

REPORT ON THE WORK  
OF THE SIXTH  
FIELD SURVEY  
COMPANY, R.E.,  
IN ITALY.

NOVEMBER, 1917.  
to  
NOVEMBER, 1918.

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### I.—EARLY HISTORY OF THE COMPANY IN ITALY.

The Field Survey Company was represented very early in the history of British operations in Italy. Lieut.-Colonel H. S. Winterbotham, C.M.G., D.S.O., R.E., arrived early in the month of November, 1917, with some "Maps" personnel, and was followed a few days later by Major L. M. King, R.E., with the first detachment of 10 printers. The Topographical Sections attached to the XIth and XIVth Corps under Lieut. H. Willet and Lieut. P. O. Spicer, had previously arrived, and were taken on the strength of the Company towards the end of December.

2nd Lieut. T. H. Galbraith also arrived early with two other ranks of the Trigonometrical Section, and they immediately started work in fixation of battery positions, and the checking of existing Italian Trig. Points.

On 24th December, Lieut. T. Curr, with C.S.M. O'Leary, and another detachment of printers, draughtsmen and clerks, together with the bulk of printing, drawing and Topographical Stores, detrained at Padova, from the Depot Field Survey Company, France.

On 8th January, 1918, Major C. S. Reid, D.S.O., accompanied by his Adjutant and Headquarters (2nd Army) Staff, arrived from France to take over the command of the Company, and Lieut.-Colonel Winterbotham returned to G.H.Q., France. Major King had already returned to France on 24th December.

It had been found necessary to call for Observation Groups and a Section of Sound Rangers, and in consequence No. 26 Group, under Capt. C. J. Strachan, No. 25 Group, under Capt. J. A. Slater, and "E" Section under Capt. O. I. Burgess, all detrained with their personnel at the end of December and the beginning of January.

Lieut. L. Hughes, Lieut. H. C. Bradshaw, and Lieut. T. E. Fargher, had also been despatched from France, and after the return to France of Lieut.-Colonel Winterbotham, C.S.M. O'Leary, and some members of the original Headquarters Staff, the composition of the Company became established under the new conditions. The Headquarters of the Company, however, after having been successively at Mantova, Legnago and Padova, where it was bombed out, was again moved to Villa Vanni, about 4 kilometres

outside Padova, but no sooner was it established than the place was taken over by the Italian Comando Supremo, and a permanent home was at length found for the Company in a villa at Ponti di Brenta.

Capt. G. F. Jones arrived from France early in February as Compiling Officer.

On the return of General Plumer and the 2nd Army Staff to France, together with some of the British Divisions, the withdrawal of the British troops from the Montello Sector was carried out, and the Company had to prepare for the taking over of a portion of the line on the Asiago Plateau. This sector presented to every branch of the Company problems never before met with, either in Italy or in France.

The time of the year—the end of March—the mountainous region, the lack of experience in such warfare, all created difficulties which had to be faced, many of which were only overcome gradually, and after experience had taught how best to deal with them.

From the point of view of maps, the area was, it is true, covered by 1:25,000 sheets, produced by the Italian Istituto Geografico Militare, but naturally, in such an area which, before the war was almost uninhabited, there were many inaccuracies. Aeroplane photographs were difficult to use owing to the distortion caused by the great differences in altitude of points on the same photo, the absence of prominent features—such as houses, cross-roads, &c.—and the difficulty experienced by the aeroplanes in obtaining the necessary height. Survey in such densely wooded country was extremely difficult, and traverses had to be run over great lengths before any attempt to fix batteries could be made.

The Observation Groups found O.Ps. of a kind undreamt of previously, but the great elevation at which they were situated often caused them to be covered in clouds for days on end. The laying of lines over snow and rocks and maintaining them, together with the difficulty of rationing posts with such unsuitable transport, formed another difficulty.

The Sound Ranging Section suffered greatly from the last named difficulties, and the extraordinary acoustic and

weather conditions could only be mastered by experience and experiment.

In spite of these problems no branch of the Company failed, even if their preliminary efforts seemed, to those who were ignorant of the work, somewhat feeble. At any rate, by the time of the Austrian offensive on 15th June, everything, with perhaps the exception of transport, that bugbear of existence, was running smoothly and well. From then until the return of the main British Force to the Piave on the opening of the Allied offensive in October, each unit made steady progress as can be seen from the attached tables of results of work done.

In preparation for the offensive in October, there was not time to move more than one Group, No. 29. "E" Section could not be moved and remained out of action. In the few days that No. 29 Group were in action they did very good work in difficult and enclosed country.

Very good service was performed by the Trig. Section, on whose work depended the success of the Artillery fire, as there was to be no previous registration.

Once more transport caused great difficulties.

## II.—HEADQUARTERS.

The Company Headquarters was situated latterly, when the 2nd Army was on the Piave front, at Ponti di Brenta, and it was from there that the move to the Asiago area was made.

An advanced depot was established on 12th March at Lugo di Vicenza, where subsequently the Corps Headquarters was located. From here the Groups were passed forward up the mountains, together with "E" Section, and the Trig. and Topo. Sections, the latter not being required by the Corps Intelligence to stop with them.

On 2nd April this Advanced Headquarters was withdrawn, and Company Headquarters established at Thiene, the Printing and Drawing Sections being left at Ponti di Brenta. By the orders of XIV. Corps "Q," the Printing and Drawing Sections were not allowed to come forward to Corps H.Q. or Thiene, and so a split had to be made. Company Headquarters, *i.e.*, O.C., Adjutant, and Compiling Officer remained at Thiene, and the Printing and Drawing Sections moved on 19th April to "Villa Amelia," Arcugnano,

South of Vicenza. This caused a certain amount of duplication of work and personnel—such as cooks, orderlies, besides Orderly N.C.Os.; however, the arrangements worked well, although there was a certain disadvantage in the O.C. being away from that part of the work, and the distance from the Corps H.Q. being great.

One Ford Car, reinforced when any important period occurred, managed to supply the wants of this Rear H.Q., which was under Capt. L. Hughes, M.C.

On 8th June, Lieut. T. Curr left the Company to command the G.H.Q. Printing Company, France, and was replaced by 2nd Lieut. H. M. Cartwright, from "E" Sound Ranging Section.

On 26th June a party of 10 men were sent to France, as being spare now that the British Forces in Italy had been reduced to 1 Corps of 3 Divisions. On 11th June Major C. S. Reid, D.S.O., left the Company to command the 2nd Field Survey Battalion, France, and took with him his Adjutant, Capt. T. A. Lodge, the C.S.M., C.Q.M.S., and some six or seven other ranks. Lieut. T. E. N. Fargher, who had commanded the Corps Topographical Section, also left to become Officer *i/c* Survey of 2nd Field Survey Battalion. These Officers were replaced by Capt. G. F. Jones as O.C. 2nd Lieut. J. M. Peakman as Adjutant, Lieut. E. Russ as O.C. Topo. Section, and Lieut. H. L. Hayman, who was sent out from England and became Compiling Officer. The places of the above Officers were taken by 2nd Lieut. V. H. Woodcock to 25 Observation Group, and Sub-Lieut. E. E. Ede to "E" Sound Ranging Section. C.S.M. O'Leary, who has been out originally with Col. Winterbotham, came back as C.S.M., other promotions being made from within the Company.

It was found necessary to have a fairly large advanced Map Store at Thiene to supply the forward units, but the main Map Store remained at Arcugnano. A very useful parcels delivery service was organised by Corps between Thiene and the Divisions in line, which saved the Company transport very considerably, maps being delivered in six hours from dispatch, twice a day.

On the 6th September the Commander-in-Chief visited the Company Headquarters and Printing and Drawing

Sections, going into each room and seeing the various methods of drawing and printing of maps.

On the move of the Corps to the Piave Area, where it became part of the 10th Italian Army, the O.C. went forward with a small map store, and established himself at intelligence, G.H.Q., on 16th October. The Company Headquarters was later established at Preganziol on 22nd October. The Printing and Drawing Sections remained at Arcugnano, as there was not time in which to move them forward; nor could the work of printing, at that time very heavy, be interrupted. An additional Ford box car was lent by "Q" to help out the Company Transport at Headquarters.

On the cessation of hostilities, and withdrawal from the Piave Sector, the Company was concentrated in the Vicenza area, the Headquarters being established at Villa Moschini, Arcugnano, on 13th November, 1918.

#### Suggestions for Improvements: Company H.Q.

In making any suggestions of improvements, it should be borne in mind that the Company was under the old establishment, which was later somewhat increased by permission being granted for the two Groups, and "E" Sound Ranging Section, to be allowed the same establishment as in France, but this came too late to be of much use in action. In other respects, the establishment was adequate in personnel.

It is not easy to write suggestions for this Company owing to its special nature, and the probability of similar circumstances not arising again. However, one change seems to be indicated which might reasonably be applied in other circumstances, and that is, a greater elasticity and mobility. In this country, rapid changes had to be made from the plains to the mountains, and *vice versa*, and things suitable in one place became very unsuitable in another. Transport was always a trouble. Ma'tese carts, for instance, were useless in the mountains, and the less said about Ford cars, the better. As touring cars on the plains they were useful, but in the mountains they broke down entirely and were a source of danger with brake failures on steep hills. As box cars they were useless everywhere. They carry so little, and do not stand the constant daily work. The class of driver of Ford cars also militates against their utility.

### III.—DRAWING AND PRINTING.

The work of the Drawing and Printing Sections is taken from the time when Captain Hughes came to the Company.

The maps used were the standard Italian sheets of 1:25,000, 1:100,000, 1:200,000, and 1:500,000, and some 1:20,000 and 1:50,000 French maps.

At first, on entry into a new area, the Lambert grid was printed on the maps received from the Istituto Geografico Militare, Firenze, or, if a large quantity were required, transfers were put down and copies printed off. After this the sheets were redrawn and revised. In the case of the Piave Area this redrawing had just been completed when the move to the Asiago Area took place. Perhaps it would be as well to say a little at this stage about the questions of scale.

At first the 1:20,000 scale was taken as the standard to suit those who had become used to it in France, but, seeing that the Italian standard sheets were 1:25,000, this meant much trouble and confusion. However, there was a very strong leaning towards them by the artillery, and therefore the revised sheets of the Piave Area were made as "special" sheets of that scale. On moving to the Asiago front, the standard scale was changed to the 1:25,000, and has remained so ever since, and the wisdom of this was proved when, at very short notice, many sheets in the Piave, Livenza, and Tagliamento Areas had to be gridded and issued.

On the Piave it was found that, save for the ever-changing channels in the river itself, the Italian maps were accurate, and few corrections had to be made. Trenches were few, and little work was required to produce a really good sheet similar to those used in France.

On the Asiago front, however, the reverse was the case. The area was contained on six of 1:25,000 sheets of a somewhat poor quality as regards accuracy and legibility. This can be said without giving offence to our Allies, whose mapping work is of a high quality. The country was of the very wildest character save for the Asiago Plateau itself, and in pre-war days inhabited by only a few shepherds. Roads were few; in fact, only one road (*i.e.*, the Ca'trano—Campiolo road) went from the plains across to Asiago, the others stopping at Lusiana and Campana. Naturally there had

been little time for the Italian military authorities to take in hand the revision of these sheets, although they had by April inserted many military roads. Another reason for the seeming inferiority of the Italian maps was that they were not used or distributed as widely as in our army, and there was a much smaller staff employed on the work.

The first work in this new area was the printing of the Lambert grid on the existing sheets, and marking the main roads in red. After this enlargements were made of the 1:25,000 maps to 1:10,000, but these were of a very poor quality. By the end of May the six 1:25,000 sheets had been redrawn and revised by us, and from these new 1:10,000 maps were made, and were much appreciated. These maps also had the enemy trenches on, a thing which the Italians only did on a few special sheets for staffs and artillery. The work of redrawing from the Italian outline had brought to light many inaccuracies, and new editions were started, in which these were corrected as far as possible, but there was much to be learnt in this work.

As mentioned before, the use of aeroplane photographs presented many new and interesting problems, the principal being perhaps the distortion due to the very steep slopes. There seemed to be no average correction to apply, and a collection of, say, six or more photographs of the same area disclosed very considerable differences. Points on which to base triangles were few, and where on one series all points would go down very well in apparently their right place, on another they would be considerably out.

Before the production of the last editions there had been time to fix points, such as houses, trigonometrically, and eventually errors were reduced to a minimum. So much for the accuracy of the redrawn maps in major points.

The thick trees, especially on our right sector, obscured all details such as roads, mu'le tracks, trenches, etc., and reliance had at first to be placed on the existing data already on the Italian maps. Later on, when many new tracks and some trenches had been added, a cry came from the divisions for more detail and more accurate work on our side of the line. Fortunately, this could be responded to, as the Trig. and Topo. Sections were then freer to deal with survey and plane table work, other than fixing our own batteries. After

about five weeks of very hard work all the principal tracks, roads, trenches, etc., had been surveyed to a reasonable degree of accuracy, and were embodied in the next editions. This may not appear from reading to be a very great achievement, but it must be remembered that the country was not only very enclosed, but in many places almost impassable, owing to its rocky nature. On the top of this, there was the problem of how to move a Trig. and Topo. Section with one motor-cycle and side-car and one Ford box car. In places, although the spot at which work had to be done was only six kilometres away, the road journey was something like fifteen kilometres, and the road was the only way by which one could go. However, by the middle of September a very accurate edition of six 1:25,000 sheets and seven 1:10,000 sheets was produced. These sheets had, of course, been gradually improved in various editions from April onwards, but the last edition was something of which any company could be proud.

These sheets mentioned above were all produced in four colours: trenches in red, outline in grey, water in blue, and contours in brown. A special R.A.F. edition was issued in 1:25,000, with woods in green. The whole of this work of survey, drawing and printing was done by the Company without any assistance, and with one demy machine.

The following dates may be taken as typical of the rapidity with which editions followed each other:—

1:25.000	1A	7-4-18
	2A	28-4-18
	2B	24-5-18
	3A	12-6-18
	3B	23-7-18
	4A	29-8-18
1:10.000	1A	6-6-18
	2A	14-6-18
	3A	23-7-18
	4A	6-9-18

Besides these standard editions, there were the various Administrative, Traffic, Counter-Battery, and Intelligence maps, which had to be brought up to date by constant revision.

The Lambert grid, with lettered blocks of ten kilometres square, and the third figures of the N.S. and E.W. grid lines inserted in the corner of the one kilometre squares, which greatly facilitated reading co-ordinates, was used. The use of the Lambert grid was troublesome in some ways, as, for example, the calculation which had to be made for the sheet corners in metres from the lines of latitude and longitude, and the case where a map of a new area was required quickly. The Italian maps also were most difficult to use for over-printing, owing to the various shapes and sizes of sheets, even of the same map, and the different qualities of paper employed.

The strain on the Printing Section was always heavy, for many reasons. Every map which was issued to our forces, save small scale maps, and even some of them, too, had to go through our machine. Even the maps supplied by the Italians had to have the Lambert grid overprinted. Our own editions followed with great frequency, and necessitated many runs according to the number of colours employed. Very often a correction on one plate necessitated corrections on the other three, as, for example, where the position of roads was altered, nearly always contour, water and trench plates had to be altered as well.

Latterly A.P. & S.S. helped with such printing as was too large for our demy machine, the plates being prepared by us. The letterpress work was heavy until the A.P. & S.S. arrived in the country. Fortunately, when near Padova, use could be made of civilian firms, which was very convenient during moves, but this ceased on our taking over the Asiago Sector.

Zinc plates were almost always used, and proved very satisfactory, while the Vandyke process was most successful. The Ordoverax process failed completely as soon as any hot weather was encountered. The climate during the spring, summer and early autumn was very good for paper, and no trouble was experienced in shrinkage.

A photographic apparatus for enlarging maps was made by the Company, and proved very useful. The country, as far as the Asiago Sector, was ideal for panoramas, and full advantage was taken of it, in so far as visibility and transport would allow.

#### Suggestions for Drawing and Printing.

There are not many suggestions for improvements in the Drawing and Printing Sections. The particular demy machine supplied to this Company was not very modern, but managed to meet our needs. In Italy, electricity being so cheap and plentiful, a motor would have been much better than petrol engines, which often went wrong.

There is no doubt that a train, similar to that used by the French, would do away with the eternal question of lorries from "Q" every time a move occurs; also it does away with the question of finding billets and offices and delays while machinery is dismantled and re-erected.

If a printing train had been used in this country more could have been done in the way of supplying maps at the time of the sudden move to the Piave for the October offensive. The distance between Arcugnano and Treviso is 85 kilometres. A good graining machine and guillotine should have been sent out originally. As it happened, by great good luck these could be hired, but at one time the owner desired their return, and a most exhaustive search failed to produce any signs of replacements, and the return did not take place.

The cameras issued were very inferior compared with those used by the Italians, and panoramas suffered in consequence, which was a pity in such a perfect country for this work.

At times more draughtsmen would have been useful, but on the whole the number was adequate. Cameras with wide-angle lenses were not available for the R.A.F., and would have been invaluable from a map-making point of view. A Liaison Officer from the Istituto Geografico Militare, at Firenze, would have been very useful, although in the first few months Lieut. Scritti was lent to the Company, and did very valuable work.

The arrival of stores was not at all satisfactory at first, especially such things as machinery, which arrived in an assortment of pieces. In one case, some shafting despatched in April arrived in November, after the cessation of hostilities, having been wrongly addressed.

#### IV.—SURVEY.

##### TRIGONOMETRICAL SECTIONS.

**Trigonometrical Section.**—The Trig. Section was, when the British occupied the Montello Sector, located at Falze, which was a central spot for work in both Corps Areas. In this Sector there was not much of special note. The Trig. points were mostly Campanile, and these, with the leaves off the trees, could be picked up easily. The Italian values were found to be good.

On the move to the Asiago Area the work of the Section became very much more difficult; of Campanile there were none, the Trig. points being beacons erected on the summits of the most prominent mountains. The country was, as has been mentioned before, very rugged and thickly covered with trees, which made observation on the beacons very difficult indeed. The values of these were not so good as the Campanile in the Montello Sector, but met all military requirements for accuracy, and later improved values were obtained. The Section moved to Lugo with the advanced depot, and proceeded up the mountains at the same time as the Groups, H.Q. being established on Mt. Mazze, near "E" Sound Ranging Section and No. 25 Observation Group.

Before the work of fixing any heavy batteries could be started, some eight miles of standard traverse had to be run. This formed the basis for subsequent traverses; and secondary Trig. Points—flags—were gradually established over the whole area.

In September the Trig. Section was engaged on survey of the roads and tracks mentioned in the opening paragraph of this report. As well as the normal work of the artillery, all Survey O.Ps. and microphone positions were fixed, also many prominent points, houses, &c., for the artillery.

It must be remembered that where in France one flag would serve as a Trig. Point, which could be seen from several neighbouring places widely apart, in these dense woods points had to be very thickly clustered.

On 2nd October the Section moved to Thiene, and proceeded to the Treviso Area on October 12th, for the Allied

Offensive. A very high standard of work, and very hard work, had to be done at this time. No previous registration was allowed to be done by the British Artillery, and everything depended on the accuracy of gun fixations and aiming points.

The Austrian Offensive of June had destroyed several Campanile, and the thick vineyards and autumn foliage rendered observations difficult; the heavy rains then experienced also added to the difficulties.

In all some 13 Heavy Artillery positions were fixed and boards made and issued in one week from the time of arrival in the area. The Topo. Section worked with the Trig. Section, as the O.C. Topo. Section was away, and the XIV. Corps, although reformed, did not wish the Topo. Section to come to them yet.

On the 13th November the Section moved to Villa Moschini, Arcugnano.

##### Suggestions.

The principal weakness was, as ever, in transport. One Ford box car, which was all that could be spared on most days for this section, was quite insufficient. A reliable box car and a 30-cwt. lorry should most certainly be allotted for this work.

Personnel was found to be adequate on the whole, although good plane table hands were lacking, but this was probably a thing which might not happen again. Had time permitted, more might have been done in photographic surveying, but with so much work to be done, it was not possible to experiment long in this. A camera was very kindly lent by the Sezione Cartografica, at Comando Supremo.

The work of transforming spherical co-ordinates to rectangular co-ordinates involved labour and loss of time, especially when working in a new area, but this could not be helped. It seems, however, to point to the advisability of Allies having a uniform system of squaring.

#### XIV. CORPS TOPOGRAPHICAL SECTION.

1. *Operations on the Montello.*—This section was one of the first units to arrive in Italy (about 11th November, 1917), and after being engaged at Headquarters for a short period in arranging maps likely to be required for operations, it proceeded to Corps Headquarters at the end of that month for operations on the Montello.

The Topographers were the first British in the field, and during the first few weeks made a rapid revision of the map comprising the forward area, the detail of which was found to be good. They also ascertained by plane table methods all the trigonometrical points available.

With a view to the accurate fixation of all battery positions, the Corps Forward Area was divided into sectors, and the Topographers, now knowing the Trig. points, commenced plane tabling, and within a few days sufficient prominent points were ascertained to enable all battery positions to be accurately fixed, and heights supplied to the Battery Commanders. Subsequently many points were fixed in the enemy lines, aiming points, as well as field and heavy artillery observation posts, and all possible assistance given to the artillery. For the first period of about six weeks this Section fixed all heavy battery positions and their O.Ps., but this work was subsequently taken over by the Trig. Section.

During the period of operations on the Montello, about 100 heavy and field artillery positions were ascertained and their heights determined.

Whilst not engaged on battery work the following map revision work was completed:—

(a) The 21 roads situate on the Montello Range were either completely surveyed, or sufficient cross roads and houses fixed, to enable the work to be completed by photographs.

(b) All new military roads were surveyed and spot levels ascertained.

(c) The names of the mountains opposite to the Corps Front were ascertained, and a panorama supplied, indicating name and height of each.

(d) It is estimated that about 200 prominent points in all were fixed.

(e) *Artillery Boards.*—About 120 heavy and field artillery boards were made, also Observation boards for Groups and Artillery.

(f) *Duplicating Work.*—All traffic, operation, movement, and other Corps maps were supplied.

(g) *Distribution of Maps.*—The distribution of maps to Corps Division, Corps Troops, and other units was carried out.

(h) *Photographic Work.*—The revision of our own trench system map.

2. *Operations on the Mountains (Asiago).*—About the middle of March, 1918, the Topo. Section left the Corps H.Q. and joined Headquarters, all battery boards and draughtsmen's work then being completed by the Company.

The outdoor staff, consisting of an Officer and three Topographers, proceeded to Mt. Pau for battery and other work at the end of March.

Upon a thorough inspection of the area, it was found that, owing to the wooded nature of the ground, and to the difficult mountainous area generally, plane table work was at this stage almost impossible. Theodolite work was therefore decided upon, and stadia traverses run from places where good resections could be obtained to the battery positions. At the commencement these traverses were often of considerable length and entailed a great amount of work, but as the work proceeded and traverse points were ascertained upon all parts of the front, battery positions were far more easily and quickly fixed. Where possible traverses from the commencement were made along roads and tracks to the batteries, and thus afforded a double purpose by revising the existing map.

About the beginning of June the Topo. Section moved to Cavalletto Camp, and continued the work of battery fixation and map revision work.

About 25th June there was a large movement of batteries, and at short notice many batteries were fixed and boards delivered.

In August orders were received to carry out a complete

and systematic revision of the map of the forward area, which was covered by dense woods.

A large number of new mule tracks and foot tracks had been constructed in this area since the commencement of the war, and there was no map of these in existence.

The staff was strengthened by the addition of three infantry.

All roads were surveyed by Theodolite traverse, and several Theodolite traverses were run across the front at intervals, and all stations marked, the tracks were surveyed by plane table traverse, and to a small extent by compass traverse; the Topographers closed each traverse upon a previously fixed Theodolite traverse station.

The periscopic fittings for Theodolite or Alidades, mentioned in details of equipment for a Survey Company, were not used.

The rate of work is shewn during August:—

Time	...	...	...	25 days				
Area mapped	...	...	...	41 km. (square)				
Length of track and road surveyed	...	...	...	103 km.				
Staff	...	...	...	<table> <tbody> <tr> <td>1 officer</td> </tr> <tr> <td>3 topographers</td> </tr> <tr> <td>1 draughtsman</td> </tr> <tr> <td>3 infantry</td> </tr> </tbody> </table>	1 officer	3 topographers	1 draughtsman	3 infantry
1 officer								
3 topographers								
1 draughtsman								
3 infantry								

At the request of the 6th Italian Army Artillery, lists of roads traverses shewing the co-ordinates of each station, and the co-ordinates of prominent objects and road junctions were prepared, and copies were sent to the Italian and French Armies.

The following is a summary of the work carried out by this Section during the whole of the operations in the mountains:—

Battery positions resected and heights ascertained	...	...	...	83
Number of traverses made and computed	...	...	...	97
Length of road surveyed	...	...	...	35 km.
Length of tracks surveyed	...	...	...	115 km.
Length of trench and wire system surveyed	...	...	...	43 km.
Telefericas surveyed	...	...	...	6
Traverse points	...	...	...	850
Area mapped	...	...	...	49 sq. km.

3. *Operations on the Piave.*—On the 1st October, 1918, the Topo. Section moved to Headquarters, and after a few days spent in organizing stores and equipment, the Section, with the Trig. Section, proceeded on the 9th October to the training area, near Padova, for revision work upon the Colli Euganie Sheet. Very little work could be accomplished, as two days later the Section was recalled, and on the 12th October they left for Treviso Area for operations on this front.

Although only in action for a short period, the Section was able to accomplish much quick and valuable work.

Upon an early and preliminary inspection of the area, it was discovered that plane table work could be satisfactorily employed, and that, although certain of the trigonometrical points had been destroyed by shell fire, certain portions of the churches within a few yards of the original stations still remained and could be advantageously utilised; these were, therefore, immediately fixed by bearings and measurements. Instances of these points were the dome on Spresiano Church and the vane on Lovadina Church.

Artillery officers subsequently pointed out certain cross roads, buildings, and other prominent objects required for artillery purposes.

Although only a few days could be given for the execution of this work, everything required and asked for was accomplished before the time limit.

Much useful work was also accomplished by the draughtsmen during this period in duplication work, and assistance rendered in the preparation of artillery boards.

The following is a summary of the chief work completed during these operations:—

Field Battery positions resected	...	...	21
Points fixed for R.A.	...	...	43
O.Ps. fixed	...	...	2
Field Artillery Boards made	...	...	33
Trench Mortar Boards made	...	...	2
Traffic Maps drawn and duplicated and 800 copies supplied.	...	...	

Forward area fixed points drawn and duplicated and 60 copies supplied.

The mounting of various scale maps for use in the field.

On the reformation of the XIV. Corps the Topo. Section reported to Corps Headquarters on the 28th October, and has since been engaged in general duties for the Corps.

#### Suggestions.

*Transport.*—One of the greatest drawbacks to the work on the mountains was the lack of transport; especially was this the case during the first two months, when Topographers frequently had two hours march before they could commence work, over the worst possible ground covered with snow; four hours per day were wasted in this way, during a time when work was most urgent.

During the map revision in August, the Topographers had to travel over 27 kilometres to and from their work, and often no transport was available.

A Napier Box Car is a necessary addition to the Section.

The two motor cycles, one with a side car, were found to be very useful for the delivery of maps and messages, for inspections and reconnaissances, and should be retained.

The two bicycles allotted to the Section could be dispensed with.

*Personnel: Computer.*—During operations where much Theodolite work is essential, a computer should be allotted to the Section.

*Sappers or Privates.*—During active operations there should be attached three Sappers or Privates, to act as staff holders, chain men, or to assist the Topographers when they work apart.

The War Establishment should provide:—  
1 Batman, and 1 R.A.S.C. Driver.

*N.C.Os.*—The three Topographers should be non-commissioned rank, as they usually have to proceed alone and report to officer i/c of batteries, etc., and have considerable dealings with officers in the course of their work.

*New Work.*—The C.R.Es. of Divisions and Corps Troops should give particulars of all new work carried out, so that the map may be made up accordingly.

The list of extra equipment below, it is suggested, should be added to that provided for a Corps Topographical Section:—

Theodolite transit, 3-in., fitted with stadia hairs	...	1
Stadia rods	...	2
Prismatic compasses, 4-in.	...	2
Aneroid barometers to read up to 3,000 metres	...	2
Zinc top for plane tables	...	3
Sketching cases	...	1
Axes, hand, 3-lb.	...	1
Hammer, claw, 24-oz.	...	1
Hooks, bill	...	1
Telescopic alidade	...	1
Brushes, colour, camel-hair	...	4

#### Books:—

Shortrede's tables	...	1
Chambers mathematical tables	...	2
Four figures log tables	...	1

#### Various:—

Kettles, camp oval, 12 quarts	...	2
Tapes (measuring), steel	...	extra 1
Thermometers, survey	...	1
Watches, keyless, $\frac{1}{2}$ chronometer	...	1
Buckets, water, G.S., canvas	...	1
Axes, pick heads	...	1
" helves	...	1
Shovels, R.E.	...	1
Lamps, reading Incanto	...	3
Tables, G.S.	...	6
Stools, camp, folding	...	6
Curves, drawing, architects, Mark II. in case	sets	2
Lamps, hurricane	...	1
Torches, electric, long cylindrical	...	1

#### SUMMARY OF WORK IN ITALY.

##### Topographical Survey:—

Area mapped	...	75 sq. km.
Length of road surveyed	...	103 km.
" tracks "	...	115 "
" trenches "	...	43 "

*Artillery Work* :—

No. of Battery Positions fixed ...	204
„ Artillery boards made ...	220
Points fixed for R.A. ...	255
O.Ps. fixed for Artillery and Groups ...	25

**V.—OBSERVATION GROUPS.**

**No. 25 Observation Group.**—This group was formed in France and proceeded to Italy as a complete unit, arriving at Padova on the 9th of January, 1918. An immediate reconnaissance of the Montello Area was made from the 10th/14th, and eventually one post was chosen on Monte Salder and two on the Montello, which gave a base of about 12 kilometres. Observation was exceptionally good and locations satisfactory. Many ranging shoots by air bursts were carried out, particularly with 102 Bde. R.F.A. in February, and proved most successful. In other respects the work was normal on this sector. Visibility was often interfered with by morning mists from the river Piave. Hostile artillery was not very active, and as the result of energetic counter-battery work, showed a disinclination to fire more than a few bursts on most days. Our raids did not produce the artillery retaliation which was experienced later, and in consequence locations were not very numerous.

On the 13th of March the reconnaissance of the right sector of the Asiago front, which had been allotted to this Group, was commenced. Meanwhile the Group gradually handed over the Montello posts to the Italians, who proposed to imitate our methods of work. The Group moved to Lugo on 22nd of the month, and Group H.Q. was established on Monte Mazze on 25th. By 30th three O.Ps. had been established on Monte Lemerle, Cima di Fonte, and Monte Nasa respectively, and results came freely, although a period of very cloudy weather impeded visibility about this time.

On 10th June a fourth post was established on Monte Foraro, which increased the length of the Group base, and greatly improved the value and accuracy of their locations. On 15th June the Austrian offensive on the Plateau caused much dislocation of lines, but one post was maintained in communication with Group H.Q. all day. The post on Monte Lemerle had always suffered from

shelling and line trouble owing to its exposed position, and it was considered advisable, now the weather was better and low clouds less frequent, to abandon it, and distribute the personnel amongst the other posts.

2nd Lieut. Woodcock joined the Group on the 30th of this month to fill the vacancy caused by 2nd Lieut. Peakman's appointment as Adjutant. There was little of note after the Austrian offensive, save that results became more numerous each month as is shown in the attached appendix. At the opening of our offensive in October the Group was left to serve the part of the Heavy Artillery which did not move to the Piave Area, and on the 15th of October took over Monte Pau post from 29 Group. The Group continued to get results up to the time of the Austrian withdrawal, when posts were called in to H.Q. On the 4th of November the Group moved to Villa Dal Lago, near Vicenza, as there was not sufficient room at Company H.Q.

**No. 26 Observation Group.**—This group arrived in the country on 28th of December, 1917, and took up its position on the right of the Montello, being in action by the 20th January, 1918. The area over which this Group had to observe was very difficult owing to the San Daniele and San Salvatore hills, which completely hid many battery flashes, as well as dividing this area into two distinct portions, which hindered simultaneous results. Two posts existed on the Montello, one in the vicinity of Arcade, and one in Spresiano, thus covering the XI. Corps front. On the return of General Plumer and the XI. Corps, the Observation Groups were reduced by one, and this Group proceeded, on 27th April, 1918, to Salonika.

**No. 29 Observation Group.**

(1) (a) *Formation.*—On 30th January, 1918, authority was given for the formation of this Observation Group. This was done hurriedly to meet the requirements of the R.A. who wanted the unit in action in one week from this date. The personnel was drawn from various sources, but only 20 per cent. were trained in the work. The two Observation Groups already in line supplied men. The R.A. of the XIV. Corps, and the XI. Corps Cyclists furnished

squads of six, and the remainder were drawn from the Divisions in line. The experiment was interesting, and served to show that the best and quickest training was the O.P. itself and not a school. Of the men employed as observers it was found that the gunners were the best, as they benefited by a previous insight into the work. The men from infantry formations—most of whom were either scouts, signallers, or battalion observers—worked well and mastered the instruments and map board quickly, besides showing great keenness in their new work. The Group benefited by infantry signallers who continually did useful work on lines when the work became too much for the three R.E. linesmen which the Establishment allowed. Reinforcements from the Survey Depot were, in one or two cases, not equal to the work owing to the lack of experience of general warfare. On the whole it was not possible to get men with the necessary technical qualifications, but, generally speaking, this presented no serious difficulty after a month's training in the line. Owing to a lack of suitable N.C.Os. the Group felt the need of the full establishment of Officers to carry out the training which was going on while the Group was in action.

(2) *Group in Line (a) (Ponte di Piavé Sector).*—February to March, 1918. The Group went into action on the middle Piave sector and established four posts with telephone communications in 48 hours. Owing to the departure of units to France at this period the counter-battery scheme was not carried out, but this did not prevent the Group from benefiting by their short experience in this sector. Campanile were used and afforded good flash observation over a wide front. The base was a big one, extending over some 9-10 kilometres. A morning ground mist, often lasting throughout the day, prevented day locations. The No. 5 Director telescope was found to be rather inadequate, and a lack of good telescopes prevented advantage being taken of the exceptional visibility which sometimes prevailed. Owing to the natural camouflage which screened nearly all the roads, very little movement was seen on this front. Gun flashes were excellent, and the gun report was often picked up from a great distance. The enemy was sparing with his ammunition, which often hindered simultaneous locations.

(b) *Altipiano di Asiago.*—March to October.—The prevalence of snow over the whole of this sector made the installation a more difficult matter. The left sector was allotted to the Group, and the points afforded for observation were unique. No Group could have experienced better. The altitude of each O.P. enabled perfect flash observation during a battle, and no interruptions were caused by barrage or heavy firing in the forward area. Early morning was usually a period of wonderful visibility. In one instance—a few weeks before the Austrian offensive was launched—troops were observed at a distance of 25—30 kilometres moving in the Caldonazzo Area. The front was interesting from the point of view of simultaneous locations. The prevalence of clouds during the day, and even at night, often produced *nil* visibility to one post, while others enjoyed uninterrupted observation. Many roads were visible only from one point. In cloudy weather, and during periods when the enemy withheld his fire, many results which were neither trisections nor intersections were obtained. Single flashes were invaluable, however, and were invariably accompanied by a time interval.

In many cases it was a matter of no great difficulty to pin-point the position of the battery and easy to direct our fire upon it. Much movement was seen throughout. The enemy, in the course of our occupation of this sector, erected many screens on roads even at 20 kilometres distance from the front. After the introduction of counter-battery work he availed himself of the valleys and hollows which the mountainous region afforded. This produced many screened or diffused flashes, and covered guns from direct and easy observation. A number of very successful shoots were carried out by the Group, and owing to the scanty protection in enemy positions these often caused exceptional fires and explosions. In one case a tri-section was obtained on a battery during its first five rounds, and a fire was produced by the first neutralizing round. Calibration points were chosen and fixed, and batteries frequently ranged on these points. The Watkins O. of F. Instrument was found to be excellent despite its weight. Gifford and French "longvue" telescopes were admirable additions to the Group Stores. The No. 5 Director was discarded.

Pack animals were used, but owing to the circuitous routes which had to be followed, the rationing of posts was not an easy matter. Telephone communications with C.B.S.O., H.A., Balloons, and Intelligence G.H.Q., were excellent, and information was easily passed through to all these formations.

The Group was fortunate on the 15th June in managing to maintain their communications, despite the disconnections caused by heavy shelling.

Owing primarily to the excellent weather conditions which often prevailed, and to the nature of the front, the existence of an organised system of observation in this sector was more than justified.

(c) *Piave—Montello—Maserada.—October, 1918.*—The Group moved straight into position in a short space of time. In the case of this sector previous experience was useful, but very few observation points existed that suited flash spotting requirements. Tree O.Ps. which might have met the needs of most battery observers were of no use owing to the impossibility of fixing up the instruments. Little or no time was available to carry out any construction. Houses were found to be the best points, and these only met the needs of the work when near to the line. The contrast between this front and the previous one was remarkable. No country could have been less suitable for ground observation than this, and the difficulties were made greater by the destruction, wrought by the artillery, of the most conspicuous houses and churches. The best points were known to the enemy and frequently shelled. Despite the difficulties referred to, both flashes and movements were located. Observers were interested by the change and showed enthusiasm.

#### Suggestions.—Establishment and Requirements.

In a short space of 10 months, during which time three fronts were covered in turn, the following points presented themselves:—

(a) *Transport.*—Owing to the size of the front over which the British force were liable to operate, the establishment of transport at times failed to suffice. Ford cars failed miserably in the mountains, and were

generally driven by unreliable drivers. Provision might have been made for an exchange of H.T. and M.T. vehicles, according to the nature of the front. Maltese carts, which were admirably suited for the plains, proved quite useless on the mountains—even when fitted with brakes—owing both to their weight and to the difficulty of using more than one horse on the narrow roads, which was necessary on every occasion. Pack saddlery was much used, even on the plains when roads became too bad for carts.

A lorry was badly needed in order to move quickly, the H.T. being insufficient to transport a Group H.Q. and four posts in one journey. Very often the unit was extremely awkwardly situated for rations, being either in advance or to a flank. The H.T. was quite unable to draw rations owing to distance, and in the absence of additional help this would have prevented work going forward.

(b) *Stores.*—To enable a Group to get into action in the minimum amount of time, it ought to be able to act without being dependent on the Trig. Section or Drawing Office. A Theodolite, &c., should be provided to allow of fixings by Groups. Boards for plotting and O.Ps. should form part of Group Stores, and be made and renewed by them. It would have entailed a waste of much valuable time to have to send this work away. A stronger type of head and breast receiver was needed to stand the rough wear.

(c) *Personnel.*—The work encountered with lines made it absolutely necessary to use observers for both laying and repairing. Provision might have been made to have all observers trained as linemen and signallers. The Group had invariably to lay its own O.P. lines. A specially trained draughtsman, who should be a computer, in addition to the draughtsman clerk, could have been fully employed. The former was required for the making and renewing of plotting boards, O.P. boards and diagrams, and the latter to keep records and be responsible for reports of results and shoots, which, if they are to be properly kept, require one man who has

nothing else to do. It was found necessary to have each observer thoroughly acquainted with his instrument, not only for its manipulation, but for the adjusting and repairing which is always necessary. An instrument mechanic would be an asset to a Group. Power might be given in the establishment to have a reliable N.C.O. i/c H.T., A.S.C. Only unpaid acting rank was allowed to this arm of the service, and it was found a matter of difficulty to enforce discipline with such "attached" men. A proficient farrier was much needed—shoeing being a great difficulty always. Such domestic wants as haircutter, tailor and boot repairer, were felt, as even Company H.Q. had no such men on their establishment.

(d) *Disposition of Personnel.*—It was found possible to establish Group H.Q. in the immediate vicinity of the centre O.P. This naturally enabled close supervision of shoots and observation by Officers of the Group. In many cases it was found more practical to concentrate the transport at the Group H.Q., but in others essential to have each post complete with cart and horse. The personnel of the fourth post were employed on lines and reinforcing the other posts in some cases, and this kept up the strength of the posts in the absence of reinforcements.

(e) *Co-operation with Artillery.*—A considerable amount of work was done in connection with the calibration and ranging of our own Heavy Artillery, and undoubtedly the best results were obtained by correcting on the M.P.I. of five or more rounds, but here the Observation Groups were handicapped in three ways, in each of which considerable improvements might be arranged. Firstly, owing to the non-existence of Hotitzer shells with time fuzes, no air burst ranging could be done, though the country was most suitable for this, and many rounds of ammunition could have been saved had there been a supply. Secondly, telephone communications with H.A. Brigades were bad as a whole, there seems no reason why Observation Groups should not, as a matter of course, have a direct line to H.A. Brigades, as is the case with Balloon Sections, and

much time and annoyance could thereby be saved. Thirdly, there was a tendency for Observation Groups to be called in at the last moment, with no previous notice, when aeroplane observation had failed and the conditions were very difficult.

Closer liaison between H.A. Brigades and Observation Groups would improve this, and it is to be hoped would lead to increase of confidence.

Interesting work in the way of ranging was also done with the Field Artillery, and improved liaison between Groups and D.As. would prove that the former could frequently be of great service in calibrating batteries. No firing experiments were tried, which was a pity, as interesting results might have been obtained.

(f) *Conclusion.*—It might be recorded that the fact that the Group changed its sector and assumed a more or less mobile state tended to increase the men's interest in the work and the general efficiency of the unit. The observers showed less tendency to regard events in the enemy lines as normal, and were able to draw useful comparisons.

With a few additions to the Establishment an Observation Group could be made a complete mobile unit, and able to take its place in line with the artillery under almost any conditions.

## VI.—"E" SOUND RANGING SECTION.

1. MONTELLO FRONT.—"E" Section arrived at Padova on the 7th January, 1918. On the 8th January an advance party proceeded to Montebelluna for the purpose of reconnoitring a sound-ranging base from Monte Salder to the Montello.

At a meeting of the Field Survey Company and the R.A. it was decided to make "E" Section responsible for all guns north and north-east of the Montello. The advanced party accordingly moved to Giavera on the 12th,

Owing to the broad No Man's Land afforded by the River Piave, it was possible to place the microphones well forward, in most cases within 2 000 metres of the southern bank, with the O.Ps. on the northern and north-east edge of the Montello, immediately overlooking the River Piave. The microphones were placed on a straight line, facing approximately N.N.E., four on the Montello itself and two on the plane to the east, with a distance of 1,519.2ms. ( $4\frac{1}{2}$  sound seconds) between each pair of microphones.

Conditions were generally favourable to sound ranging, N.E. being the prevalent wind. Hostile artillery activity was not great, but a high percentage of guns firing was usually located, there being exceptionally few days of *nil* locations.

The wind was generally gent'e, and consequently variable; otherwise conditions were not dissimilar to those prevailing in France.

The section went out of action on the 25th March, the cable being picked up in three days.

2. ASIAGO PLATEAU.—An advanced party moved to Lugo on the 14th March for the purpose of reconnoitring a microphone base overlooking the Asiago Plateau. It was immediately recognised that a regular base would be impossible, and that each microphone position would have to be carefully chosen. Two alternative bases were presented:—

(1) From Busibollo across Magnaboschi and Langa-bisa to Cime Taglio.

(2) From Mte. Pau across Cma. del Porco to Mt. Cimone.

Owing to the fact that the forward base lay right across our battery area and would involve a great length of cable, it was decided to take up our line on the second range of mountains. It was also believed that, as the second range was very much higher than the first, it would probably pick up sound better. This was afterwards found to be the case. All microphone positions were chosen and surveyed by the end of March.

Microphone positions were chosen with a view to:—

(1) Good hearing (near summit on forward slopes of mountains).

(2) Possibility of survey.

(3) Distances apart and line of microphones as nearly as possible regular.

(4) Good routes for cable.

Conditions (1) and (3) were conflicting. Condition (4) prevented the two eastern microphones from being placed as far forward as had been desired.

The base was consequently very irregular, which made computing very difficult, especially when many guns were firing.

Owing to the shortage of cable, the cable that had already been used on the Montello had to be relaid on the mountains. This caused us a great deal of trouble the last few months on the mountains. For the same reason, only one O.P. could at first be established.

The Ford car and the Ford box car were found incapable of standing the strain of mountain work for any length of time. The Daimler 30-cwt. lorry was reported as incapable of ascending the mountains; consequently the Section's transport was of small service in getting into action. Material and cable had been taken up, Headquarters constructed, and men housed before it was possible to bring up the technical stores and start work on line laying. Subsequently the Ford car was changed for a Fiat type 70 and the Daimler lorry for a Fiat 30-cwt. lorry, the Ford box car remaining. These changes greatly relieved the transport problem.

The microphone lines were laid by the Section itself, with one Maltese cart only as transport. The O.P. line was laid by Signals. This work, together with microphone emplacements and O.P. was completed within 10 days of getting the personnel of the Section up the mountain, and the Section was in action on the 27th April. There was immediate trouble with the lines owing to constant blasting in the making of new roads. The Italians attempted to mend the

lines they had broken, so that not only were they incorrectly joined line to line, but the joints themselves were made so badly that they interfered with the efficient working of the microphone system. This trouble was gradually diminished as the linemen became acquainted with the lines and the routes, by diverting lines to avoid bad places.

As the Section became familiar with the mountain conditions, which were new to all ranks, the number of locations increased. The lines, especially the one to the O.P., were badly cut up during the hostile attack on the 15th June, on which day the O.P. was struck by a gas shell. The O.P. was moved and the Section in action again by the evening of the 16th.

The establishment of a Western O.P. on Mte. Ceramella on the 1st July immediately opened up the groups of batteries on and behind Mte. Campolongo. During May and June it was found that, as had been expected, the two Eastern microphones had been placed too far back, both for picking up sound well and for the uniformity of the base. These two microphones were moved forward in the beginning of July. The microphones now lay roughly on an arc of a circle, facing N.N.W., at an average distance of about 1500 ms. (4.6 sound seconds) between neighbouring microphones, the flank microphones being on Il Taglio and Mte. Pau. The improvement, both in facility and accuracy of computing results, was immediately felt. Owing to the shelling both O.Ps. had later to be moved, the West about 200x further East on 27th August, and the East from Mte. Bruscon to Mte. Langabisca on 15th September. Hostile artillery activity had been small during May and June. It was increased considerably after the hostile attack on 15th June. Numerous locations were obtained from the beginning of July onwards. The constant falling of locations on or near the same spot, the closeness of tri-sections from both Observation Groups to the Section's locations, and prisoners' statements (annexed to C.B. Report 4-8-18—5-8-18) tended to show that the accuracy was frequently greater than claimed, although the peculiar wind conditions prevented the accuracy being as high as that obtained in France.

A continuous nine days' period of locations is appended, and comparison made with the total locations in C.B. report:—

		Total locations in C.B. report.	Sound Ranging Locations.
6 p.m.	4-7 to 6 p.m.	5-7 ... 16	10
"	5-7 "	6-7 ... 10	9
"	6-7 "	7-7 ... 17	15
"	7-7 "	8-7 ... 10	10
"	8-7 "	9-7 ... 12	12
"	9-7 "	10-7 ... 9	9
"	10-7 "	11-7 ... 1	1
"	11-7 "	12-7 ... 13	12
"	12-7 "	13-7 ... 11	10

Total: 9 days.

6 p.m. 4-7 to 6 p.m. 13-7 ... 99      88—89 per cent.

Daily average ... 11      10

The number of batteries located in one day frequently exceeded 20, and on the 15th August rose to 24. The Section went out of action on the 8th October, the cable being picked up before moving the personnel on the 14th October.

A complete list of the number of batteries located daily is attached. The Section was not put in action for the Piave battle, but was held in readiness at Treviso to be sent forward if the line should settle down.

*Experience of Sound Ranging in the Mountains.*—It was found that the microphones with the least restricted view of the hostile battery area picked up the sound best, and the higher the microphone the better. The best position for a microphone is probably about 20 feet below the summit on the forward slope of a mountain. Woods had no effect on the passage of sound; on the contrary they formed a most efficient natural wind screening. Gun reports were frequently picked up on all the microphones when inaudible to the Observers on the lower ground in front.

The heavy howitzer in the Grubach Valley was a good example of this. Only on two occasions did the Observer hear the gun report of this howitzer, yet the microphones seldom failed to pick up the sound if the apparatus was set in motion at the right time. As the Austrians usually fired this howitzer under cover of some H.V. gun, the apparatus was set in motion by the O.P. for the H.V. gun, with the result that the gun reports of both gun and howitzer were recorded by the microphones, and both were located from the same record. The rattle of 18-pdr. and 60-pdr. shells across the valley was very confusing to the Observers, but had no effect on the microphones. Echoes were only bad—particularly from the Onde de Choc—when the clouds were low.

The peculiar wind conditions, especially whilst the snow was still on the mountains, and when thunder was about, impaired the accuracy of locations, and frequently made locations impossible even when the sound was well picked up. On some occasions clouds were seen to be blown in four totally different directions at the same time. In the mornings the southerly drift from the plains, caused by the greater warmth on the plain, was unfavourable to sound ranging. This, however, improved when the snow had finally melted. Greater accuracy was obtained by getting fuller and more frequent wind observations from Meteor. Observations were sent from two stations on Mte. Mazze and Mte. Busibollo of winds at surface, and at 5,000 feet, 6,000 feet, and 7,000 feet above sea-level, and were invaluable. The two stations rarely agreed absolutely, and the wind veered with height at an alarming rate. The angle between surface wind and wind at 10,000 feet above sea-level was frequently as much as 180 deg. An essential for sound ranging on the mountains is that all the microphones should be as nearly as possible at the same height. This was approximately the case with "E" Section's base, except that No. 5 on Mte. Busibollo was considerably lower than Nos. 4 and 6 on Cme. di Fonte and Mte. Pau respectively.

It was found that, although the geometrical error involved was small, the wind error for favourable winds (*i.e.*,

winds assisting sound from gun to Observer to a greater extent at 7,000 feet above sea-level than at the surface) was considerable, the readings from No. 5 frequently spoiling good locations.

The microphones were at first inclined to get very damp, owing to the melting snow dripping through the cement barrels originally used for covering the microphones. Special hutches with a double roof, and covered with tarred felt, raised off the ground on struts, had to be constructed.

The continuous thunderstorms were constantly burning out the microphone grids and other delicate instruments. Extensive experimental work was carried out with lightning protectors, with the result that casualties to microphones were reduced, although never entirely eliminated.

The most effective protector, when placed near the microphone, was as follows:—

Three darning needles were adjusted with their points just not touching, one being placed in each leg and one to earth. In addition, an induction coil of resistance 20 ohms to 30 ohms was placed in each line between microphone and protector. It was found that severe electrical discharges burnt away the points of the needles so that protectors had to be changed after every storm. The lines could be put to earth both at H.Q. and at a test box. By the beginning of August it was found possible to save the microphones on the shortest routes always, and nearly all the microphones, if the hostile activity would permit the Section to go out of action during the storm and sufficient warning of the arrival of a storm were given. Finally, even the longer routes were saved by placing a switch in O.P.s. nearer the microphones to enable these microphones to be disconnected or earthed. A monthly list of microphone casualties is appended:—

May.	June.	July.	Aug.	Sept.	Oct.
31	16	28	8	5	0

*Communication with Counter-Battery Office.*—A direct line to Counter-Battery is essential. It was frequently found

possible to inform C.B. of the activity of known batteries at once, sending them the computed pin-point later. It is suggested that numbers be given to previously located batteries, even before the position is recognised on the photograph, as this would simplify the reporting of the activity of these batteries. During July and August the forward field guns and howitzers were moved further back, which made it more difficult to locate these places. Several H.V. guns of various sizes came into action. These were always easy to locate approximately. Some of their characteristics are given in the following table:—

	Greatest recorded Shell Wave—Gun Wave Interval.	Range.	Time of Flight.
<b>B344.164 (Heavy,</b>			
probably).			
21 cm. N.G. ...	8.25 secs. ...	15,500x app. ...	33 secs. app.
<b>H4.H070.980.</b>			
15 cm. N.G. ...	4.95 " ...	11,000x "	
<b>H072.955.</b>			
15 cm. N.G. ...	4.8 " ...	8,350x "	
<b>C790.150.</b>			
15 cm. N.G. ...	4.85 " ...	11,540x " ...	29.4 "
or 13 cm. N.G.	5.15 " ...	10,500x "	
<b>C505.120.</b>			
?12 cm. N.G....	2.1 " ...	13,900x " ...	38.1 "
	3.6 " ...	8,600x " ...	20.4 "
<b>C502.070</b>	... 4.75 " ...	10,100x "	
<b>505.072</b>	... 2.8 " ...	10,400x "	
10 cm. N.G.	... 2 variations.		
<b>C480.120</b>	... 1.7 secs. ...	10,820x " ...	30.97 "
10 cm. N.G.			
3 variations ...	2.6 " ...	11,000x "	
	3.1 " ...	11,000x "	
<b>C325.115</b>	... 3.8 " ...	10,900x " ...	30.2 "
10 cm. N.G.			
2 variations ...	2.8 " ...	9,000x "	
<b>H115.990.</b>			
Hvy. How. 23 cm.(?)	... 8,000x " ...	57.6 "	
	11,400x " ...	52.2 "	
	12,300x " ...	49.7 "	

### Suggestions.

In order to get into action quickly, two 15 cwt. box cars or 30 cwt. Fiat lorries are necessary for the laying of the line alone. A Ford box car is useless for this work, especially on the mountains.

Lightning protectors had to be designed and constructed in the Section. Any turning had either to be done outside or by hand. This caused regrettable delay. A small lathe should be added to the Section equipment to facilitate and hasten the construction of instruments of this nature.

There were only three computers (for some time only two) on the establishment of this Section. It is essential that there should always be at least one computer on duty. In busy times two officers and two computers are kept working at high pressure in order to locate all active batteries quickly. During a ranging shoot the computing staff engaged on the shoot should be kept separate from the computing staff engaged on the ordinary work of locating, in order that ranging should not interfere with locating. Also, in busy times, it takes one computer most of the morning to compile and write reports. It is suggested that the establishment of computers be raised to five. This work requires great intelligence, and cannot be done by any member of the Section.

A type of detachable O.P. (4 ft. 6 in. high by 3 ft. 6 in. by 2 ft. 6 in.) either of corrugated iron attached to scantling, or on the principle of an Armstrong hut, would be of great service. Small barrows or carts, on the principle of the Lewis gun carriage, for transporting the instruments, would be of great convenience in mobile warfare.

The establishment of linemen and buzzer pioneers is just enough. In the event of casualties it is not enough. We frequently had all six linemen out on the lines at once. It is suggested that the establishment of linemen and buzzer pioneers be raised to 10.

In efficient work the Advanced Post Observing Officer should visit at least one O.P. every day. Messages and daily reports have to be taken to the C.B. Officer (sometimes, as on the Montello, to two C.B. Officers). It is suggested that a motor bicycle be added to the establishment,

Number of hostile batteries located daily by "E"  
Section (Sound Ranging) 6th Field Survey Co., R.E.:—

Day of Month.	Feb.	March	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	—	6	—	3	—	2	7	5	—
2	—	1	—	2	—	3	6	1	5
3	—	—	—	—	1	15	1	4	7
4	2	7	—	2	—	15	5	2	4
5	1	3	—	—	—	4	18	1	8
6	4	3	—	—	2	20	7	5	8
7	1	9	—	—	2	18	3	8	7
8	—	9	—	1	1	17	15	3	1
9	5	8	—	—	—	18	2	5	—
10	1	7	—	—	1	—	3	2	—
11	5	7	—	1	1	1	5	6	—
12	2	3	—	1	1	21	13	3	—
13	3	3	—	1	1	14	11	3	—
14	3	6	—	2	3	6	3	6	—
15	—	17	—	1	—	—	24	5	—
16	3	8	—	2	—	8	11	4	—
17	7	9	—	—	—	4	8	9	—
18	2	4	—	3	—	12	1	5	—
19	5	12	—	—	—	6	11	3	—
20	5	7	—	—	—	7	20	5	—
21	9	11	—	1	8	4	4	6	—
22	5	8	—	—	3	—	12	6	—
23	1	—	—	1	1	12	10	—	—
24	1	2	—	1	1	5	14	—	—
25	11	—	—	1	1	2	2	10	—
26	4	—	—	—	3	—	2	—	—
27	4	—	—	—	3	9	3	1	—
28	7	—	—	—	2	6	9	4	—
29	—	—	—	—	—	14	4	3	—
30	—	—	—	3	4	21	1	2	—
31	—	—	—	—	—	10	2	—	—
—	91	150	—	26	39	274	237	117	40

241

733

Daily, approximate:—

3.25 6.25 — 8 1.3 8.8 7.6 3.9 5.7

Total number of locations made:—

Montello ... 435 M. Mazze ... 1,140

VII.—CONCLUSION.

It may appear to some that this account is not complete, nor is it, but the writer has not any data or knowledge of the original formation or work of the Company. Holding, as it did, a position rather different from the old Companies at Army Headquarters, some of the suggested improvements may not apply in the future, and some may have already been anticipated and obtained in France. At times a wider knowledge, by other branches of the service, of the work and capabilities of a Survey Company would have saved time and trouble. Especially was this the case when the 14th Corps became G.H.Q. on General Plumer's return to France, and when the Company moved from Thiene to Treviso.

The country over which the British forces fought for the most part was entirely different from any experienced before, and everyone had to learn how to act and how best to meet the new problems which arose. Most certainly the Company owed a good deal to being under Intelligence, where Colonel Mitchell, C.B., C.M.G., D.S.O., was thoroughly conversant with and knew its powers, and knew personally many of the officers and men. At all times he was willing to do everything to help the Company, and by his sympathy encouraged everyone. A closer liaison with the artillery seemed to be indicated, but it was, on the Asiago Plateau, so difficult to get round to all units and keep touch with the Printing and Drawing Sections at Vicenza, that more could not be done in this direction. After the return of Major Reid the Company seemed to have become very isolated, at any rate from Maps, G.H.Q., France, and a return by Field Survey Battalions of the complementary copies of maps sent by this Company would have been very interesting, and removed the feeling that the 6th, the youngest of Field Survey Companies, was not included in the family circle of its more famous parents in France.

A visit from someone either from France or the War Office would have been much appreciated, and had Major Bragg been able to spare the time to come out "E" Section would have been helped very much, while he might have found some new problem of interest.

Considering the somewhat insanitary conditions of the country, and the rough living in the mountains, the health

of all ranks was good. Influenza epidemic attacked the Company at various times, and there was a very severe outbreak in No. 25 Observation Group at the end of November.

The following awards and mentions have been given to the Company up to 1st January, 1919:—

B.E.O.	... 1	M.S.M.	... 3
M.C.	... 2	Mention	... 7
D.C.M.	... 1	Croce di Guerra	2

### VIII.—APPENDICES.

From 1st January, 1918, to 31st October, 1918:—

Zinc plates used	... ..	294
Litho runs at—		
H.Q.	... .. 606,717	} 698,987
A.P. & S.S.	... .. 76,870	
Civilian firms	... .. 15,400	
Letterpress runs at—		
H.Q.	... .. 245,419	} 264,219
Civilian firms	... .. 18,800	
Photographic negatives exposed	... ..	793
Prints taken	... ..	3,744
Ordoverax impressions	... ..	3,877
Maps issued from 15th January	... ..	324,083
Artillery boards made	... ..	377
Trigonometrical stations fixed	... ..	154
Points fixed for artillery	... ..	225
Kilometres of trench surveyed*	... ..	43
" " roads, etc., traversed*	... ..	218
Square kilometres of topographical survey*	... ..	75

### Battery Locations.

Observation Group.	Quad.	Tri.	Inter.	F. & T.	Fl.	Total.
25	... 8	203	427	66	333	1037
26	... 2	9	9	15	—	35
29	... —	182	337	124	468	1111

Combined results by No. 25 and 29 Observation Group:—

Six-sections.	Quinque.	Quads.	Tri.	Int.	Total.
1	8	14	5	2	... 30

\* On Asiago front only.

Locations made between 18th January, 1918, and the Cessation of Hostilities.

	No. 25 GROUP.					No. 26 GROUP.					No. 29 GROUP.					E (S.R.) SECTION.				TOTAL.				
	Quad.	Tri.	Inter.	F. & J.	Flash.	Quad.	Tri.	Inter.	F. & J.	Flash.	Quad.	Tri.	Inter.	F. & J.	Flash.	Out of Action.	Out of Action.	Out of Action.	X		Y	Z	Approx.	
January ...	—	1	5	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10		
February ...	4	11	16	14	—	2	9	7	14	—	—	1	7	11	—	—	—	—	—	12	90	67	265	
March ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
April ...	—	—	11	2	23	—	—	—	—	—	—	3	15	12	15	—	—	—	—	—	—	—	81	
May ...	1	15	16	4	22	—	—	—	—	—	—	15	18	4	35	—	—	—	—	—	28	14	172	
June ...	3	22	26	5	48	—	—	—	—	—	—	16	52	12	94	—	—	—	—	—	2	16	20	316
July ...	—	33	65	6	47	—	—	—	—	—	—	38	53	11	64	—	—	—	—	—	9	80	149	565
August ...	—	35	68	10	47	—	—	—	—	—	—	59	77	20	80	—	—	—	—	—	4	59	152	611
September ...	—	30	96	7	79	—	—	—	—	—	—	38	89	38	131	—	—	—	—	—	4	54	102	668
October ...	—	56	124	16	67	—	—	—	—	—	—	11	26	16	49	—	—	—	—	—	—	—	865	
	8	203	427	66	333	2	9	9	14	—	—	181	337	124	468	—	—	—	—	31	327	504	3053	

COMPANY OFFICERS AT THE CESSATION OF HOSTILITIES:—

Officer Commanding:—

Major G. F. Jones, B.E.O., R.E.

Adjutant:—

Capt. J. M. Peakman, R.E.

i/c Drawing:—

Capt. L. Hughes, M.C., 6th Battn. Worcester Regt. (S.R.)

i/c Printing:—

2nd Lieut. H. M. Cartwright, R.E.

i/c Compilation:—

Capt. H. L. Hayman, R.E.

i/c Survey:—

Capt. T. H. Galbraith, M.C., R.E.

25 Observation Group:—

Capt. J. A. Slater, R.F.A.  
2nd Lieut. V. H. Woodcock, R.E.

29 Observation Group:—

Capt. H. C. Bradshaw, R.E. (T.).  
2nd Lieut. W. D. Smith, R.G.A. (S.R.).

"E" Sound-Ranging Section:—

Capt. O. I. Burgess, 3rd Battn. Monmouth Regt. (T.F.).  
Sub-Lieut. E. E. Ede, R.N.V.R.  
Lieut. K. H. S. Hague, Canadian R.G.A.  
2nd Lieut. L. Hanuy, R.E.  
2nd Lieut. R. T. Owen, M.M., R.E.

XIV. Corps Topo. Section:—

Lieut. E. Russ, R.E.