

CHAPTER X

ITALY

The following diagram, maps and plates are relative to this chapter:—

	<i>Page</i>
<i>Diagram 6. Survey organization—Mediterranean 1944–45</i>	<i>Facing 304</i>
<i>Sketch Map 10. Italy</i>	<i>290</i>
<i>Plates at end of book</i>	{ 28. <i>Italy 1:250,000</i>
	{ 29. <i>Italy 1:100,000</i>
	{ 30. <i>Italy 1:50,000</i>
	{ 31. <i>Italy 1:25,000</i>
	{ 32. <i>Sicily 1:25,000</i>
	{ 33. <i>Italy 1:50,000</i>
	{ 34. <i>Italy Road Map 1:200,000</i>
	{ 35. <i>Italy "Going" Map 1:100,000</i>

SECTION 1. SURVEY ORGANIZATION AND NARRATIVE

Strategical background

At the Washington Conference in May, 1943, it was decided that the major offensive against the European mainland to bring about the defeat of Germany would be mounted from the United Kingdom in the early summer of 1944.

At that time operations in the Mediterranean area resulting from the allied landings in North West Africa (operation "Torch") and the westward advance of Eighth Army from Egypt, were approaching a successful conclusion. The Combined Chiefs of Staff, who at the Casablanca Conference had instructed General Eisenhower to follow up operation "Torch" by mounting an assault against Sicily in July, now directed that, in exploitation of the capture of Sicily, he should plan operations to eliminate Italy from the war, to establish air bases from which heavy and sustained air attacks could be made against Germany, and to contain German divisions in southern Europe. The latter would not only aid the projected invasion against western Europe, but also help to weaken German opposition against Russia.

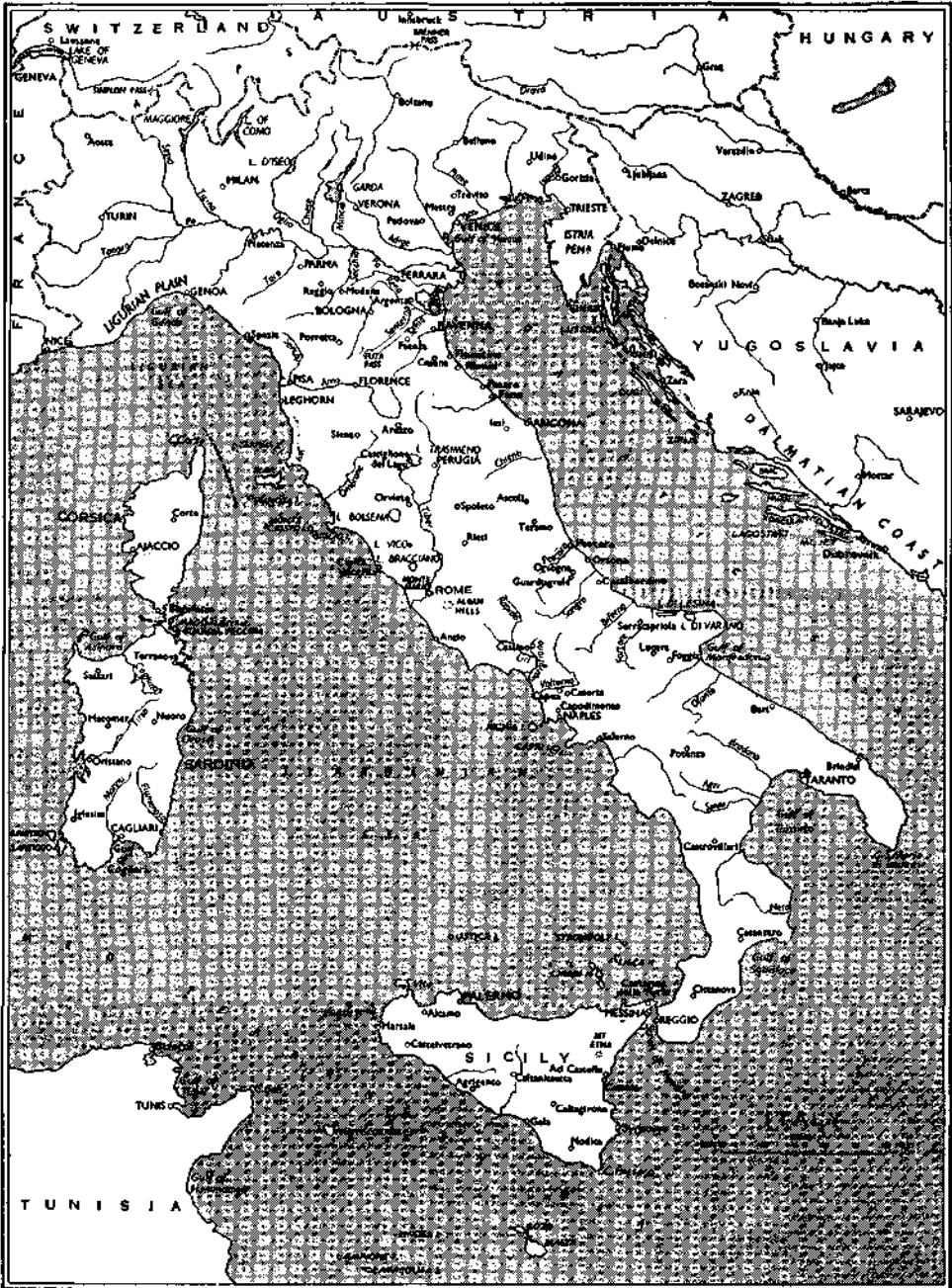
For these projected operations General Eisenhower was allotted all the ground forces in the Mediterranean area except for certain British and American divisions which were to be returned to the United Kingdom on the conclusion of the Sicilian campaign.

The operations for the capture of Sicily are dealt with in Chapter XII, Section 4, pages 496–504.

Early planning

Various alternative plans were considered. The first was to launch a sea-borne assault across the Straits of Messina to the toe of Italy so as to secure a lodgement in Calabria. Alternative consideration was given to the capture of Sardinia and Corsica, from which islands there would be a flank threat against the west coast of Italy, and also a threat against the southern coast of France.

SKETCH MAP 10



Drawn by Ordnance Survey, 1951.

The fall of Mussolini on 25th July introduced a new factor affecting policy. There now arose an urgent need to precipitate an Italian surrender, and U.S. Fifth Army was directed to plan for an assault landing (operation "Avalanche") in the Bay of Salerno, near Naples, with target date the first week in September, 1943. Meanwhile planning preparations continued for the assault on the toe of Italy across the narrow straits by formations of Eighth Army (operation "Baytown").

The course of military operations

To explain and clarify the various survey activities during the campaign, it will be well to summarize the principal operational events which took place between the first week in September, 1943, and May, 1945, when the German armies were defeated and surrendered unconditionally.

INITIAL LANDINGS AT REGGIO, SALERNO AND TARANTO

The assault across the Straits of Messina was successfully accomplished by Canadian and British divisions of Eighth Army on 3rd September. On that date the armistice with Italy was signed but not announced.

On 9th September the landings at Salerno took place, accompanied by an announcement of the armistice. The assault was carried out by Fifth Army, with a northern Task Force (British) and a southern Task Force (U.S.). On this same date elements of 1 Airborne Division (British) landed at Taranto and secured the port.

On 16th September troops of Eighth Army, having made their way up the coast from Reggio, made contact with the Salerno force, and also with the troops of 5 Corps from the Taranto area. All the allied forces in Italy now came under the command of H.Q. 15 Army Group.

The evacuation of German troops from Sardinia began on 11th September and was completed by 18th September. French units then occupied Corsica, this island being cleared of the enemy by 6th October.

NAPLES AND THE FOGGIA AIRFIELDS

By 28th September the important airfields at Foggia had been captured by Eighth Army, and Naples was occupied on 1st October. Italy declared war on Germany on 13th October with the status of co-belligerent, and there were indications that German forces intended to make a stand on a line to the south of Rome, with strong intermediate defensive lines in between that position and their contact with the Allies further south.

A directive issued by General Eisenhower on 30th September stated that the principal objects of subsequent operations in connection with the advance to the winter line were as under:—

The capture of a specified line which would make secure the Foggia airfields and the Naples area.

The subsequent capture of a line which would secure Rome and its airfields.

The unification of command of the entire Mediterranean theatre was effected on 10th December. This added to General Eisenhower's responsibilities Greece, Albania, Yugoslavia, Roumania, Hungary, Crete, the Aegean and Turkey. He was nominated as Allied C.-in-C. of the Mediterranean theatre,

but shortly after this he handed over to General Sir H. Maitland Wilson when he proceeded to the United Kingdom to become Supreme Commander for the invasion of western Europe.

During the winter of 1943-44 the operations developed into a slow, painful advance through difficult country against an enemy exploiting natural obstacles by mines and demolitions, but the allied forces were containing a large number of German divisions in Italy and, by their occupation of Corsica, were offering a potential threat against southern France. It seemed clear that the only way of frustrating the enemy's defensive policy was by exploiting amphibious landings along the coast behind his lines.

ANZIO AND THE WINTER CAMPAIGN

Planning for a landing at Anzio had been started by Fifth Army planning staff in November, 1943, the target date being 20th December. As a preliminary to this assault landing, Eighth Army opened the first stage of the battle for Rome by attacking in eastern Italy across the Sangro River on 26th November. Bad weather, floods, impassable roads and strong enemy resistance halted their advance some 25 miles short of Pescara, the objective.

An attack by Fifth Army in western Italy, forming the second stage leading up to the Anzio landing, was launched on 1st December. Progress was slow, and it became clear that the advance of the two allied armies would not be sufficient to make possible the projected landing at Anzio on 20th December. As the landing-craft situation was critical, with demands for several to be sent back to the United Kingdom for operation "Overlord," it was considered that further postponement was impossible. The operation, as originally envisaged, was therefore abandoned.

Then came the Allied Conference at Tunis on 25th December, when it was directed that the drive on Rome must be continued so as to secure depth for the protection of Naples and the Foggia airfields, and to inflict as much damage as possible to the German armies in anticipation of the allied offensive in western Europe. As a result, consideration was given to the strategy necessary to speed up the Italian campaign so as to make possible an attack against southern France in the spring of 1944. Planning was now resumed for the amphibious landing at Anzio, with 22nd January as a provisional target date. Authority was obtained for the retention of the vital landing craft for a further short period before their return to the United Kingdom. Early in January a reorganization of the Fifth and Eighth Armies was begun so as to release assault formations for intensive training.

As a preliminary to the landing, Fifth Army launched an offensive on 12th January across the Rivers Garigliano and Rapido, and the assault at Anzio took place on 22nd January. The enemy, after regrouping, stubbornly withheld the allied attacks, with the result that this phase of the allied winter offensive came to a close by the end of January.

Early in February, 1944, a German counter-attack against the Anzio beach-head was held and the bitter struggle against the strong Cassino position started, the famous monastery being destroyed by air-bombing on 15th February. The enemy again attacked strongly against the Anzio beach-head but without success.

In mid-March another allied attack in the Cassino area was staged but was abandoned, and there was a pause for regrouping. Meanwhile Eighth Army

had broken partly through the enemy's main defences on the Adriatic coast and held firm on these positions during the Anzio and Cassino fighting.

Apart from the landings at Anzio the winter campaign had not been spectacular, but it had engaged some 18 German divisions, inflicting on them considerable casualties; Italy was out of the war, the pressure against the Russian armies had been lessened, and it was obviously of great value as a preliminary to the forthcoming operations in western Europe.

With the advent of better weather, and after further preparation and re-grouping, Cassino was eventually captured on 18th May, and this opened the way to an advance on Rome culminating in its occupation on 4th June.

Before dealing with the successful allied offensive which led up to the capture of Rome it will be well, at this stage, to consider the planning and operational stages of the assault invasion of southern France which was planned, mounted, and carried out under A.F.H.Q. control, and which involved extensive and urgent mapping preparations.

THE INVASION OF SOUTHERN FRANCE ("ANVIL")

At the Quebec Conference in August, 1943, the Combined Chiefs of Staff decided that a diversionary attack should be made against southern France. Later, at the Cairo Conference, it was agreed that this should be a major assault, and it was subsequently embodied in the agreement with Russia at the Tehran Conference when high-level plans for the opening of a "second front" in western Europe were drawn up.

It was originally intended that the invasion of southern France should be launched in conjunction with and coinciding with the main assault in northern France (operation "Overlord"), probably in May, 1944, while the allied forces in Italy which, it was assumed, would by then have forced the enemy beyond the Pisa-Rimini Line, were to maintain the strongest possible pressure without detracting from the French operation. No other offensives were to be undertaken in the theatre. The original plan envisaged an assault landing on the beaches in the vicinity of Marseilles and Toulon, and a subsequent advance northwards in the direction of Lyons and Vichy.

The major problem affecting the planning was the shortage of assault craft. Even though the amphibious operation which was scheduled to take place in the Bay of Bengal against the Japanese during 1944 was deferred, there were many conflicting demands for assault craft, not only between the Mediterranean and European theatres, but within the Mediterranean itself, where, owing to slow progress up Italy towards Rome, there were plans for amphibious landings behind the enemy flanks. Another important factor was the decision by the "Overlord" planners to increase the strength of their assault in northern France which entailed a further demand for landing craft.

Meanwhile H.Q. Seventh (U.S.) Army was designated as the planning and operational staff for the invasion. Uncertainty about the numbers of landing craft that would be available and the strength of the assault force, combined with the operational difficulties in Italy owing to slow progress following the Anzio landings, gave rise to doubt, during the latter part of February, whether the projected operation in southern France could take place as originally planned. This doubt was strengthened when a new directive from the Combined Chiefs of Staff gave to the Italian campaign overriding priority over all existing and future operations in the Mediterranean, and gave it first call on all resources within the theatre. At the same time, however, it was directed that alternative plans should

be prepared for an operation which, although not prejudicing the Italian campaign, would contribute towards the invasion of northern France by containing the maximum number of enemy forces. The first of such alternatives was to be an invasion of southern France by a two-division assault, building up to about ten divisions, making use of French forces to the maximum extent.

As time passed it became increasingly clear that, whatever operation was planned against southern France, it would have to be postponed till some time after the projected early June target date for operation "Overlord."

Late in March an appreciation of the situation in Italy indicated that in view of German resistance at Cassino and elsewhere which was holding up the advance on Rome, the earliest possible date for the assault in southern France would have to be deferred till mid-August. This introduced a doubt as to whether such an operation, which must inevitably weaken the allied forces in Italy, was the best way of assisting the allied invasion in northern France. It was considered by A.F.H.Q. that the available craft and forces might be better used for conducting amphibious landings and subsequent operations to further the progress of the campaign in Italy itself. One such plan envisaged a penetration through the Pisa-Rimini Line into the Po Valley and an amphibious operation against the Istrian Peninsula for exploitation through the Ljubljana Gap into the plains of Hungary, thus threatening the heart of Germany by the back door in combination with the Russian advance from the east.

These alternative possibilities and plans are mentioned here in some detail as they illustrate the extent of the mapping problems which faced the Director of Survey at A.F.H.Q. during this period. Obviously he had to be prepared to provide maps for any or all such developments.

The allied invasion of northern France ("Overlord") took place on 6th June, 1944, and a new factor now arose. General Eisenhower desired that operations should be carried out which would clear additional French ports so that allied formations might be deployed in France more rapidly and on a broader front than was feasible within the limited Normandy bridgehead. To facilitate this he agreed to divert resources to make possible an assault in southern France to capture a major port. A.F.H.Q. still considered that a continuation of the advance in Italy to the Po Valley and the Ljubljana Gap, assisted by amphibious operations against Trieste, appeared to be the best strategic policy, but General Eisenhower's requirements were accepted as decisive, and the Mediterranean Command was directed to carry out the assault against southern France with 15th August as target date, using three divisions for the assault, building up to ten, and with extra resources in the way of craft and troop carriers sent out from the United Kingdom.

It was now possible to define the objects of this operation which were:—

- (a) To contain and destroy enemy divisions which might otherwise oppose General Eisenhower's forces in northern France.
- (b) To secure a major port for the entry of additional allied forces, and to establish new lines of communication therefrom.
- (c) To threaten the southern flank and rear communications of the German forces opposing the allies in northern France.

Marseilles and Toulon were the port objectives, with subsequent exploitation up the Rhone Valley to Lyons and Dijon. It should be noted here that, at one

time, the planning staff had considered Bordeaux as a port objective. It will be realized what is involved in the way of map preparation and production when widely separated alternative objectives are selected for an assault landing with their extensive exploitation areas and subsequent lines of advance, and to what extent a major change of plan dislocates an already large mapping programme.

On 30th July H.Q. 6 Army Group was established in Corsica, which would provide subsequently a co-ordinating command and control of the American and French forces which were to land in southern France, and which would come under General Eisenhower's command when contact with the "Overlord" forces was established.

The development of allied operations in Normandy, and the break-through of American forces into Brittany profoundly affected the strategic situation, as there now appeared to be a possibility of opening up important ports in Brittany for the unopposed and rapid entry of the Mediterranean forces scheduled for the landing in southern France. It became necessary to consider the possibility of diverting these forces to the Brittany ports and this, of course, would have introduced new and unexpected complications with regard to map supply. However, the Combined Chiefs of Staff, in view of uncertainty about the progress of allied operations in Brittany, did not agree to such a diversion and, in fact, the ports were not freed till considerably later. On 10th August it was decided to proceed with the planned assault in southern France. The principal mounting ports were Naples, Oran, Taranto and Brindisi, at each of which it was necessary to assemble the requisite map stocks for issue under security conditions. An airborne division was to take off from its bases in the Rome area.

The assault took place successfully in the early hours of 15th August, rapid advances being made up the valleys of the Rivers Rhone and Durance. During the second week both Toulon and Marseilles were cleared, and organized enemy resistance south of a line from Grenoble to Bordeaux had ceased, Bordeaux itself still holding out and remaining in enemy hands for some months.

On 11th September contact was established with the U.S. Third Army which formed the right flank of the allied forces operating from Normandy. On 15th September H.Q. 6 Army Group became operational, in command of Seventh U.S. Army and First French Army, and came under General Eisenhower's command. At this stage the responsibility for map and survey control with 6 Army Group passed from A.F.H.Q. to S.H.A.E.F.

THE SUMMER AND AUTUMN CAMPAIGN IN ITALY (1944)

On 12th May Fifth and Eighth Armies launched an offensive on a wide front against the Gustav Line, crossing the Rivers Rapido and Garigliano. Cassino with its monastery was taken on 18th May, after an assault by British and Polish troops, and the Allies advanced towards the Adolf Hitler Line, the Fifth Army attack in the Anzio beachhead synchronizing with the Eighth Army attack further to the east.

After a rapid pursuit the battle for Rome started on 30th May, in the Alban foothills, Eighth Army advancing along Highway 6. Rome was entered on 4th June and, with the Germans retreating, there was a further advance along the whole allied line. Civita Vecchia was taken by Fifth Army on 8th June, Eighth Army capturing Orsogna, Pescara and Perugia.

On 30th June a further offensive was launched along the whole front and

French troops occupied Siena. Fifth Army then broke through and entered Leghorn on 19th July, and Eighth Army advanced through Arezzo and captured Florence on 11th August. By the end of August the enemy was back on the main Gothic Line, but this position was breached by Fifth Army in the west, and by Eighth Army in the east later in the month.

Bad weather in October slowed up movement across the Po Valley. There was a change in command towards the end of November when General Alexander was promoted Field-Marshal and appointed Supreme Commander in the Mediterranean, and General Mark Clark, from Fifth Army, became C.-in-C. 15 Army Group.

THE WINTER OF 1944-45

Progress during the winter months was slow, owing to stubborn enemy resistance, heavy rain and bad road conditions, but Eighth Army took Ravenna early in December, New Zealand troops entering Faenza on the road to Bologna a few days later. Towards the end of the month the Canadians thrust towards the R. Senio and Fifth Army withdrew slightly following a German attack in the valley of the R. Serchio.

THE FINAL STAGE

In April, 1945, the Allies once more resumed the offensive, Fifth Army executing a surprise attack in the mountains dominating the Ligurian Plain, and Eighth Army making a further advance from the Senio bridgehead, assisted by a sea-borne landing behind the enemy line. On 12th April Eighth Army crossed the R. Santerno in strength, and Fifth Army began a new assault south of Bologna four days later.

Bologna was freed on 21st April and both armies advanced and crossed the R. Po. By the end of the month Verona, Genoa, Milan and Venice had been occupied, and Mussolini had been executed by his own countrymen. On 1st May New Zealanders crossed the R. Isonzo and made contact with Marshal Tito's forces. Other troops entered Udine, and Fifth Army were advancing along the Gulf of Genoa.

On 2nd May the German forces in Italy surrendered.

Survey planning

In accordance with the normal survey policy of looking well ahead and, for security reasons, spreading the mapping programmes over wide areas, the production of maps of Italy had been taken up between G.S.G.S. (War Office) and the Survey Directorate Middle East as early as 1941.

As soon as plans for operation "Torch" were put in hand, it was obvious that in exploitation of such an operation, combined with a successful advance by Eighth Army from Egypt, the way would be open for the capture of Sicily, Corsica and Sardinia, and allied landings in Italy itself. Priorities for hastening the production of Italian maps were therefore raised, and after the initial landings in North West Africa the Survey Directorate A.F.H.Q. took over a large share of the work. Particulars of the map series involved, their production and revision, and the preparation of triangulation data will be found in Sections 2 and 3.

Survey organization

In its main essentials, the survey organization for the Italian campaign was a continuation of that which existed for operation "Torch" and for the Eighth Army operations from Egypt into Tunisia and the subsequent campaign in Sicily. In supreme control of survey and mapping within the theatre was the A.F.H.Q. Survey Directorate, which remained at Algiers until June, 1944, when it moved to Caserta, near Naples.

Shortly after the initial landings in Italy in September, 1943, the allied forces on the mainland came under the command of H.Q. 15 Army Group which was later known as H.Q. Allied Armies in Italy (A.A.I.) and finally, in December, 1944, was reconstructed with its original title of H.Q. 15 Army Group. A small Survey Directorate at this H.Q. controlled the survey and mapping work carried out by the allied survey units of the Fifth and Eighth Armies. With the British Eighth Army there was a normal Army Survey Directorate, and with the Fifth (U.S.) Army, which was under American Command, survey control was exercised, in accordance with U.S. Army practice, by the Army Engineer. The latter always had one, and at times two, British survey officers and some British O.R.s in his engineer section at Army H.Q.

Survey units, either British, American or Polish, were available at all the above levels, *i.e.* at A.F.H.Q., H.Q. 15 Army Group and with the two armies in the field. U.S. Corps also had their own Engineer Topographical Companies. When a British corps was sent to Greece to restore and maintain order at the time of rebel disturbances, a small survey directorate and a field survey company R.E. accompanied the force.

The general set-up of the survey organization within the Mediterranean theatre is shown diagrammatically in Diagram 6 and consideration will now be given to the various echelons:—

A.F.H.Q. Survey Directorate (D. Survey—Brigadier R. L. Brown)

This was originally formed in the planning stage for operation "Torch" when it consisted of two British and two American officers and a few other ranks and enlisted men. Complications due to differences between American and British methods of staff control quickly became apparent and so, with real Anglo-Saxon compromise, the Survey Directorate was organized as part of the Engineer Section A.F.H.Q., but with a British chief as Director of Survey who was given direct access to the Chief of Staff and to all the various staff branches. This somewhat mongrel and quite unorthodox arrangement continued throughout the campaign till the end of hostilities and proved to be a thoroughly efficient and happy one.

It may be noted that this was a different arrangement from that adopted in the case of S.H.A.E.F., also an integrated British-American headquarters. There the Survey Directorate, headed by a British Director of Survey, and composed of British and American personnel, formed the Map and Survey Section of the Operations (G-3) Division and, though responsible directly to the Chief of the Operations Division and not to the Chief of Staff, the Director of Survey had direct access to all staff divisions and to the air staff, and dealt direct on technical survey matters with the Director of Military Survey (War Office), and with Directors of Survey in other theatres when necessary.

At the start the Survey Directorate at A.F.H.Q. was a small one, but it was always foreseen that, with the development of operations, a large increase

would be necessary. What was not foreseen was the delay that would occur in effecting such necessary increases.

By April, 1943, when the operations in Tunisia were drawing to a close, the directorate had four British and five American officers, and had under its direct control one U.S. engineer topographical battalion, two map reproduction sections R.E., and one field survey depot R.E. Operations in North Africa ceased on 12th May, and on 18th May Brigadier R. Ll. Brown assumed duty as Director of Survey, an appointment which he held until the end of the war. It was now evident that the directorate, and the survey service generally, needed expansion and reorganization to meet an increased commitment and to prepare for new projected operations. Extra topographic officers and enlisted men were obtained from the United States, and the American quota then became six officers and four enlisted men who, in the absence of an authorized establishment, were mostly held on an "expediency" basis. Meanwhile one New Zealand and four South African survey officers were unofficially added, raising the British quota to 10 officers and 17 other ranks. The directorate remained at this approximate strength for the remainder of the war and, together with two map depot teams (U.S.), operated throughout as a single integrated team, more or less on the British system, serving the needs of all ground and air forces. Its *de facto* status was never properly legalized but, as everything worked so smoothly, matters were allowed to remain undisturbed.

The chief function of the A.F.H.Q. Survey Directorate with the survey units under its direct control was to ensure and control the preparation and supply of maps and triangulation data for all operations that might take place. Some of the maps were newly compiled, others were old ones brought up to date by revision, and they were supplied either as bulk stocks, or in the form of reproduction material for use by army survey organizations serving the Fifth and Eighth Armies and their supporting air forces. The strategic and independent air forces in the theatre were served directly by A.F.H.Q. Survey Directorate.

For purely land operations it is usually possible to complete a mapping programme at the base, or at least to carry it to a stage when it can be handed over to army groups and armies, who then assume responsibility for subsequent mapping tasks in their areas of immediate and prospective operations. This was in fact done all the way up Italy, responsibilities for mapping and revision being decentralized and modified, where necessary, to conform to the progress of operations.

In the case of amphibious operations, however, a G.H.Q. survey organization is often very closely concerned with the assault force and its intimate needs for maps and survey. Sometimes these amphibious operations are mounted at short notice, and the survey units of the assault force, though of course vitally interested in the mapping programme concerned, may have little time or opportunity to study and prepare for the operation and its requirements. They are probably more immediately concerned with the problems of embarkation and working out plans for the survey tasks they will have to undertake after landing. Under such conditions a G.H.Q. survey organization should be in a position to hand over to an assault formation the results of any survey planning and production that has already been done, and resources in the way of survey units far in excess of its normal allotment.

Survey Directorate A.F.H.Q. supplied such direct assistance for the invasion of Sicily (in conjunction with Middle East), the Salerno landings, the occupation of Sardinia, Corsica and Elba, and the invasion of southern France.

For the landings at Anzio the mapping up of the assault force was controlled by the army concerned.

The survey units under direct A.F.H.Q. control at the beginning of the campaign in Italy were as under:—

British

- 516 and 518 Field Survey Companies R.E. (late of First Army).
- 11 and 12 Map Reproduction Sections R.E.
- 2 Air Survey Liaison Section R.E.
- 10 Field Survey (Stores) Depot R.E.
- 7, 12 and 26 Field Survey (Map) Depots R.E.

U.S.

- 649 Engineer Topographical Battalion (Army).
- Atlantic, Mediterranean, and Eastern Base Section Map Depots.
- 2611 and 2697 Engineer Map Depot Detachments.

In February, 1944, extra mapping strength was added when 30 Engineer Topographical Battalion (G.H.Q.) became available at A.F.H.Q. It did not, however, stay long as it was redeployed to the Pacific during the summer. Further map depot detachments were added, also two American model-making detachments.

On the British side "B" Air Survey Liaison Section was formed and took the place of No. 2 Section when the latter went to South East Asia Command. Towards the end of the campaign 13 and 19 Field Survey Companies R.E. came directly under A.F.H.Q. control, and 11 and 12 Map Reproduction Sections were amalgamated to form 650 Field Survey Production Company R.E. No. 524 (Palestinian) Field Survey Company R.E. and two further Palestinian field survey depots also operated under A.F.H.Q.

Preparations for the invasion of southern France delayed the move of A.F.H.Q. from North Africa to Italy. The Survey Directorate was then at its peak strength of 17 officers, with 1,800 technical personnel (British and American) under its direct command in A.F.H.Q. survey units, and a further 1,200 in the Middle East. Algiers was, however, much too far from the scene of operations, and the Survey Directorate moved to Caserta in June as part of the general move of A.F.H.Q., just before the invasion of southern France. The A.F.H.Q. survey units also moved to Italy with the exception of 30 Engineer Topographical Battalion which went to the Pacific, and 649 Engineer Topographical Battalion, which was assigned to Seventh Army for the French operations.

Apart from Africa, the area of the survey directorate's responsibility for mapping amounted to some 880,000 square miles. The number of individual map sheets for which the directorate held and maintained reproduction material was nearly 18,000. The number of maps produced for the theatre was over 134,000,000, more than four times the total number produced for the First World War.

The production of maps is, however, of little operational value unless they are distributed to the ground and air forces at the right place and time. The commendations which were received by the Director of Survey from both air and ground commanders were adequate proof, if any was needed, of the satisfactory manner in which the mapping requirements of the allied forces were met during the campaign.

On the termination of active hostilities in May, 1945, the responsibilities of A.F.H.Q., from a survey point of view, naturally lessened. There was a demand for the American officers to be redeployed to the Pacific theatre and the reduction of the survey directorate started in earnest. Brigadier R. L. Brown, after six years' service in the Mediterranean, gave up his appointment as Director of Survey and returned to the United Kingdom.

H.Q. 15 Army Group (D.D. Survey—Colonel K. M. Papworth; later—Colonel V. E. H. Sanceau)

While awaiting the authorization of an establishment for a survey directorate at this H.Q. when the Italian campaign started, Colonel K. M. Papworth was attached as D.D. Survey from a pool of officers held at A.F.H.Q. known as the Survey Planning Increment. This served many uses and kept the wheels turning when delays due to war establishment procedure would otherwise have held up the appointment of officers to essential posts. Two captains, one British and one American, were sent as his assistants, and No. 16 Field Survey Depot R.E. carried out map depot duties.

The establishment, when authorized, provided for a D.D. Survey (Colonel), two A.D.s Survey (Lieutenant-Colonels), one of whom was on permanent loan to Fifth Army, a D.A.D. Survey (Major) and a captain. For most of the period 517 Field Survey Company R.E. was under the direct control of H.Q. 15 Army Group, and at various times and for short periods, 13, 19 and 514 Field Survey Companies R.E. were also available to meet special requirements together with extra field survey depots and map depot detachments.

15 Army Group comprised the Fifth (U.S.) and Eighth (British) Armies with the usual allocation of army group troops. The survey directorate was responsible for:—

- (a) Controlling and directing the field surveys, mapping and map supply within the army group.
- (b) Supplying the special mapping needs of the various staff branches at army group H.Q. (Operations, Intelligence, etc.).
- (c) Supplying maps direct to army group troops.
- (d) Supplying maps to strategic air forces based on the Italian mainland while A.F.H.Q. was back in North Africa. This responsibility reverted to A.F.H.Q. when the latter moved over from Algiers to Italy.
- (e) Supplying maps to the Second Tactical Air Force, which worked in co-operation with the army group.

In accordance with A.F.H.Q. survey policy the responsibility for new mapping and revision, and for printing map stocks of certain series, was delegated by A.F.H.Q. to 15 Army Group on an area basis. These area responsibilities were altered as operations progressed northwards. 15 Army Group in turn decentralized responsibility to the two armies in accordance with their current and immediately prospective operational areas, retaining for execution by its own unit or units, certain tasks which were not of immediate operational interest to the two armies.

In April, 1944, Colonel Papworth was appointed D. Survey at G.H.Q. Middle East and he was succeeded by Colonel V. E. H. Sanceau as D.D. Survey 15 Army Group. The latter remained in this appointment for the remainder of the war.

Eighth Army (D.D. Survey—Colonel V. E. H. Sanceau; later—Colonel S. G. Hudson)

The survey directorate crossed over to Italy in September, 1943, with Colonel V. E. H. Sanceau as D.D. Survey. The units at first operating with Eighth Army were 13 and 517 Field Survey Companies R.E., 7 General Survey Section R.E., and 20 (Army) Field Survey Depot R.E. In December, 517 Company, after 14 months' valuable service with Eighth Army from Alamein to Tunisia, Sicily and Italy, passed to 15 Army Group command, and was replaced by 514 Field Survey Company R.E. from Middle East. Then, in March, 13 Field Survey Company was assigned for duty under A.F.H.Q. control, its place being taken by 49 South African Survey Company. In March also the Polish Survey Directorate joined Eighth Army and assumed control of the work of 12 Polish Field Survey Company and 312 Polish Field Survey Depot. They remained with Eighth Army throughout the campaign.

When Colonel Sanceau was appointed D.D. Survey at H.Q. 15 Army Group he was succeeded by Colonel S. G. Hudson, who retained the appointment of D.D. Survey Eighth Army till the close of hostilities.

20 (Army) Field Survey Depot was redesignated 29 Field Survey Depot and, in the late summer of 1944, 514 Field Survey Company, after nine months of strenuous and efficient service with Eighth Army, was withdrawn, being replaced by 518 Field Survey Company from A.F.H.Q., one of the two original units with First Army during operation "Torch." Together with 49 Survey Company (S.A.E.C.), 7 General Survey Section, and 29 Field Survey Depot, 518 Company remained with Eighth Army till the end of the war.

The technical activities of the Eighth Army survey units are referred to in the appropriate sections which follow. That their work was appreciated as playing a worthy share towards final victory is shown by the following message received by D.D. Survey from the Army Commander:—

"I want to thank and congratulate all ranks of the Survey Service for the splendid work you have done throughout the whole Italian Campaign, especially during the last great battle, and since the end of hostilities when you have been as busy as ever. Your success in providing whatever maps have been required has only been achieved as the result of the greatest forethought, energy and hard work on the part of all concerned.

"During the planning stages and during the mobile phases, the pressure has been intense, and the strain on your organization has been great. But with the best possible will you have surmounted every difficulty and you have never failed to meet the most far-reaching demands, often at the shortest notice.

"Well done indeed; you have played an essential part in the final defeat of the enemy."

Fifth Army (Senior attached British Survey Officer—Lieutenant-Colonel A. H. Dowson, R.E.)

As Fifth Army was predominantly American, under American command, the survey organization was basically in accordance with normal U.S. practice. This meant that survey control was exercised by the Army Engineer at Army H.Q. A topographical engineer officer (Lieutenant-Colonel J. G. Ladd) had, however, been appointed to deal with survey matters, and he carried out the functions of what, in the British Army, would be those of a D.D. Survey,

Two British officers were attached from the A.F.H.Q. Survey Planning Increment as his assistants. Lieutenant-Colonel A. H. Dowson R.E. was the senior of these, and he remained at Fifth Army H.Q. for the duration of the campaign.

There was no engineer topographical battalion with Fifth Army but the following units were available throughout practically the whole period:—

- 66 Engineer Topographical Company (Corps).
- 46 Survey Company (South African Engineer Corps).
- Detachment of 3059 Engineer Model-Making Detachment.
- 1710 and 1712 Engineer Map Depot Detachments.

The first two of the above units provided strong map-printing resources, and the survey groups of 46 Company carried out most of the field survey work that was required along the army front.

A second engineer (corps) topographical company was available for part of the campaign, but these corps units were under the control of the corps engineer, and it was only by mutual agreement between the army and corps engineers that they were made available for use at army level. Their functions were primarily to fulfil the local needs of the corps they served.

As in the case of Eighth Army, programmes of mapping and revision were delegated to Fifth Army by the Survey Directorate 15 Army Group in accordance with current survey policy laid down by A.F.H.Q.

SECTION 2. MAPS AND MAP PRODUCTION

Italian mapping policy

MEDIUM AND LARGE SCALES

The pre-war national mapping policy of Italy, which was controlled by the Istituto Geografico Militare at Florence, appears to have been concentrated principally on the covering of the whole country on the 1/100,000 scale and also on *either* the 1/50,000 *or* the 1/25,000 scale. The latter covered the towns and more densely populated areas, and the 1/50,000 covered the more open and less densely populated parts of the country. The three scales between them formed the medium and large scale tactical maps of the whole country, including Sicily and Sardinia, and were based on good original surveys. They were on corresponding sheet lines based on the graticule, each 1/25,000 sheet being one-quarter of a 1/50,000 sheet, each of the latter being one-quarter of a 1/100,000 sheet.

The series will now be considered in more detail:—

- (a) 1/50,000 and 1/25,000. The date-range of the copies of these maps available to the War Office just before the war extended over a wide period (1863–1937). Generally speaking, modern revision was concentrated in the north, but in Sardinia nearly all the sheets were dated 1931. In Sicily the 1/50,000 sheets were mostly pre-1900 in the north and dated 1923–37 in the south, but the dates of the 1/25,000 maps varied over the whole island.

Thus the probable current accuracy of these two series, which formed the original basis of all other Italian topographical maps, varied largely from area to area. In some few cases the 1/25,000 originals were enlargements of the relevant 1/50,000 maps.

The Italians published the 1/25,000 maps in black only. For the 1/50,000 series the earliest editions were printed in black only, but later military editions were in five colours with a sales edition in three.

- (b) 1/100,000. This series formed the official Carta d'Italia, covering the whole of Italy, Sardinia and Sicily, and varied in date from 1907 to 1937. Early editions were in black only, but later editions were in three and four colours. Here again much of northern Italy and the toe in the south was dated post-1930, Sardinia was wholly 1931, and in Sicily, while all sheets were post-1920, the majority were dated between 1930 and 1937.

SMALL SCALE (1/250,000)

The whole of Italy and Sicily was covered by a 1/250,000 series known as the "Carta d'Italia del Touring Club Italiano," dated between 1929 and 1937. This was published on graticule sheet lines on the same basis as the larger scales, and each small scale sheet covered the same area as six of the 1/100,000 sheets referred to above.

War Office mapping programmes

The Directorate of Military Survey (War Office), using its own map production resources and those of the Ordnance Survey, undertook the initial preparation of map series covering the Italian theatre, including Sicily, Pantellaria, Sardinia and Corsica, and the mainland up to the junction with other series either in existence or in contemplation in France, Switzerland, Austria and Yugoslavia.

The following brief notes indicate the scope of such production which began on low priority late in 1941 with the colour-separation reproduction of the 1/100,000 series and the copying of the 1/50,000 and 1/25,000 sheets.

The prime objective was the preparation of reproduction material in the form of kodelines or colour pulls for despatch to the Middle East, and later to A.F.H.Q., so that local printing of stocks could be undertaken when required in case of emergency. The next step was to produce better and more up-to-date editions by incorporating revision, adding colour plates, and sending out fresh kodelines or colour pulls. Considerable use was made of the photo library which was built up at the Central Interpretation Unit (C.I.U.) at Medmenham, where arrangements were made for revision traces to be prepared from available air-photographs. These traces were used either in the United Kingdom for map revision by G.S.G.S. or Ordnance Survey agencies, or they were sent out to the Middle East or A.F.H.Q. for use there.

Priorities for production were subjected to frequent alteration in accordance with changes of strategic plan and forecasts of probable future operations. Sicily, Pantellaria, Sardinia and Corsica had early priority, and the mainland of Italy was naturally taken up from south to north.

In June, 1943, available drawing resources in the United States were offered, and advantage was taken of this by allotting to the Army Map Service, Wash-

ington, the production of new 1/50,000 sheets in northern Italy where almost complete 1/25,000 cover existed, but where 1/50,000 mapping was very limited. The resulting sheets naturally differed in style from those in southern Italy and elsewhere which were direct reproductions from the Italian series (Plate 33).

With the completion of map series on various scales, including a certain amount of revision and improvement done in the United Kingdom, and the despatch of reproduction material to the Middle East and A.F.H.Q., the responsibility for further revision and improvement, and for any new mapping required, was delegated to A.F.H.Q. during 1943 when the War Office was becoming heavily committed on map production programmes for operation "Overlord."

The principal mapping projects will now be considered:—

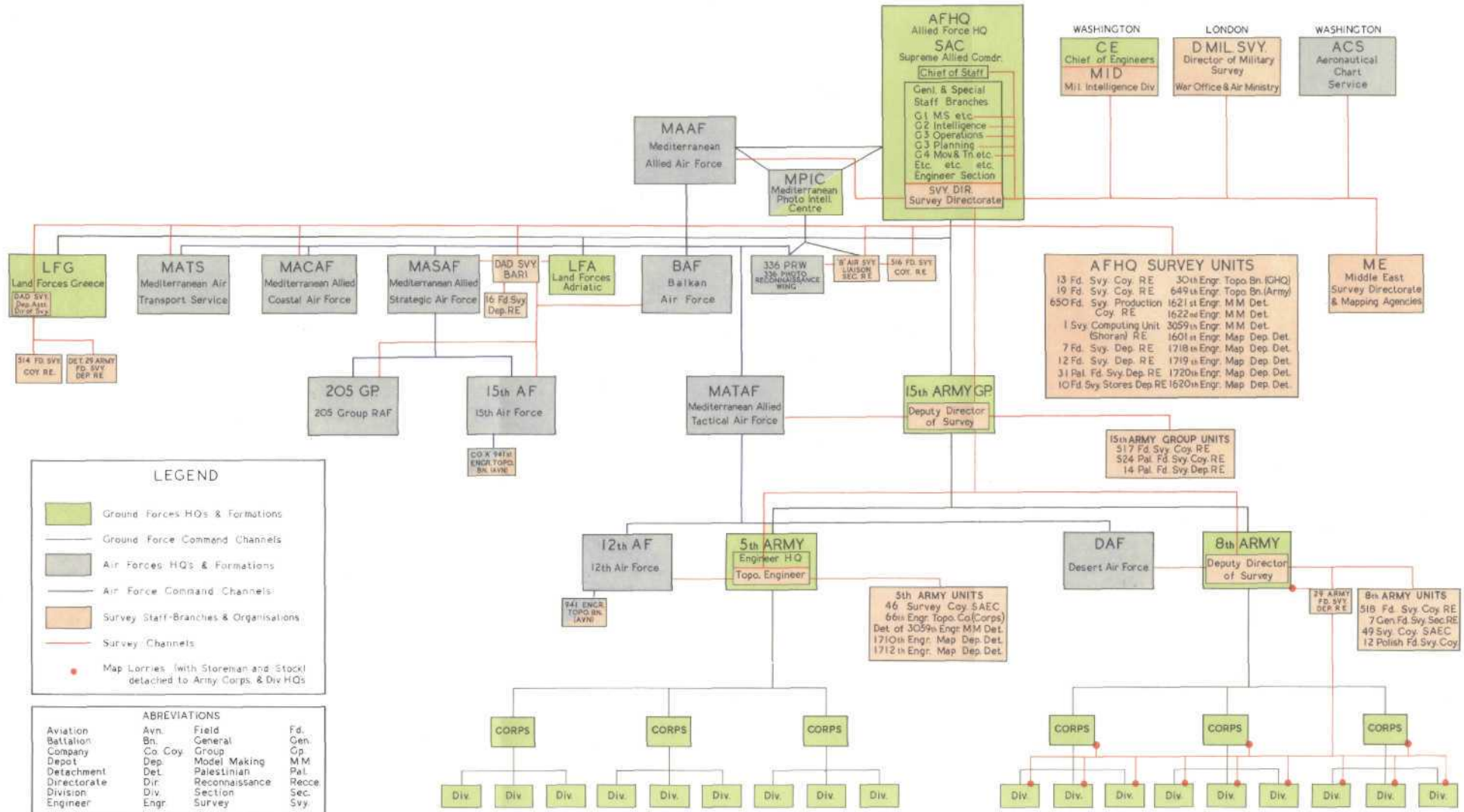
(a) *Small scale.*

- (i) *GSGS 2758. 1/1,000,000 (Europe).* This general series, whose primary use was for topographical "form at a glance" by both Army and R.A.F., covered the whole theatre. By 1943 these sheets were in process of being converted from their original form to Army/Air style.
- (ii) *GSGS 4072. Europe (Air) 1/500,000.* Essentially a flying map which was compiled during 1941–42 and covered the whole Italian theatre.
- (iii) *GSGS 3982. Europe (Air) 1/250,000.* Also an air map and fairly up to date, being compiled, so far as Italy was concerned, mainly from the 1/250,000 Carta d'Italia.
- (iv) *GSGS 4230. Italy 1/250,000 (Plate 28).* Started in November, 1942. It covered Sicily and the Italian mainland, but not Sardinia or Corsica, and was copied by photographic colour-separation from the 1/250,000 Carta d'Italia (dated 1929–37). It was published by G.S.G.S. in Army/Air style with red road fillings, purple layers, green woods, and water in a prominent blue. In the north the series was extended to join, without overlap, the adjacent G.S.G.S. series at the same scale of France, Germany and Yugoslavia.
- (v) *GSGS 3982 (Military).* This was an adaptation of the air map (see (iii) above). It incorporated fuller detail from the Carta d'Italia, and was published in Army/Air style to cover Sardinia and Corsica.

(b) *Medium scale.*

GSGS 4164. Italy 1/100,000. This was a direct reproduction of the Italian 1/100,000 sheets. It suffered in quality owing to the muzziness of the contours and the thickness of the names and basic detail on the Italian originals. Work of reproduction began in the south, and by mid-1943 sheets were available for Sicily, Sardinia and Corsica, and for the mainland as far north as Naples. The first monochrome edition was quickly followed by a second which carried a revision of communications, road classification being shown by red filling, and for Sicily a certain amount of revision was incorporated from air photos. Work continued steadily over the northern areas so as to provide complete coverage at this scale for the whole of Italy.

MAP & SURVEY ORGANISATION MEDITERRANEAN THEATRE OF OPERATIONS 1944 - 1945



(c) *Large scale.*

GSGS 4229. *Italy* 1/50,000 (Plate 30).

GSGS 4228. *Italy* 1/25,000.

The mapping material available consisted of record copies of Italian maps on these scales of which the 1/25,000 sheets covered practically the whole of northern Italy, the majority of Sicily, and odd patches over the remainder of Italy and Sardinia. The 1/50,000 material covered all southern Italy, the greater part of Sicily and Sardinia, and isolated blocks in northern Italy.

The first edition published by the War Office was a facsimile reproduction in black from the Italian sheets with the addition of the British military grid. A second edition was taken up with priority to Sicily, Sardinia and southern Italy. This incorporated some revision, and was made into a coloured edition by emphasizing certain classified roads with a red filling and showing water features in blue. For clarity the basic detail, which included also the contours, was usually printed in brown and, with the overprinted roads and water, it was known as a "griblet"* edition. The revision for Sicily and Sardinia, which was given early priority, included a careful comparison between sheets on all scales so as to get the benefit of whichever one was the most modern. Air-photo revision was also used. In spite of the care taken many errors were found and, in the case of Sicily, which had first operational priority, revision detail was sent to A.F.H.Q. for the local production of third editions.

By mid-1943 the situation was as under:—

Sicily.—Second (coloured) editions of both series had almost completely replaced the first editions. Seven 1/25,000 sheets were completed in a third edition, and several new 1/50,000 sheets were under production so as to complete 1/50,000 cover of the island.

Sardinia.—The second (coloured) edition of the 1/25,000 series had superseded the first edition in the south and in a few other areas, and was approaching completion for the whole island. New 1/50,000 sheets were in preparation so as to cover the island completely at this scale except in the south-west corner.

Italy (mainland).—The first edition had been completed as far north as Rome. Work was continuing on sheets further to the north.

Thus, at the beginning of operations in Sicily and Italy in 1943, A.F.H.Q. was in a position to supply subordinate formations with reproduction material for 1/100,000, 1/50,000 and/or 1/25,000 sheets of operational areas for field printing, and had printed bulk stocks of smaller scale maps either by its own units or through the agency of the survey directorate in the Middle East.

It then became a question of drawing up programmes of further new mapping, revision and printing, and decentralizing responsibility for portions of such work so as to conform to the progress of operations. This was an A.F.H.Q. responsibility as, by the middle of 1943, the War Office was fully committed in the production of map series of western Europe for operation "Overlord."

* Originally the detail was printed in a grey-blue (French "gris-bleu"). Hence the bastard form "griblet."

Mapping preparations in the Mediterranean theatre

The War Office mapping projects for covering the central Mediterranean theatre including Italy were, as mentioned above, of a nature sufficient to provide an initial map coverage which was both adequate and essential to meet an emergency. In the late spring of 1943, however, with the probability of early operations in Sicily, Sardinia, Corsica and the mainland of Italy, it now devolved on the local survey organization within the theatre to amplify and improve the map series which had already been provided.

At an early stage of operations in the Middle East, the survey directorate there had called for photographic coverage of selected priority areas, not only for revision but also for the production of new 1/25,000 sheets, including Sicily where there were gaps in the Italian series. During the spring of 1943 A.F.H.Q. was fully occupied in conducting the closing stages of operation "Torch," but after the victory in Tunisia in May, 1943, D. Survey A.F.H.Q. assumed mapping control for future operations in the central Mediterranean, and the extensive resources of the survey service in the Middle East were placed at his disposal to augment those already under his control.

SICILY, SARDINIA, CORSICA AND SOUTHERN ITALY

The work of preparing maps of Sicily was about equally divided between North Africa and Egypt, planning and control being vested in A.F.H.Q. In general the work carried out by A.F.H.Q. was for American forces, and that done in Egypt was for use by Eighth Army. By means of interchange of visits and other means of co-ordination the production programme went well ahead.

Further preparation and printing of map stocks for the coming operations in Sicily continued. This included the production of several new 1/25,000 sheets covering gap areas, and the revision of others previously published. This work was done largely by 649 Engineer Topographical Battalion (U.S.) and 516 Field Survey Company R.E. Difficulty was experienced in interpretation owing to the fact that small scale photographs had to be used for 1/25,000 revision. A few of the new 1/25,000 sheets were produced by enlargement from existing 1/50,000 maps and incorporating revision from air-photos.

The presence of American troops, who were accustomed to the use of special road maps, led to the preparation of a 1/500,000 road map of Sicily and Sardinia, and also to the production of a large number of 1/25,000 photo-maps. Defence overprints were compiled and printed on maps of Pantellaria and Lampedusa, the former being at 1/25,000 scale, and the latter at about 1/16,000.

The short campaign in Sicily during July, 1943, showed that mapping preparations had been satisfactory (*see* Chapter XII, Section 4). It now became necessary to intensify the projects required for coming operations on the mainland of Italy, in Sardinia, and in Corsica. At an early stage of planning the possibility had been considered of capturing the latter two islands as a prelude to landing on the mainland. The task of amplifying and revising the maps of Sardinia and Corsica had therefore been undertaken with fairly high priority.

The military edition of the 1/250,000 Air Map (GSGS 3982) covering Sardinia and Corsica was revised, and the necessary material was sent home to the War Office so that a new edition could be published. The French Service Géographique in Algiers revised the 16 newly drawn G.S.G.S. sheets

of Corsica at 1/50,000 scale from a set of modern 1/80,000 maps which they had available. Survey units at A.F.H.Q. undertook a rapid revision of the 31 1/100,000 sheets of GSGS 4164 covering Sardinia and also produced photo-maps of parts of the island.

In the case of the mainland in southern Italy a revision programme for the 1/50,000 sheets had been in hand with Middle East for some time, and this was now hastened. At the same time A.F.H.Q. was examining the sheets with a view to the production of a third edition, and air-photos and other revision material were allocated to Eighth Army for a block of sheets in their future operational area. During August 12 third-edition sheets of the mainland were completed, 200 were in hand with Middle East, and 17 with Eighth Army. In preparation for the impending landings at Salerno and Reggio early in September, the survey units at A.F.H.Q. and with Fifth and Eighth Armies were kept busy printing stocks for the operation.

It has already been noted that over a considerable part of northern Italy there were no 1/50,000 maps. The War Department in Washington asked that this gap should be filled, and in June, 1943, it was agreed that the Army Map Service would take up the production of newly compiled sheets covering practically the whole of Italy lying to the north of Lat. 42°20'. These sheets, which were based on the existing Italian 1/25,000 series and included revision from air-photos where such were available, were published in colour. They naturally differed in style from the existing sheets of GSGS 4229 in southern Italy which had been reproduced from the Italian maps direct. Thus, with the exception of a few isolated areas, the whole of Italy was eventually covered by 1/50,000 maps.

Many miscellaneous mapping tasks of a special nature were undertaken in preparation for the landings and their exploitation. Sheets of the 1/250,000 series were overprinted with road information. Water supply data were overprinted on 1/500,000 maps. Sheets of the 1/50,000 series in the toe of Italy were, after revision of the basic detail, overprinted with enemy defences, beach detail and other topographical information supplied by G-2 (Intelligence).

On the larger scale (1/25,000), of which there was only a very limited amount of original Italian mapping in southern Italy, revision had been in hand with Middle East and, during August, A.F.H.Q. organized a revision programme for a third edition and for the overprinting of defence information on selected sheets.

When the invasion of the toe of Italy was undertaken by Eighth Army, it was understood that its advance would not proceed further than the Catanzaro neck. The German resistance at Salerno caused a change in plans, and Eighth Army was instructed to push forward at all speed to effect a junction with Fifth Army. Owing to the original instructions, and the fact that the 1/50,000 sheets were being revised, only small planning stocks had been printed of the unrevised 1/50,000 sheets in that area. It now became necessary to provide full bulk stocks for use by Eighth Army during its advance northwards. During the month of September, 13 Field Survey Company R.E. moved ten times from one location to another and, during the remaining 20 working days, it managed to print on its mobile equipment well over 1,000,000 copies of these maps, which was an effort well worthy of record.

General mapping and revision policy for the standard map series

As soon as the campaign on the mainland had been launched, A.F.H.Q. was faced with the problem of ensuring that the allied armies fighting their way

up through Italy should be adequately supplied with essential maps in sufficient numbers and as up to date as it was possible to make them in the time available.

The initial production and revision work of the War Office and the Middle East had given an excellent start. The general controlling policy of D. Survey A.F.H.Q. was to decentralize mapping and revision responsibility for the 1/100,000 and larger scales to the survey organizations in the field for those areas which were of immediate tactical interest to them. For such areas A.F.H.Q. handed over to 15 Army Group all available material which was required for the work, such as air-photographs, revision correction traces where already made, and so forth. D.D. Survey 15 Army Group then sub-allocated tasks to Fifth and Eighth Armies, retaining some of the work to be done by survey units under his direct control. The armies were primarily concerned with the revision and production of maps covering their current operational area and the areas immediately ahead. As sheets of the larger scales were revised, the revision of the corresponding 1/100,000 sheets was taken up. In addition to the air-photos and other material supplied by A.F.H.Q., the armies obtained further photo-cover through army channels, and made use of captured maps and other acquired material.

15 Army Group, with its two armies, was responsible generally for the battle-zone itself and for the areas immediately ahead of and to the rear of it, while A.F.H.Q., with Middle East assisting, assumed responsibility for other areas within the theatre, both inside and outside Italy. Whenever the survey units in the field were in a position to undertake any work surplus to their own army group or army requirements, tasks were allotted to them from A.F.H.Q.

As the armies moved north there was, in consequence, a constant change in the allocation of spheres of mapping responsibility between A.F.H.Q. and subordinate formations. In Italy, as in other theatres, the survey directorates with the field armies, who bore direct responsibility for the day-to-day provision of maps to the fighting troops and planning staffs, were often apprehensive about whether the revision and supply of map material for areas ahead of the current battle-zone would be available from behind in time for them to get the stocks printed. The tendency was, therefore, for them to conduct their own revision of all tactical maps which were likely to be required in the near future.

Field formations were, in general, responsible for the printing of their own stocks of medium and larger scale maps, and bulk stocks of the smaller scales were printed and supplied by base installations. In this connection Middle East carried out a great amount of work for A.F.H.Q. on an agency basis.

It has already been noted that the first editions of the G.S.G.S. reproductions from Italian medium and large scale maps were in monochrome only. The task of producing revised editions included not only the revision of the basic detail but also the preparation of colour overprints for roads, woods, etc., in order to clarify the somewhat crowded detail and make it more legible.

Early mapping preparations for the invasion of southern France

The landing of an allied force in the south of France to assist General Eisenhower's main assault in Normandy had been considered during the early stages of planning. D. Survey A.F.H.Q. had therefore taken early steps to initiate a programme of mapping for those areas which seemed most likely to be concerned. Mapping projects for the major operation in western Europe

("Overlord") had been in hand with the War Office since 1942 and sheet line systems and map design for the whole of France had already been laid down by G.S.G.S. Within this general scheme, therefore, D. Survey A.F.H.Q. assumed responsibility for the preparation of maps covering those parts of southern and south-central France through which an allied invasion force from the Mediterranean would most likely operate. The whole programme was co-ordinated by the Survey Directorate (War Office) and, with their agreement, D. Survey A.F.H.Q. farmed out much of the work direct to American mapping resources in the United States.

Early references indicate that as far back as August and September, 1943, revision work was in hand at A.F.H.Q. for certain of the prospective 1/50,000 sheets of southern France, as well as for the French 1/200,000 series. Some of the results of this work were sent back to the War Office to assist in the production of the regular series.

As time went by, and the target date for the operation was postponed, mapping programmes were amended to fit in with other requirements. Later on, when a definite decision was taken to undertake the operation, the work was again intensified.

Mapping activities during the autumn and early winter of 1943

After the breach of the R. Sangro position in November, heavy rains set in and movement was slowed down. This eased up the map-printing situation (the printing "run" for 1/50,000 maps was temporarily reduced in Eighth Army to 5,000 for the two corps), and this enabled personnel to be given a rest and machines to be overhauled. In December these numbers were raised again to 12,000 for the 1/50,000 scale and 20,000 for each of the 1/100,000 sheets.

Fifth Army produced defence overprints on 1/50,000 base maps for the planning and execution of the Anzio assault operation. Relief models and photo-mosaics were also included.

By the end of September the maps of southern Italy had either been completed or handed over to field formations for them to revise and put into "griblet" form. A.F.H.Q. then became heavily engaged on revision programmes for maps of northern Italy, Middle East taking over a large share of this work. All work at A.F.H.Q. on maps south of Lat. 42° 20', except in the Naples area, then stopped. Bad weather during November prevented systematic photography, and many gaps in northern Italy still remained uncovered.

In December an "improvement" programme was started by A.F.H.Q. for the 1/50,000 series extending from just north of Rome as far as Rimini. For some sheets better quality original Italian material was obtained from G.S.G.S. and new reproductions were made. In other cases existing kodak negatives were improved by extensive touching up and photo-writing. In the case of the newly produced U.S. Army Map Service (A.M.S.) sheets the Canadian type of grid "ladder" numbering was added.

During the winter of 1943-44 there was a demand for a layered edition of the 1/100,000 sheets. Layer plates were prepared for printing in brown and green, with white for the bottom layer up to 100 metres altitude. In many of the coastal and valley sheets of low altitude this meant that there was no layer-colouring at all, a fact which considerably eased production. Requests were frequently made throughout the campaign for the layering of 1/50,000 sheets

and even of the 1/25,000. In a few cases of special importance this was done, but it was beyond the capacity of the survey service to take this on as a regular programme except to the detriment or even cancellation of other much more vital work.

The U.S. Army, during its training, had been accustomed to the use of special road maps for road movement as distinct from the normal type of topographical map. They therefore produced a 1/200,000 road map of the mainland which was good and clear, and was much used for movement purposes. It became a best seller (Plate 34).

Eighth Army mapping activities early in 1944

In January, 1944, revision responsibility for an area just north of Florence-Rimini was passed to Eighth Army. Revision of 1/25,000 sheets started in the Ancona and Pesaro areas, followed by that of the 1/50,000 and 1/100,000 scales. During January Eighth Army fought along the Ortona-Guardiagrele front where the 1/50,000 maps were found to be very inaccurate. They had been revised in October from incomplete, small scale photo-cover, but it was clear that the original survey was of inferior quality, and more accurate and legible maps were requested by the artillery. The following work was then taken up by survey units of Eighth Army:—

- (a) The revision of the 1/50,000 sheets using photos of larger scale.
- (b) The production of 1/25,000 "key" maps for artillery use.
- (c) The production of a limited number of new 1/25,000 sheets of areas in front of its present position.

Owing to the inaccuracy of the 1/50,000 maps in this particular area, a rapidly produced type of skeleton 1/25,000 map known as a "key" map was produced to satisfy the minimum needs of the artillery in the shortest possible time. It was essential to reduce to a minimum the amount of detail to be plotted, and the R.A. quoted as essential the showing of streams (which ran in deep and very steep-sided ravines), tracks and track-junctions. It was agreed that plotting errors not exceeding 50 metres relative to the grid would be tolerable.

A trial sheet was produced by a topographical section of 514 Field Survey Company. The detail was plotted in the field in pencil from 6-inch (focal length) vertical photographs which had already been block-plotted and enlarged to 1/25,000. The compilation took a few hours only, and the pencil drawing was then sent back to the unit for fair drawing and reproduction. This trial sheet aroused considerable interest in both corps, and other sheets were produced. The idea was to improve these "key" maps in two stages, first by adding more detail and then by adding form lines so as to provide large scale maps for "set-piece" attacks by all arms. The average time of production was four days for the "key" map in skeleton, and ten days for the improved version. They were widely used.

Some new 1/25,000 sheets were made following the general style of GSGS 4228, but omitting unimportant detail. The master-control was laid down by slotted template, the detail being compiled from enlarged 6-inch vertical photos and large scale obliques. Contours were obtained by two methods. In one case height control was obtained from the coast-line, spot heights, and trig heights on the 1/50,000 maps, supplemented by parallax readings from 6-inch

enlarged photos, contouring being done under the Fairchild stereoscope. In the other case contours were taken from the 1/50,000 sheets, and adjusted to the actual ground shape as indicated by photos under the stereoscope.

"Going" overprints were produced to assist movement by armoured vehicles, and they illustrated lines of approach and natural obstacles based on interpretation from air-photos. Quick ground appreciation was almost impossible from the very fully detailed Italian-type maps in their original form (Plate 35).

Eighth Army penetrated the enemy defences on the Adriatic coast during January, 1944, and then, during the rest of the winter of heavy rain and bad weather conditions, held firm in their newly gained positions while the fighting round Anzio and Cassino was going on further to the west. Little photography of survey quality was coming in at this time owing to the bad weather, though a certain amount of gap-filling reconnaissance photography was obtained, and revision continued of forward areas where there was now an increasing demand for 1/25,000 maps.

Arrival of 30 Engineer Topographical Battalion (U.S.)

This unit, with its extensive mapping resources including multiplex equipment, became available for work at A.F.H.Q. during February, 1944, and was employed without delay on the following types of work:—

Improvement and revision of 1/50,000 maps of Italy.

Collation maps of Italy (1/50,000).

Block-plots in Fifth Army area.

Revision and improvement of 1/25,000 maps of eastern France.

Town plans in southern France.

A.F.H.Q. was asked to prepare block-plots covering areas in advance of the actual Fifth Army front where there was little trig control, and where the available photos had excessive tilts. The photo-centres were located by multiplex methods to facilitate radial line plotting, and the multiplex equipment was also used to bridge the gaps between available control.

The spring and early summer of 1944

Various changes and exchanges of survey units took place between A.F.H.Q., 15 Army Group and the two armies during the spring. In March, Eighth Army took over part of Fifth Army front, but the latter's revision of the maps concerned was up to date, and the former was able to embark on a long-term revision programme. The production of new 1/25,000 maps from air-photos was also initiated where, hitherto, only enlargements from the 1/50,000 had existed. With better weather more photography was coming along to aid these projects.

During April, when conditions on the front were more or less static, two important developments occurred, namely, the demand for and provision of gridded large scale vertical photos, and a large increase in the demand for 1/25,000 maps.

An alternative strategical plan, which might have involved possible operations in northern Yugoslavia, made it necessary to prepare mapping cover of that part of the Balkans. New multiplex mapping of Yugoslavia at 1/25,000 was therefore started, and the A.F.H.Q. revision programme of Italy on

1/25,000 scale was now confined to the area of Milan and the north-west, with Middle East concentrating on the revision of north-eastern Italy round the Gulf of Venice. For southern France the revision of GSGS 4411 (1/25,000) was nearing completion for the limited areas taken up, and revised kodelines were sent home to the War Office. The 1/50,000 maps of eastern France (GSGS 4471), which had been reproduced direct from modern French sheets, were too large to be printed on the American mobile field presses, and were therefore modified in size.

During May, in connection with the allied offensive towards Rome, the main mapping effort at A.F.H.Q. was the production by multiplex methods of new 1/25,000 sheets in an area to the north of Rome. The control framework was dense and good, and blocks were laid down by slotted template. As events turned out the rapid allied advance during June and July outran much of this new work, comparatively little of it being available in time, but the project afforded valuable lessons in technique and training for the personnel of 30 Engineer Topographical Battalion.

The field armies, as a result of their northward advance, now approached close to an area covered by a large block of modern Italian 1/25,000 mapping which had been extensively revised.

As good-quality survey photography had been obtained over southern France, A.F.H.Q. started the production of new 1/25,000 sheets. They also sent over to A.M.S. Washington the original negatives and other material for a block of sheets in the Upper Rhone Valley so that production could be undertaken there. By the end of July complete 6-inch cover existed over southern France south of Lat. 46° and east of the Paris meridian. It was generally found, however, that 6-inch photos taken from 30,000 feet were unsatisfactory for mapping on 1/25,000 and 1/50,000 scales unless they were supplemented by larger scale photos for identifying control and interpreting map detail.

In July, Eighth Army was busy preparing for an advance along the axis Florence-Bologna through the Gothic Line. Then in August there was a change of plan involving a thrust along the Adriatic coast through Pesaro and Rimini to Faenza and Ravenna. This necessitated another big programme of gridded photos and defence and "Going" overprints, and the building up of map stocks for 14 divisions. With this change of plan, Eighth Army was able to hand over to Fifth Army large stocks of maps covering the axis Siena-Florence-Bologna, thus avoiding an overlap of effort and waste of resources.

Map records

Survey branches with all the major formations, *i.e.* at A.F.H.Q., H.Q. 15 Army Group, and the two armies, found the need for establishing Map Record Sections. This was generally done by allocating to one particular unit the responsibility for receiving, holding, indexing and issuing the material required for the carrying out of revision and new mapping projects. This included library-record copies of maps, air-photos, captured maps and other acquired material. Thus the holding and control of such material was centralized and properly organized in each formation and, as responsibility for areas changed, it became necessary to transfer the map-record material from one formation to another. By July, 1944, the armies held all available map-record material for the 1/100,000 and 1/50,000 series right up to the north of Italy,

with 1/25,000 material up to about 46°, and reproduction material for the latest edition of the 1/50,000 maps of northern Italy was received from Washington in August and passed on to both armies.

Relief models

The production and use of relief models on various scales was a regular feature in the American Army. They had trained and provided special model-making detachments for this purpose and, whenever conditions became static, or there was planning for a staged offensive, models were usually constructed of the enemy positions. In June, for example, models at a scale of 1/25,000 were made of the Pisa-Rimini Line.

Italian Military Geographical Institute

The Italian national survey organization had its headquarters in Florence. During German occupation it had been employed on cartographic work for the benefit of the German forces in Italy and, when the enemy was driven out of Florence, most of the equipment was stripped, though the buildings remained intact. Much of the original staff still remained in Florence and was collected together. Survey records had mostly been removed by the Germans, but a certain number of printing plates of Italian series and some original drawings were still held.

By degrees the Institute was restored to a workable basis under its own control and, under allied supervision and direction, it was eventually used to assist in map production work of various sorts.

Final mapping preparations for the invasion of southern France

The date finally fixed for the assault invasion of southern France by Seventh (U.S.) Army was 15th August, 1944.

Survey planning was now intensified by A.F.H.Q. and was divided into two phases. During the first phase which ended on 7th July, Survey Directorate A.F.H.Q. was located alongside H.Q. Seventh (U.S.) Army at Bouzarea in North Africa, and all the resources of A.F.H.Q. survey units were made available. Much help was also given by the Survey Directorate Middle East.

The second phase started on 7th July, when A.F.H.Q. and H.Q. Seventh Army moved to Naples. From then until "D"-day the Survey Directorate maintained a detachment of two survey officers and four other ranks at Seventh Army H.Q. to assist in their mapping problems. A drawing section was also attached to G-2 (Army) to prepare their Intelligence and collation overprints. During this phase two Field Survey Companies (13 and 516) worked under the survey detachment at Seventh Army H.Q. under the strictest security conditions. 19 Field Survey Company was released from 15 Army Group to work under A.F.H.Q. control, and the resources of 30 and 649 Engineer Topographical Battalions were available.

From 10th July till 15th August the three British field survey companies mentioned above worked exclusively on special mapping projects for the operation, including collation maps, special overprints, "Going" maps, beach panoramas, the layering of 1/50,000 maps, and the preparation of a "Gee" lattice chart for radar navigation control of aircraft. All the work was conducted under the strictest security, no passes being allowed till after "D"-day.

Officer couriers were used for escorting map material between the survey directorate and units doing the work. Armed escorts were employed, and follow-up vehicles were arranged for in case of a road crash.

649 Engineer Topographical Battalion produced a number of annotated photo-mosaics, and over 50 relief models were constructed for the operation. During August 30 Engineer Topographical Battalion completed 42 new 1/25,000 sheets by multiplex in the Rhone Valley, and A.M.S. Washington was working on a block of 1/25,000 sheets further to the north. Many new town plans were prepared by A.F.H.Q. units, and the revision programme included 45 sheets at 1/25,000 and 54 at 1/50,000. Bilingual (English-French) marginal data were prepared for all 1/25,000 and 1/50,000 sheets in the area, and bulk stocks of these series were printed. There were, in addition, many miscellaneous maps, diagrams and other special productions to meet the requirements of the Navy, Army and Air Force staffs. In all, over 15,000,000 copies of maps were issued for the assault and establishment of the bridgehead.

The subsequent rapid advance of Seventh Army up the Rhone Valley brought about many changes in the A.F.H.Q. mapping programme, and it was necessary to switch resources rapidly from one job to another as old needs were cancelled and new ones arose. During September, machines were working at full capacity printing the 1/100,000 and 1/250,000 series of eastern France and southern Germany. 19 Field Survey Company was running five machines three shifts a day and supervising the work of two civilian printing firms.

By October Seventh Army had advanced so far that all uncompleted work on the mapping programmes of southern France at A.F.H.Q. and at A.M.S. Washington was cancelled.

The autumn and winter (1944-45) in Italy

By the end of August, 1944, as a result of the allied offensive following the capture of Rome, the enemy was back on the main Gothic Line, but this was broken through during September by Fifth Army in the west and by Eighth Army in the east. The large scale map situation from now on was good, as there was complete 1/25,000 coverage ahead right up to the northern Italian frontier.

Bitter fighting between Pesaro and Rimini and beyond slowed up progress and enabled the revision programme to be brought well up to date. By the end of September, Eighth Army had examined and corrected practically all the 1/25,000 sheets as far as Venice, and the new A.M.S. 1/50,000 sheets north of the R. Po had been checked over. Opportunity was also taken to carry out a revision of communications (*i.e.* roads and railways) on both the 1/50,000 and 1/100,000 sheets before printing.

46 South African Survey Company and 66 Engineer Topographical Company, who were serving the mapping need of Fifth Army, were constantly engaged on the revision and stock-printing of the standard series and of the many miscellaneous tasks required of them.

There was now a big demand in Eighth Army for large scale gridded photographs. Two sections working two shifts turned out an average of 20 a day. The gridding was done from 1/25,000 maps with an accuracy, it was claimed, of 25 metres in close, and 50 metres in open country. These gridded air-photos were used by forward infantry and their supporting artillery as a quick and sure means of identifying small but important target detail which was often very obscure or not shown on the maps. Description started with the photo-serial num-

ber, then the grid "square," after which the description was worded the same as if the ground itself were being viewed. The photos were indexed on the maps.

The withdrawal of German forces in all parts of Europe during September, 1944, led to an increased potential demand for maps covering all the approaches into Germany, thus giving urgency to many A.F.H.Q. mapping liabilities. Work was intensified on map production for northern Yugoslavia and southern Germany in case of a sudden German collapse. A large printing programme of 1/100,000 maps of southern Germany, Austria and Hungary was undertaken, and several town plans along the southern approaches to Vienna were compiled. Between September and December the Survey Directorate at H.Q. 15 Army Group concentrated on an extensive revision programme of the Yugoslav 1/25,000 and 1/50,000 series. Action was also taken for Middle East to supply small quantities of all available large scale maps of the southern Balkans and the Aegean Islands.

Early in September, Sixth Army Group (Seventh U.S. and First French Armies) passed beyond the A.F.H.Q. theatre boundary in France and thereafter came under S.H.A.E.F. control, but A.F.H.Q. continued to assist by printing and supplying road maps and 1/250,000 scale maps of eastern France and southern Germany.

In October, 30 Engineer Topographical Battalion was under orders to leave the theatre for duty elsewhere and their cessation of work was a great cartographic loss to A.F.H.Q.

On Eighth Army front progress was slow during October in the flat, wet country between the Rimini-Bologna road and the Adriatic. Map revision kept well up to schedule, and was extended beyond Venice along the general line Padova-Gorizia.

Revision of 1/25,000 maps of Italy

It may be of interest to note some features of the technical specification issued by Survey Directorate Eighth Army in connection with 1/25,000 revision from air-photos. Generally speaking a complete and thorough revision of everything of military importance was required. Examples of items which were *not* considered to be of military importance, and which were not to be included for revision were the following:—

- Footpaths and mule tracks in flat country.
- Minor corrections in shape.
- Very small buildings, especially in built-up areas.
- Semi-permanent buildings, such as huts.
- Vegetation, except where it had a definite pattern and was a landmark.

All illegible, thick, and weak parts of the basic detail were to be clarified and improved. It was found that from seven to 21 man-days were required for each sheet for compiling the correction trace, and from seven to 14 man-days for correcting the kodak film, of which from one to seven man-days were required for the clarification and improvement of the existing detail on the film. The work was normally classified as second and third priority, and quality was given precedence over speed except when the time factor was paramount to meet operational requirements. A full 100 per cent check of all work was required, and every use was made of small scale photo-cover, especially for revisions covering a large area, in connection with road and rail communications, lakes, coastlines, woods, etc.

Revision of communications

This type of revision was sometimes undertaken on all the three larger scales before printing when opportunity offered. The main task was the adding of new communications detail for roads, railways, etc., and the deletion of old detail where it no longer existed on the ground according to air-photo or other evidence. In the absence of other information, the classification of new roads had often to be determined from the photos alone. It was necessary to make a careful study of the system of road classification which was given in the "Notes on G.S.G.S. maps of Italy," published by the War Office. When compiling their own series G.S.G.S. translated the Italian functional classification into terms of width and surface. This was quite arbitrary, and gave a good approximation in average country, but did not apply in exceptional types of country such as in Alpine areas. It was a generally accepted rule that the classification of roads shown on the map and still existing should never be altered as a result of photo-study alone unless there was some quite definite evidence of a change of function. The final authority for position in all cases was, however, the air-photo.

Fifth Army revision activities during 1943-44

The normal allotment of topographical units to a U.S. Army was one engineer topographical battalion and three engineer topographical companies (one for each corps). There was never at any time a topographical battalion with Fifth Army, and for most of the period under review there was an average of only two survey units available, the 66 Engineer Topographical Company and the 46 South African Survey Company (S.A.E.C.), together with part of a model-making team and engineer map depot detachments.

The topographical units were kept at full stretch. Their main task was the preparation of revision models and the actual revision correction of the kodak films for all three scales, 1/100,000 and larger. The following figures give a summary of their revision output from August, 1943, to November, 1944:—

General revision from air-photos	459 sheets
Wholly redrawn	35 sheets
Straight photographic enlargements	19 sheets
Newly compiled and drawn from air-photos	3 sheets
General revision from captured sheets	45 sheets
Redrawn for clarity	5 sheets
	—
Total	566 sheets
	—

Mapping in Greece

When 3 Corps was sent to Greece to deal with the rebel rising there a small survey directorate and 514 Field Survey Company R.E. accompanied the force. Various mapping jobs were undertaken in addition to the task of helping to put the Greek Military Topographical Service on a working basis. Four new 1/25,000 sheets were completed in the Patras area, and one new 1/50,000 sheet round Athens. A new 1/500,000 road map of Greece was also produced. Revision work on the 1/100,000 series was hindered by the interference of rebel activities.

Liaison with the Greek Military Topographical Service was established in January, 1945. They co-operated well, contributing accommodation, equipment and air-photos. With assistance from Middle East a new mapping programme was then initiated in connection with the rehabilitation of the Topographical Service, including:—

- A complete 1/100,000 series of the whole country with Greek characters.
- The overprinting of Greek characters on the existing 1/250,000 series.
- A bilingual edition of the new 1/500,000 road-map.

Mapping preparations for the spring offensive (1945) in Italy

By the end of 1944, the probable form of the final operations in Europe began to take shape, and the mapping situation became more or less clarified. The reconstruction in December, 1944, of H.Q. Allied Armies in Italy as H.Q. 15 Army Group as an operational and tactical headquarters only, involved the transfer of certain mapping programmes and units to A.F.H.Q. The latter then took over responsibility for all mapping outside northern Italy, for which purpose any spare productive capacity of 15 Army Group units was placed at A.F.H.Q. disposal. The new A.F.H.Q. mapping programme now centred mainly on Austria and northern Yugoslavia.

During December, 1944, A.F.H.Q. had been studying the map situation for Austria. There was an existing Austrian series at 1/75,000 from which A.F.H.Q. produced two pilot sheets in "griblet" form, at a scale of 1/50,000. The intention was to cover the whole country first of all with a monochrome edition by direct photographic copying from a library set of the Austrian 1/75,000 sheets obtained from the War Office. This was to be replaced north of Lat. 47° by a second revised edition in "griblet" form. Concurrently arrangements were made to send over original 6-inch negatives to Washington where A.M.S. would compile by multiplex about 80 new 1/25,000 sheets of selected areas south of Lat. 47° for publication at 1/50,000 scale. A similar programme of another area was arranged with the Chief Engineer E.T.O.U.S.A. in Paris under the topographical control of D. Survey S.H.A.E.F. A.M.S. also undertook the compilation from Austrian map material of further 1/50,000 sheets where no photo-cover was available. These would eventually replace corresponding "griblet" sheets of the originally produced A.F.H.Q. 1/50,000 series (Med. 4). A further programme was undertaken by the War Office whereby they would produce a number of 1/50,000 sheets by colour separation from Austrian originals. These were to replace sheets of the original Med. 4 series. G.S.G.S. also undertook the reproduction by colour separation of all available Austrian 1/25,000 sheets for publication as GSGS 4529.

To meet 15 Army Group needs, A.F.H.Q. modified selected sheets of the 1/100,000 series (GSGS 4416) in Germany, Austria and Hungary by introducing certain colour changes including those for road classification. Middle East prepared layer plates on the brown and green system already used for Italy.

The programme of 1/25,000 production and revision for northern Yugoslavia, which had been started by 15 Army Group, was continued under A.F.H.Q. control. The 1/100,000 and 1/50,000 series were also under revision, and town plans for the same area were compiled so as to be ready for possible operations there.

Several special maps for air use were produced including Radar Navigational Charts. A novel form of relief map at 1/M scale was issued in negative form

in which the normal detail appeared white on a black ground. This was found useful for navigational purposes. Sheets of the Europe "Air" series at 1/500,000 in south-eastern Europe were overprinted with flak information.

516 Field Survey Company R.E., working under A.F.H.Q. control in support of 336 Photographic Reconnaissance Wing, was employed largely on the production of lithographic photo-mosaics, communication overprints, and other intelligence maps.

Target fixation and the plotting of enemy defences

No. 7 General Survey Section R.E. was attached to the Mediterranean Air Intelligence Unit (M.A.I.U. West) for several months. Its principal tasks were the fixation of targets for the counter-battery organization (C.B.O.), a check of the plotting of the Italian trig points on the maps, the calculation of grid constants, and the plotting of enemy defences, which had been located on reconnaissance photos by the M.A.I.U. interpreters, for subsequent incorporation in defence overprints.

The fixation of targets was effected by first of all transferring their positions from reconnaissance photos to survey photos, the grid co-ordinates of whose principal points had already been determined and plotted on a skeleton block-plot. By means of radial line methods of intersection, the position of each target was fixed and its co-ordinates measured from the grid. The programme was a continuous one, each move forward introducing a new set of targets whose positions were required by the C.B.O.s so that concentrated artillery fire could be directed on to them if required.

During static periods a dense system of such targets was established on the enemy front. Between May and September, 1944, over 1,200 such fixations were determined, and with the advent of bad weather conditions 7 General Survey Section was then temporarily removed from M.A.I.U. for other urgent work, returning again in time to carry out further target fixations before the spring offensive. This target fixation work eventually came to an end late in April, 1945, when the enemy forces had been defeated and were retreating. Ground checks on 42 targets fixed on the Senio front showed that the mean point of impact of shells was on the target in 25 instances, and in only three cases was it more than 50 yards off. Assuming perfect gunnery this represented a very satisfactory result.

The need for the determination of grid constants was brought about by the fact that, over various parts of the Italian mainland, variations were found in the relation between the list co-ordinates of trig points and their plotted positions on the map relative to the grid. As the gun positions were as a rule fixed by survey methods in terms of trig co-ordinates, and the targets were often fixed cartographically by direct measurement from the grid on the map, it was essential that the two should be in sympathy. For each sheet, therefore, a constant was determined which would put one lot of co-ordinates in sympathy with the other. The chief users of these grid constants were the C.B.O. staffs.

The constants were required to be accurate to about 25 metres, and experiments determining the values indicated that they lay generally within this margin. Although giving a good indication of the accuracy of the overall projection plot, the constants did not take into account random errors in cartography. It is of interest to note that the standard of cartography apparently fell towards the north of Italy.

Controlled photo-mosaics

American artillery units had been led to expect, during their peace-time training, that their engineers would produce controlled photo-mosaics for them. Consequently, in the early stages of the Italian campaign, particularly in the Liri Valley, they made repeated demands for them. Most of their training in the United States had been over relatively flat country where the production of these mosaics offered little difficulty. Italy, on the other hand, was extremely mountainous, and this fact, coupled with the inadequacy of the air-photo cover available, the lack of sufficient trig control, and the shortage of survey resources, made it impossible for the Army Engineer to meet the artillery demand. In spite of this, controversy went on for some time and culminated in a compromise by which survey resources were devoted mainly to the production of new or revised large scale maps, but were also used for compiling what were termed "semi-controlled" mosaics. These were made usually from large scale low oblique photographs which had been approximately rectified, and were laid down more or less on large scale map control. Warnings were issued that they were not as accurate as the maps, and therefore could only be considered a supplement to, and not a substitute for them. They were lithographed and were very variable in quality.

The final period (January–May, 1945)

The relatively static nature of operations during the rains and fogs of January, February and March, 1945, afforded an opportunity for much progress in mapping preparation both at A.F.H.Q. and with the field formations.

In Eighth Army two new features arising in January were the layering of a few selected 1/25,000 sheets for a special purpose, and the preparation of a new type of topographical overprint on 1/25,000 maps for selected defended areas (Plate 31). The special information was overprinted in red and blue on a brown base, and presented in clear form to the user valuable information regarding roads, bridges, waterways, crossing places for tanks and infantry, flooded areas, etc. In the case of the waterways, sections of the banks and the widths were shown by marginal sketches. These topographical overprints were in great demand. During February, Eighth Army produced a block of eleven such sheets, and also a number of defence overprints in the battle area. In March a large programme of gridded 36-inch air-photos was taken up covering most of the immediate battle zone.

The planning staffs were now urgently asking for maps of Austria in anticipation of future movement northward, so practically all the drawing resources with A.F.H.Q. were concentrated during February on the preparation of the first monochrome edition of the 1/50,000 (Med. 4) series covering the whole of Austria. Concurrently, revision models were in preparation for the second "griblet" edition which was to replace the monochrome sheets north of Lat. 47°.

A special road map at 1/300,000 scale was put in hand to cover Austria and north-western Yugoslavia by the colour separation of an existing motoring map. Meanwhile 15 Army Group and its two armies continued their programmes of revision and printing of the maps of northern Italy on scales from 1/25,000 to 1/100,000, and were also doing revision work of areas outside Italy on an agency basis for A.F.H.Q. The mapping situation for northern Italy was now well on in the course of preparation for the coming allied offensive.

Fifth Army, in addition to its extensive revision and printing commitments, was continuing to turn out relief models of enemy positions for planning and briefing purposes, and was also producing a number of semi-controlled photo-mosaics at 1/12,500 scale.

In April the Allies delivered their full scale assault. The success of the mapping and survey arrangements during this battle was largely due to the excellent initial provision of maps by the War Office, the early acquisition of properly taken survey photographs, the forethought, good organization, skill and industry of the survey staffs and units at all levels, the complete and harmonious working together of the allied surveyors, and the time that was available for revision and printing. Apart from the regular series much value was gained from the defence overprints, topographical overprints, gridded photos, semi-controlled mosaics, and the target fixations.

In western Europe the Allied Forces under General Eisenhower were, by April, moving rapidly into Germany in pursuit of the defeated German armies and this, combined with the rapid advance of the Allies in Italy and the Russians from the east, stretched survey resources to the limit. Previously planned programmes had to be recast, and it seemed probable at one time that troops of General Eisenhower's 6 Army Group would enter Austria from Bavaria before those of 15 Army Group could cross the frontier from Italy.

Arrangements were therefore made between the Directors of Survey at A.F.H.Q. and S.H.A.E.F. whereby all available reproduction material for maps of Austria should be flown over from Italy to S.H.A.E.F. for immediate printing of stocks in Paris. Meanwhile all hastening action was taken by A.F.H.Q. to complete the first edition of Med. 4 (1/50,000) all over Austria. Towards the end of April the mapping situation with A.F.H.Q. was as under:—

- 1/50,000 (4229) Italy. An extra block of sheets which had been produced by A.M.S. to complete the series in northern Italy was received from Washington, and all sheets were handed over to 15 Army Group control.
- 1/50,000 (AMS 702) Yugoslavia. Kodelines were received by A.F.H.Q. from Washington and were passed to 15 Army Group with responsibility for further maintenance.
- 1/50,000 (Med. 4) Austria. 191 sheets of the unrevised monochrome edition were completed, printed and distributed. There were 75 sheets under revision for the "griblet" edition.
- 1/50,000 (AMS M771) Austria. 81 sheets were being compiled and newly drawn by A.M.S. for four-colour printing. Of these 36 were based on multiplex compilation from air-photos, the remainder being from map plus photo material.
- 1/25,000 (4228) Italy. All sheets had been handed over to 15 Army Group up to the Austrian frontier.
- 1/25,000 (4528) Austria. 73 sheets of the modern Austrian 1/25,000 series had been colour-separated by G.S.G.S. and were available in kodeline form. Revision was in hand.

Thus it will be seen that, immediately before the surrender, the armies in Italy were fully equipped with maps for operations leading up to the frontier and the mapping situation was well in hand for Austria itself. After the surrender there was little opportunity for immediate relaxation of pressure. All work in hand for Austria was continued as the maps were required for occupational purposes. In addition, the Yugoslav occupation of Venezia

Giulia introduced a new situation and, so as to be able to meet any eventualities, Eighth Army had to undertake urgent mapping preparations for that area.

Conclusions

After the cessation of hostilities in Italy, a conference was held at A.F.H.Q. with the object of discussing and collecting the needs and experiences of map users, based on the varied operations which had been carried out in the Mediterranean Theatre, while people's ideas were still accessible and fresh in mind. Amongst those attending this conference were representatives of the H.Q. staffs of armies, corps and divisions, the R.A.F. and U.S. Army Air Force, engineers, armoured forces and infantry, and of course officers of the survey service.

The following brief summary of the main conclusions which emerged are quoted as they may be of future interest:—

(a) *Scale.* The 1/25,000 map was regarded as essential, the importance of accurate contours being stressed. There was also a definite requirement for both 1/50,000 and 1/250,000 maps. It was stated that the 1/50,000 map was needed by infantry and artillery in pursuit operations and the artillery could shoot off it in emergency if it was of good quality. Armoured units and the Tactical Air Forces also needed it. If one of the large or medium scales had to be given up it was considered that this should be the 1/100,000.

(b) *Colouring.*

(i) *Monochrome.* Black monochrome was preferred to brown, but monochrome maps in general had not proved satisfactory.

(ii) *Additional colours.* Where additional colours were possible the order of preference for coloured detail was:—Roads, water, contours, woods, layers. In a minority recommendation the Tactical Air Force considered that woods and layers were of paramount importance.

(iii) *Layers.* Brown and green was found more satisfactory than the purple layering in spite of the disadvantage that the former made difficult the use of a green tint for woods.

Except possibly under very static conditions, the layering of 1/25,000 maps was impracticable, and this applied generally to the 1/50,000 also.

(c) *Detail.*

(i) *Woods.* Stress was laid on the importance of representing wood shapes correctly, this being of special importance from an air force point of view. It was suggested that, where possible, there should be some method of differentiation between various types of trees.

(ii) *Marginal data.* It was generally felt that too much marginal information was provided. There was, however, no agreement as to the minimum requirements.

(iii) *Magnetic data.* Artillery staffs suggested that the magnetic data should be expressed relative to grid north.

(iv) *Contours.* The importance of accurate contours was stressed, also of making the contour interval such that they were not too close in hilly country. The adequate numbering of the contours and their accentuation at regular intervals was regarded as important.

- (d) *Road Maps.* The opinion was expressed that there was a definite need for a road map as distinct from a small scale topographical map.
- (e) *Scales of Issue.* The following scales of issue were found generally satisfactory:—

Scale	Area	Issue to Corps H.Q. and Corps Troops	Issue to Divisions (Each)
1/25,000	Corps area	1,000	1,000
1/50,000 } 1/100,000 }	Corps area	1,500–2,000	1,500–2,000
1/250,000 (or similar scale)	Army area	600	200

- (f) *Air photographs.* These were considered as being an essential supplement to maps. Basic photo-cover should be gridded and should carry some reference to enable the photo to be related to the map.
- (g) *Trig data.* Artillery staffs required a standard distribution of trig lists to artillery regiments.

SECTION 3. TRIANGULATION AND FIELD SURVEY

Historical foreword

The fundamental geodetic network in Italy was started in 1859 with the measurement of a base at Foggia, and was continued until its completion towards the end of the 19th Century. There were eight measured bases, six of them in Italy itself, one in Sicily, and one in Sardinia. The development of the triangulation followed in the wake of each base measurement as it was completed.

The work was undertaken for the dual purposes of map-making and, in collaboration with the surveys of other countries, of measuring the shape and size of the earth. The fundamental meridian of the map was established as that one which passed through the geodetic point of Monte Mario at Rome.

Triangulation data originally available to the Allies

Before the landings in Sicily and on the mainland in July and September, 1943, the only trig data available consisted of the Italian Primary Triangulation, records of which had been published by the Royal Italian Geodetic Commission in "Elementi della Rete Geodetica Fondamentale" in two parts:—

- (a) North of the Rome Parallel dated 1908.
- (b) South of the Rome Parallel dated 1919.

The longitudes of trig points were referred to Genoa (1908) which constituted the Italian datum, and bearings and distances of the sides were also quoted. The first task was to convert these geographical co-ordinates to rectangulars based on the North and South Italy grid systems which had been adopted for use by the Allies. The Survey Directorate at A.F.H.Q. then published its first trig lists as under:—

- No. 1. Sicily.
- No. 2. Sardinia.
- No. 3. Italy, south of Lat. $43^{\circ} 10'$.
- No. 4. Italy, north of Lat. $43^{\circ} 10'$.

With the progress of operations, further material was captured or acquired, and the trig lists which were compiled therefrom were brought into sympathy, where necessary, with the Italian Primary Triangulation on the Genoa datum by means of correction graphs or blanket corrections.

Acquisition of supplementary trig lists for coastal areas

At the outset, when the lists of primary points formed the only trig data available for Italy, Sicily, and Sardinia, the problem of ground control was acute as it was not dense enough for air survey purposes. Fortunately a further list of trig points was acquired during the early stage of operations which gave co-ordinates of points along the coasts of Italy, Sicily, Sardinia and the north-eastern Adriatic. This list had been published by the International Hydrographic Board (I.H.B.) and the trig points were related to a number of independent origins whose longitudes referred to Greenwich.

It was obvious that this supplementary list must be made use of at all costs, as it supplied a fair density of points along the coastal areas where it was probable that local air-photo mapping would be required. A preliminary examination showed that the points were not in sympathy with the Italian primary system, so a detailed investigation was undertaken to determine a method whereby they could be properly related to it. There were about 400 points in this I.H.B. list in addition to those which were common to both systems.

The values of the common points were compared, and the Italian primary co-ordinates were accepted as standard. The value of the longitude of Genoa which was used to convert the I.H.B. points from Greenwich to the Italian origin was:—

Genoa— $08^{\circ} 55' 15.93''$ E. of Greenwich.

All conversion work was carried out using longitudes referred to Genoa.

The I.H.B. list, as received, was divided into seven zones, each zone being the result of an individual survey based on its own particular origin.

Certain of these zones were subdivided by A.F.H.Q. into groups, making a total of 12 groups, and a mean correction was calculated and applied to each group to bring it into sympathy with the Italian primary network. The range of variation from this mean correction was such that practically all the points could be used for air-photo control, and some could be used for triangulation purposes in connection with ground surveys where approximate results only were required.

On completion of the adjustment and conversion of the geographical co-ordinates to rectangular co-ordinates on the military grid, A.F.H.Q. published the values as A.F.H.Q. trig lists, copies of which were sent to armies in the field.

Capture of further trig data

With the capture of Sicily, and progress up the Italian mainland, further trig data were acquired from various sources such as military headquarters, university libraries, local government offices, etc. Where these included the

results of secondary, tertiary, and lower-order surveys they were of great value as they offered the extra ground control which was urgently needed for target fixation and artillery surveys and for air-photo mapping.

Grid Zones

Italy was covered by two grid zones known respectively as the North Italy and South Italy Zones. (See Diagrams 2 and 8.) Their junction was along the 43rd parallel, roughly 100 miles to the south of Florence.

As in other theatres, where the inconvenience due to a change of grid within the operational area had to be faced, all necessary preparations were made to facilitate the change-over with its attendant alteration of grid co-ordinate systems. When it came to the point, however, the armies were going ahead fairly fast when they reached the junction between the two zones, and the change-over was effected with little inconvenience or dislocation.

Methods of publishing trig lists

Trig lists were, in general, of two types:—

- (i) Those originally produced by A.F.H.Q. on an area basis rather than by map sheets.
- (ii) Later editions produced by A.F.H.Q. and by armies in the field compiled on a 1/100,000 map-sheet basis.

The original data consisted of acquired or captured Italian or German trig folios in which the points had been listed alphabetically. Their geographical co-ordinates were given and the points of origin varied generally between Genoa, Rome, and Castanea delle Furie in Sicily. The following procedure was adopted in preparing the allied trig lists:—

- (a) All geographical co-ordinates were first adjusted to the Italian trig datum and longitudes referred to Greenwich.
- (b) The adjusted co-ordinates were then converted to rectangular grid co-ordinates on the British military grid for the theatre (North or South Italy Grid).
- (c) Trig lists were then compiled on a 1/100,000 map-sheet basis in order of "eastings," listing the serial numbers, classification of the point, grid co-ordinates, elevation, sketches and descriptions. A monochrome copy of the 1/100,000 map concerned was included at the back of the booklet, on which the positions of the points were indicated by means of a red overprint. A preface was included to explain what adjustments had been made to the original data, and the source of that data.
- (d) Errata and addenda were compiled from field reports and other sources and were entered up on a trig-list record copy held at A.F.H.Q.

Early field-work in Italy

In connection with the Eighth Army operations in southern Italy two topographical sections of 13 Field Survey Company landed on 3rd September to work with the composite batteries of 3 Survey Regiment R.A. operating with 5 Division and 1 Canadian Division. Owing to the rapid advance they passed quickly through the small area for which minor trig data were available, but this

was compensated for by the fact that practically no survey data were required during that early stage by the artillery.

In general, check observations showed that the primary trig was very good. The minor points in the south, however, had suffered many changes and the results appeared to be of doubtful quality. As progress continued northwards the quality of the minor triangulation improved.

As winter came on, bad weather and difficulty of movement slowed up the advance. The Eighth Army front was contracted, and the requirements of the artillery survey were considerably reduced. The 3rd and 5th Survey Regiments R.A. each had only parts of one battery working forward, and it was found unnecessary to have more than two topographical sections R.E. in the field. Their work consisted almost entirely of checking the existing minor trig, and it proved satisfactory in most areas.

On the western flank with Fifth Army, Survey Group A of 46 South African Survey Company was operating in support of 10 Corps. Plentiful fixations were made, and all the artillery was soon put on the theatre grid.

Preparations for the invasion of southern France

In anticipation of the assault operation in the south of France A.F.H.Q. Survey Directorate, by arrangement with G.S.G.S. (War Office), took over responsibility for the conversion of trig values in parts of southern France from geographicals to rectangular grid co-ordinates. This work continued through the autumn and winter into the spring of 1944, and trig lists were prepared for issue to the U.S. Seventh Army when the operation was launched in the summer of 1944.

Discrepancy between trig-list values and the map co-ordinates of trig points

Shortly before the landings in Sicily, when the plotting of the primary trig points in Sardina and Sicily was being checked on large scale maps, it was noticed that there was a discrepancy between the trig-list values of the points and their values, as measured on the map, referred to the Monte Mario graticule which had been superimposed on the face of the map as a consequence of the Monte Mario meridian having been adopted as the fundamental meridian for mapping. Investigations into this problem were extended systematically over the whole of Italy, and it was found that the discrepancy was not constant all over but differed in various parts of the country. As a consequence it was decided to prepare a table of grid constants, one for each sheet, which would enable corrections to be made to measured map grid co-ordinates so as to put them in sympathy with the values obtained by ground survey which were computed from trig-list values. This action was especially necessary for the artillery, as they might well have their guns positioned by ground survey and their targets measured from the map, and it was essential that the respective co-ordinates should be in sympathy.

Trig library at H.Q. Allied Armies in Italy

During March, 1944, a trig library was set up with 19 Field Survey Company R.E. This dealt with bulk stocks of trig lists and arranged for their distribution to armies as required. It also maintained records of the field surveys, original record documents, original computations and records of trig lists.

German trig lists

Many German military trig lists were captured during the campaign. They had adopted the German Gauss Kruger grid for their military maps, and their trig lists gave co-ordinate values on this system. They had therefore to be converted to the North or South Italy grids before they could be issued to and used by the allied forces. Rapid methods for this conversion were evolved which eliminated the intermediate stage of conversion to geographicals.

A particularly satisfactory haul of German trig lists was made during June, 1944, by which date all the known Italian trig folios north of Lat 43° and most of the German lists had been obtained.

The Germans accepted the Italian geodetic triangulation as the datum for their trig work in Italy. The latitudes were accepted without correction, and the meridian of Monte Mario was defined as $12^{\circ} 07' 12.000''$ E. of Greenwich.

Field surveys on Eighth Army front in the spring of 1944

Taking advantage of a comparatively static operational period the topographical sections of 49 South African Survey Company and 12 Polish Field Survey Company reobserved and recomputed a close network extending over the whole of the Eighth Army front. This included a large number of intersected points in enemy territory, and the network so provided formed a sound basis for an extension forward when the advance was renewed.

Capture of further records of the Italian triangulation

On 15th June, 1944, the capture in Rome of complete records of the Italian lower-order triangulations supplied details of a control which gave between 160 and 240 points on each 1/100,000 sheet. In most areas this now supplied a network sufficiently dense to allow the artillery survey observers to resect their positions and obtain satisfactory bearings without the need for further triangulation on the part of engineer survey units.

As the original Italian triangulation had been carried out in the middle of the 19th century, it was to be expected that some of the stations would have been destroyed, rebuilt, or covered up by new buildings. The engineer survey parties were therefore instructed to check the existence and identification of Italian points in areas likely to be used for artillery deployment, and to restore or amend any that were found destroyed or in error. It was satisfactory to find that about 85 per cent of the old stations still existed in good order. In many of the cases where stations were found to have unreliable values it is probable that the errors were due to faulty proof-reading or transcription when the original Italian publications were produced.

In some areas, where the hill-tops were thickly wooded and where the country was of an exceptionally difficult type, it was found necessary to supplement the listed points by fixing a number of new stations.

More valuable trig data were captured during August in Florence. It mainly consisted of records of modern work, amongst which were the results of the readjustment of the geodetic network reoriented on Rome. It included also the extension loop along the Dalmatian Coast from Trieste to Foggia.

Field survey with Fifth Army during 1944

On Fifth Army front surveys in the field were controlled by Group A of 46 Survey Company S.A.E.C. augmented by survey platoons of U.S. and British

units. The work of checking the existing triangulation and providing new points extended over large areas of extremely rough and difficult terrain. The mountain-tops were often mined and booby-trapped and under enemy artillery fire. Between October, 1943, and October, 1944, the following work was completed:—

Italian trig stations verified	264
Italian trig stations amended	305
New trig stations established	624
Stations found destroyed	83

Field surveys with Eighth Army during the winter of 1944–45

The task of meeting field survey requirements on Eighth Army front was successfully accomplished by 49 Survey Company S.A.E.C. and 12 Polish Field Survey Company during this period. Weather conditions made survey work difficult in the Po valley, and this was aggravated by dense cultivation and the systematic destruction of high buildings and towers which might have served as trig points.

Throughout the advance on the Adriatic sector, it was possible to maintain a check of the control ahead of the advancing troops. This was done by the co-ordination of forward observations on all corps fronts, though, on the left flank of the army sector, the enemy's habit of holding out to the last in the hills denied the full use of valuable points in that area.

The first experience of conditions in the Po Valley north of Rimini indicated that, although it was still probable that control checks would keep in advance of artillery requirements, forward rays were likely to be considerably more restricted, involving the need for fixing a greater proportion of new stations. A new technique was evolved for checking existing trig points in forward areas by the stereoscopic examination of air-photos but, although this undoubtedly provided useful advance information, the use made of these annotated photos hardly justified the time and labour spent in their preparation and distribution.

Operations were more or less static during January, February and March, 1945. Mist and fog greatly hampered field observations but it was possible to build up ample trig cover along the army front.

The final stage

The allied full scale assault on the enemy positions in northern Italy was launched in April, 1945. The success of the artillery action during the opening stages of the battle undoubtedly owed much to the completeness of the survey preparations which had been going on during the preceding months.

Up to the crossing of the R. Po on 26th April, the topographical section of 518 Field Survey Company was able to keep the R.A. survey units supplied with trig information well forward in the battle-zone. From then on, however, the retreat turned into a rout, and movement was so rapid that field survey control could not keep pace with it. The need for survey, however, fell away with the collapse of resistance, so both topographical sections were withdrawn and put on to other work.

Special survey training for bridging operations

In February, 1945, a topographical section of 49 Survey Company S.A.E.C. underwent a training course on the Volturno River near Capua in connection

with surveys for anticipated bridging operations across the R. Po. The task of the section was to be as follows:—

- (a) The accurate determination of the water gap.
- (b) The marking of the centre line of the bridge.
- (c) Drawing a profile of each bank on the centre line, and also of the river bed.
- (d) The fixing of levels at the roller sites for launching the Bailey sections.
- (e) Fixing levels for the approach roads.
- (f) Taking soundings along the anchor line, 250 feet upstream from the centre line.

On 22nd April, the section came under command of C.R.E. corps troops. The preliminary reconnaissance was carried out at 0230 hours on 26th April. At about 0400 hours the enemy blew one of the remaining pillars of the demolished railway bridge near by, and by 0700 hours the far bank was reckoned to be clear of the enemy and the survey proceeded. By 2000 hours on 27th April, the last floating section was being put in place and the section's task was complete.

Somewhat similar work was done by a section of 49 Survey Company (S.A.E.C.) for C.R.E. 13 Corps Troops, and in addition they did the survey for the bridging of the Rivers Adige and Piave.

Modern adjustments of the Italian primary triangulation

Amongst the data obtained by the allied survey service from Italian and German sources were the results of modern observations, including a new chain down the Dalmatian Coast, and new adjustments of the primary trig nets. This material seems likely to have a considerable effect on future trig lists of Italy, and on those trig lists of the Balkans which fall along the Yugoslav and Italian frontiers.

Amongst this new material were the following:—

- (a) The 1940 adjustment of the Italian first-order triangulation, together with the adjustment of the 1941–42 Italian survey along the Dalmatian Coast.
- (b) The German adjustment of part of the Italian primary network for the publication of co-ordinate lists based on the Einheits system.
- (c) The German investigation into the triangulation in the area of the Italy-Yugoslav frontier.
- (d) The German adjustment of the Yugoslav primary triangulation to the Italian system.

On the Italian mainland, the 1908 adjustment, as published in the "Elements of the Fundamental Geodetic Net," was known to contain errors, and it did not cover Venezia Giulia and Venezia Tridentina, which parts of Italy were previously included in the Austrian first-order net. From the material acquired during the war, data became available for adjusting all the trig lists of Italy to a net of Italian first-order triangulation, and also for determining a sounder connection between the Italian and Balkan systems.

SECTION 4. MAP SUPPLY AND DISTRIBUTION

Introduction

No matter how much care, forethought and labour are expended in the design and production of maps for the use of ground and air forces, they will be of no avail unless proper steps are taken to store, issue, transport and deliver the right maps at the right time to those who require them, whether at a headquarters for planning, on the lines of communication, or amongst the fighting formations.

Unlike other commodities such as rations, ammunition, etc., which are appropriate to any part of the theatre, maps are of an ephemeral nature only, and require continual change and replacement as troops move from one area to another. The more rapid and fluid the operations the greater are the difficulties of distribution. It is essential, therefore, to have in being an organization which is capable of continuous and efficient action to ensure proper map storage and distribution.

Initial organization

For the operations in the Central Mediterranean the Survey Directorate at A.F.H.Q. was responsible for exercising a general control over map supply and distribution. Map stocks were obtained from the following main sources:—

- The United Kingdom (G.S.G.S. War Office).
- The United States (Army Map Service, Washington).
- Survey Directorate, G.H.Q. Middle East (who produced and printed maps on an agency basis for A.F.H.Q.).
- Survey units (British and American) under the direct control of A.F.H.Q.
- French Service Géographique at Algiers.
- Survey units under the direct control of H.Q. Allied Armies in Italy (15 Army Group).
- Survey Units with Fifth and Eighth Armies.

During the early part of the campaign, base stocks of maps were assembled and stored in British and American map depots situated at Algiers and other parts of North Africa. At the end of May, 1943, following the successful termination of the operations in Tunisia, the units available for map depot work were as follows:—

- British* 7 Field Survey Depot R.E. Algiers (A.F.H.Q.).
12 Field Survey Depot R.E. Tunis (First Army).
20 Field Survey Depot R.E. (Eighth Army).
- U.S.* Atlantic Base Section (A.B.S.) Map Depot (Casablanca).
Mediterranean Base Section (M.B.S.) Map Depot (Oran).
Eastern Base Section (E.B.S.) Map Depot (Constantine).
Two Engineer Map Depot Detachments established with Seventh Army for the receipt of coded stocks for the Sicily operation.

10 Field Survey Depot R.E. arrived from the United Kingdom in June, 1943, and took over stores depot duties, thus releasing No. 7 Field Survey Depot for map depot duties only. These were heavy in consequence of preparations for the invasion of Sicily (operation "Husky").

Map distribution arrangements for "Husky" are described elsewhere in the notes on that operation. (See Chapter XII, Section 4.)

Preparations for operations in Italy

In preparation for operations on the mainland of Italy subsequent to the occupation of Sicily, map stocks were assembled at Algiers on arrival from overseas and from local printing resources, and they were gradually split up between there and Tunis. For planning purposes open stocks were supplied to H.Q. 15 Army Group, to 5 and 10 Corps and, later, to U.S. Fifth Army. The map stocks in Algiers were divided into operational and non-operational stocks. The former remained in the A.F.H.Q. depot operated by 7 Field Survey Depot and the latter were stored in a depot run by 649 Engineer Topographical Battalion. 12 Field Survey Depot (ex First Army) continued to operate the map depot in Tunis. Maps for use by the air forces were transferred to the Island Base Section map depot at Palermo and the Eighth Army map depot at Syracuse.

For the mapping up of forces taking part in the landing operations at Salerno (operation "Avalanche") stocks were shipped to Oran, Tunis and Tripoli. A.F.H.Q. Survey Directorate sent personnel to Tunis and Tripoli for the detailed distribution of maps to British units taking part in the assault and follow up. Reserve stocks in large quantities were prepared for shipment to Fifth Army map depot by an early follow-up convoy.

On 24th August, a conference was held at Algiers which was attended by the officers of the various map depots, engineer intelligence officers from the U.S. Fifth and Seventh Armies, representatives from British survey units, and representatives from the North African Air Force. Their respective responsibilities with regard to map distribution were clarified, and details of the coming operations were discussed so as to foster efficient co-operation within the theatre. Assistance was given to Fifth Army by A.F.H.Q. in organizing and equipping two engineer map depot detachments for service at Salerno.

Turning now to Eighth Army, 20 Field Survey Depot R.E. had been organized during the desert campaign as an "Army type" unit, with a main and rear depot, and with sub-sections equipped with specially fitted map lorries for attachment to the headquarters of corps and divisions. The rear depot (Palestinian personnel) moved by air from North Africa to Sicily on 26th August to join the main depot. Efforts were now concentrated towards preparations for landing on the Italian mainland across the Straits of Messina. Maps were issued from Syracuse direct to formations.

The opening of the Italian campaign (September, 1943)

Although all formations taking part in the initial landings were adequately mapped, the margin of safety on most deliveries was uncomfortably small. After completing its work in Tunis 12 Field Survey Depot moved to A.F.H.Q. and joined No. 7 at Algiers.

Officers from A.F.H.Q. had helped to map up the troop ships leaving the ports of Bougie and Philippeville for Salerno, and a topographical section of 518 Field Survey Company R.E. did the same at Bizerta and then rejoined its unit at A.F.H.Q.

An advanced map depot (A.M.D.) which was formed from 20 Field Survey Depot crossed over to the mainland on "D" + 3 and set up at Reggio. It

held reserve stocks of sheets already issued to Eighth Army formations, and also carried sheets of more forward areas. Syracuse now became unsuitable as a base map depot for Eighth Army so stocks of the mainland were moved to Aci Castello whence consignments were despatched daily to the A.M.D. on the Catania ferry.

As operations developed, map distribution became more difficult. The advancing troops were moving rapidly to effect a junction with the Salerno bridgehead and road transport up the toe of Italy became very precarious owing to broken bridges and damaged roads. As bulk stocks arrived by ferry from Sicily they were sent forward to advanced map depots which were continually being opened and closed as it became necessary to move forward. The British wing of 20 Field Survey Depot acted as the A.M.D., and the Palestinian wing took over and wound up these depots as they were left behind. At this stage of the campaign only 13 Corps, consisting of two divisions, was concerned, and all stocks for the divisions were delivered in bulk to Corps H.Q., the latter preferring to assume full responsibility for distribution to the troops under its command.

5 Corps then landed at Taranto and, though not yet under Eighth Army command, it was supplied by the latter with maps at A.F.H.Q. request from an A.M.D. opened up at Taranto. This was relieved by the Palestinian detachment at the end of September, and the freed A.M.D. went on to Bari where it started to open up a base map depot.

After the capture of Naples, U.S. forces established there a Peninsular Base Section Map Depot operated by 2634 Engineer Map Depot Detachment. Arrangements were also made for 16 Field Survey Depot to move from Taranto to Bari to operate the base map depot for H.Q. 15 Army Group.

Meanwhile 26 Field Survey Depot was newly formed to work in conjunction with Nos. 7 and 12 at A.F.H.Q. in Algiers. Stocks were being received from the United Kingdom and the U.S.A. by convoy. Those from America were chiefly air maps and road maps of Italy.

During early October, map distribution with Eighth Army became less difficult, and the British and Palestinian wings of 20 Field Survey Depot were concentrated at Bari. But when Main Army H.Q. moved forward, the main depot transferred to Lucera to form an A.M.D. The detachment of No. 20 which had been operating with Fifth Army then returned to Eighth Army. Big consignments of 1/250,000 maps were being received by air from A.F.H.Q. and Middle East, and the situation regarding stocks was now easier. Further consignments of air maps were received and were added to the Bari stocks. The supply of maps to the Desert Air Force was the responsibility of Eighth Army.

The winter of 1943-44

With the slowing down of operations owing to weather and bad communications, opportunity was taken to build up stocks of forward areas in the A.M.D., making use of large consignments taken over from Fifth Army and also those received from the Middle East. The front of Eighth Army was split by mountain ranges which ran down the middle of Italy, and this resulted in poor lateral communications between the two main axes of the Army's advance. The A.M.D. was moved forward from Lucera to Serracapriola, and a mobile A.M.D. was attached to H.Q. 13 Corps moving along the inland axis.

16 Field Survey Depot, which had been established at Bari, now took over

from No. 20 the stocks of special air maps held there, and also the bulk stocks of all sheets covering the area behind the rear boundary of the army.

A.F.H.Q. was sending over continuous supplies of maps to Naples and, during December, these included maps of the Balkans. Space was assigned near Naples for 12 Field Survey Depot which, on arrival from North Africa, was given the task of handling British survey stores and certain categories of maps under the direction of 15 Army Group.

In December there were changes in the spheres of operational responsibilities between the two armies, and the A.M.D. which had been attached to 13 Corps was moved into 5 Corps area, where it became a general A.M.D. serving all the forward troops of Eighth Army.

No. 20 was reorganized during January, 1944, which resulted in a saving of transport and personnel. The Palestinian personnel, who now formed a separate unit, remained responsible for operating the base map depot. The A.M.D. with its maps and stores moved forward from Serracapriola to Casalbordino, and large map consignments were received from A.F.H.Q. including road maps and first instalments of the revised 1/25,000 series. On the arrival of the Canadian Corps a new corps sub-section of the field survey depot was formed.

In February, there was a readjustment of depot responsibility at Algiers. 26 Field Survey Depot opened a new depot to handle new operational stocks arriving in the country. 7 Field Survey Depot was made responsible for handling 1/M maps and all smaller scales, all maps for air forces only, all maps of Italy, Africa, the Iberian peninsula, and areas east of 30° E., together with all maps of general interest.

February also saw the closing down of the Eastern Base Section map depot at Tunis, its bulk stock being distributed between Algiers, Naples and Palermo. Shipment of bulk stocks to Italy was speeded up, and opportunity was taken to send to salvage all used and obsolete maps.

The spring and early summer campaign of 1944

When the Polish Corps became operational, its map supplies were issued by 312 Polish Field Survey Depot, bulk transfers being effected from 20 Field Survey Depot of sheets covering or adjacent to the Polish area of operational responsibility. The role of the depot was identical with that of an A.M.D. attached to a corps.

In North Africa the Atlantic Base Section map depot was in process of closing down in March, and its stocks were distributed to Oran, Algiers, and to salvage. The shipments from U.S.A. which, in the past, had come to Casablanca, were now diverted to Oran.

In preparation for operations in southern France, the engineers of the Northern Base Section in Ajaccio established a small map depot there to which consignments of maps, mainly for use by the air forces, were shipped from A.F.H.Q.

By April the map depot situation with H.Q. Allied Armies in Italy was showing steady improvement, comprising 12, 16 (Palestinian), and 27 (Palestinian) Field Survey Depots together with U.S. Engineer Map Depot Detachments 2634 and 2658 which were assigned to the Peninsular Base Section. With Eighth Army 20 Field Survey Depot, which had in March become No. 29,

opened up at Varriano during May. Two new sub-sections had been formed for incoming divisions and were equipped with map lorries racked on an improved system, a third sub-section being held in reserve.

The allied armies were advancing rapidly northwards in June and July towards Florence and the Gothic Line. A.F.H.Q. moved over from Algiers to Caserta early in July, and 16 and 12 Field Survey Depots were transferred from H.Q. 15 Army Group to A.F.H.Q. command. In replacement 14 Field Survey Depot (Palestinian) was moved from Middle East to H.Q. 15 Army Group and took over the Varriano map depot from 29 Field Survey Depot (Main), the latter moving forward with Eighth Army. No. 14 then moved on to Rome, its main function being to hold stocks of all maps of Italy north of Rome, and small stocks covering the area between Naples and Rome. By the end of June, two weeks after its arrival, it had taken 8,000,000 maps into stock and issued over 1,000,000.

In mid-July 29 Field Survey Depot (Rear) moved from Bari to Rome to take over the survey stores, leaving No. 14 to deal only with maps. A small port detachment was left at Bari to look after incoming shipments.

For the first seven months of the Italian campaign, the map distribution personnel with Fifth Army consisted of one map depot detachment only. A second one was assigned in June, 1944, and these two units (each of one officer and 12 enlisted men) handled the following quantities:—

Received from A.F.H.Q. for distribution on "D"-day	1,580,000
Received from higher H.Q.s after "D"-day	12,500,000
Received from new printing by army survey units	10,520,500
	24,600,500

During the early summer 1712 Map Depot Detachment operated a forward map depot which carried only combat stocks of forward areas. 1710 Map Depot Detachment operated a rear depot which carried general stocks and also took over stocks which were left behind by the forward depot as it moved forward.

Operation "Anvil" (Invasion of southern France)

H.Q. Seventh Army (U.S.) moved over to Italy with A.F.H.Q. early in July, and preparations for mapping up the allied invasion force went ahead. The following map depots were employed for map distribution duties in connection with the operation:—

Oran	1620 Engineer Map Depot Detachment (U.S.).
	1711 (later 1719) Engineer Map Depot Detachment (U.S.).
Algiers	26 Field Survey Depot R.E. (British).
Naples	1709 (later 1720) Engineer Map Depot Detachment (U.S.).
	1713 Engineer Map Depot Detachment (U.S.).
	12 Field Survey Depot R.E. (British).

There was also a security breakdown depot in Naples which was operated by 661 Engineer Topographical Company (U.S.). The numbers of maps issued by the survey service for the assault and for the establishment of the bridgehead were:—

Standard maps	14,833,000
Collation maps	135,350
Going maps	50,250
Layered maps	57,500
Panoramic beach sketches	84,000
Miscellaneous printings	110,900
	15,271,000 copies

In addition there were issued:—

Contact photo prints	1,900
Half-tone litho prints of air-photos	101,000

Subsequent to the assault large consignments were sent to Seventh Army in France from North Africa, Italy and Middle East, much of this going by air. By early September the "Anvil" operation forces had passed beyond the theatre boundary of A.F.H.Q. but, by arrangement with S.H.A.E.F., A.F.H.Q. continued for a while to supply Sixth Army Group with road maps and also 1/250,000 and 1/100,000 topographical maps of Germany.

The summer and autumn of 1944

During August there was a change of plan which involved Eighth Army in a main thrust along the Adriatic Coast instead of along a more central axis. As Fifth Army thereby took over the western end of Eighth Army front, the latter was able to hand over to the former nearly half a million maps covering the Siena-Firenze-Bologna axis.

29 Field Survey Depot (Adv.) had moved early in July from Orvieto to Castiglione del Lago, moving on two weeks later to Arezzo where it remained till the end of August when it was transferred across to Iesi on the Adriatic coast in conformity with the new operational plan. Since landing in Sicily in June, 1943, this depot had moved once every three weeks, each move involving the loading and unloading of up to 3,500,000 maps. These always had to be ready for issue within a few hours of arrival at the new destination. Within four days of its arrival at Iesi over 750,000 maps had been issued.

In anticipation of future operations northwards, H.Q. 15 Army Group organized a detachment of 14 Field Survey Depot in Rome to handle bulk stocks of areas ahead of the current battle-zone. This enabled large consignments for the two armies to be assembled and issued promptly, and also separated the bulk stocks from the smaller stocks which were held in the main depot for 15 Army Group use.

During September, 7 and 10 (Stores) Field Survey Depots crossed over to Italy leaving No. 26 as the only one remaining in North West Africa.

About this time the offensive operations of the allied armies under General Eisenhower in western Europe, and the Russians in the east, caused a general withdrawal of German forces on all fronts including the Balkans. This resulted in an increased demand for maps covering all approaches into Germany, and limited stocks to cover a possible advance into southern Germany were transferred to the armies in Italy. September was in consequence a busy month. Air shipments were extensive, over 100 tons being moved thus during September and October, including a large consignment to 3 Corps in Greece.

29 Field Survey Depot (Rear), under 15 Army Group control, moved forward from Rome to Fano in September, its task being to hold bulk stocks of maps

covering a zone ahead of the army operational area. Eighth Army was now having bitter fighting between Pesaro and Fiumicino, eight miles beyond Rimini, and 29 Field Survey Depot moved on from Iesi to Fano.

26 Field Survey Depot closed down in Algiers during October, as also did the Mediterranean Base Section map depot in Oran. All useful stocks held in North West Africa were shipped over to Italy, including a quantity to be used for printing on the back to alleviate the paper shortage.

The Survey Directorate, 15 Army Group was now stocking up with maps of southern Germany as an insurance against a possible sudden collapse of the enemy forces. These bulk stocks included road maps, and topographical maps on the 1/250,000 and 1/100,000 scales. Orders were also placed with Middle East for the printing of small quantities of all available large scale maps of the southern Balkans and the Aegean Islands.

Both armies advanced considerably during October. With Fifth Army an advanced mobile section, consisting of nine 2½-ton trailers racked for map storage, moved to the Futa Pass area so as to facilitate distribution to II (U.S.) and 13 (British) Corps.

The winter lull (January–March, 1945)

During January, all Palestinian personnel in 29 Field Survey Depot were replaced by British personnel from No. 26, which had been disbanded. The released Palestinians were utilized to form a new depot to operate under A.F.H.Q.

On its arrival in Italy, A.F.H.Q. Survey Directorate assumed the role of strategic map support to 15 Army Group, and this involved the building up in A.F.H.Q. forward map depots of insurance stocks covering northern Italy, north-western Yugoslavia and southern Germany. A stock-level policy was evolved which scheduled the map coverage and quantities of the strategic map reserve to be held by A.F.H.Q. This formed the stockholding policy for the map depots and, with more or less static operational conditions during March, it was possible to put this policy into effect by transferring stocks from 15 Army Group depots and sending up consignments from rear depots to those further forward.

Eighth Army moved their A.M.D. to Ravenna where stocks of all sheets up to the R. Po were assembled ready for issue. Their main and rear depots were at Cesena. The stage was now set for the April assault which proved to be the final chapter of the operations in Italy.

The last few weeks

A full scale assault by both armies was launched in April involving very extensive map distribution. Map depots were working right round the clock.

With Fifth Army the forward depot moved to Porretta, then to Modena for seven days followed by a quick move on to Verona. After the break-through in the Argenta Gap, demands in Eighth Army became heavy owing to the fluid situation and the employment of quick-moving armoured forces. Nearly all the operational deliveries subsequent to 9th April were made from the A.M.D. at Ravenna but, after the Army had crossed the R. Po, the depot moved forward to Ferrara.

The surrender of the German armies in Italy took place on 2nd May. Map issues continued to be brisk. Fighting in Germany was still going on and, at S.H.A.E.F. request, A.F.H.Q. arranged for two plane-loads of maps to be

ready for delivery to Sixth Army Group in the event of a move south into Austria. There was no difficulty in supply as all the maps required for entry into Austria had been assembled in the A.F.H.Q. forward depots.

H.Q. 15 Army Group transferred 14 Field Survey Depot to Bologna to which place all map stocks required for northern Italy, Yugoslavia and Austria had been moved from Rome.

Eighth Army now had two main tasks; firstly to take part in the occupation of Austria, and then to deal with the situation arising from the Yugoslav occupation of Trieste and Venezia Giulia. These final stages kept their map depot very busy. Six days after moving to Ferrara the main depot went on to Mestre near Venice and on 10th May to Udine. At first only those maps required for the occupation of Austria were stocked at Udine. Later it was necessary to include those needed for the Trieste area. This involved very heavy transport commitments, the depot having to collect from Mestre, Ferrara, Bologna, Cesena and as far back as Fano. The transport of the field survey depots could only meet about 10 per cent of requirements. Reliance was placed on using a pool of up to 30 lorries from field survey companies, mostly from 49 Company (S.A.E.C.).

Final comments

The number of maps produced for the theatre was over 134,000,000, made up as follows:—

From the U.K. and U.S.A.	55,950,000
From the Middle East	10,101,000
Printed by A.F.H.Q. units	36,163,000
Printed by 15 Army Group units and units of Fifth and Eighth Armies	31,887,000
Total	134,101,000

Not all of these were issued for use, but they had to be handled on receipt and stored in map depots where they were sorted, catalogued, and racked ready for immediate issue and delivery to other depots or direct to formations. All this involved a great deal of skilful organization, efficient co-operation, and hard work on the part of all concerned. The personnel of the various map depots, though working out of the limelight of publicity, deserved high credit for their contribution towards final victory.

SECTION 5. MAP SUPPLY TO THE AIR FORCES

Introduction

The evolution of an efficient system of map supply to the allied air forces in the Mediterranean Theatre was, perhaps, of special interest in that it was complicated by a variation in normal map supply procedure as between the British and U.S. forces.

The requirement was to furnish adequate quantities of maps of the following categories to all allied air forces and auxiliary units in the North African and Mediterranean theatres of operations:—

- (a) Standard and special navigational maps peculiar to air use.
- (b) Standard topographical maps on all scales. These were produced primarily for the ground forces, but were also essential to air operations.
- (c) Lithographic and photographic copies of photo-mosaics.

With an integrated (British-U.S.) Allied Force Headquarters for the theatre, the initial problem was to devise an organization which would produce the desired result without overlapping or duplication of effort.

Development of mapping support to the air forces in the Mediterranean Theatre

From the beginning of operation "Torch" (the invasion of North West Africa) it was agreed that the maps to be supplied to the allied air forces in the Mediterranean theatre for special air use would be the standard British air-maps, and that they would be supplied initially through the Directorate of Military Survey (War Office), and later by subordinate survey directorates. In December, 1942, the A.F.H.Q. Survey Directorate was established in Algiers and controlled the production and procurement of maps for both ground and air forces. Organized under the Chief Engineer, in accordance with U.S. practice, but with a British Director of Survey, it assembled stocks of the standard British air-maps for supply to the R.A.F. and the 12th U.S. Air Force, and assumed responsibility for all mapping in North Africa exclusive of Middle East areas. The special air-maps were supplied directly to the air forces in the quantities required by them, and this procedure was followed for the Sicilian operations and the opening stages of the Italian campaign. In October, 1943, D.D. Survey at H.Q. 15 Army Group assumed responsibility for supply to the tactical air forces which were in direct support of the ground forces. In addition to the special air-maps large quantities of standard topographical maps, as used by the ground forces, were supplied for close-support bombing and other purposes. The air forces so supplied included the Desert Air Force, the 12th U.S. Air Force, and the Tactical Bomber Force. Maps for air forces based in North Africa were supplied by A.F.H.Q. Survey Directorate in Algiers.

In November, 1943, it was agreed between D.D. Survey 15 Army Group and the Engineer Command 12th U.S. Air Force that map requirements for 12th Air Force would be determined by the latter and demands forwarded through the Engineer Command, the maps then to be supplied from map depots under the control of D.D. Survey. The other elements of the Tactical Air Force, in accordance with normal British practice, continued to deal direct with the survey directorates at H.Q. 15 Army Group and at H.Q. Eighth Army.

In January, 1944, the Engineer Command U.S.A.A.F. (Mediterranean) was formed. A forecast of map requirements for all U.S. air forces in the theatre was forwarded to A.F.H.Q. Survey Directorate who proceeded to stock up accordingly, and this arrangement continued till about October when it was agreed that as the Survey Directorate, through its subordinate survey representatives and map depots, had such a close contact with the air forces with regard to supply, the forecast of map requirements would follow the same channels as those through which the maps themselves were supplied, namely those of the theatre survey organization. The survey directorate then assumed complete responsibility, on an informal basis, for the supply of both air- and ground-maps to the air forces.

Although the accepted and normal channel for map supply to the R.A.F. was through the survey directorates according to British practice, the difference

between British and American practice left some doubt officially as to who was responsible for supply to the U.S. Air Forces. The system described above, which had developed through a progression of expedients, had by 1945 tended to conform to the standard British procedure, and the U.S. Air Forces seemed satisfied and desired its retention. To regularize the informal situation the C. in C. Allied Air Forces therefore issued a directive in April, 1945, assigning responsibility to A.F.H.Q. Survey Directorate for the supply of all maps, except target charts, to air forces in the theatre.

Thus the responsibility for the production, procurement, printing and distribution of maps for ground and air forces rested with one central authority, namely the theatre survey organization headed by the Director of Survey at A.F.H.Q.

Aeronautical charts

Late in 1944, the U.S. Air Forces enquired about the availability of the Army Air Force aeronautical charts which had been produced by the Aeronautical Chart Service in Washington. These had not previously been held in quantity by survey depots as they did not conform to the agreed standard series for use in the theatre. D. Survey, however, at once undertook to obtain sufficient stock to meet requirements.

Special map production for the air forces

Until about May, 1944, very little special map production was undertaken for the air forces other than the production of target charts by the engineer topographical companies (aviation).

Early in 1944, however, there were periodical requests for the production of special navigational maps, which were met on high priority by A.F.H.Q. Survey Directorate. During the winter of 1944-45 the production of special maps for air forces increased, and close contact was established between air force navigation officers, engineer topographical companies (Aviation), and the survey directorates in order to facilitate the production of special maps and navigational aids. These included the preparation of a special air navigation chart incorporating revised town shapes and flak overprints. The production of flak overprints on 1/500,000 air-maps, and the preparation of special overprints for long-range navigation using radar aids was also undertaken.

Survey data for "Shoran" controlled bombing methods

In October, 1944, A.F.H.Q. Survey Directorate was asked by the air forces to provide geodetic data for use in connection with "Shoran" controlled bombing methods, and a survey computing team was assembled to deal with this. The problem consisted of fixing two "Shoran" ground-stations by trig survey methods, accurately locating and fixing the position of selected targets from air photographs by photogrammetric methods, computing the geodetic distance from ground-station to target, and determining the air line distance, at the time of bomb-release, between the aircraft and the ground-station. It was estimated that the distances so determined were not likely to be in error by more than about 25 to 30 metres on average.

SECTION 6. AIR PHOTOGRAPHY FOR MAPPING AND REVISION

Early activities

In Chapter IX, which dealt with operations in North West Africa ("Torch"), it has been noted that there was practically no provision in that theatre for the production of survey photography except in the final stages when 60 Squadron of the South African Air Force, which was operating with Eighth Army, covered parts of Tunisia using two Mosquito aircraft which were at its disposal. The notes on the Sicilian operations (*see* Chapter XII, Section 4) show that D. Survey, Middle East had taken energetic action to obtain survey photography of Sicily well in advance of the projected operation so as to be able to compile new maps and revise existing ones. Much of this work was carried out from June, 1943, onwards by the Mosquitoes of 60 Squadron.

Other photography, taken primarily for Intelligence purposes, was undertaken by the North African Photographic Reconnaissance Wing (N.A.P.R.W.). They supplied 6-inch photos covering Sicily, Sardinia, parts of southern France and the toe of Italy. "Lightning" aircraft were used carrying a 6-inch vertical camera and two 24-inch obliques set at 6° or 9° from the vertical and flying at a height of from 25,000 to 30,000 feet. By mid-June, 1943, most of Sicily had been so covered, but the sorties were erratic and short.

Attachment of a survey officer to N.A.P.R. Wing

In July a survey officer was attached to the Wing for the following main purposes:—

- (a) To select photographs which would be of use for mapping.
- (b) To inform the survey organization of what photography was available, and to ensure that duplicate films were available for despatch to the Assistant Director Intelligence (Ph.) in London, G-2 (War Department, Washington) and the Middle East Intelligence Unit.
- (c) To obtain prints as required by A.F.H.Q. Survey Directorate.
- (d) To ask for photo-cover to be flown over areas required by Survey for mapping and revision.

Allocation and cancellation of a survey flight (Mosquitoes)

Representations having been made of the need for survey photography, one flight of three Mosquito IX aircraft was flown out to North Africa from 540 Squadron (Medmenham) specially for that purpose. However, owing to a sudden emergency elsewhere, the aircraft were required for other purposes and the flight returned to the United Kingdom almost immediately after its arrival. This left, as the next best available operational aircraft for photographic purposes, the "Lightnings" of a U.S. Photo Reconnaissance Squadron which was, in July, allocated for carrying out survey requirements on the Italian mainland.

Photo situation during the autumn of 1943

- (a) *Photography for Italian map revision.* By September, 1943, a considerable amount of photography was available covering southern and central Italy, and many sorties were being flown over parts of the Balkan peninsula. Sets of prints for use by the two armies in Italy were supplied from Cairo, and both armies now held all available 6-inch cover and a

large amount of 24-inch cover as far north as Spezia, though it was very incomplete. Air-photos were now in constant use for the revision of 1/50,000 and 1/25,000 maps of central and northern Italy and also of southern France. Weather conditions were bad during the winter months, and there were many gaps in the photography.

The supply of photographs from N.A.P.R.W. to Eighth Army was regularized by A.F.H.Q., and it was now possible for the army survey directorate to build up cover traces and organize its revision programme in a more satisfactory manner. The flimsy cover diagrams prepared by N.A.P.R.W. were very sketchy, however, and it was only by checking up with the Army Air-Photo Intelligence Unit (A.A.P.I.U.) that arrangements could be made for demanding further sorties to fill the gaps.

- (b) *Photo library.* In November, 1943, A.F.H.Q. Survey Directorate organized a photo library, making use of personnel belonging to 1601 Engineer Map Depot Detachment (U.S.), thus ensuring a better distribution of photos among the survey units.
- (c) *Cover diagrams.* A useful feature introduced about this time was the compilation of cover diagrams drawn up on 1/250,000 map sheets with the 1/100,000 sheet lines overprinted. This was found to be of great assistance in the organization of map revision as the 1/50,000 and 1/25,000 sheets formed subdivisions of the 1/100,000 sheet lines. During December A.F.H.Q. sent to both armies two sets of photos with the plots marked up on the overprinted 1/250,000 maps, and Eighth Army now held most of the available cover as far north as Bologna.
- (d) *Block-plots for target fixation.* A programme of target fixation for counter-battery purposes by the use of block-plots was taken up during the winter, the work being done on 9 × 9-inch prints at about 1/50,000 scale, using large scale photos for identification. To cover the gaps in these block-plots, 15 Army Group asked for further 6-inch photography. The construction and operation of the block-plots was done by 7 General Field Survey Section R.E. and continued with success during the remainder of the war.

The early part of 1944

- (a) *Formation of the Mediterranean Allied Photo Reconnaissance Wing (M.A.P.R.W.).* In January, 1944, the N.A.P.R.W. became M.A.P.R.W. All orders for photographs were then canalized through the Mediterranean Photo Intelligence Centre. A.F.H.Q. arranged for sorties over northern Italy, southern France, Greece and the Balkans. Demands were now heavy as new large scale mapping was being undertaken by Multiplex methods for southern France, the Balkans and parts of Italy.
- (b) *Demands for new large scale maps.* Both artillery and infantry in Eighth Army were now demanding fully detailed large scale maps in areas where none hitherto existed. When producing a special 1/25,000 map in the Orsogna area it was realized that gaps in photography, which seemed small on the 1/250,000 sortie diagrams, appeared enormous when it came to actual large scale compilation. However, complete cover for this job was obtained by D.D. Survey through G (Air) at Army H.Q.

- (c) *Film library.* A.F.H.Q. Survey Directorate established a film library for original 6-inch negatives. This was organized and controlled by 30 Engineer Topographical Battalion (U.S.) which was doing new map compilation by Multiplex methods, and required the original negatives from which to make the diapositives. These films covered the Balkans, southern France, and central Italy, and films of the more northerly parts of Italy were ordered. During March 6-inch sorties were flown along the Rhone Valley, and gaps in Italy to the north-west of Turin and in the Spezia district were covered under A.F.H.Q. control.
- (d) *Redistribution of photo coverage.* By March, 1944, the hand-over of air-cover from A.F.H.Q. to H.Q. Allied Armies in Italy was complete except for areas in north-east Italy, and an air-photo library was set up with 19 Field Survey Company R.E. which was operating under the direct control of D.D. Survey 15 Army Group. With changes in army areas and responsibilities, March was a busy month with regard to air-photos. It was necessary to redistribute the photo-coverage between the armies and units. All photos taken over by Eighth Army were sorted and indexed on a 1/100,000 map-sheet basis.

The spring and summer of 1944

- (a) *Improvement in weather conditions.* Conditions for air photography had been bad during the winter, but with better weather from April onwards great impetus was given to the photographic programme. Eighth Army was now receiving a steady flow of large scale photos, but the presence of many gaps made it difficult to plan a long-term revision for the 1/50,000 and 1/25,000 series. A further flying programme was asked for through G (Air) at Army H.Q. to fill these gaps.
- (b) *Preparations for the invasion of southern France.* By the end of July, 1944, photo-cover had been obtained for that part of France lying to the south of Lat. 46° and east of the meridian of Paris, as this appeared to be the most likely operational area for the projected invasion. Experience in large scale map compilation by Multiplex methods showed that the 6-inch photos alone were unsatisfactory and should be augmented by larger scale photos for the identification of control and detail. It was hoped to combine split 12-inch cameras with all 6-inch sorties over France, but the mounting of the cameras caused delays.
- (c) *North-east Italy, Yugoslavia and Austria.* During August, 1944, Eighth Army took over a record number of photos which covered the whole of north-east Italy lying to the north of Ravenna and east of Verona. These were at once sorted, listed and plotted on the cover diagrams so that the revision planners could organize their work.

Photography in northern Yugoslavia and in southern Austria made a lot of progress during these summer months, and in September the 6-inch mapping photography covering the approaches to Vienna had been completed in accordance with an A.F.H.Q. specification. The rapid advance of the allied forces northwards through southern and central France made it possible to cancel many of the flying demands which had been placed there and switch the photographic resources elsewhere.

- (d) *Gridded photos.* During the summer there was a growing demand for gridded large scale photos. Nearly 700 of these were produced and issued during July and August. The gridding was done by comparison with the 1/25,000 maps, each grid intersection being plotted by revision methods. They gave a wealth of detail at a scale of about 1/15,000.

The final stage (October, 1944–May, 1945)

- (a) *Transfer of film library to Italy.* In November the 6-inch film library which had been maintained by 30 Engineer Topographical Battalion in North Africa was transferred to Italy, with a section to do the contact printing, enlarging and rectifying.
- (b) *Austria.* With the prospect of the German armies being eventually forced back into Austria, an extensive mapping project for that country was organized under A.F.H.Q. control. Photo-coverage was an urgent essential and, as the mapping was to be done by Multiplex methods, 6-inch (K-17) original negatives were required. By January, 1945, much of the basic cover had been received, and the original negatives together with the master positives of long focal length photos covering the main communications, were sent to A.M.S., Washington, and also to S.H.A.E.F. (for E.T.O.U.S.A.), both of whom were to assist in the productive work.

During January and February, bad weather conditions hindered the flying programmes over Austria, but in March a considerable increase in output was possible owing to a good spell of fine weather, and progress thereafter continued to be satisfactory. The maps of Austria were not actually required for operations but were completed for occupational use.