British-Canadian Military Cartography on the Western Front, 1914-1918

by **JEFFREY S. MURRAY***

If the number of reference inquiries arriving at the National Archives of Canada serves as any indication of research trends, then we may be witnessing a renewed interest in the military cartography of the First World War. Although it is encouraging to see these documents finally receive some attention, I must admit to some reservations about the manner in which they are often used. Most researchers are interested in war maps simply as illustrations of the textual record. They accept the items without considering the circumstances in which the maps were created, their limitations, or even their reliability. Part of the problem no doubt originates with the almost total lack of information available on First World War maps. Since the publication frenzy by veteran cartographers and surveyors immediately following the war, there has been no new research on this material for more than half a century.[1]

Perhaps, then, this is an ideal time to review the cartographic record of the First World War through a discussion of British series maps, in particular the large-scale topographic maps and trench overlays produced by the Ordnance Survey.[2] These series maps were basic to any military operation on the Western Front and were often used as a foundation for the compilation of more specialized cartographic products. This review should be of specific interest to archivists, insofar as they are more likely to find British topographic and trench series maps in their collections than any other type of First World War map.[3]

The obvious advantage of accurate, large-scale maps to military operations was not immediately apparent to British or Canadian commanders at the outbreak of the First World War. Earlier experiences in South Africa should have alerted senior officers to some of the problems of map production and supply; nonetheless, they were completely unprepared for the variety and quantity of maps that twentieth-century warfare would require. At the commencement of hostilities, for example, the units responsible for providing maps to the British Expeditionary Force only consisted of: the Topographic Sub-Section, General Staff, General Headquarters, which included one officer and a clerk; another officer and clerk attached to Headquarters, Line of Command, which was responsible for reserve supplies; and the Printing Company, Royal Engineers, which looked after reproduction. Three Field Survey Sections had also been assembled by special arrangement with the Board of Agriculture and the War Office, but they were just as quickly disbanded on the grounds that the war was to be fought in a civilized country,

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which had already been mapped.[4] This was a pitifully small beginning, in view of the fact that mapping operations eventually included about 1,200 personnel by the end of the war.[5] The Topographic Sub-Section alone was expanded to nine officers and fifty other ranks.

When the British Expeditionary Force embarked for France in August 1914, it was supplied by the Ordnance Survey with two medium-scale, topographic series maps on the western theatre. One such map covered Belgium and northeastern France at the scale of 1:100,000 (approximately one inch to one and three-quarter miles). Designated as series GSGS 2364 by the Geographical Section, General Staff, the map consisted of 23 separate sheets printed in five colours; waterways were in blue, contours in brown, forests in green, roadways in red, and all other cultural information in black. Contours were drawn in 10-metre intervals. In some cases, the topography was shaded in order to accent the slopes and make the maps more readable;[6] in other instances, the topography was divided into eight altitudinal class intervals, which were colour-coded in various shades of green, yellow, orange, and brown.[7]

The second series provided coverage of France at the scale of 1:80,000 (approximately one inch to one and one-quarter miles). Designated as series GSGS 2526 by the Geographical Section, General Staff, the maps were photographic reproductions of the nineteenth century *Carte de l'État-Major*. Originally engraved, the sheets lacked colour to aid in the interpretation of geographical and cultural features (Figure 1). As well, ground relief in the *Carte de l'État-Major* was depicted by hachures — short lines drawn in the direction of a slope — rather than by contours. Although the hachures were skilfully executed and offered a realistic representation of hills and valleys, they did not provide an accurate indication of elevations.[8]

More detailed maps were not issued to the troops because the medium-scale maps were considered to be adequate for the war of movement that prevailed at the time. But after the opening battles of Flanders in October, the front more or less stabilized, resulting in a continuous entrenchment of the two opposing forces from the northwestern European coast to the Swiss border as each side prepared for a war of attrition.

The entrenchment of ground forces along the Western Front indirectly led to some interesting changes in the methods by which artillery was deployed on the battlefield. Prior to entrenchment, the artillery was used in much the same fashion as it had been in previous wars; that is, it was employed in the open where gunners could see their target and direct their fire accordingly. But with the advent of trench warfare, the artillery also had to assume less exposed positions, well away from the main action. Larger-scale maps were required almost immediately in order to provide battery commanders with an accurate method for calculating the range and bearing of hidden targets from a concealed position. When coupled with other technological advances, such as the telephone and accurate surveys of the battlefield, indirect artillery fire quickly became an effective part of offensive and defensive military strategies.

At first the Ordnance Survey attempted to meet the demands of the artillery by simply enlarging the 1:80,000 French *Carte de l'État-Major* to 1:40,000, but this procedure merely compounded the inaccuracies of the originals. At best, the French map accurately located important features, such as churches and crossroads, to within only 50 yards. The surrounding countryside was even more generalized, being accurate to only 200 yards.[9] Furthermore, the hachure method of relief depiction provided no measurement of the

vertical relationship between a target and an artillery piece.[10] Consequently, the maps were of little value to battery commanders, even when enlarged to the more workable 1:40,000 scale.

Some large-scale maps of France already existed, including the 1:20,000 fortress plans and the 1:2,500 cadastral plans, but these were not very satisfactory: their quality was inconsistent; they were often out of date; and they usually covered only a small portion of the area of military operations. Consequently, by the end of 1914, it had become obvious that a completely new, large-scale topographic map was required. Wherever possible, this new map was to be based on re-surveys of the countryside and would eventually include an area of about 12,000 square miles.[11]

In general, maps covering areas immediately west of the front were produced from a quick plane-table survey carried out in early 1915 under the direction of Major H.S.L. Winterbotham.[12] Maps produced by this method were estimated to be accurate to within 20 to 40 yards. For obvious reasons, plane-table surveys could not be employed in areas occupied by the German army. Consequently, maps east of the front were compiled by the Ordnance Survey from several sources, in particular, cadastral plans, aerial photographs, and the highly questionable *Carte de l'État-Major* when no other coverage existed. The two former sources produced plans that were accurate to within 20 yards. In areas immediately adjacent to the Belgian border, the Ordnance Survey relied mostly on the French fortress plans. Maps produced from the latter were estimated to be accurate to within 30 yards.

For areas in Belgium, the British Expeditionary Force was more fortunate; the Ordnance Survey was able to make direct reproductions of the 1:20,000 and 1:40,000 sheets already published by the Institut Cartographique Militaire. The reproductions could even be printed from the original Belgian plates. The 1:10,000 map, which existed in manuscript copy only, was also rescued from Belgium before the German invasion. Where required, the British base map of Belgium would be primarily a photographic reduction of the 1:10,000 drawing. The only immediate revisions required were those that made the sheets more readable by eliminating some of the detail (for example, by changing the contour interval from one metre to five metres).[13] The final product was estimated to be reliable to within 20 yards.

Throughout the war, military cartographers used every means at their disposal to obtain the latest intelligence and to incorporate this information into their maps (Figure 2). But the most useful source was vertical aerial photographs taken from an aircraft. Initially, cartographic information was updated by simply projecting the vertical image onto a base map by a camera lucida, an instrument for projecting an image onto a flat surface through mirrors and prisms. By this method, detail from the air photograph could be fitted to the map, but if the camera was not perfectly vertical at the time of the exposure, the cartographer ran the risk of plotting a distorted image. Eventually the British developed a procedure for re-photographing the aerial image from the original negative onto paper mounted on a movable easel. By comparing the distance between points in the photograph to the actual known distance recorded in earlier surveys, the easel could be moved to correspond to the tilt in the photograph at the time of exposure, virtually eliminating the distortion.[14]

Although this technique was appropriate for mapping horizontal relationships, it was inappropriate for measuring topographic relief, and could not be used to draw contours.

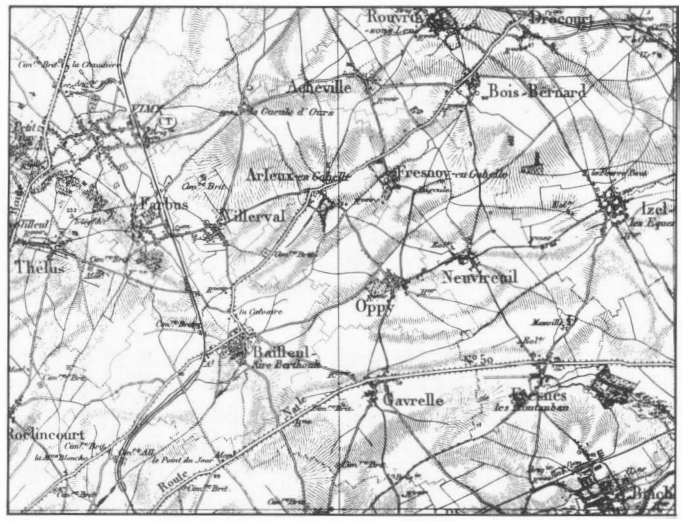

Figure 1: *This extract from the 1:80,000 French map shows the small town of Vimy where Canadian troops attained a significant victory against the German Army in April, 1917. Although the 1:80,000 series was well known for its inaccuracies, the series served as the backbone of French mapping for more than a century. Both the Allied and Axis nations reprinted the series even as late as the Second World War. This extract was selected from a sheet reprinted in 1941.* Courtesy: National Archives of Canada, C-132036.

Figure 2: *Kite balloons such as this one over Arras, France, were widely used to reconnoiter the countryside behind the German lines. Intelligence compiled from such sources would be added to map updates on a regular basis.* Courtesy: National Archives of Canada, PA-3651.

Therefore, in areas where plane-table surveys could not be carried out, the Ordnance Survey was required to rely on the levels recorded from earlier surveys of France, specifically, the Nivellement Général.[15] Cartographers had to convert these measurements into contours by following the shape of the ground as indicated by the hachures in the *Carte de l'État-Major*, amended wherever possible by mine and railway plans.

Archivists who undertake research on the maps of the Great War will find that it was rather common for troops at the front to complain about the accuracy of the contours on Ordnance Survey maps. The troops frequently found that captured German maps bore different contours. The British troops naturally assumed that the Germans had studied the ground they occupied and had drawn their contours to give an accurate representation of the topography.

The Germans, however, used the same sources as the British for their contour depictions. Differences were actually the result of carelessness on the part of German cartographers, as well as a general indifference to good quality maps.[16] For example, some German war maps in the collections of the National Archives of Canada were even left with the French hachures; the contours were never plotted. Apparently, the British were able to run tests on both maps and concluded that the contours on German maps were indeed less accurate than were the contours on their own maps.[17]

The compilation of any map, even if it is drawn from air photos, requires a good network of triangulation stations to bring together the features measured by the surveyor. Fortunately, both France and Belgium had already established national triangulation networks prior to the war, and the French Admiralty had also established triangulation stations along the coast. Other stations interconnected points along the French and Belgian borders, thereby making it possible to relate the surveys of both countries. In the end, most churches, windmills, and other outstanding features within the area of operations had been fixed by at least one of the four systems.

It was a major responsibility of field survey units to maintain this network of triangulation stations. Because the stations were usually prominent features, such as church towers, and were easily visible from a distance, they were frequent targets for the opposing army's artillery. When a triangulation station was destroyed, field survey units were responsible for re-establishing the point or an alternative. Survey units were also required to fix, by intersection, all recognizable features visible by theodolite behind the German lines. These new points would then be used to push the triangulation network forward, if the front should advance, and would ultimately prove useful for compiling maps showing the German lines.

The new maps produced by the British Expeditionary Force to support operations along the Western Front were of three scales: 1:10,000, 1:20,000, and 1:40,000.[18] For the most part, the three series were identical, having been drafted first on the 1:20,000 scale and then either enlarged or reduced to the other two scales.[19] Judging by the items held in the National Archives of Canada, the maps were printed by the Ordnance Survey in one to five colours. The 1:40,000-scale (GSGS 2743) maps were the most elaborately coloured, although some sheets were also produced as monochromes. The larger-scale 1:10,000 (GSGS 3062) and 1:20,000 (GSGS 2742) maps were typically less colourful: they were printed in one to three colours, with black, brown, and blue predominating. Because the application of each colour required a separate run through the printing press, the number of colours added to each sheet were probably dependent on how urgently the map was required.

As with the 1:100,000-scale maps of Belgium and northeastern France (GSGS 2364) discussed earlier, a small number of the 1:40,000 topographic map was also published in a layered edition — that is, major changes in altitude were colour-coded. This added feature made it slightly easier for inexperienced personnel to read the maps, an important attribute considering the hasty military education given to some officers. Once again, because of the extra demands the additional colours put on the printing presses, distribution of the layered edition was necessarily limited, usually to commanders of formations and staff.[20] Archivists may find in their collections the occasional sheet from the 1:20,000 and 1:10,000 topographic maps that has also been layered. These sheets will have been either hand coloured or will have been printed by one of the Field Survey Battalions. No layered maps larger than the 1:40,000 scale were produced as part of the regular issue.[21]

Once basic information on the cultural and physical characteristics of the countryside had been compiled into a topographic map, a detailed plotting of military defences could be undertaken. The procedure entailed the conversion of the multi-coloured topographic map into a monochrome base map, coloured grey or black. Intelligence information on military organization was then added as an overprint. In this way, the intelligence could be easily updated to reflect the quickly changing situation on the battlefield without the trouble of changing the base map each time. Changes to the overprint were dated at the top of the map. In the interest of security, only information on German defenses was at first shown, and this was provided as a red overprint.[22] By July 1917, details on the British defences were also being overprinted, but in blue, and the information was limited to only the first 600 yards back from the front. To the uninformed, this discrepancy in the two mappings makes the British lines appear significantly less complex than their German counterparts.

Throughout this period a secret edition of the 1:10,000 map that showed all the British trenches was also being published. Although it gave no information on the British trenches, other than their complete layout, the series was still issued in small numbers and was given a very limited distribution (e.g., one map per Infantry Brigade). This move was justified by senior command on the grounds that, if the map were captured, the Germans would then no longer have to go to the trouble of photographing the British lines.

In reality, however, the Germans were acquiring the information anyway, because many frontline soldiers carried their own sketches to help them find their way about the maze of trenches. These "home-made" sketches carried all sorts of information and were far more revealing than a regular map, issued under proper controls. The irony of the situation became obvious when it was pointed out that some frontline toops were so desperate for information on their own trenches that they were using captured German maps!

For much the same reasons, there was also resistance against the issue of a 1:20,000 map showing all the British trenches. Consequently, the trench plans that accompanied such official correspondence as monthly defence schemes and reports on defence lines had to be individually hand-drawn on regular topographic maps by each field unit, resulting only in a waste of labour.

Gradually, senior commanders began to recognize the benefits to be gained by providing the troops with a tracing of their own trenches, even if the information should fall into enemy hands. "It became evident that there was no reason for secrecy in showing the

trace of our [British] trenches, provided that no really secret details were inserted. Such secret details obviously include battery and trench mortar positions, command posts, ammunition stores, telephone routes, [used and unused trenches], etc.; in fact any detail which cannot be readily located and plotted from air photographs."[23] Consequently, by January 1918 the 1:20,000 and 1:10,000 trench overlays began to show the British trenches in full detail.

From early 1915, information on German trenches and barbed wire was plotted onto the British 1:10,000 topographic map from air photos, either by measuring from points of detail or by reflecting the image by means of a camera lucida. The method worked reasonably well in closed country, where there were fences and roads from which the positioning of the information could be verified, but was less accurate in more open country. Apparently, the error factor in positioning was seldom more than 20 yards.[24] Errors in registering the overlay on the paper during the printing process sometimes occurred, and could drastically exaggerate inaccuracies resulting from poor data compilation.[25]

To prevent mistakes in their identification and to facilitate their use in military reports and orders, all British series maps were given unique numbers and, in some cases, unique names. The British method of referencing trench maps was based on the system used in Belgium. Areas in France were made to conform by simply extrapolating the system westward. The Belgian system placed the principal meridian through Brussels and used a grid overlay that divided the country into blocks, each of which measured 32,000 metres (east/west) by 20,000 metres (north/south). Each block in this grid constituted a single map sheet at the 1:40,000 scale and listed as its coordinates the distance from Brussels. Each block in the Belgium grid was also designated by a unique number ranging from 1 to 71. The blocks that extended into France were given the number of the westernmost block in Belgium and were distinguished from other blocks in the row by a letter suffix. For example, the blocks extending into France west of the Belgian block 62 were numbered 62A, 62B, 62C, and 62D. These numbers then also became the reference numbers for map sheets in the 1:40,000 series.

The 1:40,000-scale trench and topographic maps were overlaid with a reference grid that divided each sheet into 24 squares, four rows of six units each. The squares along the two inside rows measured 6,000 yards square; the two outside rows were slightly smaller, each measuring 5,000 yards north-south by 6,000 yards east-west. The grid was placed with its central point in the middle of the 1:40,000 sheet and was allowed to overlap the sheetlines — which were cut along metric gridlines.[26] The 24 units were identified by the upper-case letters "A" to "X" and were further subdivided into 1,000-yard squares, which were numbered from 1 to 36 in the case of the larger squares and 1 to 30 in the case of smaller (Figure 3). Each of the 1,000-yard squares was then quartered into four minor squares measuring 500 yards on a side. Beginning in the northwest corner, the minor squares were lettered from "a" to "d".

A reference point would be located by dividing each axis of the minor square into tenths and measuring its distance west to east along the southern side of the square, then south to north along the western side. The southwest corner of the minor square was always taken as the point of origin. For example, the complete reference for the crossroads located in the village of Troy in Figure 4 would read 62^{c}.T.18.d.9580.

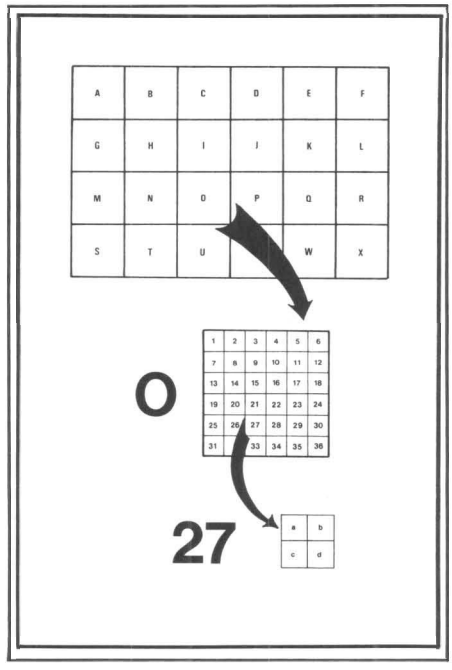

Figure 3: *The grid overlay from a 1:40,000 map.*

Figure 4: *An extract from a 1:10,000-scale trench map, sheet 62C S.W.4.* Courtesy: National Archives of Canada, C-131732.

The British system of squaring was intended mainly for the identification of reference points. It has already been pointed out that the grid did not conform to the metric coordinates of the individual sheets. According to Colonel Charles Close, the metric grid was not adopted because it was thought that the army would not accept it; personnel were not accustomed to working in metric and it was felt that they would find the conversion difficult.[27] Consequently, the system proved somewhat awkward because it required the user to convert survey coordinates, as expressed in meters, into map references, and vice versa. It was not until June 1918 that the British agreed to change their grid overlay to the more convenient metric system, which combined map references with survey coordinates, a system similar to one already employed by the French. The decision to make this change was partially initiated in response to a special inter-Allied conference on map uniformity. The war ended before the change could be implemented.[28]

Subsequent enlargements of the 1:40,000-series trench map used the same grid system. Each sheet in the 1:20,000 series covered only one quadrant, which would be identified as N.W., N.E., S.W., or S.E., depending on its position within the 1:40,000 sheet (Figure 5). For example, a 1:20,000 enlargement from the lower left corner of the 1:40,000-series sheet 57 would be referred to as sheet 57 S.W.

A 1:10,000 enlargement followed the same pattern by dividing the 1:20,000 sheets into quadrants. These were numbered in a clockwise direction starting with the northwest quadrant. Each sheet was also provided with the name of one of the principal cities or towns in the area. A 1:10,000 map sheet from the northeast quadrant of the 1:20,000-series sheet 36 S.W. would, therefore, be identified as sheet 36 S.W. 2 Radingham.

The 1:20,000 series was the more popular topographic map used by British and Canadian forces. As a base map, the scale was well suited to accept a variety of overprints, which featured specialized "target" and "position" information on enemy trenches, railways, dumps, machine gun and mortar emplacements, wire entanglements, and observation posts (Figure 6). The series was especially preferred for medium and heavy artillery, and for counter-battery work. The 1:10,000-series map was also used by field artillery but was primarily intended as an infantry trench map.[29]

To meet artillery needs, the maps were usually cut into squares and pasted to an Artillery Board, which was designed to allow the accurate plotting and measurement of bearings and distances. Because fluctuations in humidity and temperature can cause paper to expand or contract more in one direction than in another, it was important that the board be coated with a material that was not susceptible to changes in the weather. The preferred construction of Artillery Boards was a zinc sheet mounted on a wooden board or frame. By the end of the war, survey units assembled more than 11,000 boards for the artillery.[30]

Until the end of 1917, most map reproduction and printing for British and Canadian military purposes was undertaken by the Ordnance Survey (OS) in Southampton. Usually the maps were shipped from Southampton to Portsmouth, then carried by steamer to Le Havre and on to Rouen, Abbeville, or Calais. More urgent materials went by train through London to Folkestone, across the Channel to Boulogne, and thence to General Headquarters.[31]

Although the Survey's presses provided an impressive 32 million sheets over the course of the war,[32] the supply line between France and England was subject to transportation delays and enemy action in the Channel. Accordingly, the Overseas Branch of the

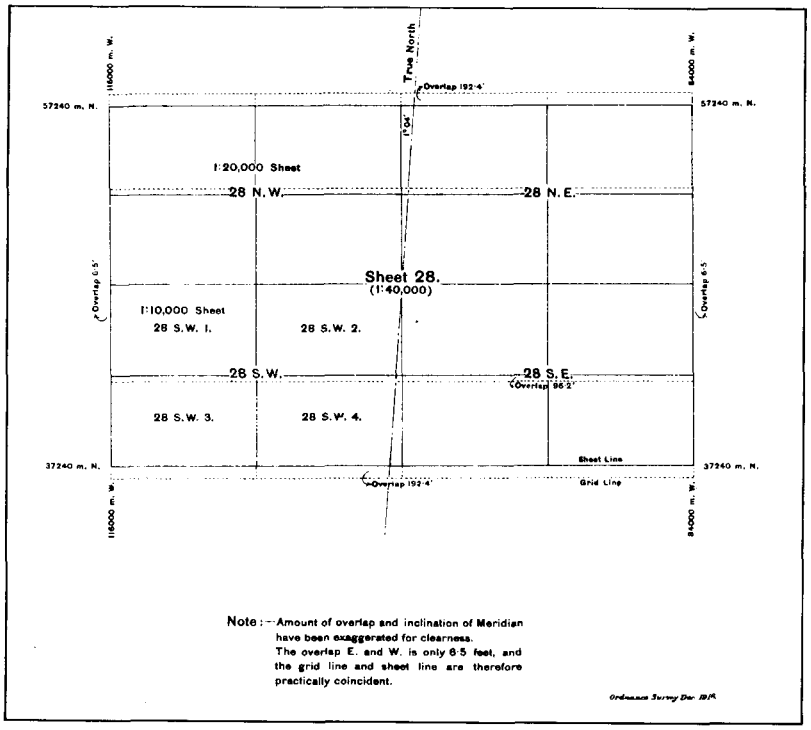

Figure 5: *The system used to subdivide large-scale British series maps of the Western Front. Source: Great Britain. General Staff.* Maps and Artillery Boards, *London, 1917.*

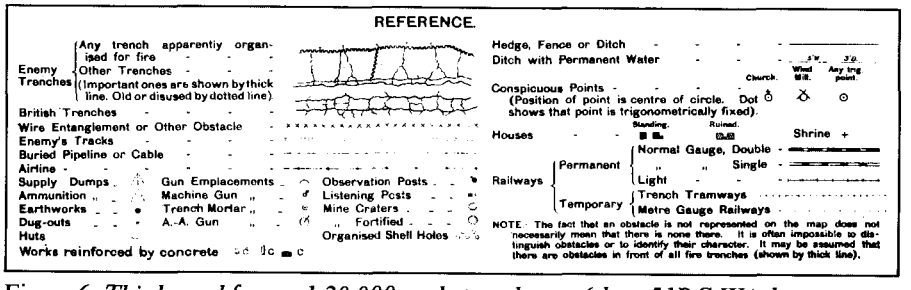

Figure 6: *This legend from a 1,20:000-scale trench map (sheet 51B S.W.) demonstrates some of the sophisticated overprints used by British cartographers to summarize intelligence data.* Courtesy: National Archives of Canada, C-131730.

Ordnance Survey (OBOS) was established in France to meet printing requirements for large-scale maps and for more urgent work. The OBOS was initially established at Wardrecques, near St. Omer on the Aire Canal, and had a total complement of two officers and 149 enlisted ranks, of whom 46 were from the Women's Auxiliary Army Corps. It began production just before the German spring offensive of March 1918, and was in operation for only four months before pressure from the German advance forced a move to Aubengue, near Boulogne. Despite the short period at Wardrecques, the four OBOS presses contributed more than one million sheets to the war effort. The Aubengue facility had equally impressive production statistics to its credit. During the final British assault in August, the presses produced a phenomenal 400,000 impressions in just 10 days.[33]

Each Field Survey Company also had its own printing facility, which generally consisted of a small, lithographic hand press or an apparatus for photographic copying. All printing machines were the flat-bed variety and initially could handle only small-format papers. Towards the end of the war, larger machines were supplied which could accommodate paper sizes up to 22½ by 35 inches. By late 1917, the Field Survey Companies were also equipped to copy photographically the regular series sheets, which then functioned as base maps for the production of specialty sheets. As the Field Survey Companies acquired the proper equipment, they were able to print and overprint regular series sheets for themselves without relying on the Ordnance Survey.[34] The field presses were intended for productions with limited distribution, such as specialty maps required by small units for a particular operation. This does not mean that the field presses were less important than their counterpart in the Ordnance Survey office. Indeed, during the battle for Cambrai in November 1917, the field presses alone produced more than 180,000 sheets.[35]

Canadian units also made extensive use of photocopying methods. The holdings of the National Archives of Canada contain many examples of large-scale blueprint maps, which were produced by the simple process of "sun printing." This process duplicated a hand-drawn map, at the same scale as the original, onto light-sensitive paper. The original, which would be drawn on a transparent paper, such as tracing paper, was simply laid on top of the sensitized paper and exposed to the sun. The resultant map was a monochrome image (white lines on a blue background) of the original. In some cases, colour would be applied to the map by hand, after the copying was completed. Depending on the quality of the sensitized paper and the weather, it could take several days to make only a dozen copies of a single map.[36]

Maps were distributed by the Ordnance Survey to Corps and Divisional Headquarters on a daily basis, as well as to any other units that might have special needs. A day's run for a "map" car might be anywhere from 40 to 100 miles on roads that left much to be desired, using a vehicle that was not always reliable.[37]

According to directives from senior command, all maps were to be treated as "secret" publications. They were not to be sent out of the country without the permission of General Headquarters, or to be issued to formations below the level of Brigade Headquarters. In theory, their circulation was to be strictly controlled by giving each item a serial number and by keeping a record of its distribution.[38] Departures from this practice appear to have been frequent, a fact which is not surprising given the volume of material that was produced and circulated on a regular basis. This probably explains why few of the maps

in the holdings of the National Archives of Canada have serial numbers. Illegible and torn maps were replaced without reprimand, but the loss of any item was not taken lightly.[39] Despite such control measures, it was not uncommon for enlisted ranks to acquire maps. As the number of war maps that have appeared in private papers collected by the National Archives of Canada will attest, many trench maps were apparently kept by the troops as souvenirs of battles. Sometimes, they were even sent home to families by ordinary post.[40]

As was mentioned earlier, the Canadian Expeditionary Force relied heavily on both the topography and trench series maps produced by the Ordnance Survey. In some collections, archivists may find maps that are attributed to the Canadian Corps Topographic Section, Canadian Engineers. However, these items were likely re-issues or enlargements of maps that had been published previously by the Ordnance Survey. They were probably re-issued by the Canadian Corps to meet specialized, but limited requirements.

The Canadian Corps Topographic Section produced mostly large-scale, specialty maps, such as plans of redoubts, batteries, and other units of defence. Because these maps frequently accompanied field reports, they were often in manuscript format, or were produced in limited quantities by small hand presses or by "sun printing." On 14 May 1918, only six months before the end of the war, the Canadian Corps Survey Section was formed, with a strength of five officers and 172 men. Under the command of Captain W.R. Flewin, the new unit absorbed both the Corps Topographic Section and the Intelligence Observation Section.[41] Despite its impressive name, the new unit was not a major map producer. Instead, it was mainly given counter-battery duties, including the fixing of Canadian batteries and the accurate location of enemy artillery positions through flash spotting and sound ranging.

Although the Canadian Corps relied heavily on its British counterpart for most of its regular series maps, this does not imply that maps were any less important for Canadian military purposes. Consider, for example, the Canadian assault of April 1917 on Vimy Ridge, a single operation which included the heaviest artillery bombardment of German lines in the entire war to that point. Some 40,000 maps were used, many of which were distributed to troops at the front. Entrusting maps to the common soldier was an unprecedented practice in British military circles. In addition, many of the trench series maps of Vimy were published in ten updated editions. Obviously, Canadian commanders were demanding accurate information for their artillery, as well as the latest intelligence in preparation for the battle.

The cartographic record provides an unique perspective on the history of the First World War. Since the earliest maps date from the period of the first engagements along the Western Front, the cartographic record offers the necessary time depth for studying changes in military tactics, especially as they relate to trench warfare. In addition to their obvious usefulness for researching technological achievements within the field of military cartography, the maps of the First Word War also indirectly document technological innovations in other areas of early twentieth-century warfare, such as the methods of engaging artillery fire. This interrelationship between maps and various technological developments underlines the important role played by the cartographic record throughout the Great War. It should also remind researchers and archivists alike that the maps of the First World War are important records in their own right and, if they are to be fully appreciated, they must be examined as meticulously as any other record form.

Notes

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1 The only exception would be Peter Chasseaud's recent *Trench Maps: A Collectors' Guide. Volume 1, British Regular Series 1:10,000 Trench Maps, GSGS 3062* (Lewes, E. Sussex, 1986).

2 A series map consists of many sheets, all of which share the same scale and design specifications. The sheets form a common grid and fit together to cover a large area.

3 Other series maps produced by the British military in support of operations on the Western Front included: administrative maps; intelligence maps; artillery maps; and engineering intelligence maps. However, these series were never produced in the same large quantities as the topographic and trench series maps considered in this paper and are, consequently, less likely to be found in collections.

4 Great Britain. [General Staff]. *Report on Survey on the Western Front 1914-1918.* (London, [1936]), pp. 5-16

5 H.S.L. Winterbotham, "Geographical Work with the Army in France," *The Geographical Journal* 54 (1919), p. 13.

6 For example, see sheet number 17, dated 1-10-16, or sheet number 28, dated September 1917. Both these sheets are held in the collections of the Cartographic and Architectural Archives Division, National Archives of Canada (hereafter NA).

7 For example, see sheet number 18, St. Quentin, dated October, 1918. This sheet is held in the collection of the Cartographic and Architectural Archives Division. NA.

8 A more complete description of this series is provided by [Gerald Maxwell]. *The Military Map: Elements of Modern Topography* (French School of War), (London, 1916).

9 Great Britain. General Staff. *Maps and Artillery Boards* (London, 1917), Fig. 6.

10 Knowing the lay of the land is absolutely crucial for accurate artillery fire. If a target lies on ground that is substantially higher than the gun, then the shot will fall short. Conversely, the opposite is true when the target is lower than the gun. Crest clearance must also be checked to ensure that high ground does not lie along the line of the shell's trajectory.

11 Winterbotham, "Geographical Work with the Army in France," pp. 13-14.

12 A plane-table is a device for plotting the lines of a survey directly from observation. It consists of a drawing board, which is mounted on a tripod, and a leveling device. It is used with a special telescope, or alidade, for sighting on a graduated rod, or stadia. The three instruments are used together to measure and plot survey points.

13 *Report on Survey on the Western Front*, p. 18

14 A more comprehensive description of First World War aerial photography and map production is provided by Lieutenant-Colonel M.N. MacLeod, "Mapping from Air Photographs," *The Geographical Review* 53 (June 1919), pp. 382-440.

15 Great Britain. General Staff. *Notes on Levels in Northern France and Belgium* (London, 1917), p. 13.

16 Arthur R. Hinks, "German War Maps and Survey," *The Geographial Review,* 53 (January 1919), pp. 30-44.

17 For example, see NA, Records of the Department of Militia and Defence RG9 III, C5, vol. 4397, folder 7, file 2; Maj. C.R. Bertram to 1st, 2nd, 3rd, 4th Can. Divisions, and Can. Corps Headquarters, 16 June 1919.

18 Throughout 1914-15, the Ordnance Survey experimented with a topographic map in which the sheetlines were measured in yards to correspond to the British system of artillery squares. The maps were known as the "B" series and were numbered GSGS 2742 A. Only a few sheets were produced for the series before it was cancelled in favour of sheetlines that followed the Belgian metric system.

19 Great Britain. General Staff. *Maps and Artillery Boards*, p. 5.

20 Several attempts were made throughout the war to produce a layered map using a variety of shades of a single colour (and thereby requiring only one extra printing). The intention was to produce a map that would be easy to read but would not place too much extra demand on the printing presses. Unfortunately, the attempt did not meet with much success. See: *Report on Survey on the Western Front*, pp. 45-66.

21 *Ibid*, p. 46.

22 With a few exceptions — and these will be noted on the sheets involved — this colour arrangement was used until the summer of 1918 when it was reversed to conform to French maps. See NA, RG9, III C5, vol. 4386, folder 8, file 8; Maj. Gen. G.P. Dawnay to the 3rd Army, 24 June 1918.

23 *Report on Survey on the Western Front*, p. 48.
24 Great Britain. General Staff. *Maps and Artillery Boards*, p. 5.
25 *Ibid.*
26 The grid projects beyond the sheetlines by almost exactly 500 yards on the east and west sides, and 61 yards on the north and south sides. By dropping one row of 500 yard squares on the east and west sides, the grid could then be made to coincide with the sheetlines. On a 1:40,000 sheet, only half of the 1,000 yard squares appear along the east and west margins (only units "b" and "d" appear along the west side, and units "a" and "c" on the east). Along the north and south sides, however, the grid was allowed to project the 61 yards beyond the sheetlines (*Report on Survey on the Western Front*, p. 160).
27 Colonel Close makes the comment in H.S.L. Winterbotham, "British Survey on the Western Front," *The Geographical Journal* 53 (April 1919), pp. 271-73.
28 NA, RG9, III C5, vol. 4386, folder 8, file 8; Maj.-Gen. G.P. Dawnay to the 3rd Army, 24 June 1918.
29 Chasseaud, *Trench Maps*, p. 5.
30 W.A. Seymour, ed., *A History of the Ordnance Survey* (Folkestone, Kent, 1980), p. 225.
31 *Ibid*, p. 224.
32 Winterbotham, "Geographical Work with the Army in France," p. 17.
33 W.A. Seymour, ed., *A History of the Ordnance Survey*, p. 233.
34 This description of printing methods has been abstracted from Peter Chasseaud, *Trench Maps: A Collectors' Guide, Volume 1, British Regular Series 1:10,000 Trench Maps, GSGS 3062*, p. 4.
35 Winterbotham, "British Survey on the Western Front," p. 270.
36 One such incident is recorded in correspondence between the Commander, Royal Engineers, 4th Can. Div., and the 11th Can. Inf. Brigade; see NA, RG9, III C5; vol, 4373, folder 19, file 2.
37 Winterbotham, "Geographical Work with the Army in France," p. 18.
38 NA, RG 9 III C5, vol. 4403, file 1, folder 7; memo from Maj.-Gen. H.B. Williams, General Staff, 2nd Army, to 1st Canadian Divisional Engineers, 23 March 1916.
39 For example, see NA, RG 9 III C5, vol 4386, file 8, folder 8; letter from Capt. G.S. Cunningham, 3rd Can. Div. to Commander, Royal Engineers, 3rd Canadian Division, 8 June 1918.
40 NA, RG9 III C5, vol 4403, file I, folder 7; Williams to 1st Can. Div. Engineers.
41 A.J. Kerry and W.A. McDill, *The History of the Corps of Royal Canadian Engineers* (Ottawa, 1962), pp. 249-50.