

CHAPTER VI

ITALIAN EAST AFRICA

The following maps and plates are relative to this chapter:

		<i>Page</i>
<i>Sketch Map 5. East Africa</i>		140
<i>Plates</i>	{	
<i>at end</i>		17. <i>Eritrea 1:50,000</i>
<i>of book</i>		18. <i>East Africa 1:500,000</i>
		19. <i>East Africa 1:250,000</i>

SECTION 1. SURVEY ORGANIZATION AND NARRATIVE

Introduction

The pre-war status of Italy as an Axis partner made it practically certain that when convenient Mussolini would enter the war on the side of Germany. His opportunity came with the collapse of France and the withdrawal of the B.E.F. from Dunkirk, and Italy declared war on the Allies on 10th June, 1940. Broadly speaking, up to December, 1940, the initiative remained with the Italians, but in the four months between January, 1941, when we were able to take the offensive, and May of that year, a campaign took place which was remarkable for rapidity of movement, the vast distances covered, and difficulties of communications. The probable area over which operations might take place was a large one. With Italian Somaliland, Abyssinia and Eritrea it formed a solid block of territory with an area of over 1,000,000 square miles extending from the border between Kenya and Italian East Africa in the south to the northern boundary of Eritrea, and from the Anglo-Egyptian Sudan in the west to the Indian Ocean, British Somaliland, the Gulf of Aden, and the Red Sea in the east. Very little of this area had been properly surveyed, and there were large tracts for which little cartographic information was available.

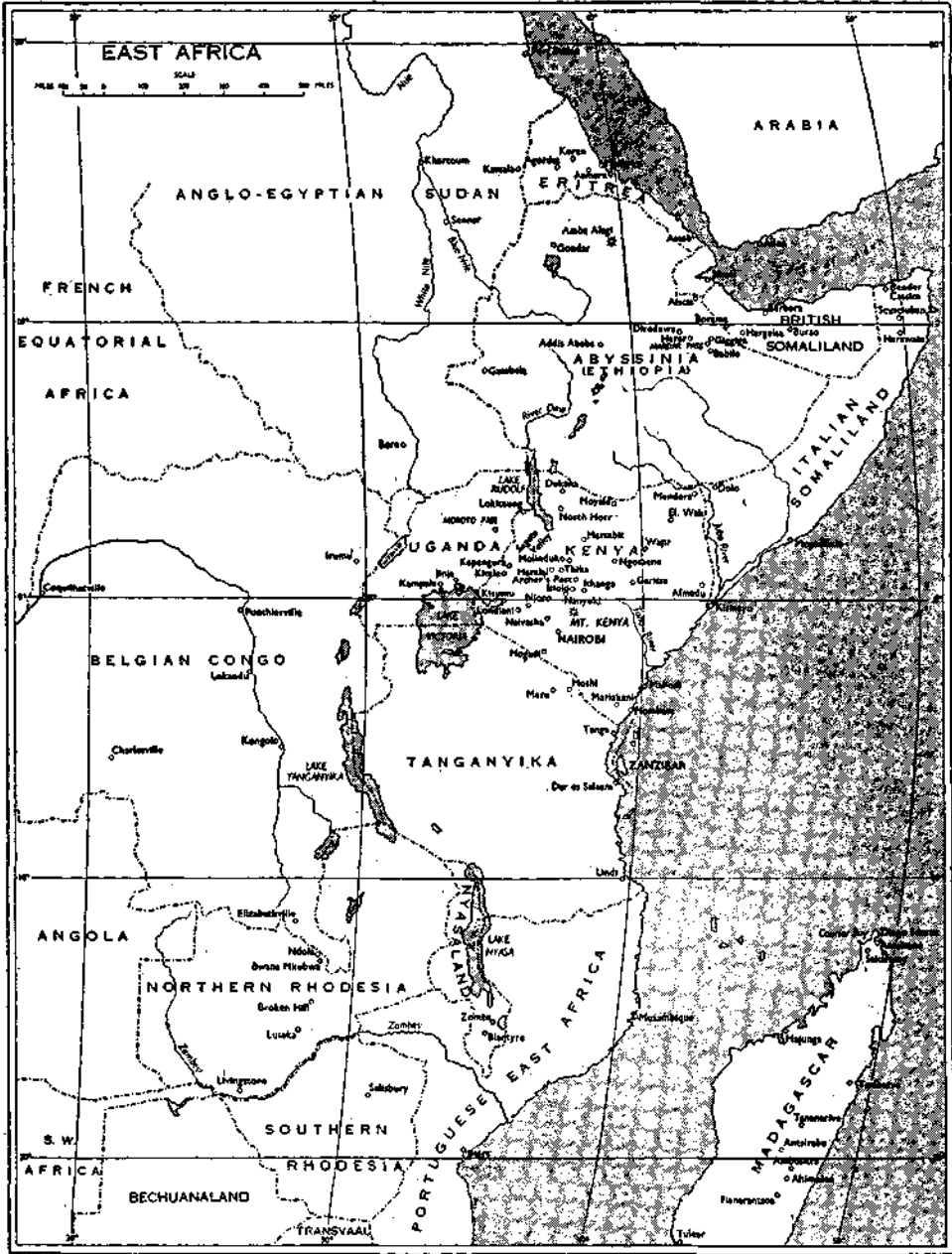
The campaign was conducted in the form of two co-ordinated offensives, one from the north and one from the south. The northern operation against the Italians in Eritrea was under General Platt's command, based on the Sudan. The southern offensive against Italian Somaliland and Abyssinia, under the command of General Cunningham, was based on Kenya.

The primitive uncivilized nature of the theatre of operations with its variety of terrain, great distances and climatic difficulties, opened up a special and difficult problem for the Survey Service, which was composed of units from East Africa itself, the Union of South Africa, Southern Rhodesia, Nigeria and the Gold Coast, and the United Kingdom.

The northern operation in Eritrea

514 (Corps) Field Survey Company R.E. (under the command of Major H. S. Francis, R.E.) arrived in Middle East Command during the winter of 1940-41 and was immediately sent south to Khartum to operate with General

SKETCH MAP 5



Drawn by Ordnance Survey, 1951

Platt's forces against Eritrea. On its way south from Cairo it carried out some compass traverses including one of the route from Shellal to Wadi Halfa.

When it arrived in Khartum, planning was well advanced for the offensive against Eritrea, and there were many demands for miscellaneous mapping and other local surveys, including reconnaissance surveys for the Chief Engineer. Triangulation was undertaken to form a basic framework from which to carry forward a trig control during the advance on Keren, which was the key defensive position in Eritrea, and where it was expected that the Italians would put up considerable resistance.

The unit was equipped with standard lorry mounted reproduction plant which enabled much valuable map and other miscellaneous printing to be carried out, not only for the planning staff, but also for issue to the troops taking part in the operations.

There had been constant frontier clashes during the latter half of 1940, the Italians outnumbering considerably the British troops available from the Sudan. On 19th January, however, Kassala, an important British frontier post, was recaptured, and the offensive into Eritrea began. Agordat was taken on 1st February, and on the 3rd the advance towards Keren was continued. Movement was so rapid that the topographical sections of 514 Company were not able to keep pace in their attempt to carry forward the triangulation. Work on it was therefore suspended, and the unit moved forward to the Keren area where in the high mountain district fierce fighting took place before Keren itself was captured. During this period 514 Company established a triangulation control, based on captured Italian data, to cover our own positions, and intersected points in enemy-occupied territory for the fixation of targets required by the artillery.

For these offensive operations round Keren 514 Company produced a considerable number of maps, sketch maps and panoramas, including an excellent map of Keren itself, much of this work being compiled from air photos when they were available.

Keren was captured on 27th March, 1941, Asmara surrendered five days later, and Massawa was occupied on 8th April. Meanwhile in Abyssinia General Cunningham's forces, after a rapid campaign across the Juba River into Italian Somaliland, had struck north into Abyssinia and, with the capture of Addis Ababa on 6th April, and the surrender of the Duke of Aosta at Amba Alagi on 17th May, the campaign against the Italians in East Africa was virtually concluded.

On completion of its survey duties in Eritrea, 514 Company returned to Middle East Command, where it took part in the Western Desert Campaign. Its standard of mapping and survey work in preparation for and during the Eritrean operations was of a very high order.

Survey units taking part in the southern operations

- (a) *East African Survey Unit.* In March, 1939, when Hitler marched on Prague, a scheme was drawn up for the formation of a field survey unit in East Africa consisting of trained surveyors belonging to the Survey Division of the Tanganyika Department of Lands and Mines. These surveyors, who had joined the King's African Rifles (Reserve of Officers), were ready to take the field at short notice and consequently when the European war broke out in September, 1939, the unit could be mobilized for active service with little delay. Originally known as

the Field Survey Unit K.A.R., which title was altered at the end of October to 1 Field Survey Company, East African Engineers, it was mobilized on 1st September, 1939, and was located at Dar-es-Salaam. The personnel, which comprised practically the whole of the survey staff of the Department of Lands and Mines, were at first organized as a Headquarter Section, No. 1 Field Section, and a Map Reproduction Section. The initial war strength of the unit was dependent, not so much on the work it might have to do, as on the available personnel and equipment.

No. 2 Field Section was formed at Nairobi, the personnel being drawn from the Survey Departments of Kenya and Uganda. The formation of No. 3 Section was under consideration, embodying personnel to be drawn from Southern Rhodesia, when it became known that a separate survey unit was being raised in that Colony. The third section was subsequently formed in February, 1940. During the winter and early spring of 1940 the East African Field Survey Company was handicapped by shortage of personnel and by its own long lines of communication. Up to the end of April, 1940, its Headquarters and map reproduction section were at Dar-es-Salaam, the latter section being staffed mainly by civilians. No other facilities for map production were available at that period, and it was fortunate that the flat-bed offset machine belonging to the Survey Department was available. Later, when the East African Survey Group was formed with its own printing plant and personnel, the map reproduction section at Dar es Salaam was disbanded and returned to civil duties.

- (b) *Southern Rhodesian Survey Unit.* Early in March 1940, this unit, was mobilized at Salisbury (Southern Rhodesia). It was recruited from the staff of the Southern Rhodesia Survey Department consisting of licensed surveyors, survey assistants, mining surveyors and geologists, architects, draughtsmen and clerks. After a few days spent in training at Salisbury the Commanding Officer (Major J. E. S. Bradford) went on in advance to Dar-es-Salaam for discussions with the East African Survey Company Commander. Proceeding by road convoy the unit reached Nairobi on 28th March, after covering 1,650 miles in 13 days under bad weather conditions, and while in Nairobi East African native ranks and followers were obtained. European personnel were attached to the Map Reproduction Section at Dar-es-Salaam to gain experience of the work going on there, and to be trained in the reproduction processes with a view to the subsequent formation of a mobile map production unit.
- (c) *West African Survey Unit.* During July, 1940, the survey resources in East Africa were augmented by the arrival of a survey unit from West Africa. This unit was part of the Royal West African Frontier Force, and its personnel belonged to the Nigerian and Gold Coast Regiments. The officers were European personnel belonging to the civil survey organizations of the two colonies, and the trained surveyors, draughtsmen and lithographers were recruited from the native staff of the Nigerian and Gold Coast Survey Departments. It is worthy of note that the West African natives had, at that period, reached a far higher stage of technical survey development and training than had the East African, and they played a very important part in the work of the Survey Service in East Africa. Originally two separate detachments, controlled

respectively by Gold Coast and Nigerian Brigade Commanders, they were later combined into the West African Survey Unit.

- (d) *South African Survey Company.* This unit, composed of volunteers, came into existence some time after the outbreak of war. Mobilization was ordered in May, 1940, the strength of the unit then being 31 officers, one warrant officer, and 113 other ranks. It was known as the 1 (S.A.) Survey Company, South African Engineer Corps (S.A.E.C.). After a road and rail journey the unit reached Nairobi on 3rd August. An engineer survey officer of the Union Defence Force (Lieutenant-Colonel N. G. Huntly) was appointed A.D. Survey for the South African Force in East Africa and he acted as liaison officer with Force H.Q. on Survey matters affecting the South African units. He was incorporated into the Survey Directorate, East Africa Force Headquarters, when this directorate was formed in July, 1940.

The H.Q. sections of the unit included administrative and transport personnel, a geodetic (computing) section, a drawing section, and instrument repair and hygiene sections. Later, a photo-topo section was added and, in December, 1940, the lithographic personnel of the Army Printing and Stationery Service (A.P. & S.S.) was attached to the Survey Company for map reproduction purposes. Up till then this lithographic section of the A.P. & S.S. had been working independently and not under the control of the Survey Service. The balance of experience in most countries, both in peace and war, tends to show that there are overwhelming advantages in having map reproduction working under the same general control as the other processes entailed in the production of a map, such as the ground survey, the compilation, and the drawing. The various stages of map production require constant and close collaboration between the branches concerned and, even granting good liaison and co-operation between parallel organizations, there is no doubt that centralized control of all branches of survey and production, especially on active service, is desirable. As a result of this attachment three printing officers and about 50 other ranks were affiliated to the 1 (S.A.) Survey Company with their reproduction plant which was mainly mobile.

The personnel of the drawing section was drawn from various government, municipal and private drawing offices and, before leaving South Africa, some very useful and intensive training in topographical mapping was undertaken.

In the middle of December, two mapping sections arrived from the Union and were employed with the unit's photo-topographical section. These mapping sections had the advantage of about two years' training and experience in topographical work in the Union before the war, mainly on 1/25,000 mapping with and without air photos, but few had been trained as draughtsmen.

There were five field sections, each of four officers and 12 other ranks, with 20 or 30 African labourers. Their principal duties comprised triangulation and the fixation of control points for mapping, artillery requirements, and engineer purposes. In addition to the above sections a forward H.Q. and map depot were established and maintained from the end of August, 1940, till the end of March, 1941.

(e) *No. 60 (Photographic) Squadron. S.A.A.F.* The importance of air photographs for mapping purposes needs no elaboration. These were of paramount importance in East Africa under active service conditions, owing to the scarcity of mapped detail over large areas of country, much of which was in enemy occupation and could not be surveyed by ordinary ground methods. During pre-war years, the use of air survey methods for economic development, mapping and geological reconnaissance had been rapidly increasing in the Dominions and Colonies, and in East Africa a lead had been taken by Tanganyika Territory where survey flights for such purposes were inaugurated in 1929.

In September, 1939, the survey aircraft in Tanganyika were taken over by the R.A.F., and during the first few months of the war no aerial photography was possible. A proposal that a Civil Air Survey Company, whose head office was in South Africa, should undertake the air survey of the northern frontier district was not sanctioned. In January, 1940, however, one of the Tanganyika aircraft which had been taken over by the R.A.F. was made available for the photography of certain areas in the northern frontier district using films and other photographic supplies provided by the Government of Zanzibar. Little was done, however, until the arrival of the South African Air Force (S.A.A.F.) personnel and equipment in July.

In June, 1940, No. 1 (Survey) Flight of the Photographic Squadron S.A.A.F. had been organized for operation in East Africa. Three Airspeed Envoy aircraft were flown up during June and July, but one was condemned as unsafe and could not be used, and another crashed *en route* killing all the occupants. Until the end of August, work was restricted, as only the one machine was available and the weather conditions were bad.

When the Survey Directorate (East Africa Force) was formed in July, the technical control of the Survey Flight came under D.D. Survey, and operational and administrative command remained with the Air Officer Commanding (A.O.C.) in East Africa. The function of this Flight was to take photographs of areas required by the Survey Directorate, to develop the films, and produce contact prints which were then handed over to Survey for the compilation of the maps by the photo-topo sections of the East African Group and the 1 (S.A.) Survey Company. Personnel of the squadron were attached to the latter unit to form a developing and printing section. In order to maintain effective co-ordination and liaison, a representative of the squadron attended the daily conferences which were held at the Survey Directorate.

One Anson aircraft was flown up to East Africa from the Union at the end of September, 1940, and in mid-October the one and only Airspeed Envoy, which had been carrying on a solo task, was flown down to the Union and a second Anson flown up in exchange. A third Anson came up in mid-January, but unfortunately one of the three was shot down a fortnight later.

The areas over which photography was required were now increasingly in places where the Italians could deploy fighter opposition. As a consequence the Ansons had to be taken off survey photographic missions and were used on map transport duties.

After being under warning notice for some time, 60 Squadron was transferred to Middle East in June, 1941, where it took over more suitable aircraft and proceeded to increase the reputation it had rightly earned during its sojourn in East Africa. In spite of so many difficulties and with limited resources, the never-failing efforts of pilots, ground staff and photographic personnel produced a great deal of most valuable and urgently required photography.

(f) *Survey Directorate and East African Survey Group.* The Director of Survey, Middle East, who exercised a general control over survey activities in the East African Command, visited Nairobi during July, 1940, to study local survey conditions and to make recommendations for any necessary reorganization which he might consider necessary.

Up till July, the work of the East African and the Southern Rhodesian Survey units had been carried out independently of each other, though with a certain amount of liaison between the two officers commanding. The unit from West Africa had only just arrived and had not carried out much work as yet in the field. The impending arrival of the South African Survey Company and the presence of the air photographic resources of the South African Air Force, combined with the considerations stated above, made it obvious that some form of central Survey control was necessary. The War Office was asked to provide a Survey Directorate for Force H.Q., in order to control all Survey activities in East Africa. This was approved and, pending the arrival of the War Office nominee, the Commander of the Southern Rhodesian Survey Company (Major J. E. S. Bradford) was appointed to act as A.D. Survey.

It was also decided that an East African Survey Group should be formed, consisting of the three units from East Africa, West Africa, and Southern Rhodesia respectively. Major Bradford, while still retaining command of the Southern Rhodesian Survey Company, was appointed Commander of the Group. The 1 (S.A.) Survey Company was not at any time included within this Group but worked as a parallel organization reporting direct to the Survey Directorate at Force Headquarters which in fact, if not officially, included the A.D. Survey of the South African Force.

The object of this grouping was to enable the best and most efficient use to be made of the available technical resources of the various units. It should be noted that, in general, the separate units forming the Group had been raised and organized more or less on the basis of the personnel available rather than on any logical establishment based on probable survey requirements.

The general organization of the Group was to include a headquarters and depot as a semi-permanent establishment. This field H.Q. would undertake the provision and supervision of field parties, control the depot which would be a centre for refitting and reorganizing, and also act as a rest camp and training centre for both survey and military training. The lithographic production plant, together with the drawing and map compilation centre, were to be at Nairobi, near the H.Q. of the South African Survey Company. Arrangements were made for increasing the drawing strength of the Group by the addition of draughtswomen (civilians at first, but later recruited into the F.A.N.Y.), and

Asiatic draughtswomen who were civilians and were only employed on non-security work.

The Survey Directorate was established on 23rd July, 1940, and the Survey Group on 1st August, with Lieutenant-Colonel Bradford performing the dual functions of A.D. Survey and Commander of the Survey Group.

Survey conferences were held several times each week by Lieutenant-Colonel Bradford which were attended by Lieutenant-Colonel Huntly and the O.C. South African Survey Company. The O.C. 60 Squadron (S.A.A.F.) was called in whenever necessary. In his capacity as A.D. Survey Lieutenant-Colonel Bradford also attended the "Operations" conferences at Force Headquarters, and thus it was possible to keep survey activities and future planning in phase with operational requirements, and co-ordinate the work of the Survey Group and the South African Survey Unit.

Miscellaneous items of organization (Southern operations)

By the end of August, 1940, a central organization had been set up to deal with all survey records. It was known as "Central Survey Records" (C.S.R.). Later on it was found necessary to separate its various functions, and therefore, in December, 1940, three records branches were formed, known respectively as the Central Cartographic Records, Central Trig Records, and Central Photographic Records.

It was considered at the outset that field parties of the South African Survey Company and of the East African Survey Group would be best employed on trig and topographical work respectively in view of their weight of peace-time experience in these branches. By this arrangement, which was never a very rigid one, three sections of the South African Survey Company provided trig control for the topographical survey which was carried out by the units of the Group; another section was used for putting the existing Kenya triangulation in order, and also to train for artillery co-operation, and a fifth section was trained for topographical mapping. Later experience indicated that the wide professional training of the South African surveyors made it completely unnecessary to restrict them to trig work. They could, if it had been necessary, have been successfully employed at the outset on ground topographical surveys, and indeed they proved their ability later when they completed some very rapid and successful topographical field mapping of the El Alamein area in Egypt.

In a War Office letter to G.H.Q. Middle East in October, 1940, the technical responsibilities of the Survey Directorate (E.A.F.) were laid down. By these instructions D.D. Survey (East Africa) was made technically responsible for all survey and mapping connected with the operations of the East African Force. He was also made responsible for similar matters concerning Tanganyika, Kenya, Uganda, Nyasaland, Northern Rhodesia and Zanzibar, on which subjects he was to correspond direct with the War Office. Technical questions jointly affecting both the Middle East and East African Forces were to be resolved by D. Survey, Middle East Command, in consultation with the D.D. Survey in East Africa.

On 6th November, 1940, Colonel Hotine, the War Office nominee, arrived from the United Kingdom and assumed duty as D.D. Survey. Lieutenant-Colonel Bradford, who had been acting A.D. Survey pending Colonel Hotine's arrival, resumed duty as Commander, East African Survey Group. Colonel

Hotine was accompanied by a D.A.D. Survey (Major), one Captain (a map reproduction expert) and eight other ranks.

It was soon realized that map reproduction facilities were inadequate and would require greater co-ordination. The War Office was asked to send out a Map Reproduction Section R.E. and, in order to provide greater co-ordination with map production, the lithographic sections of the South African Army Printing and Stationery Services were attached to the South African Survey Company.

Divisional and Brigade Survey Sections

When offensive operations against the Italians started in December, 1940, it was decided to attach two officers of the East African Survey Group to the attacking force. They went into action with the 12 (A.) Division and 1 (S.A.) Brigade at El Wak, and the success of this attachment was influential in reaching a decision to form divisional and brigade survey sections, to deal with the conditions resulting from a 1,200-mile front, few and bad lines of communication, and large tracts of desert. Survey sections were formed and attached to 1 (S.A.) Division, 11 (A.) Division, and 12 (A.) Division respectively, to come under the operational control of the divisional commanders, though their technical control remained with D.D. Survey. Their tasks were roughly as follows:—

- (a) Preparation and reproduction of sketches to illustrate operational orders, etc.
- (b) Rapid sketch mapping from air photos of limited areas, the photos being taken by Army Co-operation Squadrons.
- (c) Fixation of position in bush areas, and the guiding of troops to their objectives.
- (d) Assistance, when necessary, with artillery surveys.
- (e) Assistance with map distribution.

In the case of the East African Group units, forward H.Q.s were established in the divisional areas. Each had a map store, and controlled the field surveys in the divisional areas. The survey officer at a forward headquarters was responsible for reinforcing the divisional survey section when necessary, and for its technical efficiency. He kept in touch with Divisional H.Q.s for these purposes, and assisted in all possible ways regarding surveys and map supply for the troops.

The South African Survey Company did not, however, establish a forward H.Q. in the area of the 1 (S.A.) Division. Arrangements were made for reinforcements for the divisional survey section to come direct from the South African Survey H.Q. at Nairobi. There was, however, a forward map depot, and the officer i/c the divisional survey section was responsible for the map supply of his division. Brigade survey sections were provided also by the South African Survey Company for the 25 (E.A.) Infantry Brigade and, later, for the 2 (S.A.) Infantry Brigade.

The period leading up to December, 1940, when active operations started, was a time of intense preparation and organization for the Survey Service. Mapping programmes, which are dealt with elsewhere, involved unremitting hard work for all concerned. Once started, the campaign was fought with

lightning speed. Throughout the ensuing months of fighting the survey staffs and executive branches were working literally night and day, often without rest for 48 or more hours at a time. There were many difficulties and temporary setbacks, which was to be expected when taking into account the rapid movement, ever lengthening lines of communication, and difficult means of transport over roads that were often impassable. The General Officer Commanding stated at the end of the campaign that the Survey Service never let him down, though there was one occasion when operational maps really did fail to reach the troops in time. This was for the battle at the Marda Pass. The maps were sent forward to the advanced area by air in plenty of time, and were duly unloaded on the airfield. By some mischance they were reloaded on a plane returning to Nairobi and, while the battle was being fought, they were discovered lying at Nairobi airfield!

With the capture of Addis Ababa on 6th April and the surrender of the Duke of Aosta at Amba Alagi on 17th May, 1941, the bulk of the Italian Army had been defeated and one of the principal objectives of the campaign had been attained. There was, however, plenty still to do before the operations could close down, and this applied to survey as to every other form of activity.

Other theatres were now clamouring for reinforcements, especially the Middle East. Colonel Hotine had relinquished his appointment as D.D. Survey East African Force towards the end of February, 1941, on being posted for duty in Greece, and he was succeeded by Colonel J. E. S. Bradford, who had been combining the appointment of East African Survey Group Commander with that of Commander of the Southern Rhodesia Survey Unit. The possibility of transferring some of the survey strength from East Africa to the Middle East was now being considered and, as a result of a recommendation submitted to the G.O.C. East African Force, the following moves and actions took place:—

- (a) 1 (S.A.) Survey Company moved to Middle East complete with all equipment and personnel, including the attached litho section. It was originally ordered to move by road about the middle of April, and left shortly afterwards. The unit was, however, recalled by Force H.Q. after one day's journey, and ordered to proceed by sea. Shipping was not available to move it until the end of June, 1941. After their departure, all reproduction work was undertaken by the East African Survey Group, which was shortly reinforced by a Map Reproduction Section R.E. from the United Kingdom.
- (b) No. 60 (Photographic) Squadron S.A.A.F., which had been doing such excellent work for Survey in spite of the lack of suitable aircraft, left for Middle East on 18th June. More suitable types of aircraft were awaiting them there.
- (c) A.D. Survey of the South African Survey troops (Lieutenant-Colonel N. G. Huntly) moved to Middle East for attachment to the Survey Directorate there.
- (d) The Central Trig Records, which had been controlled by the South African Survey Company, were handed over to the computing section of the East African Survey Group.

Enemy survey resources

Survey parties advancing with the field formations entered Addis Ababa on 6th April, 1941, and an advanced Survey Directorate was established there. An investigation was immediately made of the Italian Survey resources and quantities of survey instruments and equipment were found, together with large stocks of maps, map compilation material, and ample supplies of drawing office, photographic and printing stores.

Amongst the booty was the equipment of a map reproduction unit, including printing presses and a camera, though the lens from the latter was missing. There was also a well-equipped civil air survey organization and, though it was a private company, the director had been mobilized and the firm had been doing work for the Italian Army. Their offices were therefore taken over and the plant confiscated.

Reorganization of the Survey Service in East Africa

Colonel Hotine (late D.D. Survey, East Africa) returned to Nairobi from Cairo early in May, 1941, to arrange for the best application of the survey resources now remaining in East Africa to meet immediate needs and probable future military requirements. After investigation Colonel Hotine prepared a recommendation on the subject, taking into account the factors affecting the military situation, which were:—

- (a) Operations were continuing, and in view of the rainy season which was approaching, Italian resistance in difficult mountainous country might take a long time to overcome.
- (b) A British Military Mission was going to be established to arrange for the raising and training of Ethiopian troops.
- (c) The administration of the territory recently occupied would be a British responsibility.
- (d) Kenya would probably remain an intermediate base and training area.
- (e) It seemed possible that there would be an extension of the East African Command.

It was therefore necessary to maintain resources for carrying out field surveys and for improving existing maps, and it seemed clear that not only could the available resources be reduced no further but, on the contrary, they required some reinforcement.

The East African Survey Group, which alone remained in the Command, consisted of three units, none of which could operate efficiently on its own. Though it had been possible to operate successfully hitherto as a group, and though this could probably meet all foreseen requirements in East Africa with little reinforcement, the units could not usefully be employed elsewhere without complete reorganization and re-equipment. Consideration was given to the possibility of moving the Group as a whole to Addis Ababa, where it could make use of the Italian equipment, but it was considered better to bring the captured material back to Nairobi and retain the H.Q. of the Group there. It was recommended that the Divisional Survey Sections should revert to the operational control of the Group as soon as they were no longer required for active operations with divisions. The Survey detachment was to remain at Addis Ababa in order to form a link between the Survey Directorate and Advanced Force H.Q., the Divisional Survey Sections, the Administration of

Occupied Enemy Territory, and the Military Mission. It would also arrange for the evacuation of captured and requisitioned material from Addis Ababa to Nairobi.

With the altered operational situation it was considered appropriate to reduce the status of the Survey Directorate to that of a Corps type, with one A.D. Survey (Lt.-Col.) and one captain. At this time also proposals were submitted for an amended establishment for the East African Survey unit (now known as No. 55 Survey Company E.A.E.). Experience had shown that it was unbalanced in many directions, and it was only its embodiment in the Group that had allowed its potential survey strength to be used with efficiency. It was now desired to reorganize it so that it could operate fully as an independent unit. Recommendations of a similar nature were sent to the War Office regarding the 56 (West African) Survey Company which was to return to West Africa in August. In the case of No. 57 (Southern Rhodesian) Survey Company it was decided that no change in establishment should be made at that time.

Concluding notes

Although there remained a considerable amount of survey and mapping work to be done, the above summary deals with the principal items of survey organization for the campaign against Italian East Africa. Many of the difficulties, improvisations and hard "collar work" might possibly have been avoided by a more realistic and adequate pre-war consideration of probable requirements in case of war.

It would appear that more note might have been taken of the lessons to be learnt from the 1914-18 operations in East Africa, including the organization of adequate peace-time survey services in the Colonies, whose duty would have been to prepare good maps of potential operational areas. Apart from their requirement for war, such maps are a first essential for a proper economic development of any country. The development of a Colonial Survey Service on broader lines than heretofore seems to be essential.

The arrangements for collecting, in peace, copies of all maps produced by foreign powers were not good enough. Many captured maps were of a date that indicated that they should have been in the War Office map library some time before the war started.

Map reproduction facilities were a source of weakness. Arrangements might possibly have been made for some form of central map production establishment to have been set up, in peace-time, to serve the needs of the East African Colonies.

Although, under normal conditions, it was general policy that survey units should be controlled at army level, there seems to be no doubt that, under conditions such as applied in the East African campaign, the detachment of survey sections to divisions and even brigades, was justified. Under such circumstances the personnel must be well trained in rapid compilation from air photos, map revision and astronomical fixations, and must have some form of light portable reproduction plant. The sections should be small, very mobile and physically tough. They must be fully trained in all their technical and military duties.

SECTION 2. MAPS AND MAP PRODUCTION

Pre-war mapping situation

The potential area of operations in East Africa was a large one, including Kenya, Abyssinia, British, French and Italian Somalilands, and Eritrea, together with the border areas of Uganda and the Sudan. Very little of this had been systematically surveyed, and there were large tracts about which little topographical knowledge was available. About four-fifths of it was in Italian occupation and, though it was supposed, and later confirmed, that the Italians had carried out a good deal of survey work, little information was known about it until a later stage in the operations, when enemy map material was captured.

On the maps which were initially available from War Office sources the detail had been compiled from a variety of information. A small amount was based on accurate surveys. The remainder depended on travellers' route traverses, administrative officers' sketch maps, boundary commission surveys and other sources.

The following maps bearing various dates of publication by the War Office were in existence:—

1/2M. Standard African series covering the whole East African area. Sheets dated from 1936 (Juba River) to 1940 (Kenya), so were fairly well up to date, in so far as the revision material available at the War Office allowed them to be.

1/1,000,000. A series which covered Tanganyika, southern and north-western Kenya, and Uganda. There were no sheets covering Abyssinia or Italian Somaliland.

1/250,000. Parts of south-western Kenya and Uganda—31 sheets (1912–25).

1/250,000. British Somaliland—17 sheets (1934–39).

1/300,000. Tanganyika—34 sheets (1916).

Except for the standard African 1/2M series which covered the whole potential theatre, these maps were not of much value for operations in northern and eastern Kenya, Italian Somaliland and Abyssinia. There were also a few sheets at various scales which were not of any great operational importance, and one or two old Boundary Commission maps dating back some years.

In addition to their own G.S.G.S. map publications the War Office held in their map library sets of record copies of a certain number of foreign maps within the area, but it would appear from later evidence that these library sets were not as complete or as up to date as they might have been.

Probably the most up-to-date published maps of Abyssinia and Italian Somaliland were those of an Italian 1/400,000 series of which copies were on public sale in places such as Mogadishu, but only a very few of these sheets had been secured. During the five years of pre-war occupation of Abyssinia by the Italians, they carried out a great deal of mapping mainly from air photographs, and from 1938 onwards they published new sheets from time to time. It would appear probable that copies of these new productions might have been obtained by direct or indirect means from Addis Ababa or elsewhere in the territory but, as events turned out, it was not until the capital was occupied by British forces that copies were secured.

In the case of Madagascar and French Somaliland, it was presumably known that the French Service Géographique published new sheets at fairly

regular intervals, and yet the collection of record copies held in the War Office library in 1939-40 appears to have been incomplete and very largely out of date. For example, a sound and reliable 1/20,000 series in Madagascar covering Diego Suarez and its environs, including Courier Bay where a British force landed in May, 1942, existed in 1939, and could have been purchased anywhere in Madagascar, or direct from the French Service Géographique, but there was no complete library set held by the Geographical Section. Another unexpected but useful source of information was a set of 1/200,000 geological maps of Madagascar, up to date as at 1939. These maps were discovered in the Public Library, Johannesburg, and in the Geological Survey Offices at Pretoria and Salisbury, and copies were sent to the East African Force.

Early mapping activities

The entry of Italy into the war against the Allies was obviously a very real possibility ever since September, 1939. At that time there were some 39,000 square miles in the Northern Frontier District of Kenya, along the borders of Abyssinia and Italian Somaliland, for which there was no reliable topographical information. It would seem, therefore, that under such circumstances it would have been advisable, for defensive or offensive planning, to have concentrated survey resources as early as possible for mapping this area by a rapid survey in order to determine the positions of features important for military purposes, such as roads, tracks and water supply.

The East African Field Survey Company had been formed in September, 1939, and, as the strength of the military forces in Kenya at that time was such that a defensive policy would have to be adopted until reinforcements should arrive from West and South Africa, these limited survey resources were directed to the lines of communication and certain defensive areas. This work consisted of road traverses, astronomical and triangulation fixes to provide control, and the detail survey of such strategical points as the frontier camp at Moyale and other areas. Arrangements had been made in Southern Rhodesia for the formation of a Survey Company, but it was not until late in February, 1940, that H.Q. East African Force asked for this unit to be sent to East Africa. The unit was actually mobilized early in March and moved up by road. It was unfortunate that there was no survey representation at Force Headquarters in those early days to press the need for the early concentration of survey resources, and to advise how these resources should be employed to meet urgent mapping requirements.

Even when the Southern Rhodesian and East African survey units were both available together in Kenya they were employed during April and May, 1940, on the production of 1/100,000 maps, on regular $\frac{1}{4}$ -degree sheet lines and by normal ground methods, of areas which were not vital for impending operations. This, no doubt, would have been all right if the entry of Italy into the war was likely to be long delayed, but it was not covering the 39,000 square miles of unknown country along the Italian frontiers with maps which would be vitally necessary when active operations started. In actual fact, the two survey unit commanders made a joint recommendation to the General Staff that the policy governing this survey programme should be changed, and that rapid survey methods should be undertaken for the production of 1/250,000 or 1/500,000 maps where most urgently required. This recommendation was approved, but, if there had been a survey representative with Force H.Q., he

would have advised the General Staff that it was more important to have small scale maps of the whole potential area of operations, showing important tactical features, rather than a few well-mapped sheets on a larger scale, forming a solid block of survey over areas of less operational importance.

Rapid reconnaissance surveys to produce sheets of the Tana River area were carried out very quickly between about 25th May and 8th June, 1940, and the material was flown for reproduction by the map printing section at Dar-es-Salaam. By 14th June, copies of the maps were distributed. The maps were on the scale of 1/500,000, and were the forerunners of the standard series at that scale which became the regular issue for the fast-moving campaign in Abyssinia and Somaliland.

Mapping policy

When the Director of Survey, Middle East (Brigadier R. L. Brown) visited East Africa in July, 1940, he laid down certain general lines of mapping policy. Generally speaking, these instructions, though varied, amplified and altered in minor respects during the course of the campaign, remained the basis of all subsequent mapping programmes.

The policy, as then laid down, is summarized below:—

- (a) 1/2,000,000 series. This was the standard G.S.G.S. series of Africa. The Union of South Africa was asked to undertake the maintenance and printing of this series to the south of latitude 4° N.
- (b) 1/1,000,000 series. The Survey Service of the East African Force was to undertake the compilation, production and maintenance of this series on International sheet lines south of Lat. 8° N. This mainly concerned the area of potential operations and movement, at any rate during the early stages of the campaign.
- (c) 1/500,000 series. This was to consist of sheets compiled on a regular system of sheet lines measuring 2° each way, and was to be based on surveys of accessible areas, reconnaissance reports and any other map material that could be obtained. Special features were to be photographed from the air. Reference has already been made to the forerunners of this series, when sheets of the Tana area were surveyed by rapid reconnaissance methods by the East African and Southern Rhodesian Survey Units (Plate 18).
- (d) 1/250,000 series. Mapping on this scale was to be undertaken on regular 1° square sheet lines in all the more developed areas. The South African Survey Company was to undertake this task, and the first areas to be mapped were to include the Moroto Pass, Kapengura, Maralal, Archer's Post and the country towards Meru (Plate 19).
- (e) It was intended that survey parties should be disposed in such a manner that complete blocks of topography for the 1/250,000 and 1/500,000 series would be available in a comparatively short time.
- (f) 1/50,000 and 1/25,000. Use was to be made of the South African Air Photographic Unit for rapid air surveys of selected areas on these scales.
- (g) The projection was to be the Transverse Mercator, with grid belts having a width of 5° of longitude, with central meridians at 32° E., 37° E., etc.
- (h) Spheroid. Clarke 1880.

- (i) The East African grid system was to be on a yard basis, and the original intention was that it should extend northwards only as far as Lat. 8° N. This limit was, however, subsequently extended further.
- (j) It was recommended that civil map reproduction agencies, such as that at Dar-es-Salaam, should carry out such work as was required, in the manner to be laid down by the force commander.

Mapping programme (August, 1940)

By mid-August a mapping programme was drawn up, the work being split between the newly formed East African Survey Group and the I (S.A.) Survey Company. Early on the priority list were one 1/1,000,000 sheet and several at 1/500,000. In October, 1940, this programme was considerably extended, and included the production of 24 sheets at 1/500,000, 12 at 1/250,000, and 4 at 1/25,000 all to be completed by 10th December. The large scale maps were to cover Archer's Post, Isiolo, Marsabit and Nyambeni. Those on the smaller scales covered the frontier areas.

Grid system

A proposal which was made to H.Q. Union Defence Force, and agreed to by them, was that the East African grid system should extend as far as Lat. 12° S., and that, to the south of that latitude, the South African grid system should be used. The War Office, when informed about this, pointed out that this would leave Northern Rhodesia partly on the East African 5° belt system and partly on the South African 2° belt system. It was therefore decided that the East African grid should be carried south to the Zambezi River, leaving Southern Rhodesia and the Union of South Africa on the South African 2° belt. It was later agreed that the East African grid should extend northwards as far as Lat. 20° N.

Formation of Central Survey Records (C.S.R.)

At the end of August, 1940, a Central Survey Records organization was formed. Its main function was to maintain all survey records in an accessible form, to facilitate the distribution of survey information and data to all who required it, and for use at Survey H.Q. for map compilation.

The records comprised:—

- (a) Geodetic, astronomical and triangulation records.
- (b) Cadastral plans, original compilations from air photos, and plane-table sheets.
- (c) Air photographs and sortie diagrams.
- (d) Fair drawings and history sheets for all maps.
- (e) Secret maps, sketches and records used in map production.

At a later date, owing to the rapidly growing volume of work, it became necessary to subdivide this into three branches known as Central Trigonometrical Records, Central Photographic Records, and Central Cartographic Records. They operated under the technical control of the Survey Directorate.

During the period of rapid advance into Abyssinia, the production of maps of all kinds was maintained at very high pressure. The work of the photo-topo sections, who were responsible for the actual map compilation and

fair drawing from photographs, produced a constant flow of maps, all of which passed through the hands of the Central Cartographic Records (C.C.R.). A series on 1/250,000 scale was in course of preparation in February and March, 1941, embodying the latest information from maps which had been captured as the army advanced through Somaliland to Mogadishu and thence northwards to Harar and Addis Ababa. Every effort was made to issue maps at least one jump ahead of the troops, but movement was so rapid that it became necessary to stop work on those maps which overnight became of back area interest, and jump ahead of the troops once more. This 1/250,000 series, when completed, covered practically the whole of the eastern part of the operational theatre, including a revision of the existing G.S.G.S. series of British Somaliland.

Further mapping policy decisions

A second mapping conference was held by D. Survey, Middle East, in Nairobi in mid-November, 1940, when the following decisions were taken:—

- (a) The northern limit of the East African grid system was to be 20° N.
- (b) The responsibility for the local production and maintenance of the 1/2,000,000 series was to be limited to sheets lying to the north of Lat. 4° N., the Union of South Africa dealing with sheets to the south.
- (c) The East African Survey Service was to be responsible for the production of the 1/1,000,000 series as far north as Lat. 8° N., beyond which Middle East would assume responsibility.
- (d) East Africa was to be responsible for the production of all maps on scales larger than 1/1,000,000 for its own operational area.
- (e) Arrangements were to be made for the exchange of captured map material between East Africa and Middle East.
- (f) The map printing resources of the East African Survey Group were to be strengthened. To this end a request was sent to the War Office asking for a Map Reproduction Section R.E. to be sent out.

Map reproduction organization

Experience during the 1914–18 war and subsequently has shown that, for the most efficient application of modern map production methods, it is desirable that all the stages that go towards the making of a map, from the survey on the ground to the final photography and printing, shall be under the one basic control. This principle was followed when the British Military Survey Service was organized and built up on mobilization, and it was arranged that field survey units should be self-contained with sections capable of undertaking field surveys, compilation and drawing, and the reproduction and printing of the fair drawn map.

In East Africa the East African Survey Group had some hand-operated plant, and were supplied by Middle East with some more up-to-date machinery, though the latter required some additional European reproduction personnel in order to function properly. These resources were, however, inadequate to deal with the mapping programme which lay ahead, and the arrival within the theatre of the lithographic section of the South African Mobile Printing Company proved a valuable asset.

In the Union of South Africa the peace-time topographical maps were not printed by the Survey Department, as in most other countries, but by the

Government Printer, who was responsible for both letterpress and lithographic printing. On mobilization the Government Printer had become the Director of Army Printing and Stationery Supplies (D.A.P. & S.S.) in the Union Defence Force and, with the above-mentioned mobile printing unit he proceeded to East Africa as an organization which was quite separate and distinct from the Survey Company. The latter, therefore, did not have under its own control any map printing resources of any sort.

On technical grounds it was clearly necessary that both the East African Survey Group and the 1 (S.A.) Survey Company should be completed as self-contained mapping organizations by the addition of photographic and lithographic reproduction resources. To meet this requirement for the East African Survey Group, the War Office, as stated above, was asked to send out a Map Reproduction Section R.E. With regard to the South African Survey Company, the D.D. Survey (Colonel Hotine) took immediate steps, after his arrival, to recommend to the General Staff that the photo-litho section of the A.P. & S.S. should be attached to the Survey Company. This recommendation was approved and put into immediate effect.

At a later date, after the occupation of Addis Ababa, captured Italian printing plant was made available to add strength to the printing facilities.

Spelling of place names

In accordance with Middle East practice the spelling of place names conformed to the territory in which the places were situated, *i.e.* English spelling in Kenya, and Italian spelling in territories under Italian occupation. After January, 1941, however, it was decided to include in addition the more usual, though perhaps less accurate, spelling of certain places, *e.g.* Chisimaio (Kismayu).

Reproduction of captured maps

Captured maps continued to come in as the advance progressed, and much useful information was obtained in Mogadishu, but it was not until the fall of Addis Ababa that the great bulk of Italian map material became available.

Captured maps were forwarded to Survey H.Q. at Nairobi and were carefully examined, first of all with a view to the reproduction of those Italian maps which were required immediately for current operations and secondly with a view to using the information for the new production and revision of the East African publications.

Much of the captured material consisted of compilations from air surveys undertaken by the Italian Coniel organization which was operating in Abyssinia, and the fair drawings, generally the result of work with their Santoni stereo-plotter, appeared to be of a high standard.

To illustrate the speed with which the reproduction of Italian maps was undertaken, it is recorded that in May, 1941, 17 captured maps were reproduced, chiefly by direct photo-lithographic methods, without grids but with the marginal information translated into English, and were ready in 36 hours for immediate issue to the troops in the field.

Further notes on the East African mapping programme

Throughout the months of preparation, and during the period of the campaign itself, map production continued at very high pressure on the lines

laid down in the original policy. In addition to the regular 1/500,000 series, which included 62 2° sheets covering the whole battle area, there were 38 sheets on 1/250,000 scale, and a vast number of maps on larger scales of specific areas or places which were produced from air photos and ground surveys by field and divisional survey sections. In April, 1941, it was decided to extend the 1/500,000 series to the north of Lat. 12° N., and it was eventually carried up to Lat. 18°, taking in the whole of Eritrea.

By June, 1941, when the pressure of work had somewhat subsided, it was clear that, with the new information which was available from a variety of sources, a revision of the 1/500,000 maps could be undertaken. At the same time as this happened 56 (W.A.) Survey Company was placed under orders for transfer to another theatre, but alternative drawing reinforcements were expected in the shape of a drawing section from 512 (Army) Field Survey Company R.E. from Middle East. A revision scheme was accordingly drawn up at the end of June to deal with the whole of the 1/500,000 series. In some cases there was no further information to add to the existing editions but, in the majority of cases, a great deal of new information was available, both in the form of mapping material and also with regard to ground control for air surveys. During the course of the campaign, numerous extensions had been observed to the triangulation, and many new astronomical fixations had been determined.

Gazetteer

Before the 1 South African Survey Company was transferred to the Middle East, it had completed a gazetteer for use with the 1/500,000 map series. This contained over 23,000 place names, for which grid references were given. Its compilation took about 3,000 man-hours in addition to a further 600 man-hours for subsequent checking.

Air survey activities

Though field survey parties in East Africa were able to cover large areas by car reconnaissance, their operations were necessarily limited owing to the size of the potential battle area, and by the fact that they could work only to a very limited extent in enemy territory. It was thus apparent that air survey methods would be of the utmost importance.

A few areas in the northern frontier district of Kenya were photographed early in 1940, but little was done until the arrival of No. 1 Survey Flight of the S.A.A.F. in June, 1940. For its technical work this Flight came under the control of the Survey Directorate, but operational and administrative command remained with the Air Officer Commanding in East Africa. No. 1 Survey Flight later became No. 60 (Photo) Squadron S.A.A.F.

The photographs taken by 60 Squadron were used mainly for mapping work carried out at Survey H.Q. in Nairobi. In the field photographs were taken by Army Co-operation Squadrons and these were used by divisional and brigade survey sections for the rapid production of maps. Many of the maps were of the hasty sketch map type, which were constantly and urgently required by the troops for day-to-day operations, especially when faced with an enemy defence position and the prospect of a battle, or when some special topographical feature such as a river lay ahead.

The photography of certain river lines, defence positions and training areas formed one of the first tasks of the Survey Flight. In November, 1940, the following survey photography was ordered:—

- (a) The Somaliland boundary area, in the form of strips 14 miles apart.
- (b) Block photography for 15 miles on either side of the Marsabit-North Horr-Dukana road.
- (c) Extensions to the Marsabit defensive area.
- (d) Portions of the Omo River in southern Abyssinia.

The air survey of road strips and specific objectives in enemy territory went on ceaselessly so long as weather conditions and equipment permitted, and most of the routes by which the army advanced into Italian Somaliland were mapped from the air. Meanwhile other photography continued in northern Kenya and southern Abyssinia, so that it was possible to map considerable stretches of the Italian lines of communication and of the country round Lake Rudolf.

In December, 1940, as referred to earlier, a Central Photographic Records section was formed in Nairobi from personnel of the photo-topo sections of the East African Survey Group. Records of all air survey work were kept here, whether the compilation was done by the Survey Group or by 1 South African Survey Company.

During all its photographic operations the Survey Flight was much handicapped by a shortage of personnel, aircraft, spares and equipment, and suffered a severe loss when one of its aircraft was destroyed near Afmadu in Italian Somaliland.

In February, 1941, the aircraft situation was somewhat eased by using personnel and camera equipment of the Survey Flight in Glen Martin aircraft belonging to, and piloted by, personnel of 14 Squadron S.A.A.F. During the rapid advance northwards through Abyssinia, the squadron did most valuable work behind the enemy lines. However, by March, 1941, the lack of replacement aircraft brought these activities to an end.

In spite of the shortage of equipment and other resources 60 Squadron had played a vital part in the campaign, and its contribution in providing photographs for map production was of the highest order. This entailed high-pressure work and the utmost co-operation between the photographic staff, the photo-topo sections who did the compilation and drawing, and the printing sections who, often working for 48 hours at a stretch, produced the maps for an urgent operation in a minimum of time. The following is a typical example of such a job:—Photographs taken over the operational area or behind the enemy lines would perhaps reach Nairobi on, say, Monday evening. By midnight the development of the films and the production of prints would be completed, and the photo-topo sections were busy on compilation. Their drawings would be ready for reproduction by Tuesday night, and the printed map stocks would be handed over to the Survey Directorate for distribution in the small hours of Wednesday morning. The consignment required by the troops would be taken to an airfield nearby and sent forward by air to its destination, reaching the hands of the users probably about 48 hours after the photographs had been taken.

During the period when this urgent air-photo mapping programme was being undertaken, the photo-topo mapping sections of both the East African Survey Group and the South African Survey Company worked in the closest

collaboration, and the whole work of production was centrally controlled through the Central Cartographic Records section, whose officers constantly checked the work as it came from the photo-topo sections.

The great speed of the advance and the consequent lack of information of the exact requirements of divisions naturally introduced difficulties with regard to the production of air survey maps at Survey H.Q. at Nairobi. The large staff of compilers and draughtsmen who are necessary for the rapid preparation of maps of extensive areas could obviously operate only at the base, where also there existed facilities for rapid printing. The need for strip maps of roads lying along the probable axes of advance could generally be foreseen and provided for, but these usually did not cover a broad enough survey on either side of the road when a battle had to be fought. Even with a survey representative attached to divisional headquarters, it was often impossible to obtain information of detailed requirements early enough to allow of the preparation and distribution of special maps to all concerned in time. The road strip maps were regarded only as the initial route plans of the advance, to be supplemented by block photography when additional information as to enemy positions could be obtained.

Some of the above problems concerning the supply of urgent air surveys of battle areas were largely solved by the employment of division and brigade survey sections. The latter were able to produce maps when even the division survey sections were not close enough to complete them in time. Using photographs taken by Army Co-operation Squadrons, and working in close co-operation with brigade staffs, they were able to map enemy positions within a few hours of the receipt of the photos, and orientation and scale were checked up on the ground by the surveyors. The photographs taken by the Army Co-operation Squadrons were not up to the high survey standard of those taken by No. 60 (Photo) Squadron, whose personnel were highly skilled in this specialized branch of air photography, but even so, the maps of small areas so produced on the spot in small quantities proved invaluable. The maps were drawn in a bold exaggerated style when for infantry use, as distinct from those of a more conventional form which were required for artillery purposes. Thus hill features were depicted by exaggerated form lines, roads were shown by very heavy lines and, whenever possible, the maps were printed on a portable "Ditto" machine so that colours could be used.

Maps of enemy positions, with a reproduction of the actual air photographs shown alongside, were found to be very useful and, where the lack of reproduction equipment in the field did not allow of this, a set of photos was, if possible, supplied to the brigade or battalion commander for use in conjunction with the map.

SECTION 3. TRIANGULATION AND FIELD SURVEYS

An account of the original basic triangulation work in Kenya and its progress between 1906 and 1914 will be found in the *Historical Outline and Analysis of the work of the Survey Department of Kenya Colony* (Williams), published by the Government Printer, Nairobi.

With an average triangular error of less than two seconds, the observations appear to have been good, but the scale depended on one short measured base of 1.3 miles only in length, and the work was computed piecemeal instead of

on a well-organized comprehensive system. Here and there some figure adjustments were made and, although some check bases were measured, no adjustment was made for them and they were considered only as a check against gross errors.

This basic triangulation was projected in Cassini Soldner co-ordinates in 2° belts, the origins being the intersections of the odd-numbered meridians with the Equator. The Clarke 1858 figure of the earth was used and the unit of measurement was the British foot.

For military surveys carried out in connection with the operations, an East African war system of co-ordinates was adopted. The projection selected was the Transverse Mercator (Gauss Conformal), in 5° belts, e.g. 30° to 35° E., 35° to 40° E., etc. A scale factor of 0.05 per cent (1/2,000) was introduced, giving a scale error of 1/2,000 at the central meridian of each belt, zero at about 1° 49' on either side of it, and 1/2,200 at the extremities. The figure of the earth adopted was Clarke 1880, and the unit of measurement the British foot. To derive the military grid co-ordinates, feet were converted to yards, and 5,000,000 yards added to the northings and 450,000 to the eastings, thus ensuring that all grid references would be positive.

The basis of this East African war system was a closed loop of triangulation around Mount Kenya known as the Mount Kenya circuit. This loop consisted partly of a chain of triangles belonging to the basic Kenya triangulation, and partly of another chain, picked out from various independent triangulations observed during the early war period by the East African Survey Group and the South African Survey Company. This closed loop formed the basis for the computation of the existing Kenya work and the extensions therefrom. The origin of the Mount Kenya circuit was the trig station at Molinduko, the latitude and longitude of which were taken from the Kenya Survey Department's records and converted to Transverse Mercator co-ordinates using Clarke's 1880 tables. A length and azimuth for the side Molinduko-Ithanga were taken. The heights, as taken from the Kenya records, were not altered.

It is of interest to note that a feature of the computation of the East African war system was the use of "error contours" graphs in the process of adjustment, a useful and quick expedient which was used also in other theatres for various analogous purposes.

Observations for astronomical fixations formed a marked feature of the work in East Africa. They were required for the control of plane-table surveys and road traverses, and for the determination of position in bush or featureless country in connection with the guidance of troops to their objectives. The Daventry "pips" were used as wireless time-signals for astronomical observations. The accuracy of the "pips" was guaranteed to ± 0.2 second and, in general, consistently good results were obtained.

The records relating to triangulation were maintained by the Central Trigonometrical Records Section. The data were kept in an easily accessible form so as to be available to any one requiring this at short notice. This section also undertook the indexing, examination and filing of the data obtained amongst captured survey material. Enemy records supplied much useful and interesting information, and it was apparent that the Italians were fully alive to the value and importance of survey data in connection with military operations.

Although the bulk of the triangulation work was carried out by the South African Survey Company, it will be noted, from what follows, that the other

survey units took a fair share in the establishment of mapping control at one time or another. Some of the special tasks carried out are given below. The list is very incomplete and is given only to serve as an example of the sort of work undertaken.

- (a) *Sugota Valley.* In September, 1940, 1 South African Survey Company began the extension of the Kenya triangulation northwards along either side of the Sugota Valley, and this was pushed forward over a wide area to the frontier district bordering on Abyssinia.
- (b) *Marsabit area.* A local triangulation system was observed by the East African Survey Company in the Marsabit area. A short base was measured, and position was determined by astrolabe observations for latitude and longitude at one end of the base, where an azimuth was also taken. This local system was later connected to the Kenya triangulation.
- (c) *Isiolo chain.* The East African Survey Company also observed a local chain of 18 stations in the vicinity of Isiolo. This depended on five points of the Kenya triangulation, of which the latitudes and longitudes were taken from the Kenya records, and were converted to Transverse Mercator with the Clarke 1880 tables. An extension to this chain was later observed by 1 South African Survey Company, who also carried out a local triangulation to the north of the Isiolo chain for topographical work in the Archer's Post area.
- (d) *Isiolo-Marsabit chain.* This was observed by the East African Survey Group, and extended from the Kenya triangulation in the Isiolo area as far north as the Marsabit system. Additional fixations to the south and west were observed by the South African Survey Company.
- (e) *Ngomene area.* A triangulation was observed in the Ngomene area by the Southern Rhodesia Survey Company before it was incorporated into the East African Survey Group. The basis of the work was the Kenya network, and the co-ordinates of the initial stations were calculated from the latitudes and longitudes taken from the Kenya records, but converted to give them the values they would have had if the Kenya triangulation had been computed on the Clarke 1880 spheroid instead of the 1858.
- (f) Further triangulation was observed to fulfil the following purposes:—
 - (i) To control the survey of a training area at Njoro, where points belonging to the existing Kenya network were used by the East African Survey Group as a basis for their new work.
 - (ii) To control surveys in the Moyale area. For this local system, observed by the East African Survey Company, a 6,000-foot base was measured, and latitude, longitude and azimuth were observed.
 - (iii) To control air surveys at North Horr and Lokitaung. These two systems lay to the east and west respectively of Lake Rudolf. The Lokitaung system depended on a well-chained base over five miles long. Both systems were observed by the South African Survey Company, and an extension to the Lokitaung series was made by the East African Survey Group.

In August, 1941, a field party started work on a triangulation to connect the Lokitaung series in North West Kenya to the Uganda network, which was dependent on the geodetic chain of the 30th Meridian Arc. The intention was

to pick up the floating triangulation in the extreme south-eastern corner of the Anglo-Egyptian Sudan, of which certain points were common with the Lokitaung series. It was also proposed to connect across Lake Rudolf to the North Horr system, and thus to make a connection with the projected chain of triangulation along the Kenya-Abyssinia border. A connection with the Marsabit series would afford an opportunity of bringing the triangulation into touch with the East African war system.

For most of the triangulation work, the time factor was of the utmost importance, and methods had to be used which would give the required results in the minimum of time. Precision of observation depended therefore on whether the work was to be used as a triangulation from which extensions would be run, or whether it was to be used solely as control for plane-table or air survey mapping.

Field sections found on the whole that for rapid work the use of helios was impracticable for the following reasons:—

- (a) The simultaneous occupation of stations involved too many technical personnel, too much equipment and too many escort parties.
- (b) The reoccupation of certain stations could not be conveniently arranged.
- (c) Arrangements for detailed organization and timing were not possible under the existing operational conditions.
- (d) The means of communication between distant stations were too difficult.

Opaque signals were therefore generally used during rapid triangulation, and the length of sides was limited to 15–20 miles, depending on atmospheric conditions. Timber quadrupod and tripod beacons, with brushwood above and white calico below the neck of the signal were found to be satisfactory.

When triangulating for air-photo control over limited areas, where sides did not exceed ten miles, the use of flags observed eccentrically was found satisfactory, and for this type of work reduction to centre was not necessary.

On primary triangulation, with sides of from 30 to 50 miles, observing at night on to 5-cell torch batteries was found to give good results, but could only be used when five or six experienced observers were available. To ensure success, a very thorough preliminary reconnaissance was essential, and a system of signalling by morse code was necessary in order to control the showing of lights, etc.

In the rapid mapping of large areas the method of traversing roads by tachometer was too slow. Also it was found that refraction and haze caused by the great heat adversely affected the use of optical instruments for this work. To achieve greater speed, use was made of a motor-car speedometer to measure the traverse legs, direction being measured by theodolite. It was necessary to run the car on a standard 30-lb. tyre pressure, and to establish, by trial and error over a measured distance, a factor which could be used to correct the recorded mileage. By this means about 20 miles of road a day were measured.

SECTION 4. MAP SUPPLY AND DISTRIBUTION

The East African campaign produced its own peculiar problems regarding map distribution, due very largely to the wide extent of the operational area, the long lines of communication between the map-producing organization and

the forward troops, the speed of the advance and the difficulties of transport, especially during the rainy season.

In the early days of its existence, the East African Survey Group, which included the East and West African and the Southern Rhodesian Survey units, undertook the distribution of the maps which it produced and the South African Survey Company undertook the distribution of maps by means of its own transport.

By November, 1940, the problem of map supply and distribution to the field formations was assuming such vital importance that the General Staff, acting on technical advice from Survey regarding availability, decided on the scales of issue, and what maps (scale, area and type) would be required for a particular operation. Responsibility for distribution was delegated to the Survey Service at Force H.Q., which was to arrange for direct issues to units under headquarter command, and for issues in bulk to divisions and to the Air Force. The intention was that, during mobile operations, distribution would be controlled by the General Staff, who alone had sufficient information regarding locations of units to ensure distribution without delay.

The D.A.D. Survey on the Survey Directorate was placed in charge of map distribution, and arrangements were made for the transfer of map stocks held by A.P. & S.S. At that time the main stocks were at Nairobi, where a bulk map store was established in the vaults of the National Bank of India. All maps, as they came from the printers, were delivered to the above store and, immediately a new sheet was received, a routine distribution was made to units and formations without further instructions except in the case of secret and most secret maps. A monthly list of new publications was distributed to all concerned.

It soon became apparent that, owing to the enormous area covered by the operations, and the need for quick issues as new areas were entered, some form of decentralization was essential to ensure rapid and efficient distribution to the forward troops. Forward map depots were therefore set up as close as possible to the H.Q.s of the divisions taking part in the advance. A Survey officer was placed in charge of each and, during December, 1940, the following map depots were put into operation:—

- No. 1 at Kitale for 25 Brigade area.
- No. 2 at Nanyuki for 1 South African Divisional area.
- No. 3 at Garissa for 12 West African Divisional area.
- No. 4 at Bura for 11 West African Divisional area.

They were mainly concerned with the distribution of the standard map series. Special operational maps were despatched from Nairobi direct to the formations concerned, with the co-operation of the divisional and brigade survey sections.

The normal stock held by a forward map depot was 1,000 copies of each sheet of the 1/500,000 series covering the divisional area (1/500,000 being the standard operational map for the East African campaign), 100 copies of the sheets of the same series outside the divisional area, and from 100 to 200 copies of the smaller scale 1/M and 1/2M series. Small stocks of other published maps were carried. This represented about two-thirds of a divisional issue and was intended to cover wastage and replacements. The provision of a complete issue to a new division was arranged for by Survey H.Q. at Nairobi.

Requisitions for maps were passed through Divisional H.Q. for check and

approval, to O.C. Forward Map Depot. The maps were bundled ready for issue, and divisions arranged for transport to units. The detailed arrangements for distribution within the division were made by the G.S.O. 3, with the O.C. Map Depot acting in an advisory capacity. In case of great emergency, provision was made for issue direct to units or individuals without reference to Divisional H.Q., but normally direct application to the Map Depot was strongly discouraged.

In addition to the issue of maps, it was the duty of the Map Depot officers to collect surplus maps from outgoing units or formations and, after destroying those that were unserviceable, to sort and put the remainder back into stock. The guiding policy, which was strongly impressed on the Map Depot officers, was that the Survey Service existed to assist the fighting troops to the best of its ability, that maps were of little value until they actually reached the hands of the users, and that it was better to give double ration than to allow a unit to go into action with no maps at all or too few. They were also instructed to keep all concerned in their area fully and regularly informed of the maps which were available in the depots.

When 11 (A.) and 12 (A.) Divisions advanced into Italian Somaliland, Nos. 3 and 4 Map Depots were soon too far behind to be of value. Their stocks were therefore amalgamated, and a single depot moved forward early in March and was established in Mogadishu. Progress of operations gradually reduced the usefulness of the Kitale and Nanyuki depots, which were successively closed on 8th March and 7th April respectively.

Air transport was used largely for conveying maps in bulk from Nairobi to the forward areas and, though the reservation of aircraft accommodation was sometimes difficult to obtain, this method worked satisfactorily.

It has already been noted that, as operations became more mobile and movement more rapid, the map depots were too far back to function efficiently. At this stage the divisional and brigade survey sections took over the job of distribution. No attempt was made to hold large stocks, as supplies were being flown up regularly from Nairobi, and lorries were being used as mobile map stores. It was found that general distribution of the 1/500,000 map on the full scale of issue was not only impracticable but unnecessary. The fighting units experienced difficulty in the storage and transport of full scale issues, many of which, owing to the speed of the advance, were not used. Smaller and more frequent issues of sheets required for immediate use were therefore made and distribution was effected at the request of Divisional H.Q. This, in fact, became one of the most important tasks of these small units.

When Addis Ababa was captured, and an Advanced Survey Directorate was set up there, a Map Depot was also established. Stocks were replenished by supplies sent up by regular air service from Nairobi.

The depot at Mogadishu was closed on 16th June, and on 26th July the bulk map store at Nairobi was given up.