

CHAPTER VII

PERSIA AND IRAQ

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SECTION 1. OPERATIONAL BACKGROUND

The war was not going too well for the Allies at the beginning of April, 1941. The German invasion of Yugoslavia made it necessary for a British Expeditionary Force to be sent over to Greece, already hard pressed by Italian forces operating through Albania. Simultaneously, Field-Marshal Rommel counter-attacked in Libya, forcing the Desert Army, which had occupied Benghazi, to retreat back into Egypt. The subsequent evacuations from Greece and Crete completed this somewhat gloomy picture.

Enemy propaganda in Iraq had for some time been very active and German agents had succeeded in their efforts to seduce certain military and political elements in the country. At the critical moment under review this pro-Axis element in Iraq, headed by Rashid Ali, staged a revolt against the Regent.

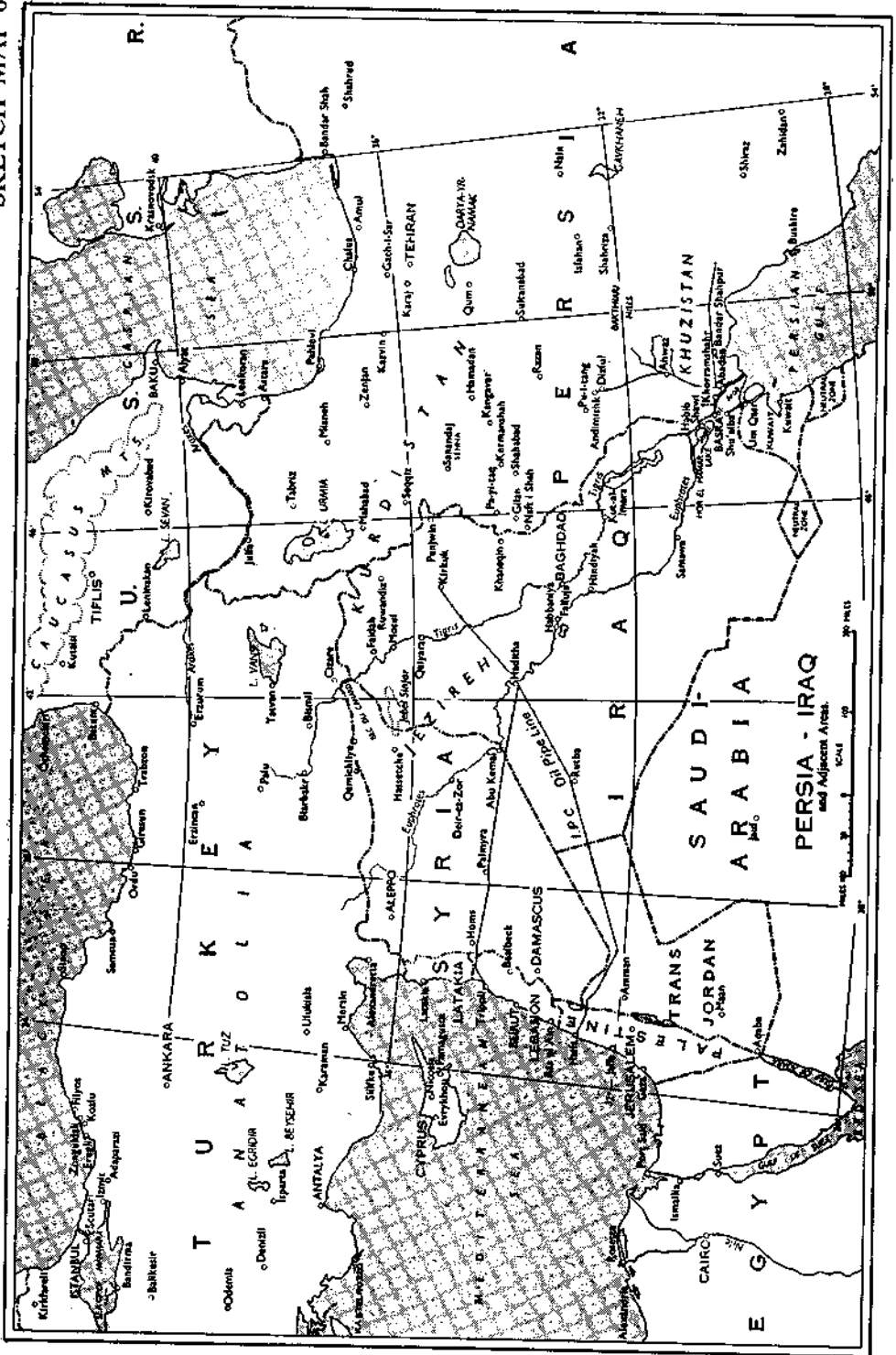
The rights given to Great Britain by the 1930 Treaty included the maintenance and use of certain stations by the R.A.F., one of these being at Habbaniya on the Euphrates, about 45 miles west of Baghdad. Iraq had been granted independence and, apart from the personnel at these R.A.F. stations, there were no British troops in the country. To prevent it from falling under German control the despatch of troops to Iraq was now essential. Fortunately, at that moment a force consisting of one Indian infantry brigade with ancillary troops and one field regiment of artillery was embarking at Karachi for Malaya, and this force was diverted, reaching Basra on 18th April. A small airborne force of infantry landed at Shu'aiba at about the same time. There were numerous incidents in the Basra area, but no organized resistance.

On 7th May, Lieutenant-General E. P. Quinan reached Basra from India and took over command of all British land forces in Iraq. On the same date Force Headquarters and the Headquarters of 10 Indian Division and of a second Indian infantry brigade reached Basra.

The initial directive issued to the Force Commander was as follows:—

- (a) To develop and organize the port of Basra so as to ensure the maintenance of such Allied forces as might be required to operate in the Middle East, including Egypt, Turkey, Iraq and Persia.
- (b) To secure control of all means of communication, including airfields and landing grounds, and to develop these to the extent requisite to enable the port of Basra to function to its fullest capacity.

SKETCH MAP 6



The Force Commander was further instructed to plan a system of defences to protect the Basra Base against attack by armoured forces supported by strong air forces, and to take steps to protect the R.A.F. installations at Habbaniya and Shu'aiba, the lives of British subjects in Baghdad and elsewhere in Iraq, the Kirkuk oilfields, and the pipe-line to Haifa. He was also to ensure the safety of the Anglo-Iranian Oil Company's installations, and its British employees in South West Persia if found necessary.

To carry out these tasks it was intended to increase the force up to three infantry divisions and possibly one armoured division as soon as such troops could be sent from India.

On 30th April, 1941, two of Rashid Ali's infantry brigades from Baghdad, supported by artillery and armoured cars, concentrated round Habbaniya and threatened the R.A.F. camp there. Hostilities broke out on 2nd May, when the camp was shelled, and the situation daily became more critical. One battalion was flown up from Shu'aiba to Habbaniya to reinforce the garrison and, on 6th May, with extensive support from R.A.F. bombers based on Habbaniya itself, and with wholehearted support from the Iraq Levies who were stationed there, the plateau overlooking the camp was cleared, and the Iraqi troops retired to Falluja.

Early in May operational control passed to Middle East Command and a small mechanized force of all arms was despatched from Palestine, arriving at Habbaniya on 18th May. Falluja was occupied and the combined British force advanced on Baghdad. The Iraqis asked for an armistice on 31st May.

20th Indian Infantry Brigade reached Baghdad by overland route from Basra on 12th June, and 21st Indian Infantry Brigade, after sailing up the Tigris to Kut, arrived at Baghdad a week later. By the third week in June the Headquarters of 10 Indian Division was established in Baghdad with the Headquarters of 20th Indian Infantry Brigade in Mosul and one battalion guarding the Kirkuk oilfield. Detachments were sent out to Haditha, Rutba and Falluja to release troops who had come over from Palestine and Trans-Jordan.

Back at Shu'aiba there were the 25th and 17th Indian Infantry Brigades and a medium battery R.A. One battalion was protecting the lines of communication to Baghdad and a fourth Indian infantry brigade was landing at Basra. With the collapse of the Rashid Ali régime, and the improved situation in Iraq, operational control reverted to the Commander-in-Chief, India, on 18th June.

Syria, under Vichy French control, was a source of great potential danger. It was of vital importance that the Germans should not establish airfields or other bases there. Early in June, 1941, Imperial and Free French forces moved from Palestine into Syria, the main thrust being along the coast towards Beirut. The plan included also a concerted thrust from the east, and General Quinan was asked to provide two Indian infantry brigade groups which should move up the Euphrates valley from Iraq into Syria. He was also asked to protect the railway from Iraq to Turkey where it ran through Syrian territory. This involved a redistribution of troops, including the move northwards of fresh formations which were arriving at Basra, so as to ensure the safety of the oil installations, to maintain effective control in Iraq, and to protect the lines of communication while the Syrian operations were in progress.

Advanced Headquarters of 10 Indian Division reached Abou Kemal on 30th June, and operational command of the columns advancing into Syria

passed to the G.O.C. Palestine and Trans-Jordan. Meanwhile a small force was assembled at Mosul for operations in the Bec du Canard to clear the Qamichliye-Hassetché-Ras el Ain area of Vichy troops, to secure the use of the railway to the Turkish frontier, and to attack the northern flank of the French forces in the Jezireh, thus establishing a threat towards Aleppo.

Happily this unfortunate episode in Syria did not last long, and fighting ceased on 12th July. 10 Indian Division (less 20th Indian Infantry Brigade which was back in the Mosul area) remained in Syria until released for subsequent operations in Persia. It reverted to command of the G.O.C. Troops in Iraq on 10th August, 1941.

On 22nd June, while the operations in Syria were still continuing, Germany attacked Russia on a wide front from the Arctic to the Black Sea. During the weeks following, as German armies pushed eastwards into Russia, overran Greece and Crete, and surged towards Egypt, the strategic situation in Iraq and Persia became more and more critical.

The end of hostilities in Syria and the German advance into Russia resulted in a changed situation in Iraq. A revised directive was issued to General Quinan on 29th July, 1941; his new instructions were, broadly speaking, as under:—

- (a) The object was to hold northern Iraq against any enemy attack coming through Turkey and/or Persia, and to develop facilities for the maintenance and employment in Iraq of a force which might amount to 10 divisions and 30 squadrons of the R.A.F.
- (b) Plans were to be prepared for holding the northern frontier of Iraq against hostile advances through Anatolia or Persia. Permanent defences in this area were to be sited so as to deny the main lines of approach by enemy armour into Iraq from Turkey or Persia so as to slow up the advance and force it into unsuitable country. Plans were also to be drawn up for an advance into Turkish or Persian territory so as to seize defiles and to carry out extensive demolitions.
- (c) A force was to be held ready to enable the occupation of Abadan and Naft-i-Shah to be carried out at short notice.
- (d) Basra Base was to be developed to maintain 10 divisions and 30 squadrons R.A.F., and Um Qasr and Koweit were to be developed as subsidiary ports.

It will be noted here that the potential area over which maps and survey might be required for operational and administrative purposes was being greatly expanded.

Mention has been made of the activities of German agents and propaganda in Iraq. They had been no less busy in Persia, where the strategic prize was so valuable. In addition to the oilfields, which were of such essential importance to the Allies operating in the Middle and Far East, Persia formed a land link between East and West, and also the only remaining land link between the Allies and Russia. German fifth-column activities were increasing rapidly and, when the Persian Government refused to accede to Allied representations that they should expel the Axis agents, it was necessary to take action to enforce their expulsion.

A striking force was concentrated on the Persian frontier in the Basra area consisting of:—

- (a) 8 Indian Infantry Division.
 - One mechanized cavalry brigade.
 - Two Indian Armoured Regiments.
 - One Army Co-operation Squadron R.A.F.
- } To occupy the refineries
and oilfield at Abadan.
- (b) Two companies of infantry with naval support to occupy Bandar Shahpur and seize the port and shipping.

Abadan was occupied with little serious opposition and, after occupying Khorramshahr, 18th and 25th Brigade Groups moved on towards Ahwaz early on 28th August.

Further to the north another operation was launched by two Indian armoured brigades on the night of 24th/25th August. Based on Khanaqin, the object was to secure the Naft-i-Shah oilfield and the Pa-yi-taq Pass through which ran the route to Tehran 600 miles distant. The southern of the two columns, after securing the Naft-i-Shah oilfield, pushed on through Gilan to Shahabad on the Kermanshah road. The northern column found the Pa-yi-taq Pass strongly defended, but with air support this was cleared and the two columns joined up at Shahabad and moved on to Zabiri. The planned attack on this position never took place as, on 28th August, a truce was agreed. Kermanshah was occupied by a detachment to secure the refinery and, on 30th August, 2nd and 9th Armoured Brigades entered the town. Contact was made with the Russians who were advancing towards Kermanshah and Hamadan from the north.

On the conclusion of hostilities in Persia the plan for dealing with the situation in that country was as follows:—

- (a) To station troops in Hamadan, Kermanshah, Shahabad, and thence along the lines of communication to Khanaqin.
- (b) To hold Khuzistan with the minimum of forces with headquarters at Ahwaz, and with a detachment at Sultanabad.
- (c) All troops not required in Persia to return to Iraq.

Tribal risings in Persian Kurdistan were dealt with by active patrolling by 9th Armoured Brigade from Senna and Kermanshah, and by 21st Indian Infantry Brigade between Kermanshah and Khanaqin. Khuzistan remained quiet, and most of the troops in that area were withdrawn to Iraq.

As the Persian Government still failed to surrender the Axis nationals British and Russian forces made a simultaneous entry into Tehran on 17th September, 1941.

The Headquarters of 6 Indian Division with 27th Indian Infantry Brigade arrived in Basra on 12th September with orders to relieve 8 and 10 Indian Divisions in Khuzistan and West Persia.

A reduction of forces took place at the end of September when 9th Armoured Brigade from Tehran and 5 Indian Division (less one brigade group) from Kirkuk began to return to the Middle East Command. On 18th October, both the British and Russian troops withdrew from Tehran, the former moving to Sultanabad and Hamadan.

During the winter of 1941-42 work continued on the construction of the fortress area in northern Iraq and in Persia. 6 Indian Division (less one brigade) remained in Persia, the whole of 8 Indian Division and two brigades of 10 Indian Division being employed on the defences in Iraq. One brigade each of 6 and

10 Indian Divisions were on protective duties in the Basra-Shu'aiba Base area, on the lines of communication Basra-Baghdad and Baghdad-Habbaniya-Rutba, in Kirkuk, and guarding the oil pipe-line. The 2nd Indian Armoured Brigade Group concentrated in Northern Iraq in November. In spite of severe winter conditions, good progress was made on the defence areas.

At the end of October, 1941, plans were prepared to receive in Iraq two British divisions, also eight squadrons of aircraft for later despatch to the Caucasus. 50 Division (less one brigade group which remained in the Middle East Command) began to arrive in Iraq in mid-November and concentrated in the Kirkuk area. At this time, when the Germans were driving hard towards Kharkov and into the Crimea, General Quinan received a new directive which gave as his primary task the defence of Iraq and Persia against an enemy advance from Anatolia or the Caucasus. In this he was to act in close co-operation with the Ninth Army in Palestine and Trans-Jordan. He was to be prepared for the following possible operations:—

- (a) Operations in Anatolia in co-operation with troops of Middle East Command and possibly also the Turkish Army.
- (b) Co-operation with the Russian Army in the defence of the Caucasus and North Persia.

To meet these contingencies he was to be prepared to maintain 10 divisions and 30 squadrons R.A.F. in Iraq and up to six divisions in Persia. He was also to develop all road, rail and river communications necessary to maintain these forces, and to ensure also the maximum possible deliveries of supplies and war material to Russia.

Changes in the general strategic situation made it necessary to send 50 Division back to Middle East Command, and its move from Kirkuk began on 12th January, 1942. On the same date operational control in Iraq and Persia once more passed from India to the Middle East Command. The forces under General Quinan's command then became the Tenth Army.

The arrival of part of 4 British Corps in Iraq during January, 1942, gave a temporary increase of strength, but this was short-lived. Part of the Corps was actually diverted to India while *en route* from the United Kingdom; the remainder, after a very short stay in Iraq, was sent on to India before the end of February and became 4 Indian Corps.

In February, 1942, revised instructions were issued from G.H.Q. Middle East to Ninth and Tenth Armies. With the limited force available it did not appear feasible to stop a hostile advance in strength through Persia and Syria, so the intention was to impose the maximum delay in order to gain time for reinforcements to arrive. If the enemy should come down from the north with superior forces, Tenth Army was to fight delaying actions and hold them on a rearward line through Dizful, Pa-yi-taq and Abou Kemal, extending westwards towards Damascus in Ninth Army area. This would mean abandoning extensive defensive positions round Mosul, and concentrating all efforts on strengthening new positions in Central Iraq.

By May, 1942, the German advance in Russia had reached a stage which made possible an enemy attack from the Caucasus through Persia. It was essential to ensure the safety of the airfields, bases, ports, oil supplies and refineries in Iraq and Persia. The plan was that Tenth Army should hold up the enemy as far forward as possible by sending light forces up to the river Araxes so as to cover the airfields in northern Persia. In any event the enemy

was not to be allowed to establish himself south of the general line Pahlevi-Kazvin-Hamadan-Senna-Saqqiz-Ruwandiz Gorge. The Russian High Command would not grant any facilities for Tenth Army to reconnoitre and prepare the ground in North Persia which was in the zone of Russian control, but reconnaissance parties were sent forward and, after establishing good relations with the Russian troops on the spot, collected some of the essential information.

Preparation of defences and communications went on steadily and, at the end of May, 1942, the Germans launched their expected spring offensive in Russia. Simultaneously German forces attacked in Cyrenaica, and the danger grew more immediate. Initial enemy successes in southern Russia during the summer of 1942 made it still more likely that they might occupy the whole of the Caucasus and invade Persia. Rommel's successes in Egypt, which took him to within 50 miles of Alexandria, not only made it impossible for forces to be moved over from the Middle East Command in case of need, but actually led to the withdrawal of troops, equipment and transport from Tenth Army to reinforce Eighth Army in Egypt.

Early in August, 1942, it was estimated that German forces might reach the R. Araxes in North Persia by late October. This caused a speed-up of defence preparations in the area. It was vital that the enemy, after his Caucasus successes, should not be allowed to follow up by striking at the oilfields and installations at the head of the Persian Gulf.

A separate Persia-Iraq Command was formed during September, responsible direct to the War Office, and the Commander, General Sir Maitland Wilson, established his General Headquarters in Baghdad on 15th September. His principal tasks remained, as before, to secure the oilfields and installations in Iraq and Persia from land and air attack, and to ensure the transport of maximum supplies from the Persian Gulf to Russia. The only troops available to meet an invasion consisted of two Indian divisions of two brigades each, and one Indian armoured division, all being under strength and short of transport. In addition Polish personnel who, with 3 Carpathian Division already in the Middle East, were to form the Polish Army, were assembling at Khanakin after evacuation from Russia. To augment this force 5 and 56 British Divisions were diverted to the Command, to be followed by 7th (British) Armoured Brigade from India and 5 Indian and 3 Carpathian Polish Divisions from the Middle East Command.

By the end of September, 1942, owing to Russian resistance at Stalingrad, the likelihood of a winter campaign in North Persia was receding, and the earliest date by which the enemy might reach the R. Araxes was put at 15th November. The available troops for defence were located mainly in the Persian Highlands about Hamadan and Kermanshah, where the winter climate was severe. The force in Persia was therefore reduced to one division with one motor brigade located at Qum and Andimishk, the remainder of the force being moved back to winter training locations on the Iraq railway.

Towards the end of November, the Eighth Army victory at El Alamein, the opening of the Allied offensive in North Africa, and the more favourable course of operations in Russia made a German threat to northern Persia during the winter most unlikely. The earliest date for possible operations was now estimated as about mid-April, 1943.

By this time also the strength of the force in the Command had been increased to two British divisions, one British armoured brigade, three Indian

divisions, one Indian armoured division, and one Polish division. By agreement with the Iraq Government it was arranged that the Iraq Army would deploy two divisions for the defence of the passes leading from the Lake Urmia area into northern Iraq, in co-operation with the Polish Army to whom the defence of that region was entrusted.

Though the eventual possibility of an enemy attack through northern Persia was the dominating consideration, there was always the chance that he might attack through Anatolia in the spring of 1943. Plans for the employment of Tenth Army in northern Iraq were always, therefore, kept under review.

As the months passed the Russian victories and the successful Allied operations in North Africa rendered a general threat to northern Persia in 1943 more and more unlikely. This, combined with Allied pressure and successes in other theatres, led to a reduction of the forces in the Persia-Iraq Command. In January, 1943, 5 (British) Division went to Middle East Command followed by 56 (British) Division in February. The remaining formations were regrouped and located in the Mosul-Kirkuk area, and on 17th February General Sir Henry Maitland Wilson left the Command, being succeeded by Lieutenant-General Sir Henry Pownall. Headquarters Tenth Army returned to India in April, 1943.

The activities of German fifth column agents and the lawlessness of certain Persian tribes made it necessary to undertake armed reconnaissances in addition to the guarding of installations and lines of communication. The possibility of a turn in the tide of war also could not be overlooked, so it was essential to maintain plans and arrangements for sending troops into northern Persia at short notice if so required.

The fortunes of Paiforce improved month by month during 1943. Though the immediate danger of enemy invasion had gone, Iraq and Persia still constituted a most important and valuable strategic geographical centre. Forward planning with a view to serving other theatres both in troops and resources could now be undertaken, and the flow of material aid to Russia was stepped up in face of continuing climatic and other difficulties. The arrival of American transportation units, magnificently equipped and trained, was a most welcome addition for the operation of the railways, ports and road haulage in Persia. Demands for oil reached fantastic heights and, in two years, half a million tons of spirit went through to Russia. The transport of material and supplies to the Russians ended in 1945, by which time 5,000,000 tons had passed through Persia.

The above brief summary of the activities in the Persia-Iraq Command is sufficient to indicate the vast area over which there was a potential requirement for maps, both for operations and for administrative purposes. Some details of the mapping and survey work undertaken are given in the following pages.

SECTION 2. SURVEY ORGANIZATION AND NARRATIVE

The pre-war survey situation in Iraq and Persia

An account of the survey work carried out in Iraq and Persia during the first world war is given in the "Records of the Survey of India, Vol. XX (The War Record 1914-20)," published by the Survey of India in 1925.

The results of those surveys were published in map series on $\frac{1}{4}$ -inch and

$\frac{1}{4}$ -inch scales. The former extended generally from Long. 40° E. eastwards to Afghanistan and India, and as far north as Lat. 40° N. There were various gaps, notably in south-western Iraq. The $\frac{1}{2}$ -inch series covered less extensive areas, but was based for the most part on systematic surveys. It proved to be of considerable value as a basis for revision during 1941–42.

Before the 1914–18 war there were no triangulation systems in either Iraq or Persia. During that war a large amount of triangulation was observed, but it was disjointed in character, and much of the work, especially in Persia, was of inferior quality. It was on this control that much of the mapping work during the 1914–18 war had been based.

A valuable legacy of the first world war was the Iraq Survey Department, which had been established under the technical direction of Survey officers from India. Between the two wars this Department observed a system of primary and secondary triangulation covering the more highly developed parts of Iraq. This was of the utmost value in 1941–43 as a basis for extensions by military surveyors both in Iraq and in Persia. There was also a large amount of minor triangulation in Iraq which had been observed before the primary and secondary networks, but which had not been adjusted to them. A levelling net had also been observed over certain parts of Iraq.

In Persia, although some scattered areas had been covered by triangulation of reasonable quality, they had not been properly connected together or to the Iraq framework.

It was laid down, therefore, during the 1941–42 campaign, that all new triangulation or other forms of control which might be established should be connected directly with the Iraq primary or secondary networks wherever it was possible to do so. All new work was therefore adjusted and computed in these terms except in the valley of the Euphrates near the Syrian frontier, where there was no Iraq geodetic work available till the late summer of 1942. In that area connection was subsequently made between the Iraq triangulation and that of Tenth Army, so that the latter could be adjusted and expressed in the fundamental terms.

Until about 1929, the Iraq Survey Department, whose chief function was the execution of $1/50,000$ and larger scale surveys for land settlement and revenue, kept up the $\frac{1}{4}$ -inch maps and extended the surveys on this scale. After 1929 the work had to be abandoned through shortage of trained personnel.

Other surveys of good quality had been carried out by surveyors of the oil companies, and they were incorporated in the $\frac{1}{4}$ -inch maps between the two wars, but their extent was very limited and, by 1941, both the $\frac{1}{2}$ -inch and $\frac{1}{4}$ -inch maps were much out of date.

The Survey of India was responsible until 1929 for the upkeep of maps to meet operational requirements as far west as Long. 40° E., but in that year the War Office assumed responsibility as far east as Long. 48° E. All originals and other records of the $\frac{1}{2}$ -inch and $\frac{1}{4}$ -inch maps of this area were transferred from India to the War Office in that year.

The Cairo Survey Conference (April, 1940)

In April, 1940, the Director of Survey, Middle East Command, held a Survey conference in Cairo at which Colonel E. O. Wheeler represented the Survey of India. Amongst other items the mapping and survey requirements for Iraq and Persia were discussed, and the following decisions were reached:—

- (a) India was to resume responsibility for surveys, computations and mapping on $\frac{1}{4}$ -inch and larger scales as far west as Long. 40° E., and between Lat. 40° N. and Lat. 28° N. The southern limit of India's area was to extend eastwards along Lat. 28° N. from Long. 40° E. to the shores of the Persian Gulf, which it was to follow eastwards to India.
- (b) Two overlapping Lambert metre grids were to cover Iraq and neighbouring areas, each grid zone forming a belt of about 8° in latitude. The Clarke 1880 spheroid was to be used.
- (c) As the $\frac{1}{4}$ -inch was recognized as being the most important military map, every effort was to be made to bring it up to date from the best material available. It was considered impracticable to bring the $\frac{1}{2}$ -inch map up to date as well as the $\frac{1}{4}$ -inch.
- (d) The production of a new 1/50,000 series covering the developed parts of Iraq and south-western Persia was to be undertaken, largely with the assistance of revenue surveys, and air photographs taken by the Anglo-Iranian Oil Company.

To implement these decisions, action was taken without delay. The Survey of India called for record copies of all $\frac{1}{4}$ -inch sheets to be sent out from the War Office pending the acquisition of the original material. Survey officers from India and the Middle East Command met in Baghdad where they arranged details regarding the proposed grid system, and also investigated the triangulation situation. At the same time a detachment of computers from the geodetic branch of the Survey of India was sent to Baghdad in order to determine and adjust the common stations between the minor work and the Iraq geodetic triangulation, so that the former could be converted to the same terms as the latter.

While the above work was going on in Baghdad, the Indian geodetic branch converted all the existing trig data of Iraq into terms of the two overlapping Lambert grids. At the same time an attempt was made, using the common points and connections established between the various systems by the Baghdad computing detachment, to adjust all the trig data, both in Iraq and in Persia, to bring it into line with the Iraq geodetic triangulation. This was successful in the vicinity of the geodetic network but, near the western frontier of Iraq and in Persia, the poor quality of the original material and other causes made the attempted adjustment in these areas valueless. Trig lists were published.

The computing detachment in Baghdad completed its task only about two weeks before the outbreak of Rashid Ali's revolt, and there were inevitable delays in the receipt of mapping material in India. Despite intensive action by all concerned, both trig data and mapping preparations were far from complete when the small Expeditionary Force sailed for Basra in April, 1941.

Record copies of all available 1/50,000 and larger scale maps were acquired in Baghdad and sent to India. These were much out of date, especially with regard to roads and railways. Arrangements were also made to obtain from the London office of the Anglo-Iranian Oil Company copies of air photographs which they held covering parts of Persia. These were used for revision of the $\frac{1}{4}$ -inch sheets and for the production of the new 1/50,000 series. As soon as the record copies of maps had been received from London, new editions of the $\frac{1}{4}$ -inch sheets were put in hand in India, and work was begun on the 1/50,000 series of Iraq and south-western Persia.

With regard to the new map sheets which were to be produced in India, a decision had to be reached on the problem of what sheet lines were to be adopted. As in other theatres, this provoked argument and counter-argument. The reader is invited to turn to Chapter XII, Section 3, where some comments are made on a similar problem which arose in connection with the maps of Greece.

The pre-war $\frac{1}{4}$ -inch and $\frac{1}{2}$ -inch maps of Iraq and Persia were on graticule sheet lines, bounded by meridians and parallels, and were not, therefore, rectangular in shape. When work was begun in India on the 1/100,000 series the sheets were laid out on a rectangular grid line system in order to conform to the 1/50,000 series which it abutted at the outset and which was likely to be absorbed subsequently.

While production of these two series went ahead in India on a grid sheet-line basis, the Survey Service in Iraq found it necessary to take up the local production of certain 1/100,000 sheets to meet an urgent demand, together with the concurrent revision of the $\frac{1}{4}$ -inch sheets. Every device had to be used to ensure speedy production. The Survey Directorate in Baghdad obtained the original drawings for the $\frac{1}{2}$ -inch maps from the Iraq Survey Department, and the the quickest and easiest procedure was, therefore, to produce the 1/100,000 series as half-degree sheets, conforming to the national $\frac{1}{2}$ -inch maps, and to incorporate field corrections. To use grid-sheet lines as was being done in India would have involved much extra labour. It was decided in Iraq, therefore, to adopt as standard the graticule half-degree lay-out for the new 1/100,000 series and to scrap all the work that had been done in India on grid-sheet lines. Subsequent experience proved this to be wise.

Arrival of Survey unit in Iraq

The first Survey unit to reach Iraq was No. 1 Indian Field Survey Headquarters, under the command of Lieutenant-Colonel J. B. P. Angwin, R.E., who acted as A.D. Survey of the Force until the arrival of a D.D. Survey. This small unit, consisting only of a headquarter section and a general section, including about six surveyors and draughtsmen, landed at Basra on 10th May, 1941, three weeks after the arrival of the Expeditionary Force, taking with it a stock of maps with which to open up a map depot. Its only map-producing equipment was a sun-printing outfit. The strength of the general section was sufficient to deal only with the map stocks which had been brought and, by working at very high pressure, to meet the many miscellaneous survey demands which at once arose.

Almost its first task was to produce a sketch map of the Habib Shawi area, a few miles north of Basra, where there was some trouble with the rebel force. This was compiled from air photographs, some of which had been taken by naval reconnaissance aircraft, and other miscellaneous material; 25 sun-prints were made and issued, a small beginning to what later became a busy and extensive map production agency. There was also a revision of a 1/10,000 sketch map of the Basra-Shu'aiba area, previously compiled in India from air photographs, which was issued with corrections marked up in red ink.

Owing to a case of cholera the arrival of No. 1 Indian Field Survey Company was delayed for some weeks, and the small headquarter unit was left unsupported during this important early period.

Survey Headquarters moves to Baghdad

Large map stocks now began to arrive from India, and a second officer was called for and was flown in as reinforcement. At the outset the claims of the Survey Service to adequate accommodation for map storage lacked recognition amongst the claims of other services, but the need was continually stressed until an old palace on the bank of the Shatt-el-Arab, alongside the unit, was allotted and was converted for use as a map depot.

On 3rd July, after the rebels had been rounded up, A.D. Survey, with about half his unit and a stock of maps, moved to Baghdad with Advanced Force Headquarters. Here again strong pressure was necessary to secure accommodation for map stocks, and to provide technical operating space for the incoming Indian Survey Company. Excellent accommodation was ultimately allotted.

A comprehensive record section was established, whose primary duty was the collection of useful survey and mapping material from every available source. There were the Iraq Survey Department maps which were used for incorporation in the $\frac{1}{4}$ -inch and 1/50,000 series. There was also a lot of material obtainable from the oil companies and other sources which had not previously been used, and whose existence had been unknown in India. Much valuable help in this connection was received from Mr. Booth of the Iraq Survey Department, who placed the material and data in his possession at the disposal of the Survey Service. Of particular value were the originals of the $\frac{1}{2}$ -inch maps which, though out of date, provided a basis for the 1/100,000 series.

Meanwhile the operations in Syria had broken out and there was a demand for sketch maps showing desert routes in the Euphrates Valley near the Syrian border. Some of these had originally been prepared by geologists of the Iraq Petroleum Company, and they were reproduced for use by the columns which moved into Syria from Iraq. These desert routes were not marked on any of the published maps, and the reproduced sketch maps proved of great value in assisting the outflanking movements into Syria.

Surveys in the Basra Base area

Soon after the departure of A.D. Survey to Baghdad in July, survey work was required for the Basra Base defence plan. Much of this area was desert, so desert beacons, consisting of bitumen drums, were placed in position at selected points, and their co-ordinate positions were determined and marked on them in white paint. In the absence of visible detail from which to resect position, fixations were made by car and compass traverse. These beacons were used as reference points to assist in the siting of the defences. Lines of levels were surveyed to ascertain areas of possible flooding from the Hor-el-Hamar lake. An important survey job in connection with the defence scheme was the field revision of 1/50,000 sheets covering the area. Conditions for work were very trying, with shade temperatures often exceeding 120° F.

Early survey work in Persia

When our troops entered Persia in August, 1941, to enforce the demand for the expulsion of German agents, No. 1 Indian Field Survey Company had only just reached Baghdad. It was immediately faced with many urgent tasks, including the reproduction of several $\frac{1}{4}$ -inch sheets from black pulls. On

arrival, this unit had only one double-demy hand-fed rotary press driven from a power lorry. Fortunately, it was possible to arrange for rotary converters to be installed so as to utilize the main Baghdad electricity supply. This one machine was a constant source of anxiety in case it should break down in the middle of an urgent programme and, when No. 4 Indian Field Survey Company's reproduction group arrived at Basra in November, equipped with two double-demy presses in trailers, one of them was immediately sent up to Baghdad.

Ground survey sections and detachments carried out reconnaissance surveys in West Persia for the correction of major communications on the existing maps. The survey parties, which were based on Kermanshah, Sultanabad, and the Dizful-Ahwaz area, worked on a system of rapid reconnaissance revision, corrections being made with reference to local detail, and a definite time-limit was set to the work in each area. In some places the map detail was so inaccurate that fixations could not be made from it. Car and compass traverses were therefore run, being tied in at both ends to fixations which appeared to be reliable. This system, though not precise, effected great improvements to the maps in a reasonably short time, and permitted the publication of interim editions. One interesting method, used probably for the first time under active service conditions, was a rapid traverse by mechanical transport from Qum to Tehran, using the Hunter short-base technique.

On the conclusion of the armistice in Persia, a goodwill mission was sent to Tabriz to meet the Russians in the hope of effecting co-operation in survey tasks. The surveyor who accompanied this mission was able to carry out some useful reconnaissance surveys along the line of march through the Ruwandiz Gorge and up the east side of Lake Urmia.

Arrival of D.D. Survey in Iraq and some problems of organization

At the end of October, 1941, Colonel G. F. Heaney reached Baghdad from India, and assumed duty as D.D. Survey of the British Forces in Iraq. By December, the survey units available comprised four small headquarter units and three Indian Field Survey Companies. Two of these latter (Nos. 1 and 4) had reproduction groups. No. 2 Indian Field Survey Company had no reproduction group. The organization of these units was briefly as under:—

An Indian Field Survey Headquarters was commanded by a Colonel or a Lieutenant-Colonel, depending on whether his appointment was that of a D.D. Survey or an A.D. Survey. It consisted of a headquarter section of clerical staff and orderlies, and a general section for technical work. Other sections, such as drawing, map supply or survey park sections might be added as found necessary.

An Indian Field Survey Company consisted of a headquarter section, a general section, two ground survey sections, an air survey section and, where desirable, a reproduction group.

It was quite clear that to meet the dated requirements of the General Staff, the survey resources for ground and air survey and for map production would be fully strained. All air survey, drawing and map reproduction was therefore concentrated in Baghdad under No. 1 Indian Field Survey Company. Only the ground survey sections were left with the other units, and those of No. 1

Company were attached to Nos. 2 and 4 Companies respectively. No. 2 Company began work in the field during November based on Mosul, and No. 4 Company, based on Kirkuk, started three weeks later.

With the arrival of D.D. Survey and his headquarter unit, and two more A.D.s Survey each with his headquarter unit, defects in the organization became apparent. D.D. Survey had been rightly regarded as being on the staff of Force Headquarters, but he was the only officer on the establishment of his headquarter unit and it was clear that he would require technical officer assistance. Moreover, his own unit had to be attached to one of the Indian Field Survey Companies for administration. The status of the lieutenant-colonels commanding the other three headquarter units was also ill-defined and unsatisfactory. They did not fit into the picture either as staff officers (A.D.s Survey) or as regimental officers. With survey control centralized at Force (or Army) Headquarters it was undesirable that they should be assigned to either corps or divisions and, even assuming that there had been sufficient work at Army H.Q. to justify the absorption of all these senior officers, it was obvious that the clerical and technical personnel which would accompany them with the headquarter units was far in excess of what was required.

For some months after their arrival in the theatre the headquarter units remained near their respective field survey companies, and the A.D.s Survey formed superfluous links between the centralized survey control at Force H.Q. and the survey companies themselves. There was a tendency for them to usurp many of the functions of the unit commanders with regard to field and other technical work, and there was an unnecessary duplication of correspondence and records. Early in 1942 two of the A.D.s Survey were recalled to India, one of them being replaced by an officer from the Middle East Command. The headquarter unit belonging to D.D. Survey and No. 1 Field Survey Headquarters were amalgamated to form a Survey Directorate to which the A.D. Survey of No. 2 Field Survey Headquarters was attached, his headquarter and general sections being left in abeyance. No. 4 Field Survey Headquarters was also left in abeyance, the personnel being attached to other units for work.

Although these changes improved the balance of the whole survey organization, there were still many defects to be remedied. D.D. Survey and A.D. Survey, though forming part of the Survey Directorate staff, were still recognized as being the commanding officers of their headquarter units, which entailed much administrative work for which they had no time, and for which their senior rank made them unsuitable. Nos. 2 and 4 Indian Field Survey Headquarters still existed on paper, a fact which necessitated a lot of returns and records. Finally, one of the difficulties in the way of a proper reorganization was that these units were on Indian establishments, and any amendments required the sanction of G.H.Q. India. It was not always certain that this sanction would be granted.

The winter and spring of 1941-42

With the possibility of a German attack through Turkey in the early spring of 1942, there arose an urgent demand from the General Staff for the following maps to be ready by 1st February:—

- (a) Revised editions of all $\frac{1}{4}$ -inch maps of Iraq extending northwards from about the latitude of Baghdad, and westwards into Syria as far as Long. 40° E. The publication of a 1/100,000 series was also required,

and all these maps were to be revised for communications and other principal detail.

- (b) 1/25,000 maps of defence areas near Faidah, Mosul, Qaiyara, Pa-yi-taq, Hindiya, Falluja and Majura.

In addition to the above, there was a constant demand from the engineer and administrative services for improved maps of Persia and large scale maps of base areas, and miscellaneous requirements from Intelligence and other branches for sketch maps and other forms of printing.

By mid-December, however, the threat to Turkey was lessened by the Russian resistance, and the completion date for the above programme was extended to 1st April, 1942. By March the threat had receded still further.

The introduction of the 1/100,000 series was a policy decision of some interest. As has already been mentioned, there were, over northern Iraq and western Persia, some $\frac{1}{2}$ -inch maps originating from first-war and between-wars surveys, which were much out of date. In southern Iraq there was a 1/50,000 series based on between-wars surveys by the Iraq Survey Department and the oil companies which, though reasonably modern, were in need of much revision. As these series of maps covered areas which were potentially threatened by a German advance through southern Russia, they varied in tactical importance as the threat developed or receded. After consideration of the material available, and the resources for handling it, the decision was taken, with the concurrence of the Middle East Command, to concentrate on a single homogeneous series on 1/100,000 scale, using the best material available in each locality, whether $\frac{1}{2}$ -inch or 1/50,000. The maximum possible revision was to be incorporated on whatever basic material was most suitable, and the work was to proceed on as firm a basis of priorities as the changing threat permitted.

To provide control for these surveys, triangulations were observed in the Faidah, Mosul, Qaiyara and Majura areas. The R.A. survey units also required trig data in connection with the defence schemes. The fixation of this control was completed in November and December, 1941.

At the request of D. Survey, Middle East, a connection was observed between the Iraq geodetic triangulation and the Syrian primary network to the west of the Jebel Sinjar range. The two systems had been based on separate origins and, though close agreement was found in azimuth and scale, there was a considerable discrepancy in position between the two.

On the occasion of a reconnaissance by an armoured brigade westwards to the Syrian frontier, a survey detachment carried trig control by the Hunter short-base traverse method along the line of march, eventually closing on the starting station. This method, which had been used in Persia a short time earlier, was now tested at high speed in desert country. Subsequent experience confirmed that even under unfavourable climatic conditions it was possible for two observers, assisted by a small party, to progress at a rate of about 25 miles a day over a considerable period, maintaining an accuracy of about 1 in 6,000. This particular traverse, after a distance of about 200 miles, closed with an error of ± 50 metres.

For the new $\frac{1}{2}$ -inch maps of the desert areas west of the Tigris an extensive programme of Hunter short-base traverses was undertaken, and this control formed the basis of all new survey work on $\frac{1}{2}$ -inch scale in that area.

Field mapping was in full swing over a wide area by the first week in December, 1941. It extended from Deir-ez-Zor in Syria to the Pa-yi-taq Pass

east of Khanaqin, and from Hindiya (50 miles south of Baghdad) to the Turkish frontier north of Mosul. This frontier was rigidly closed and, though the maps immediately beyond it were in urgent need of revision, it was never possible for surveyors to have access to the ground. The field-work included the revision of all the $\frac{1}{4}$ -inch maps within that area, and surveys for 1/25,000 maps of selected defence zones.

Mechanical transport was largely used by the survey parties. Before its use for desert surveys in about 1929 there were enormous areas in Iraq which were barred to the surveyor who was working on foot or with animal transport only. Under such conditions he had always to remain within close reach of a water supply, and was in danger from nomadic tribes if he ventured too far without escort. During the 1914-18 war, armies had seldom operated far away from the rivers, but, under more modern conditions of almost complete mechanization, all this was changed. The desert became the potential manœuvre ground for opposing forces, and an intimate knowledge of the desert topography was of great importance to the General Staff. The effect of all this on the Survey Service was, of course, very material, and large expanses of desert could no longer be regarded as of no military importance and left unsurveyed.

A surveyor, equipped with two lorries and enough food for a month, could now go practically anywhere and without danger from the local tribesmen, provided he took reasonable precautions and kept his section officer informed of his proposed camp sites. The use of motor transport naturally resulted in a great speed-up of work and, with its use, an individual output of over 500 square miles each month of $\frac{1}{4}$ -inch survey could be expected. Very careful organization of vehicle maintenance was, however, essential.

The very severe winter of 1941-42 was a very trying one both for the surveyors themselves and for their transport. The casualties amongst vehicles of the force as a whole, owing to frozen cylinder blocks, were very high. Even in Baghdad early in December the thermometer registered 13° F. of frost. In Mosul, zero temperatures were recorded, and in western Persia, where triangulation parties were struggling against blizzards and deep snow, conditions were arctic. In January, the weather became even worse, and was succeeded by a period of mud conditions, during which time movement across the desert, except along metalled roads, was impossible.

The units available for field-work were Nos. 1, 2 and 4 Indian Field Survey Companies. No. 1 Company had two ground survey sections engaged on reconnaissance revision in Persia and eastern Iraq early in November, but they were soon transferred to the technical control of Nos. 2 and 4 Companies. Thereafter No. 1 Company was employed almost exclusively on air survey, fair drawing, and map reproduction, and had no regular programme of field-work though, on occasions, small detachments were sent out for minor jobs, generally in the nature of 1/25,000 surveys of limited areas.

The first task allotted to No. 2 Indian Field Survey Company for revision and mapping was in the zone lying to the west of Long. 44°, and included the defence positions of Faidah, Mosul, Qaiyara, Falluja and Majura and other places where there was a requirement for 1/25,000 maps. Where large scale surveys already existed, such as at Falluja, they were revised, but most of the new 1/25,000 maps were made from air photographs for which ground control, height fixation, and other supplementary ground-work were required.

The main programme was concerned with the revision of the $\frac{1}{4}$ -inch maps of northern Iraq, and the field surveys necessary for the production of the new

1/100,000 series areas where $\frac{1}{4}$ -inch maps were available. The first rapid reconnaissance revision was done on the 1/100,000 scale, where $\frac{1}{4}$ -inch maps existed, otherwise on the $\frac{1}{2}$ -inch scale. On some sheets, where there was little reliable detail on which to base the revision, these rapid surveys were regarded as only a "stop gap" pending the completion of proper surveys based on a trig control.

By the middle of May, 1942, when No. 2 Indian Field Survey Company began its programme of plane-table surveys in Persia, it had completed the following work:—

- (a) Reconnaissance revision covering 15 $\frac{1}{4}$ -inch sheets.
- (b) More rigorous revision, almost equivalent to completely new survey, covering 16 $\frac{1}{4}$ -inch sheets.
- (c) Large scale surveys for the revision of 80 square miles on 1/20,000 scale covering the approaches to the important bridge over the Euphrates at Falluja.
- (d) Supplementary survey and heighting for 1/25,000 air surveys covering an area of nearly 1,300 square miles.
- (e) Various minor large scale surveys of airfields, and for administrative and other purposes.

To No. 4 Indian Field Survey Company was allocated the responsibility for field surveys east of Long. 44°, which included Persia. The work of first importance was the provision of trig control for the field mapping which was to follow in the spring of 1942.

As the existing triangulation in Persia was of poor quality and unsuitable as a basis for extension, it was imperative that all survey work should be based on fresh control connected rigidly to the Iraq geodetic net. To enable plane table surveys to begin early in 1942, it was also essential that a new triangulation, which would serve as a basis for further extensions, should be completed in western Persia during the winter of 1941–42.

Three chains were projected, each of them to be based on the Iraq secondary net in the vicinity of the frontier as under:—

- (a) Via the Ruwandiz Gorge and Mahabad, to connect up with work of the 1914–18 war in the valley between Mianeh and Zenjan.
- (b) From Penjwin, east of Kirkuk, across Persian Kurdistan to Sanandaj and thence to Hamadan.
- (c) From Khanaqin *via* the Pa-yi-taq defile to Kermanshah and Hamadan, and thence northwards to link up with the first chain in the vicinity of Zenjan.

Unfortunately, the refusal of the Russians to allow entry into their zone in north-western Persia ruled out the proposal to link up with the 1914–18 work between Mianeh and Zenjan. In addition, the very severe winter conditions made it impossible to carry the triangulation across the mountains in the Ruwandiz Gorge area, and the political situation in Persian Kurdistan did not permit the work to be extended across the border. The first project, therefore, had to be abandoned for the time being. A start was made on the second chain, but here again climatic and political conditions prevented it from being extended across the frontier during the winter.

The abandonment of the first two projects rendered it essential to complete the third before the spring. In spite of most severe cold, with temperatures

falling sometimes to minus 20° F., and facing blizzards and deep snow, the survey parties got through to Kermanshah in January, and by March had reached Hamadan. A subsequent link-up with the Iraq geodetic work *via* Sanandaj and Penjwin proved the triangulation to be of high standard, and this chain formed the backbone of all further triangulation in western Persia during 1942. Meanwhile every opportunity was taken to connect up with the disjointed triangulations carried out during the 1914–18 war, and with those of the Turkish-Persian boundary commission of 1913–14, and thus enable a re-computation and adjustment of some of this old work to be done.

While the Khanaqin–Hamadan chain was being observed, a supplementary triangulation was undertaken to control an air survey of the Pa-yi-taq area. The weather was appalling, but the task was completed, and it was followed by a strengthening of the connection between the Khanaqin–Hamadan chain and the Iraq secondary work near Khanaqin. Observations were also started in south-western Persia to control an air survey of the Pul-i-tang area and to connect up with the Khanaqin–Hamadan chain. The need for speed, the use of mechanical transport, and the topography of the country influenced the methods employed. The existence of roads which followed the centres of valleys favoured the establishment of pairs of stations some five or six miles apart on either side of the valleys. The triangulation chains followed generally the line of the roads, and consisted, where possible, of a series of quadrilaterals about 15 to 20 miles long and about 5 to 6 miles wide. Under favourable conditions a good observer could complete two stations each day from a central camp on the road.

Scale checks by Hunter short-base observations applied at intervals, and azimuth checks measured either by morning and evening sun observations or from Polaris, avoided the possibility of gross errors.

Two sections of No. 4 Indian Field Survey Company had begun reconnaissance revision surveys in north-eastern Iraq in early December, one of these sections being diverted to No. 1 Company during January to assist in the heavy drawing programme. By the end of February, 1942, seven $\frac{1}{4}$ -inch sheets up to the Turkish-Persian frontier had been completed. Here again the work was done on 1/100,000 scale except for a few areas where 1/50,000 maps, compiled in India, were used as a basis for revision.

During December, 1941, and January, 1942, five plane-table surveyors of No. 4 Company completed the field-work for a sketch map survey of 115 square miles on 1/10,000 scale of the Ahwaz area where an important base was being developed. The field-work took 15 days, and was amplified by air photographs of parts of the town. The detail survey was based on graphical triangulation starting from two trig points, and was checked by a 5,000-metre measured base. On completion of this task the section carried out a similar-type survey on 1/5,000 scale in the Andimishk area, and a 1/25,000 sketch survey of part of the Pul-i-tang defence position.

Another section of No. 4 Company took over from No. 1 Company the responsibility for the compilation of a large scale survey of 380 square miles around Hindiya. Most of the area was already covered by good, though out-of-date 1/10,000 maps, so the revision work was done on blue-prints of these for final publication at 1/25,000.

By May, 1942, No. 4 Indian Field Survey Company had completed the following programme of field-work:—

- (a) Reconnaissance revision surveys on $\frac{1}{4}$ -inch, 1/100,000 or 1/50,000 scale covering 23 $\frac{1}{4}$ -inch sheets.
- (b) Sketch survey at Ahwaz at 1/10,000 covering 115 square miles.
- (c) Large scale survey at Hindiya on 1/10,000 scale covering 380 square miles.

At the end of January, 1942, it had been decided to take up the reconnaissance revision of the maps of southern Iraq and south-western Persia, which were much out of date and which were a source of irritation and embarrassment to users in the line of communication and base areas. This task had no high operational priority, but was obviously of importance and therefore, during a pause of two months between the completion of work in northern Iraq and the start of plane-table surveys in western Persia, the work was undertaken. The reconnaissance revisions were carried out on the largest scale maps available which, over a large part of the area, consisted of the 1/50,000 series which had been compiled in India in 1941 from air photographs and other material obtained from the Iraq Survey Department.

The non-co-operative attitude of the Russians interfered considerably with the programme in northern Persia. They were occupying a zone which lay north of a line running from the tripartite junction between Turkey, Persia and Iraq across to the south end of the Caspian Sea. All attempts on the part of British or Indian survey parties to enter this zone were stopped by the Russians.

There were difficulties also as a result of unrest amongst the Persian tribesmen in Kurdistan. It was desired to observe a triangulation to link up some work already completed round Hamadan with the Iraq geodetic system and, as the movement of troops into Kurdistan from the east was forbidden in order to avoid incidents, it was decided that survey parties should enter the area from the west across the Iraq frontier. After protracted negotiations this was arranged, and the surveyors found the Kurds both friendly and helpful. In the south, where the tribesmen of the Lur and Bakhtiari Hills were notorious for looting and raiding, arrangements were made for Persian gendarmerie escorts to accompany the survey parties. On the whole the Persian villagers were found to be friendly.

The late spring and summer of 1942

The potential threat of a German offensive through the Caucasus into north-western Persia following the resumption of their offensive in southern Russia introduced, during April, 1942, a fresh General Staff requirement affecting the survey programme. The new programme covered an area extending from the Bakhtiari Hills in the south to Lat. 36° N., and from the Iraq frontier in the west to Long. 50° E. This was enlarged during May so as to extend as far north as Lat. 37° N., with reconnaissance surveys even further to the north as far as the Russian frontier, if the Russians could be induced to permit access into their zone.

In addition, 1/25,000 maps were required of several defence positions along a general line running through Razan Pass-Kangavar-Sanandaj, and all the maps covering this whole area were to be ready by 31st August. This was later extended to 15th September as a result of a postponement of the German offensive in southern Russia.

No. 2 Indian Field Survey Company maintained its headquarters at Kirkuk

until the end of June, when it moved to Sanandaj, remaining there till the middle of August. When it was clear that permission for surveyors to enter the Russian zone would not be granted No. 2 Company was moved to Zagheh, just west of the Razan Pass, in order to start work on new 1/100,000 and 1/50,000 surveys.

No. 4 Indian Field Survey Company moved from Baghdad to Kermanshah in April, and to Hamadan in May, remaining there until the early part of 1943.

The reproduction groups of Nos. 1 and 4 Indian Field Survey Companies, with their heavy printing equipment, were more or less immobile, and had been grouped together in Baghdad, in the form of a semi-permanent base installation. With the possibility of operations on the northern Iraq frontier in the spring of 1942, the reproduction group of No. 4 Company was made mobile and was attached to No. 2 Company, which was operating in northern Iraq. When, however, the enemy threat through Turkey receded, and survey work was concentrated in Persia, this mobile reproduction group rejoined its own unit. Leaving Baghdad by road on 1st June, it arrived at Hamadan two days later, successfully negotiating the steep climb over the 7,500-foot Shah Pass with its heavy printing trailers.

The plan for possible operations in western Persia in the event of a German drive through the Caucasus during the autumn of 1942 involved such an increase in the size of the force that it was clear that survey resources must be increased. There was an urgent need also for further air survey photography. A photographic survey flight of 60 Squadron S.A.A.F. had done valuable work in Iraq earlier in the campaign and now, as No. 1434 Flight R.A.F., it was transferred from Syria for another tour of duty in the Iraq-Persia theatre. Three Indian Ground Survey Sections were sent on temporary loan from India in June. The headquarters of the Mobile Echelon and three topographical sections of 512 Field Survey Company R.E. arrived from Egypt in July and, in the same month, 19 Field Survey Company R.E., consisting of headquarters, reproduction section, and three drawing sections, also arrived from Cairo, their printing equipment arriving later by sea. It had been obvious that the resources of Nos. 1 and 4 Indian Field Survey Companies would not be sufficient to meet the map reproduction and printing demands for the enlarged force, so the additional strength provided by the arrival of 19 Field Survey Company was very welcome.

Communication difficulties with Persia ruled out Baghdad, or indeed anywhere in Iraq except possibly Basra or Shu'aiba, as a location for 19 Field Survey Company. It was essential that the place selected should be near the base for security reasons and, after much consideration, Ahwaz was chosen, where a suitable building existed for the installation of a base printing unit. The presses were in operation by about the end of November and their early programme included the printing of reserve stocks of $\frac{1}{4}$ -inch and 1/100,000 maps. As an insurance against the possible total loss of paper stocks in Cairo, at a time when German forces were driving deep into Egypt from Libya, large quantities of paper were sent across from Cairo with 19 Field Survey Company.

Strategically and technically Ahwaz was satisfactory, though it was difficult to exercise close control over the work there from the Survey Directorate at Baghdad. Also, the climate was very trying in the hot weather, when the temperature rose to 132° F. in the shade. Living quarters were in tents, there was little in the way of recreational facilities, and a high rate of sickness resulted. The heat naturally caused technical difficulties in printing but, to the credit of

all concerned, the work went on well, with high output and a cheerful overcoming of all difficulties.

During the first few months in Iraq, all maps had been printed in black and brown only. There were complaints that the detail was not clear so red was introduced for roads, tracks and footpaths, and also for the grid letters and numbers on maps of 1/100,000 scale and smaller. In the case of larger scales this was not done as it was considered that the map detail was not usually congested, and that as they were usually produced in a hurry to meet an urgent demand, time would not be available for the extra printing. For the same reason requests for showing water features in blue could not be complied with.

As a first measure, roads were classified according to width and were given numbers referring to their vehicle-carrying capacity. Later on the necessity was stressed for distinguishing between concrete, tarmac, and other forms of metalled surface, as such differentiation was important for movement planning. Symbols were therefore introduced to indicate roads as under:—

Concrete or tarmac	Solid line
Metalled, gravel or other surface	Long heavy pecks
Natural surface	Double lines of short pecks

A series of "Going" maps was published early in 1942 covering much of Iraq and parts of western Persia. The "Going" information was overprinted in colour on a specially designed 1/500,000 map which was printed in black, red and grey. The overprint colours followed the style adopted as standard in the Middle East, viz.:—

Good going	Red
Fair going	Yellow
Difficult going	Green
Impassable	Blue

The reconnaissance for these maps was carried out very hurriedly, using $\frac{1}{4}$ -inch sheets. The basic 1/500,000 maps were compiled before the results of the new surveys were available, and contained little topographical detail.

The survey programme in Persia in the spring of 1942 differed considerably from that in Iraq six months previously. The Russian recovery during the winter made it probable that there would be no immediate danger to northern Persia until some months after a resumption of the German offensive on the southern Russian front. This afforded time for a considerable mapping and survey programme before that threat should become imminent. Many of the maps had already been revised for communications and major changes during the autumn, and the spring programme comprised a large amount of original surveys based on the new triangulation control which had just been established.

In many ways western Persia was ideal country for the small scale topographical surveyor. It consisted in the main of a large plateau, with an average altitude for the valleys of about 4,000 feet above sea level. Where they were not bare rock, the lower slopes of the hills were undulating grass slopes, trees being scarce. Water was plentiful, and the "going" in the valleys was good, enabling vehicles to move across country with a fair amount of freedom. Though malarious in the valleys after May, there was very little sickness amongst the field parties. Below 6,000 feet it was hot during July, August and September. The rainy season extended from October to March, with little rain during the

rest of the year. Frequent high winds caused a lot of dust, which seriously interfered with the work of the surveyors, especially those engaged on triangulation during the early summer.

Observers of No. 4 Indian Field Survey Company extended the triangulation in western Persia as fast as possible during the spring of 1942, computing the results as they went along, and the western plateau was soon covered. The work of the plane-tablers was controlled by a rigid time-table, to ensure the completion of the fair drawing, reproduction and printing of all sheets by 31st August. The arrangement of work was such as to provide surveys on 1/100,000 scale of those areas only for which maps on this scale were considered necessary by the General Staff. These same surveys were used as material for compiling the new $\frac{1}{4}$ -inch editions. The remainder of the area was surveyed on $\frac{1}{4}$ -inch scale. There was no time to await the completion of the 1/25,000 surveys of the selected defence positions so as to incorporate them in the smaller scale maps.

The average rate of progress originally laid down was 150 square miles each surveyor a month for new 1/100,000 work, and 500 square miles for the $\frac{1}{4}$ -inch surveys. In order to work up a head of work for the rigidly-planned reproduction programme a higher output had to be encouraged and enforced in the case of some of the earlier sheets, at the expense of some accuracy and loss of detail in the higher hill country. Once the surveyors had become accustomed to the work, the higher rate of production was comfortably maintained, and it was considered that it might even have been increased without loss of material accuracy. It was remarkable the way in which these hurried surveys stood up to check against large scale ground and air surveys of the same areas which were done later when time permitted. It was, indeed, a highly creditable performance on the part of the Indian surveyors who carried through this project under great pressure, and it was not surprising that, at the end of the summer, most of them were showing signs of exhaustion.

During June, 1942, when it seemed that the expected German offensive in southern Russia had been postponed, the completion date for the survey programme was extended to 15th September. It was then possible to take up a larger area on both 1/100,000 and $\frac{1}{4}$ -inch scales. All this field-work was completed and was passed for drawing and publication before the end of July.

For the selected defence positions which were sited to guard mountain passes in northern Persia against a possible German offensive from the north, 1/25,000 maps were required. At first these were prepared by making straight enlargements from existing $\frac{1}{4}$ -inch or 1/100,000 maps, on which the defence detail was marked as indicated by the formations on the ground. This method was, however, found to give such inaccurate results that it was necessary in most cases to carry out rapid 1/25,000 sketch surveys. Good topographers engaged on this work produced some outstanding results in speed and quality, and the resulting maps proved to be entirely satisfactory for the purpose required. The plane-table field sheets were mosaicked, reproduced, and printed in black and brown. It was arranged that these defence positions should be covered also by air photography so that deliberate air survey maps could replace the sketch maps at a later stage.

No. 1434 Flight R.A.F. had reached Tehran early in July and, by the end of August, had covered with vertical photography about 2,400 square miles of the defence areas. Other zones of possible operational importance were photographed, bringing the total up to about 5,000 square miles. By early

September the weather had deteriorated to such an extent that little further survey photography was possible.

The rate of supply of air photographs was, however, not quick enough to guarantee the completion of the deliberate air survey maps at 1/25,000 scale covering the whole of the defence areas, including both the defence and target zones, by the end of September. It was therefore agreed that only those portions in each of the positions concerned which contained the defences themselves should be covered in the first place by deliberate 1/25,000 air survey maps, and that the whole of each area, including the target zones, should first be mapped by 1/50,000 ground surveys. These latter surveys were completed during September by sections of Nos. 2 and 4 Indian Field Survey Companies, and comprised five sheets at Razan, one at Askaran, and seven at Kangavar.

The whole of the air survey strength of the Indian Field Survey Companies was assembled in Hamadan at the end of July, 1942, under the command of No. 4 Company. It was reinforced in September by a drawing section from 19 Field Survey Company R.E., and together they formed an Air Survey Group. By the middle of March, 1943, this group had completed about 30 sheets on 1/25,000 scale of the defence areas in north-western Persia, besides other work on 1/50,000 scale.

Formation of the Persia-Iraq Command, and the autumn and winter survey programme, 1942-43

When the Persia-Iraq Command was formed in September, 1942, Colonel K. M. Papworth was appointed D.D. Survey. Pending his arrival, Colonel Heaney left Tenth Army for Baghdad, Lieutenant-Colonel L. de V. Carey officiating as D.D. Survey, Tenth Army, in his absence. An establishment for a G.H.Q. Survey Directorate had been sanctioned, and personnel for this were obtained from survey units in the Command. Office procedure was organized to deal with survey control, map reproduction, survey records, and all the other incidentals appropriate to the new Command organization. Colonel Papworth assumed duty on 24th November, Colonel Heaney returning to Tenth Army, where the Survey Directorate was reduced in size and reorganized on lines more suited to a mobile army headquarters.

Although Paiforce was now a separate Command, responsibility for the general control of survey policy and the posting of senior survey officers remained with the Director of Survey, Middle East.

The G.H.Q. Survey Directorate now took over control of 19 Field Survey Company at Ahwaz and No. 1 Indian Field Survey Company in Baghdad. This left Nos. 2 and 4 Indian Field Survey Companies under Tenth Army command.

A new map distribution unit was formed (No. 10 Indian Field Survey H.Q.) for operational map distribution in Tenth Army. It was organized with personnel and transport which would provide sub-sections to work with corps and divisions, as was the practice in the Middle East Command. As the personnel for this unit had been hitherto running map depots at Baghdad and other places, it was necessary to replace them by a distribution unit which would work under G.H.Q. One Palestinian map depot was therefore obtained from Middle East which, on arrival, was posted to Ahwaz.

The Mobile Echelon of 512 Field Survey Company R.E. had returned to Middle East at the end of October, 1942, and, early in November, the two

topographical sections of 19 Field Survey Company R.E., which had not accompanied that unit when it came to Iraq in July, crossed the desert from Egypt and joined up with their parent unit at Ahwaz.

By mid-September, 1942, all the ground surveys required to complete the programme laid down by the General Staff had been finished. The period in the field had been a strenuous one, with its effect on men and vehicles. Sections were therefore brought into their headquarters as they completed their tasks, and they were given an opportunity for rest and refitting and some military training.

In the middle of October, a fresh programme of field-work was started. This extended the recent surveys eastwards in the direction of Tehran and Nain. Work was on the $\frac{1}{4}$ -inch scale except for a small area west of Tehran, where $\frac{1}{2}$ -inch maps were available. These sheets were revised at 1/100,000 scale. No. 2 Indian Field Survey Company worked north of Lat. 35°, and No. 4 Company to the south of it. In spite of bad weather during November, the programme was finished by the end of December.

Meanwhile, during the autumn pause in ground mapping, the triangulation had been extended north-east and eastwards to provide control for the further mapping referred to above. Under most difficult weather conditions two triangulation chains were carried over the mountain range north of Tehran, reaching the Caspian Sea near Amul and Chalus. But as the coast-line was under Russian control the two chains could not be connected. Another triangulation extension was observed extending from Isfahan southwards to Shahriza, and eastwards to Nain on the road to India.

It had long been desired to connect the new triangulation in Persia with the Iraq geodetic framework. An attempt to do this in October had to be abandoned owing to floods and political difficulties, but later on, 19 Field Survey Company R.E. undertook the task, completing it in February, 1943.

With all this field-mapping there was, of course, a vast quantity of drawing to be undertaken back at headquarters. During the winter of 1942-43 survey units were employed on the following:—

- (a) Fair drawing of the recently completed work in the field.
- (b) Fair drawing of $\frac{1}{4}$ -inch sheets of southern Iraq which had been revised during the previous spring.
- (c) Compilation and fair drawing of $\frac{1}{4}$ -inch sheets of north-western Persia, incorporating some Russian 1/200,000 material which had been obtained on an exchange basis.
- (d) The air surveys of defence positions in Persia.
- (e) The redrawing of $\frac{1}{4}$ -inch maps of the Caucasus.

Statistics were kept by the Survey Directorate for all the fair drawing undertaken, and some representative figures of output may be of interest and are given below. These represent work on average sheets with a good standard of drawing. The sheets formed part of the mapping programme for Persia, and were drawn by No. 1 Indian Field Survey Company in the summer of 1942 during the heart of the hot season. Draughtsmen worked for eight hours a day for six days a week. In some cases double shifts were adopted of about $7\frac{1}{2}$ hours a shift.

Fair drawing was normally on the scale of the published map. Separate originals were drawn for outline, contours, and roads. Grid letters and figures were included on the road drawings, but the grid lines were cut in on the

negatives. The fair drawings were mounted on thin sheets of metal to prevent distortion, and place names were typed separately and stuck on with "Durofix." The times shown below include that taken to stick on the names. The operation of drawing the three fair models and typing the names were thus carried out concurrently. The figures given represent an average number of man-days per sheet over six sheets for each of the scales represented:—

Scale	Number of man-days				
	Names	Outline drawing	Contours	Roads	Total
$\frac{1}{4}$ -inch 1/100,000	13	18	15	10	56
	4	15	19	7	45

The practice of mosaicking the original field documents as they were received from the field-parties became universal. The field-sheets were cut up and mosaicked so as to form complete sheets, the pieces sometimes being laid down on to a projection of the sheet on glass to ensure correct positioning. One of the principal reasons for this method was to be able to make a quick reproduction of the results of the new survey without any delay. In such cases the mosaic was copied as it stood and printed in brown, with the principal names hand-drawn, and with the main communications and streams overprinted in black. Provided the quality of the field-sheets was good it was thus possible to publish an advanced edition of a sheet within a few days of receipt of the field documents. This type of advanced edition was particularly valuable for the preliminary 1/25,000 sketch maps of the defence positions.

In the case of the 1/100,000 series a usual method was to enlarge the $\frac{1}{4}$ -inch originals up to the scale of production. The corrections resulting from the reconnaissance revision were made up in the form of addition and deletion models which were handed, as they stood, to the publication section. The deletions were duffed out on the negatives, and bromide prints then made on which the additions were drawn in black. The bromides were then reproduced.

The rapid sketch maps that were prepared of the defence positions and certain base areas were naturally not up to the standard of accuracy which would be required for artillery purposes. It was, therefore, necessary to mark them clearly in such a way that they would not be used for this purpose. A note such as "Sketch survey only. Not for artillery use" was printed boldly in the margin.

The final phase (1943)

The relief of Stalingrad by the Russians in November, 1942, and the beginning of the Russian offensive westwards altered the whole political and strategical picture in Persia and Iraq.

By the end of January, 1943, all the Axis forces had been driven by Eighth Army out of Libya into Tunisia, and the last stages of the operations in North Africa were begun, which ended in the final defeat of all enemy forces in Africa during May. The threat to the Middle East was over, and in March this resulted in a reorganization of the military Command in Persia and Iraq and a big reduction in the size of the force.

Early in 1943, there had been a proposal to form a new G.H.Q. Survey

Company somewhat on the lines of the unit which had been operating at G.H.Q. Middle East. The new directive for Paiforce in March caused this proposal to be dropped. Under the new Command organization the following survey units which had been under Tenth Army passed to the direct technical control of the G.H.Q. Survey Directorate:—

- 4 Indian Field Survey Company.
- 10 Indian Field Survey H.Q.
- 13 Indian Drawing Section.

No. 2 Indian Field Survey Company had left Tehran for the base at the end of January and embarked for India in March, and the resulting survey organization after the departure of H.Q. Tenth Army to India in April was as under:—

- G.H.Q. Survey Directorate
- 19 Field Survey Company R.E.
- 1 Indian Field Survey Company.
- 4 Indian Field Survey Company.
- 10 Indian Field Survey H.Q.
- 14 (Palestinian) Field Survey Depot.
- 51 Drawing Section I.E.
- 52 Drawing Section I.E.
- 14 Computation Section I.E.
- 21 Survey Park Section I.E.

In February, 1943, approval was given for the formation of a Polish artillery survey regiment, one field survey company and a field survey depot. Personnel were selected from amongst the officers and other ranks of the Polish Army in the east, and the build-up of the survey units began. Training with British and Indian units was arranged, and equipment was provided from British sources, including one double-demy printing press in trailer, which had become redundant when 4 Indian Field Survey Company was re-equipped with mobile demy machines. These Polish survey units eventually left Paiforce in September, 1943, on transfer to the Middle East.

Suitable personnel were selected also from the Iraq Army for the formation of an Iraq Army Survey Branch, and courses were held for them by No. 1 Indian Field Survey Company, and later by the Iraq Civil Survey Department.

During April, 1943, 19 Field Survey Company R.E., on completion of its field programme, left Ahwaz and moved back to the Middle East Command in May. In this same month the appointment of D.D. Survey, Paiforce, was abolished, and Colonel Papworth was transferred to the G.H.Q. Survey Directorate, Middle East. There were alterations in the map depot organization also at this time. The map depot at Kermanshah closed down in April and 10 Indian Field Survey H.Q. moved back to Baghdad. 18 (Palestinian) Field Survey Depot arrived in Baghdad on 24th May from Middle East and took over the map depot there from 10 Indian Field Survey H.Q. and also the depot at Kirkuk. A detachment from 14 (Palestinian) Field Survey Depot took over the map depot at Tehran.

Three check bases were measured in Persia during April and May, 1943, by 4 Indian Field Survey Company. They were located at Hamadan, Tehran and Isfahan, and provided a very satisfactory scale check on the existing triangulation in West Persia.

There was a big exodus of survey units from Paiforce during July. The following left the Command:—

- 1 and 4 Indian Field Survey Companies.
- 10 Indian Field Survey H.Q.
- 21 Survey Park Section.
- 51 and 52 Drawing Sections.
- 14 Computation Section.

To satisfy the survey requirements of the Command after the departure of the above units the following new units were formed on 17th July:—

- | | |
|-------------------------------|---------------------|
| 81 General Section I.E. | 1 Officer, 24 O.R.s |
| 82 Ground Survey Section I.E. | 1 Officer, 59 O.R.s |
| 83 Reproduction Group I.E. | 1 Officer, 58 O.R.s |

The personnel for the above was found mainly from Nos. 1 and 4 Indian Field Survey Companies. The equipment came from the same source.

With the departure of the units mentioned above, together with No. 2 Indian Field Survey Company, which had left previously, it is fitting that due credit should be paid to their remarkable achievements. From their arrival in 1941 until shortly before their departure they were fully employed on productive surveys. In this time some 120,000 square miles in Iraq and over 100,000 square miles in Persia were either re-surveyed or revised at scales of 1/100,000 or $\frac{1}{4}$ -inch, and in some cases at both scales. The rate of progress of original $\frac{1}{4}$ -inch survey was as high as 600 square miles a man each month, and that of 1/100,000 survey over 100 square miles a month. In addition, some 76 sheets covering approximately 4,500 square miles at 1/25,000 or 1/50,000 were prepared from air photographs and ground surveys.

In Persia alone over 2,500 miles of triangulation was completed and, although speed was a prime factor, and the accuracy aimed at was only that required to provide a framework for the plane-tables, examination showed that it could be considered for the most part as being of the same order as the Indian minor triangulation or the Iraqi secondary work.

The difficulties against which the surveyors had to contend were formidable, and some of them have been already mentioned. It is sufficient to recall that the terrain in which they worked varied in altitude from the plains of Iraq to the mountain ranges of Persia, where surveyors were often working at over 10,000 feet and in temperatures of from 0 to 127° Fahrenheit.

The units possessed survey tradesmen of the highest order, and in particular plane-tables who, for small and medium scale work in mountainous country, had few equals. The draughtsmen and printing personnel maintained an equally high standard.

The British units, 19 Field Survey Company R.E. and the Mobile Echelon of 512 Field Survey Company R.E., contributed most valuable service during the months which they spent in the theatre. It was noticeable, however, that the standard of skill as plane-tables amongst British personnel was far below that of the Indian surveyors. This was, of course, to be expected in view of the fact that the Indian topographers spent a large part of their peace-time service on plane-table surveys. The Palestinian Field Survey Depots, which came over from the Middle East, helped very considerably in the difficult task of map storage and distribution.

Thus, during the spring and summer of 1943, the survey service with Paiforce

was reduced almost to the status of a care and maintenance party. When Colonel Papworth was transferred to the Middle East, Lieutenant-Colonel L. de V. Carey, R.E., assumed command of the survey organization which remained. The reduced establishment was able to meet all demands made upon it to fulfil the two principal remaining roles of the Command, namely, the protection of the oil installations, and the keeping open of the overland route to Russia.

Lessons

In the sphere of survey direction and control, the arrangement whereby an A.D. Survey commanded a small headquarter unit which was not an integral part of the General Staff was unworkable and unfortunate. In due course this was rectified.

The need for proper military training before Indian Survey Units were sent overseas does not seem to have received sufficient consideration. Although the technical training was of a high standard, it was noticeable that officers and N.C.O.s did not have a proper idea of their military responsibilities. It would also appear that, in the selection of officers and N.C.O.s for these units, too much attention had been paid to their seniority in the Survey of India, in which Department most of the personnel had served before the war. This was, perhaps, in the natural order of things when it is realized that a civil staff had been hurriedly mobilized for military service overseas. In a number of instances men who were technically fitted for senior posts in the civil department were found to be entirely unsuited to become officers or N.C.O.s in a military unit.

The technical achievements of these Indian Survey Units in Iraq and Persia were magnificent, but it is very probable that, if they had been involved at an early stage in active military operations, they would have found themselves up against conditions and difficulties to combat which their military training was insufficient.

On the administrative side these units were organized in such a way that the responsibility for discipline and administration was largely left to the adjutant and quartermaster. This had the effect of making the junior officers feel that their responsibilities were purely of a technical nature, and would have left them ill-equipped to fend for themselves had the units become split up during operations as happened in other theatres.

On the other hand, for the particular type of survey work on which they were employed in Iraq and Persia, the Indian Survey Units were technically well organized and equipped. The Indian equivalent of a British topographical section provided two trig observers and eight topographical surveyors. Each topographical surveyor had three or four unskilled men who, by carrying equipment and generally ministering to the surveyors' needs, left him free to concentrate on his technical work.

The late arrival of survey units in Iraq was a great handicap. Where there is likely to be a big programme of survey and mapping work in an operational theatre an early start is of vital importance. It would have been of great advantage, therefore, if the Indian Survey Units had been sent to Iraq at a much earlier stage so that they could have been available in greater strength to deal with the requirements of the Expeditionary Force.

The patchwork character and poor quality of the first-war triangulation in Iraq and Persia have already been noted. The evidence indicates that elaborate adjustments which were applied to the old trig observations of inferior quality

were not worth while. Events showed that, provided the primary and secondary Iraq work had been converted into terms of the Lambert grid, this was probably all that was necessary. The intersected points and minor stations of the Iraq Survey Department were seldom of much value, through lack of adequate descriptions, to enable them to be identified with certainty on the ground.

The question of map sheet lines has been commented on earlier in this chapter. The existing maps of the theatre were on a graticule lay-out. It was a mistake, therefore, for India to have designed an extensive series, before the landing of the Expeditionary Force, on a rectangular grid lay-out. In the event most of the work done in India in this connection was of little value. The lesson to be learnt is that, for new military mapping in a potential or actual operational theatre, the national sheet lines should be adhered to as far as possible.

SECTION 3. AIR PHOTOGRAPHY FOR MAPPING AND REVISION

Towards the end of 1941, when D.D. Survey (Persia and Iraq) was faced with extensive mapping commitments, D. Survey, Middle East, arranged for the transfer from Egypt to Iraq of a Survey Flight of 60 Squadron S.A.A.F. It arrived in Mosul at the beginning of December, and remained in Iraq until April, 1942, when it was transferred back to the Middle East for survey photography in Syria. It was called for again to undertake urgent photography in Persia later in the year.

This unit was the only one available for the task, and there were numerous demands for its services. As it was transferred to Iraq primarily for survey purposes, the Survey Directorate retained control of its photographic activities, and outside demands were met to a limited extent only when they were not likely to interfere with the survey programme. The unit was equipped with F-8 cameras with 7-inch lenses, covering a film area of 7 in. \times 7 in. These cameras were old, and caused a lot of trouble, seriously interfering with output.

On arrival in Iraq, the Survey Flight was equipped with Maryland aircraft. Under the operational conditions existing at the time, these were very suitable for air survey photography, and were used effectively up to an altitude of about 25,000 feet. It would, of course, have been a very different matter if there had been enemy air opposition, in which case good-performance machines would have been essential. After a month or two, however, the Marylands were withdrawn, and were replaced by Blenheims which had an effective height for survey photography of only about 17,000 feet. Several unsuccessful attempts were made to obtain better machines.

Air photography is very dependent on weather conditions and the weather in northern Iraq and Persia was most unsuitable for air photography in winter-time owing to clouds and rain, especially in the mountainous areas. From the date of the unit's arrival in December until March, 1942, there were comparatively few days suitable for photography, and progress was slow. It was soon apparent that there was no hope of completing all the defence-position maps required by the General Staff by the end of January, 1942. The presence of snow over large areas added to the difficulties of interpretation and also, of course, hindered the work of the ground survey parties who were working on the triangulation, detail checking, and height control.

Having completed all the photography in northern Iraq that was possible

under the bad weather conditions, the Flight moved down to Habbaniya in the hopes of finding better weather. From this centre several areas in central and southern Iraq and southern Persia were photographed, and also some important base areas, notably Khorramshahr and Abadan, where photographs were required at 1/25,000 scale for camouflage-testing purposes.

All essential areas had been photographed by about mid-April, 1942, including some where it was anticipated that a demand for large scale maps might arise later, so the Survey Flight was withdrawn to the Middle East.

The first photographs were available about mid-December, 1941, and a strong air survey section was formed by concentrating under one control all the surveyors in the theatre who had been trained in air survey mapping work. Until the end of April, 1942, they were fully employed on the mapping of the defence areas and other tasks. By May the results of their work had all been published, and these comprised:—

- (a) 1/25,000 maps of defence areas; 33 sheets covering a total area of about 1,540 square miles.
- (b) 1/12,000 sketch survey of Um Qasr.
- (c) Planimetry only of a 1/25,000 survey of the Pul-i-tang defence area (165 square miles). This was completed later by 4 Indian Field Survey Company.

As a result of the extensive new mapping programme in western Persia, asked for by the General Staff in April, 1942, D.D. Survey asked for the return of the Survey Flight which had previously been in the theatre, and which was now renamed No. 1434 Flight R.A.F. After some delay it moved across from Syria and began photographic operations about the middle of July, 1942, based on Tehran.

The programme undertaken by No. 1434 Flight mainly concerned photography for the preparation of 1/25,000 maps of defence areas in north-western Persia, to replace the hastily prepared sketch surveys which had been made as a first measure to assist the initial siting of the defence works. Priority for photography was given to a series of defence positions which guarded certain vital passes against a possible German offensive from the Caucasus.

Photography of these positions, covering about 2,400 square miles, was completed during August and early September. By the end of September the weather in northern Persia had begun to deteriorate but, on completion of the above task, photography was undertaken of the Gach-i-sar area covering a defile on the road from Karaj to Chalus on the Caspian Sea. This was completed before the unit left the Command again in November, as was also the photography of several other areas for which air-photo cover was required in case they should later become operational zones.

In all, 1434 Flight took vertical photographs covering a total of about 5,000 square miles during its stay in the Command, most of which was carried out between the end of July and the first week of September, 1942.

To compile the maps from the photographs, the whole of the air survey strength of the three Indian Field Survey Companies was assembled in Hamadan at the end of July, 1942. This was reinforced in September by one drawing section from 19 Field Survey Company R.E., and they formed one composite Air Survey Group.

By the middle of March, 1943, the Group had completed about 30 sheets

of the defence localities on 1/25,000 scale, and two sheets of the Gach-i-sar area at 1/50,000.

The usual method adopted for the field-check, except in areas of high hills, was to supply blue-prints, sheet by sheet, of the compiled outline, which were taken out into the field together with a set of photographs. Roads and tracks were classified, and doubtful detail corrected. Sufficient heights were fixed by clinometer, combined with resection and intersection, to enable contouring and form-lining to be carried out on the photographs in the office.

A blue-print of the compiled outline was then made on kodatrace, and on this the contours were traced from the photographs. This method was found to give better-quality results than the "black and white" method, whereby the outline and contours were drawn in black and white respectively on the same piece of kodatrace, and separated by photography against alternate black and white backgrounds.

In high hilly country, sets of photographs were taken out on the ground before the compilation of the outline, and clinometer readings for heights taken to selected points marked on the photographs from stations similarly marked. Distances for computing the heights were later determined in the office after completion of the minor control plots.

It may be useful to record a few statistics of output in air survey production, as such knowledge is useful when framing or estimating programmes of work. The table given below refers to work carried out by No. 1 Indian Field Survey Company on 1/25,000 scale for the period December, 1941, to May, 1942. The photography for this work had all been ordered on 1/25,000 scale, but it actually averaged about 1/21,000. All surveyors worked eight hours a day for six days a week. Output figures shown represent square miles per surveyor-week.

Area	Description of country	Area in square miles	Output (square miles per surveyor-week)			
			Outline only	Contouring only	Outline and contouring	Outline, contours and completion for publication
1	Rolling	482	21	30	13	10
2	Broken plain	35	23	26	12	11
3	High hills (very steep)	194	19	10	7	6
4	High hills	60	20	16	9	8
5	Low hills and plain	168	18	15	8	7
6	Low hills and plain	96	23	14	9	8
7	Flat	209	32	32	16	12
	Average		22	20	10	9

Note.—The normal contour interval was 25', which was opened out to 50' in steep hilly country.