. Guha, with 2 traversers, completed 899 linear miles of theodolite traverse, covering sheets 72 C/1, 5, 9 and 13, G/1 and 5, and 829 linear miles of plane-table height traverse in sheets 72 C/2, 3, 4, 6, 7 and 10 and G/4, 6, 7 and 8 in the Ballia district of the United Provinces, and in the Gaya, Muzaffarpur, Patna, Sāran and Shāhābād districts of Bihār and Orissa.

This plane-table height traverse was undertaken, in the same way as last year, to provide a network of heights in areas where the preliminary editions were considered to be sufficiently accurate in plan after test by theodolite traverse, and also to provide further check on the detail.

79 linear miles of theodolite traverse were also done in 64 O/14 and 73 C/2 and 3 of the boundaries of reserved forests in the Sambalpur East Forest Division mentioned under Special Surveys.

Special surveys.—It was part of the party's programme, when it took the field, to survey 11 blocks of reserved forests of the Sambalpur East Forest Division on the scale of 4 inches to a mile, the theodolite traverse and survey being done in the same season. The boundary traverse of Kilasama, Tabla A and B, Basiapāra-Birghāt, Ramela, Jāmra, Desar-Tarida and Kusraloi A and B were completed. Of these the traverse of the Basiapāra-Birghāt Reserve has not been connected to triangulation for ascertaining geographical position.

The following reserved forests were surveyed on the scale of 4 inches to a mile:—

Kilasama	...	...	0·505	square miles.
Tabla A	...	...	0·820	,, ,,
Tabla B	...	...	0·103	,, ,,
Ramela	...	...	0·311	,, ,,
Desar-Tarida	...	...	0·547	,, ,,
Jāmra (part)	...	...	1·504	,, ,,

The programme of forest surveys had not been completed when the survey closed down owing to financial stringency.

One surveyor was employed on the revision survey of the Calcutta-Howrah Guide Map and temporarily transferred to the Office of the Director, Map Publication, for 2 years from 1st February 1932.

98. Miscellaneous.—The area is reputed to be malarious. In March and April there were many cases of cholera in the villages along the rivers. There was one case of small-pox amongst the khalasis, but otherwise the health of the party was satisfactory and there were no deaths.

99. Recess duties.—The fair mapping was allotted to three sections under Messrs. B. T. Wyatt, V.D., M. M. Ganapathy, B.A., and Abdul Ahad, B.Sc., Messrs. U. D. Mamgain, B.Sc., and S. K. Guha were in charge of the computations.

Mr. A. R. Quraishi, B.A., was transferred to No. 1 Drawing Office, Calcutta, in April on termination of the field season. Mr. Iltifat Husain (U. S. S.) proceeded on leave preparatory to retirement at the same time.

Three Class II and one U. S. S. Probationer and five surveyors were given notice of discharge at the end of the field season as a retrenchment measure.

The fair mapping and computations were completed during recess.

No. 5 Party.

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

100. General.—The Party continued surveys on the scale of 1 inch to a mile in the Central Provinces in sheets 64 D, F, G, H, K, and L. The field head-quarters were again at Nagpur in order to keep in touch with the Settlement Commissioner, the Officer in charge of the Party being also Assistant Director of Surveys, Central Provinces.

Personnel.—The field strength, apart from the Officer in charge was 2 Class I (under training), 3 Class II (1 under training), 4 U. S. Officers, 36 surveyors (12 under training), 4 traversers and 6 computers.

Two soldier surveyors in the Party reverted to their regiments at their own request. Two soldier surveyors, on completion of their fifth field season, were recommended for permanent retention in the Department, and a fresh batch of 6 soldier surveyors joined the Party from the Frontier Circle for their second period of training.

101. Areas Surveyed.—

4,691 square miles of 1-inch survey (4,245 square miles original and 446 square miles supplementary) in sheets 64 F and G;

5,696 square miles of triangulation in sheets 64 D, H, K and L;

881 linear miles of traversing in sheet 64 K.

Both the triangulation and the traverse were connected with the Bilāspur Meridional Series and with triangulation carried out by the Party.

102. Field work was organized as follows:—

Camp (1).—Mr. R. N. Hastir (U. S. S.) with 9 surveyors completed 1,105 square miles on the 1-inch scale (1,103 square miles original and 2 square miles supplementary) in Bilāspur, Drug, and Raipur districts in sheet 64 G/N.E. The area is mostly open and cultivated plains.

Camp (2).—Mr. M. A. Khan (Class II) with 12 surveyors (including 2 Class I Officers under training) completed 1,105 square miles of 1-inch original survey in Drug district and in the C. P. Feudatory States in sheet 64 G/N.W. About a quarter of the area consists of heavily wooded hills, and the remainder open and undulating plains.

Camp (3).—Mr. J. R. Chibbar (U. S. S.) with 9 surveyors completed 1,102 square miles on the 1-inch scale (967 square miles original and 135 square miles supplementary) in Bālāghāt, Bilāspur, Drug and Mandla districts and in the C. P. Feudatory States in sheet 64 F/S.W. About three-quarters of the area consists of heavily wooded hills, and the remainder open and undulating plains.

Camp (4).—Mr. Hakdad Khan (U. S. S.) with 8 surveyors completed 1,379 square miles on the 1-inch scale (1,070 square miles original and 309 square miles supplementary) in Bilāspur, Drug and Mandla districts

and in the C. P. Feudatory States in sheets 64 F/S.E. and G/3. Towards the end of the field season this camp was put in charge of Mr. J. R. Chibbar and its strength increased to 10 surveyors. About one-third of the area consists of heavily wooded hills, the remainder being open and undulating plains.

Camp (5).—Mr. N. N. Chuckerbutty (Class II) triangulated 1,675 square miles in Chānda and Drug districts and in the C. P. Feudatory States in sheets 64 D/S.W. and 64 D/12 and 16. The area consists for the most part of flat-topped heavily wooded hills, with poor communications.

Camp (6).—Mr. G. H. Khan (Class II Probationer) triangulated 1,670 square miles in Chānda, Bhandāra and Drug districts and in the C. P. Feudatory States in sheets 64 D/N.E. and 64 D/11 and 15. The area was mostly hilly and densely wooded, with poor communications.

Camp (7).—Mr. I. H. Naqvi (U. S. S.) triangulated 1,012 square miles in Raipur district in sheets 64 K/4 and 64 L/1, 2, and 6. The area consists chiefly of low heavily-wooded hills, with poor communications.

Camp (8).—Traverser Amar Singh triangulated 1,055 square miles in Bilāspur and Raipur districts and in Sārangarh State in sheets 64 K/10, 11, 14 and 15. The area is mostly hilly and densely wooded, with poor communications. In addition to his triangulation he supervised the traversing by 3 traversers of 881 linear miles in Bilāspur and Raipur districts and in the C. P. Feudatory States in sheets 64 K/1, 2, 3, 5, 6, 9 and 13.

Lieutenants Buchanan and Jelly, R.E., (Class I under instruction) triangulated 284 square miles in the C. P. Feudatory States in sheet 64 H/4.

103. Recess duties.—Fair-mapping was organised in four sections under Messrs. C. T. Hurley and M. A. Khan (Class II) and Messrs. R. N. Hastir, and J. R. Chibbar (U. S. S.). The Computing Section was placed in charge of Mr. N. N. Chuckerbutty (Class II).

No. 12 Party.

Officer in charge.—{ Lt.-Colonel C. M. Thompson, I.A., from 1-10-31 to 15-3-32.
Mr. E. A. Meyer, from 16-3-32.

104. General.—Original Survey was carried out on the scale of 1 inch to a mile in sheets 79 M/1, 2, 3, 7, 8 (parts), 83 D/4, 8 (whole), 12 (part) and 83 H/1, 2, 3, 5 (parts) in Tripura State of Bengal and in the Cāchār, Sylhet and Lushai Hills districts of Assam.

Supplementary Survey was carried out on the 1-inch scale in sheets 79 M/1, 2, 3 (parts), 4 (whole), 7, 8 (parts) in the Tippera and Noākhāli districts of Bengal.

Original Survey was carried out on the ½-inch scale in sheets 83 D/12 (part), D/16 (whole), 83 H/N.W. and H/S.W. (less portions surveyed on the 1-inch scale) in the Lushai Hills district and Manipur State of Assam and in the Chin Hills district of Burma.

Owing to progress in the intricate foot hills being so slow and the advent of the rains, it was impossible to complete the 1-inch areas in sheets 79 M/7 and 83 H/2.

Advance triangulation and traversing were carried out in sheets 79 M/5, 6 and 84 E/N.W. and S.W. Some additional triangulation and traversing to assist planetablers had also to be done in sheets 79 M/7, 8 and 83 H/1, 2.

The position of a wireless mast at Chittagong in terms of latitude and longitude was determined to the nearest 5 seconds for the Divisional Engineer, Wireless Division, Calcutta, on payment.

The field head-quarters were at Comilla.

Nature of the country.—The area under supplementary survey in sheets 79 M/1, 2, 3, 4, 7 and 8 consisted of highly cultivated and densely populated plains while the remainder under original survey consisted of low intricate hills, sparsely populated and covered with jungle and scrub.

The area under original survey in 83 D/4, 8, 12 and 16 consisted of intricate hills covered with dense bamboo jungle. In 83 D/4, 8 the hills were low and there were practically no paths, except in streambeds. In 83 D/12, 16 the hills increased in height and ran up to about 2,500 feet, and the few existing paths generally followed the ridges.

The area under 1-inch original survey in 83 H/N.W. and S.W. consisted of flat boggy country, intricate low hills, and of higher hills up to 2,500 feet covered with jungle, while that under ½-inch survey consisted of similar hills up to 6,500 feet in height.

The intricate low afforested hill areas were in all cases the most difficult to survey and could only be dealt with by planetable traverse. Fixings could sometimes be made in areas cleared for "jhum" cultivation or from "machans" in trees.

Boundary Survey.—A special traverse and plot on the 16-inch scale were prepared of a disputed portion of boundary between Tippera district and Tripura State, near Gaurāngala and Sibpur in sheet 79 M/2. The boundary was relaid by Mr. G. C. Aggarwala, B.A. (U. S. S.) with the approval of the representatives on both sides, as far as possible in accordance with Mr. Roe's award map of 1850.

A copy of the final 16-inch map, with copies of the traverse computations and co-ordinates of the pillars as relaid, was furnished to the Director of Land Records, Bengal and the Tripura State authorities.

Personnel.—The field strength of the party consisted of 2 Class I Officers (only one for most of the season), 4 Class II Officers, 7 Upper Subordinate Officers and about 56 Lower Subordinates.

Of this strength 49 took part in the planetabling.

105. Area surveyed.—

1-inch Original survey ...	...	1,089 square miles
1-inch Supplementary survey	...	1,309 ,, ,,
½-inch Original survey ...	...	2,365 ,, ,,
16-inch traverse plot Gaurāngala-Sibpur boundary.		3 linear ,,
Triangulation.—for 1-inch survey	...	122 square ,,
for ½-inch survey	...	2,183 ,, ,,
Traversing.— for 1-inch survey	...	254 linear ,,

106. Field work was organized as follows:—

Camp (1).—Mr. P. C. Mitra, B.A. (Class II), with 6 surveyors including 2 U. S. Officers, carried out original survey on 1-inch scale of 153

square miles and on ½-inch scale of 526 square miles in 83 D/8 (part), 12, 16.

Camp (2).—Mr. H. H. Creed (Class II), assisted by Mr. K. L. Dhawan, B.A. (Class II) and an average strength of one U. S. Officer and 14 surveyors, carried out original survey of 276 square miles on 1-inch scale and of 1,839 square miles on ½-inch scale in sheets 83 H/N.W. and S.W.

Camps (3) & (4).—Camp (3) started work under Mr. S. C. Chatterjee, B.Sc. (U. S. S.), while Camp (4) was a pupil camp which started work under surveyor Ilahidad Khan.

Afterwards both camps were amalgamated under Mr. S. C. Chatterjee, with an average of 19 surveyors including one Class I and one U. S. Officer, and carried out original survey of 253 square miles and supplementary survey of 1,309 square miles on the 1-inch scale.

Camp (5).—Under Mr. Muhammad Siddik (U. S. S.), with 6 surveyors increased later to 13, carried out original survey of 407 square miles on the 1-inch scale.

Triangulation.—Triangulation for 1-inch survey in sheets 79 M/5, 6, 7, 8, left incomplete by Mr. S. C. Mukherjee (U. S. S.) last year, was completed by surveyor Ilahidad Khan.

Triangulation for ½-inch survey in sheets 84 E/N.W. and S.W. was carried out by Messrs. Hawley (Class II) and Hari Singh (U. S. S.) respectively.

Traversing in sheets 79 M/5, 6, 7, and 8, was carried out by surveyor Ilahidad Khan, traverser Raja Ram Panday and computer Attar Singh. The boundaries of the Upper and Lower Jiri Reserved Forests in 83 H/1, and 2 were traversed by Mr. K. L. Dhawan, B.A., (Class II) and traverser Raja Ram Panday.

Forest Surveys.—No 4-inch Forest Surveys were carried out, as the ordinary scales were considered sufficient for Forest requirements.

107. Miscellaneous.—The health of the party was generally good, except for some cases of malaria, dysentery and one case of cholera, a disease somewhat prevalent in the Comilla district. One khalasi died of cholera and one of dysentery.

There were many wild animals in the forest areas, notably wild elephant, pig, deer, tiger and panther. There was also a variety of small game.

The weather conditions were good, except for mist and fog in the morning, particularly in the hill areas. Visibility in the hills became worse in March, when the villagers commenced clearing their "jhum" cultivation by burning undergrowth. After the middle of April work in the hill areas was hampered by rain.

There was a certain amount of terrorist activity in the Comilla and Noākhāli districts, culminating in the murder of Mr. C. G. B. Stevens, I.C.S., the Collector of Tippera and Political Agent of Tripura State. This did not tend to simplify the progress of survey in these parts.

108. Recess duties.—The mapping, consisting of 10 one-inch sheets and one half-inch sheet, was completed before the end of recess. Another half-inch sheet was completely fair drawn, except for a small area remaining to be surveyed next winter.

The drawing was allotted to four sections supervised by Messrs. P. C. Mitra, B.A., H. H. Creed, K. L. Dhawan, B.A., (Class II) and Mr. S. C. Chatterjee, B.Sc., (U. S. S.), assisted by Messrs. H. K. Kar, Hari Singh, N. C. Naug, G. C. Aggarwala, B.A., and O. P. Anand (U. S. S.).

Mr. F. M. Hawley (Class II) was in charge of the Computing Section.

IX.—SURVEY REPORTS, BURMA CIRCLE.

DIRECTOR:—Lt.-Colonel R. Foster, I.A., up to 31st March 1932.

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

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

No. 10 Party.—Topography on ½-inch, 1-inch and 4-inch scales in sheets 83 K, L, O, P and 84 I.

No. 10 Party.

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

111. General.—This party was the only one to take the field in Burma this season, as both Nos. 11 and 21 Parties were under orders of disbandment. In accordance with the retrenchment scheme, a number of last year's surveyors had to be discharged and others transferred to other circles shortly before the beginning of the field season. Their places were taken by surveyors from the other two parties, who were considered to have greater claims for retention. Many of these had no previous experience of work on any but the 4-inch scale, and were very slow to adapt themselves to small scale work. This resulted in very slow progress and, in spite of omitting part of the original programme, field work was not closed till June.

Topographical surveys were carried out in the Upper Chindwin district and in unadministered territory in the Nāga Hills in sheets 83 K, L, O, P and 84 I, and a 4-inch survey of the Indaw oilfield was undertaken for Messrs. Steel Bros.

Triangulation and traversing for current and future surveys were carried out in the Upper Chindwin and Chin Hills districts.

Field head-quarters opened at Mawlaik on 25th November 1931 and closed on 24th May 1932. Camp (3) however did not take the field until mid-December and closed early in June.

112. Areas surveyed.—

3,300 square miles of original and 313 square miles of revision survey on the scale of ½ inch to a mile;

2,287 square miles of original survey on the scale of 1 inch to a mile;

16 square miles of original survey on the scale of 4 inches to a mile.

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

113. Field work.—The strength of the party consisted of 4 Class II, 7 Upper Subordinate and 40 Lower Subordinate officers.

Work was distributed as under:—

Camp (1).—Mr. H. M. Critchell (Class II), with Mr. P. A. Thomas (Class II) as assistant, 1 Upper Subordinate officer and 15 surveyors and traversers carried out 3,000 square miles of original survey and 313 square

miles of revision surveys on the ½-inch scale and ran 155 miles of traverse for current surveys. The area surveyed lay astride the upper reaches of the Chindwin river.

The work revised had been based on rather scanty triangulation carried out a few years ago on the return of a column from the Nāga Hills.

North of Tamanthi, the camp head-quarters, and west of the Chindwin, the boundary of administered territory lies about ten miles from the river, the inhabitants of the unadministered area being Nāgās.

Six interpreters knowing the Nāga language were engaged through the Sawbwa of Singkaling Hkāmti, a small Shan State at the extreme north of the Upper Chindwin district to which some of the nearer Nāga villages pay tribute, and were allotted to surveyors working west of the river. The orders of the latter were to survey as far as they could towards the Assam border without incurring risks from the inhabitants, by whose attitude they were to be guided.

The political authorities did not expect that work would be possible more than ten miles from the river, without the aid of large escorts, unobtainable at the time owing to the political situation in Burma. Surveyors Narayan Singh and Zahur Ali, however, made friends with the Nāga headmen, and worked right up to the Assam border along the crest of the Pātkai Range, surveying the whole of Burmese tribal territory lying west of the Chindwin south of latitude 26° N, most of which was quite unknown country.

Surveyor Narayan Singh camped for some time in Makware, a village only once previously visited in 1908, on which occasion it was burnt by a punitive expedition. This village, which can muster 600 spearmen, had since then been supposed consistently hostile; but the surveyor encountered no unfriendliness and even sent in the headman on one occasion to accompany his dak runners to camp head-quarters and ensure their safe conduct through the intervening country.

The best tribute to the enterprise of these two surveyors was the astonishment of the Political Officers at the extent to which they had exceeded their instructions.

East of the Chindwin the country consisted of the low hills covered with dense jungle, as described in last year's report.

Camp (2).—Mr. F. W. Smith (Class II), 1 Upper Subordinate officer and 9 surveyors carried out 962 square miles of original 1-inch survey and 76 miles of traversing for 1-inch survey.

The country consisted of low jungle with open stretches of paddy land.

Camp (3).—Mr. J. McCraken (Class II), with 1 Upper Subordinate and 15 Lower Subordinate officers, carried out 1,325 square miles of original 1-inch survey and 16 square miles of 4-inch survey of the Indaw oil lease for Messrs. Steel Bros. He also carried out 202 linear miles of traversing to supplement triangulation, for the current year's work.

114. *Triangulation.* Messrs. Khan Muhammad, A. K. Sen Gupta, A. K. Talapatra, U. On Ba (U. S. S.) and surveyor Ikbal Muhammad triangulated an area of 5,580 square miles for future surveys in sheets 83L & P and 84E.

Mr. L. M. Ganguli (U. S. S.) triangulated an area of about 800 square miles in sheet 84I for survey during the current year.

115. Labour and Transport.—Surveyors' squads consisted usually of 3 Hazāribāgh khalasis and 2 local men. The latter were recruited for camp (1) from the Somra Tract, for camp (2) in the area of work and for camp (3) from the Chin Hills and in the area of work. All local labour caused a certain amount of trouble after the middle of April, as by that time hillmen are anxious to return to their homes and Shān and Burman villagers from the plains are most unwilling to work the whole day in the heat.

Inspecting officers, triangulators and traversers, except those in camp (1), were provided with mule transport and a few spare mules assisted in moving surveyors in areas devoid of inhabitants.

In camp (1) area, mule transport was impossible and coolies from the Somra Tract were used instead.

A dugout containing the kit of three surveyors returning to recess in June 1932 capsized in the Upper Chindwin river, an accident which entailed the loss of all the kit and the death of one khalasi.

For the first time in the survey of Burma, Hazāribāgh khalasis were repatriated by land through Manipur and the Nāga Hills, instead of by sea *viâ* Rangoon and Calcutta. This resulted in a considerable saving to Government.

116. Recess duties.—The party was organised into three drawing sections and a computing section under Messrs. McCraken, Saha and Davenport (Class II) and Khan Muhammad (U. S. S.) respectively, and all mapping was duly completed by the end of recess.

No. 11 Party.

Officer in charge.—{Major Kenneth Mason, M.C., R.E., up to 29-3-32.
Lt.-Colonel R. Foster, I.A., 30-3-32 and 31-3-32.

117. General.—As a measure of economy, No. 11 Party did not take the field during field season 1931-32 and the personnel not transferred elsewhere were employed on arrears of fair mapping of No. 10 Party and in No. 7 Drawing Office.

118. Personnel.—Three Class II, 3 Upper Subordinate and 16 Lower Subordinate officers were transferred to No. 10 Party. One Class II, 1 Upper Subordinate and 14 Lower Subordinate officers proceeded on leave or were discharged.

119. From 1st April 1932 the Party was kept in abeyance, the personnel on leave being transferred to No. 10 Party and the remainder to other units.

No. 21 (Burma Forest) Party.

Officer in charge.—Mr. D. K. Rennick, M.B.E., up to 31-1-32.

120. General.—As a measure of economy, No. 21 Party did not take the field during field season 1931-32. All instruments belonging to the Party, being the property of the Survey of India, were despatched

to Calcutta, and all furniture and equipment were handed over to the Burma Forest Department.

121. *Personnel.*—Two Class II, 2 Upper Subordinate and 14 Lower Subordinate officers were discharged or proceeded on leave pending retirement. One Class II, 1 Upper Subordinate and 24 Lower Subordinate officers were transferred to No. 10 Party and No. 7 Drawing Office.

122. On 31st January 1932 the party was disbanded, the personnel on leave being transferred to No. 10 Party.

X.—MISCELLANEOUS SURVEY REPORTS.

123. This section contains reports of miscellaneous survey operations, not dealt with under the other heads of this book, including those of extra-departmental explorations in which members of the department have taken part.

No. 15 Party (Triangulation and Levelling).

No. 17 Party (Levelling).

Officer in charge.— { Mr. D. H. Luxa, up to 25-10-31.
Lieut. I. H. R. Wilson, R.E., from 26-10-31 to 29-2-32.

No. 15 Party (Triangulation and Levelling).

Officer in charge.—Lieut. I. H. R. Wilson, R.E., from 1-3-32.

124. On re-organization of the Geodetic Branch, No. 15 Party (Triangulation) and No. 17 Party (Levelling) were combined with effect from 1st March 1932 under the designation of No. 15 Party (Triangulation and Levelling).

125. *Secondary levelling.*—In the Punjab, Punjab States and Delhi secondary levelling was carried out for the Bhakra Dam Irrigation Project (498 miles); in the Bombay Presidency, for the Lloyd Barrage Irrigation Project (4 miles); and in Bihār and Orissa, for the Bihār and Orissa Flood Area Irrigation Project (273 miles).

126. *Tertiary levelling.*—Owing to large discrepancies having come to light between the Survey and P. W. D. levelling in Bahāwalpur State, this party undertook to revise 76 sheets, some in full and some in part, amounting to 4,560 linear miles (partal 603 miles and single lines 3,957 miles). This work had originally been executed for the Sutlej Valley Project in field seasons 1924—26.

APPENDIX I.

A GRAPHICAL METHOD OF MAPPING FROM LATERAL OBLIQUE AIR PHOTOGRAPHS.

by Captain D. R. Crone, R.E.

The principles of the topographical mapping of hilly country from vertical air photographs, by the graphical methods perfected at the War Office, and also of the topographical mapping of flat country from oblique air photographs, by the methods extensively employed in Canada, are generally widely known. This article is an attempt to describe briefly a graphical method of mapping hilly country from oblique air photographs which has been used with considerable success on the North West Frontier of India.

The need for such a method arose from the fact that there are considerable areas on the North West Frontier over which aircraft are forbidden to fly, in order to avoid the violation of the frontier, which is mainly undemarcated. It was desirable to complete the topographical mapping of this area on the one-inch to a mile scale at the same time as adjacent areas were being mapped by the more usual vertical photographic methods.

The method evolved borrows its system of rectification from the first principles employed in the evolution of the Canadian oblique method for flat country (laid down by Dr. Deville as early as 1889) and its system of extending control from the photographs themselves from the radial line method for vertical photographs of Major Bagley, U. S. Army, (later improved by Captain Hotine, R.E.).

Photography.—A strip of lateral oblique photographs is taken from an aircraft flying as straight and level and at as constant a height as possible. The camera (the R. A. F. Service F.8 7 inch by 7 inch automatic film camera with 10-inch lens) is set in the oblique position in its mounting at right angles to the fore and aft line of the aircraft (or as near as possible whilst getting an unobstructed view), with its axis depressed so that the visible horizon is about 3° from the top of the picture; as the 10-inch lens covers 36°, this means that the camera will have to be depressed 15° below the visible horizon.

The strip is commenced over ground accessible to ground surveyors for fixing ground control, and exposures are made to secure that each photograph overlaps the previous one by one half *along the foreground edge.* The strip is continued until the whole area is photographed and another area accessible to ground surveyors is reached.

The height at which the aircraft is flown is chosen to secure a good visible horizon at a sufficient distance. This will generally demand a preliminary air reconnaissance. The line of flight of the aircraft is selected so that the nearer border of the area to be mapped will be included in the foreground when the aircraft is tilted to its maximum accidental tilt (about 3°).

Contact prints of the photographs are made, care being taken that they are not distorted whilst being dried.

Ground Control.—Before plotting can be commenced it is necessary to know—

(*i*) the approximate height and distance of the ground which appears as the visible horizon. This is only required very roughly, and can be obtained usually from existing reconnaissance surveys or from intelligence reports, with sufficient accuracy;

(*ii*) the position and height of three and preferably four points appearing in the end overlaps of the strip. These points must be fixed by a ground party.

One point is required in the foreground and two in the background as far away as possible, whilst still distinguishable without doubt on the photograph.

Plotting.—The various stages of plotting are—

(*i*) drawing the visible and true horizon lines and the principal line on the photograph,

(*ii*) the horizontal rectification of the necessary control points and main topographical points to form a radial line plot,

(*iii*) the resection of the plumb points (the map position of the point vertically below the aircraft at the moment of exposure) of the photographs with the radial line plot by the tracing paper method,

(*iv*) the intersection and sketching of detail,

(*v*) the vertical rectification of the photograph and determination of heights,

(*vi*) the contouring of the map.

Horizon and Principal Lines.—See Plate II showing an oblique air photograph of the Safed Koh Range, taken by No. 60 (Bomber) Squadron, Royal Air Force.

The principal point (the centre) P of each photograph is pricked in its position as determined from the camera calibration.

The visible horizon line is ruled on each photograph, and a perpendicular is drawn from the principal point P to the visible horizon and continued beyond it. The length of this perpendicular is measured. This perpendicular is the principal line. From the height of the aircraft, and the height and distance of the visible horizon, the depression of the visible horizon is calculated, allowing for atmospheric refraction. From this and the distance of the visible horizon from the principal point the distance of the true horizon along the principal line is calculated.

This is plotted on the photograph and through it a line is drawn parallel to the chord of the visible horizon; this line is a sufficient approximation to the true horizon and is referred to hereafter as the true horizon.

Horizontal Rectification. The principle of extending control by means of the photographs only is as follows:—

The end pair of photographs have the positions of their plumb points fixed by resection from the three points fixed on the ground. Three points (called minor control points) are selected in the area common to the first three photographs in positions similar to the ground control points

(one foreground and two background). The positions of these three points are obtained by intersection from the radial line plots of the first two photographs and serve as fixed points for the resection of the plumb point of the third photograph. Three more points are intersected from photographs Nos. 2 and 3 for resecting No. 4, and so on through the strip.

The object of the horizontal rectification is to make the radial line plot which gives the directions of the selected points radially from the plumb point of the photograph. These directions represent those which would have been obtained if it had been possible to set up and level a plane table at the place where the photograph was exposed and draw a series of rays to the actual points in nature with a sight rule, so that once this radial line plot is obtained the resection and intersection of detail is identical with ordinary planetable survey.

The method of rectification is to reproduce the conditions existing at the time of exposure in diagrammetic form. The points it is required to rectify, that is the ground points, minor control points and points required for sketching detail, are marked on the photograph and perpendiculars from them to the principal line are drawn.

On a piece of tracing paper (Fig. 1 in Plate III) L P is drawn equal in length to the principal distance of the camera (obtained for the particular camera and lens by calibration), and AA is drawn at right angles to LP through P.

The photograph is placed under the tracing paper with the principal line under AA and P below P, and the position of the true horizon H and the feet of all the perpendiculars Q_1Q_2 etc. are traced through. The "map" radial direction of any point O in the photograph is then found as follows, *vide* Fig. 1:—

LH is joined.

LV is drawn at right angles to LH and PV parallel to LH;

Then VP is the map projection of the principal line.

QN is drawn at right angles to VP and extended to M so that NM is equal to OQ on the photograph.

VM is joined, and is the radial direction of the point Q.

The radial directions of all points being rectified are obtained similarly.

This piece of tracing paper is the radial line plot.

Resection of Plumb Points. The ground control points are plotted on drawing paper on the scale of mapping. The radial line plot of the first photograph is placed on the map sheet and moved until the radial lines to the ground points pass through their plotted positions. The point V and the line VP are pricked through on to the map sheet. With the radial line plot of the first photograph in position, that of the second photograph is correctly set on the ground points and V_2 and line V_2P_2 pricked through.

The intersection of the radial lines to the minor control points for photograph No. 3 are pricked through, the plots removed, and the pricked points marked in pencil. This procedure is continued through the strip.

The last photograph will have two positions for its plumb point, one derived through the strip and the other directly from the ground control points appearing on it. The difference of position is distributed through the strip like the closing error in a planetable traverse.

Intersection and Sketching of Detail. The radial line plots are now fixed in position on the map sheet. Intersection of points of detail and sketching of the remainder is ordinary planetabling procedure.

Spur lines are normally considered as detail to facilitate contouring.

Vertical Rectification. The point Q on the photograph has the same height as the object O, and its distance on the map from the air station is the distance from V along the principal line to the foot of the perpendicular from O on the map.

The tangent depression from the air station is obtained on the radial line plot as follows (*vide* Fig. 2 of Plate III):—

LE is laid off ten inches along LH.

FE is drawn at right angles to LE.

LQ (*vide* Fig. 1) is produced to cut FE in D.

DE is measured in inches and divided by ten to give the tangent depression.

The calculation of the height of the air station from known ground points and of points of detail from the height of the air station then follows the normal procedure adopted in planetabling with the Indian pattern clinometer.

Contouring. The sketching of the contours between fixed heights is normal planetabling procedure.

General. The actual sketching of detail and contours can only be carried out successfully with the aid of a stereoscope to appreciate the relief of the ground. The aid given by this instrument overcomes to a large extent the disadvantage of working off a distant base with narrow intersections.

The accuracy of fixing of minor control is not high on account of the narrow angle available for intersection and resection (about 30° with the 10-inch lens), and in mountainous country dead ground is bound to occur.

The method does however provide a means of obtaining the topography of country not otherwise accessible, and its close analogy to ground survey enables normally intelligent ground surveyors to undertake the work with a minimum of special instruction. Outturns on the first areas allotted to Indian surveyors without any previous training are probably higher than they could have achieved on the ground, and the cost is considerably less.

Plate I shows the final map from oblique photographs of the area covered by the photograph in Plate II.

MAP FROM LATERAL OBLIQUE AIR PHOTOGRAPHS OF AREA IN PHOTO 07345


H
O1
O2
Q2
Q1
P
O3
Q3

Fig. 1

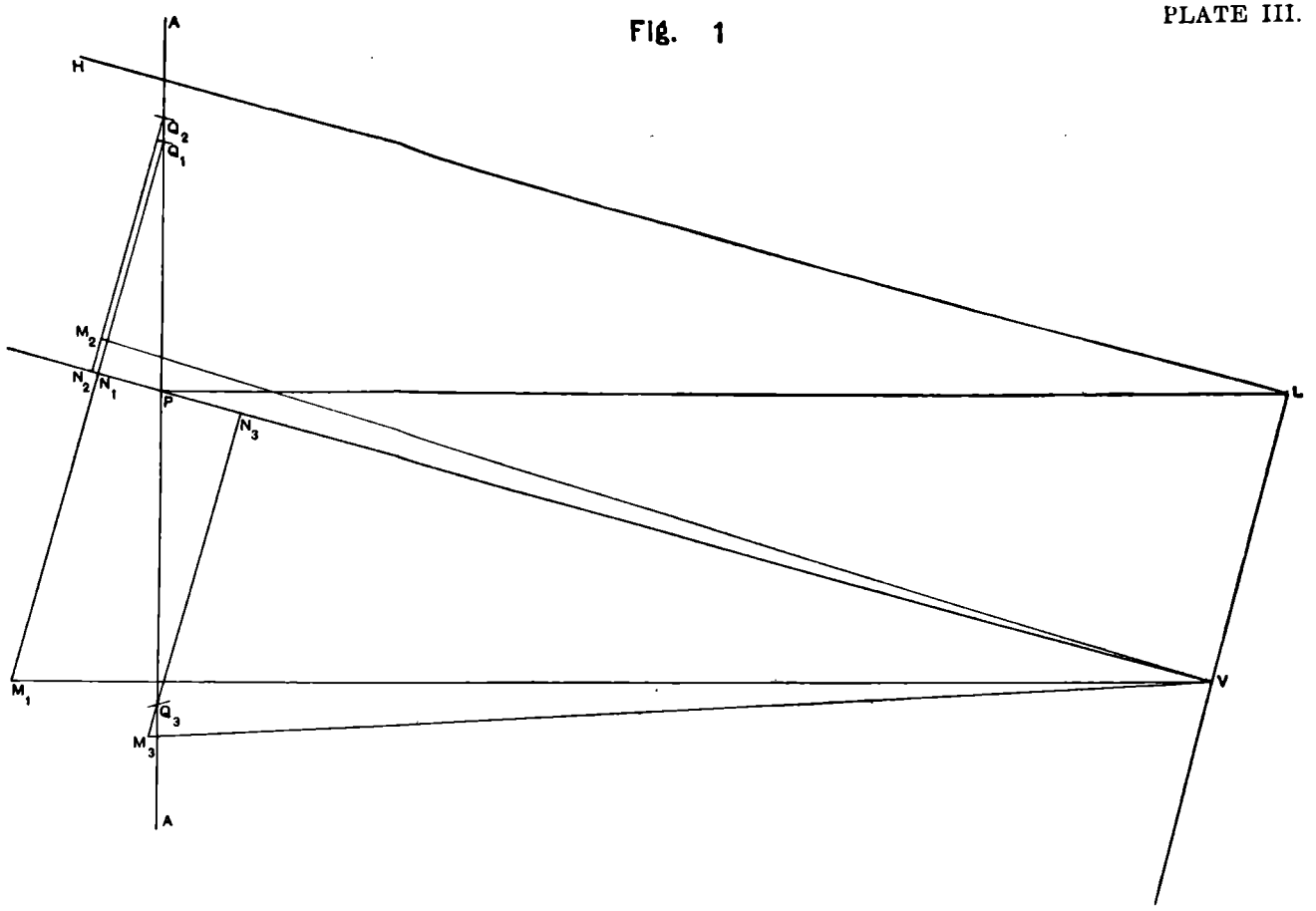
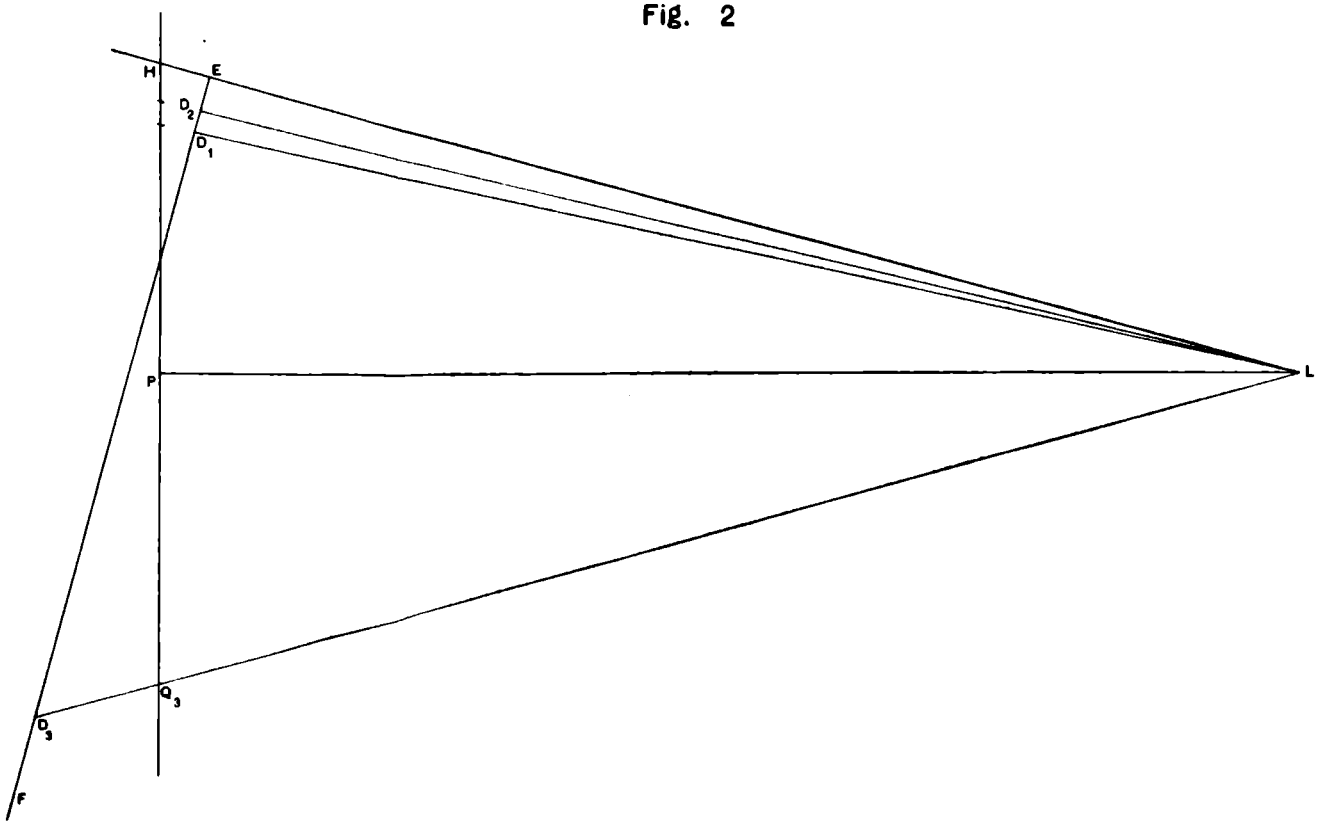


Fig. 2



AIR PHOTO TAKEN NEAR RANGPUR, BENGAL, RECTIFIED BY THE INDEPENDENT LINE METHOD. THE FOUR LINES NUMBERED 1, 2, 3, 4 JOINING THE CENTRES OF THE CIRCLES IN THE CORNERS OF THE PHOTO ARE CHAINED ON THE GROUND, AND THEIR PHOTOGRAPHIC IMAGES ADJUSTED IN THE ENLARGER TO THE CORRECT LENGTHS ON THE SCALE OF MAPPING, BY MEANS OF THE CELLULOID SCALERS SHOWN ABOVE THE PHOTOGRAPH.

THIS PHOTO IS A DIRECT REDUCTION OF A TILTED PHOTO, SHOWN DURING THE PROCESS OF RECTIFICATION. BY COMPARISON WITH THE SCALERS, IT WILL BE SEEN THAT THE UPPER TWO LINES ON THE PHOTO ARE TOO LONG AND THE LOWER TWO TOO SHORT, SHOWING THAT THE CAMERA WAS POINTING TOO MUCH TOWARDS THE LATTER. ACTUALLY, THE CAMERA AXIS WAS POINTING AT POINT P ON THE GROUND INSTEAD OF AT G, THE GROUND PLUMB POINT VERTICALLY BELOW THE CAMERA.

APPENDIX II.

THE INDEPENDENT LINE METHOD OF RECTIFICATION OF AIR PHOTOGRAPHS.

Vertical air photos, rectified to true vertical so as to eliminate accidental tilt distortion and properly scaled, are to all intents an accurate map of *flat* country, and since the Malda experiment of 1928 this has been recognised in India as the best, cheapest and quickest means of producing *large scale* maps of flat country.

For revenue maps, on the usual 16-inch scale, air photos taken on the 8-inch scale were simultaneously rectified and enlarged to the required scale from four ground control points appearing in each photo; but the fixing of these control points entailed almost as heavy traversing as for ground survey.

Since 1930 however two-thirds of the traversing has been eliminated by a system developed by the Indian Air Survey Company, by which each air photo is rectified and corrected for scale by scaling in the enlarger a line about ¼ mile long, measured on the ground in the corner of each photograph, which is common to three other photos as well, being in their common overlap (*vide* the air photo on the opposite page, taken by the Indian Air Survey Company, Dum Dum).

Occasional traverses, at intervals of 5 miles, are also necessary in order to ensure correct orientation and limit accumulation of scale error.

In Bengal, where ground and air methods of revenue survey have been tried alongside each other, the ground method's cost-rate of Rs. 300 per square mile has already been reduced by at least Rs. 62 by employing air methods, and is likely to be reduced further.

Apart from economy, the increased speed, elimination of crop damage and fraud, and possession of a permanent photographic record obtainable by air methods make the latter specially applicable to large scale revenue, city and forest surveys.

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