A Good Map Is Half The Battle! The Military Cartography of the Central Powers in World War I

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Abstract During World War I the Central Powers (Germany, Austria-Hungary, Bulgaria and the Ottoman Empire) were burdened by the heterogeneous structure of their military mapping-facilities. Nevertheless, in the end they produced far more maps than the Allied Powers. The German cartographers, without any overstatement, created the lion's share because they were present on all the fronts from Flanders via the Balkans to the Near East. This article explores pre-war cartographic efforts, looks at the various types of maps that were produced during the war, and traces the dramatic development of cartographic technology that occurred as a result. The following discussion focuses on maps created for the army. Maps for use by aviation units are discussed in a separate chapter.

1 Some Background

1.1 Preliminary Cartographic Work Prior to World War I

One might fight but cannot win a war without maps. Recognition of this bitter truth came all too late to the German troops as they reached the Marne in September 1914. There they stood, only a few kilometers away from Paris, totally lost in the French countryside.

How did this happen?? When beginning the invasion of Belgium on August 4 the troops had been given a large packet of maps which only covered the area north of the Marne (Meyer 1937, p. 370). The maps which had been printed for the adjoining region were still in Berlin. Although every effort had been made to provide maps of enemy territory (Boelcke 1921b, p. 444), there was an ever increasing degree of disorientation. Entire divisions had to make do with simple sketches (Eckert-Greifendorff 1939, pp. 327–328; Albrecht 1969, p. 8). The troops were the victim of their own rapid advances and had to fall back to avoid being overrun. Figure 1 describes the situation: On the right the position of the 1st Army under Gen. Kluck

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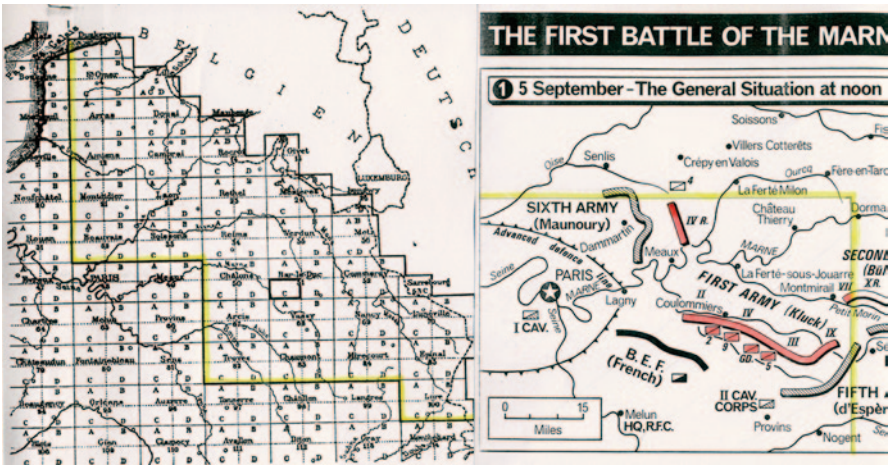


Fig. 1 On the *left* is the index map for the "Carte de France" 1:80,000 (Map of France 1:80,000). The German reprint divided the index into several different groups. Group 1 comprised 113 sheets (outlined in *yellow*). The maps in this group were given to troops as they deployed; the sheets belonging to Group 2, which included the area around Paris, were not

on 5 September 1914 is marked in red. They were situated in an area for which they had no maps. The same was true for the right flank of the 2nd Army under Gen. Bülow, directly behind them. Because the right flank of the 1st Army was being threatened by the counterattacks of the Entente forces, they had to withdraw, forcing the 2nd Army to do likewise.

One British author stated that the withdrawals only ended when the troops finally reached areas for which they had maps (Cruickshank 2006, p. 19). It is remarkable that, to the author's knowledge, in all the literature on the "Miracle on the Marne" this significant problem has never been discussed. In fact, the importance of maps in the conduct of war has frequently been overlooked. It is worth taking a look behind the scenes at this often neglected set of military tools.

The following remarks are intended to make the unfortunate situation of the German armies throughout the summer of 1914 more understandable. To achieve this it is necessary to explore the traditional structure and procedure of governmental map-making in Germany at that time, which was intimately linked with military planning. We will explain which changes this process underwent as a result of the outbreak of war.

Before considering wartime cartographic activity in detail, we need to take a look at the years preceding World War I. The critical question is whether the cartography of that period was based on planning for a "major war" and, if so, how this should be understood.

The January–February 1914 issue of the German geographical monthly *Petermanns Mitteilungen* contained a set of index sheets for the official maps which were publicly available. The collection comprised the following cartographic works:

1. "Messtischblätter 1:25.000" (Plane Table Maps 1:25,000)
   A complete set of plane table maps for Germany. However, topographic details were not uniformly portrayed.
2. "Deutsches Reich 1:100.000 (Generalstabskarte)" (Germany 1:100,000 (General Staff Map))
   Except for sheets of the border areas, this map covered only Germany. It was the map used for annual maneuvers.
3. "Topographische Specialkarte von Mittel-Europa 1:200.000 (Reymann-Karte)" (Special Topographical Map of Central Europe 1:200,000 (Reymann map))
   This structurally obsolete map covered a large part of Central Europe. To the south it extended to Lake Garda, to the west as far as Bayeux on the English Channel, to the north to Riga, and in the east to Minsk. Since the earliest parts of this map dated back to the first half of the 19th century and the cartographic styles used were not consistent, it was considered obsolete at the beginning of the 20th century. Nevertheless, it did cover a large operational area. In 1914 the *Planabteilung Metz* (map depot of Metz) assembled 49 of these sheets into 13 amalgamated sheets covering Belgium and eastern France. The sheets covering eastern Poland were also reprinted during in 1916.
4. "Topographische Übersichtskarte des Deutschen Reiches 1:200.000" (Topographical Survey Map of Germany 1:200,000)
   This map series was intended to succeed the Reymann map. Work on it had begun around 1900, and by 1913, with the exception of sheets covering East Prussia (which, in the fall of 1914, were urgently needed), 184 sheets had been produced. Thus ultimately the full set of 196 sheets was never completed. However, in contrast to the Reymann map, they covered only the peacetime territory of Germany.
5. "Übersichtskarte von Mitteleuropa in 1:300.000" (General Survey Map of Central Europe 1:300,000) (see Figs. 2 and 3).
   A rather modern map series which was begun in 1893 and which the first sheets were published in 1906. Nevertheless in 1913 the section to the West only covered the German borderlands. To the East, on the other hand, it reached as far as Southern Estonia, Minsk and Southern Poland. In the course of the war the series was extended to also cover the United Kingdom and was used as an air navigation chart.

The following maps were not listed in the index; they apparently served purely military purposes:

6. "Wegekarte des Deutsch-Französischen Grenzgebietes 1:300.000" (Road Map of the French-German border area 1:300,000) (Müller 1990, S. 63)
   This contained 24 sheets and covered the area from Amsterdam in the northwest to Bourges in the southwest. It even included a large part of Switzerland (Bern, Chur). Work on the map began in 1890 and was completed in 1904. It had a different index from the later General Survey Map of Central Europe 1:300,000 cited above.

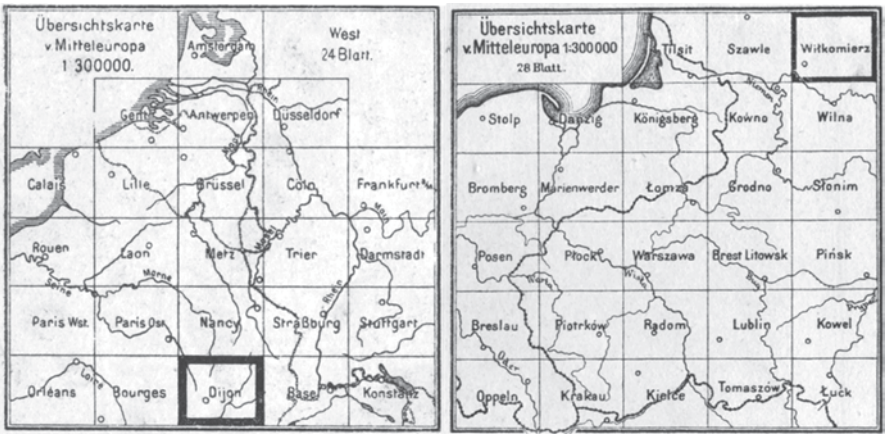


Fig. 2 At the beginning of the war two groups of map were assembled from the 1:300,000 map, one for the West and one for the East. The western group contained 24 sheets, while the eastern one had 28 sheets. Later these groups were augmented by larger sheets on which multiple sheets were combined (Zusammendrucke) to obtain a better view of the overall area (see *below*, No. 8)

Fig. 3 A segment of the sheet for Lille (1:300,000) printed in September 1913. View of Ypres and the fields where the battles in Flanders were fought

7. "Wegekarte des Deutsch-Russischen Grenzgebietes 1:500.000" (Road Map of the Russo-German border area 1:500,000) (Müller 1990, S. 63) (see Fig. 4).
   This comprised 17 sheets covering the area to the East as far as Wilna, Pinsk and Rowno (Galicia) and was printed in 1905 (or possibly 1904).
8. "Zusammendrucke 1:300.000" (Amalgamated Prints 1:300,000)
   While the General Survey Map of Central Europe 1:300,000 cited above highlighted roads in red and forest areas in green, there was an earlier version without these coloured imprints. This simplified map was used as the basis for general overview maps of "Belgien" (Belgium) (118 × 88 cm) and "Paris, östlicher Teil"

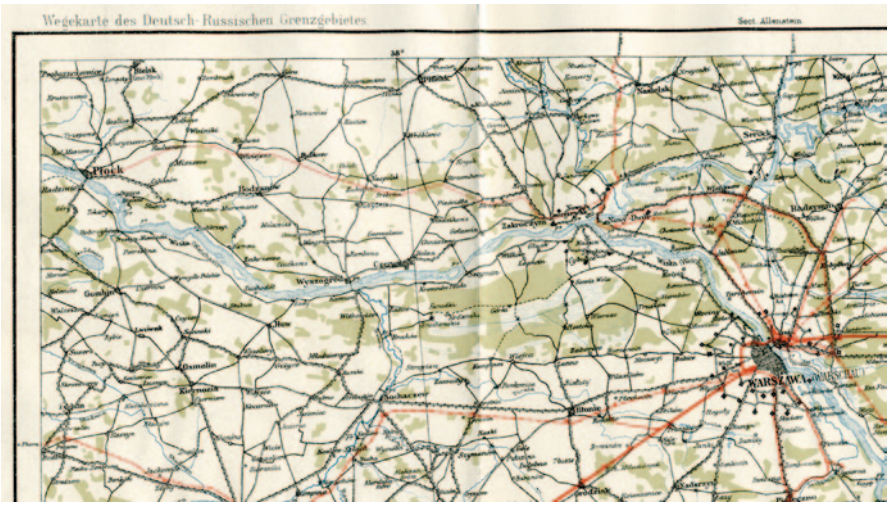


Fig. 4 "Wegekarte des Deutsch-Russischen Grenzgebietes" (Road Map of the German-Russian Border Area) was created in 1904/1905 in the rarely used scale of 1:500,000. It covered wide areas of what was later to become Poland. In contrast to the 1:300,000 map sheets, the areas covered by the fortified belt were not shown. One can, however, clearly see that Warsaw was surrounded by a series of fortified installations

(Paris, eastern section) (75 × 99 cm), and, possibly, a map of the southern section as well. These maps covered an area of four to six normal sheets (48 × 37 cm) and did not fully comply with the index map. It should be noted that the sheet entitled "Belgien", which covered wide areas of northeastern France as well as the Channel coast, appeared in 1912, whereas the other sheet, "Paris", did not appear until 1914 when the war had already broken out. In the East there were similar combined printings for Poland available as early as 1899 which continued to be produced during the war. They were well-liked because of the wide-ranging nature of the areas of operation. They encompassed an area that was more or less the equivalent of six "normal" map sheets. As the name indicates they served to provide more of a general overview of the area rather than being a basis for directing tactical operations of troops in battle.

With these maps being all that was available, it was difficult to wage war beyond the German borders. The road maps were crucial for artillery units which could not be deployed except over hard surface roads, but they were completely inadequate for the movement of entire armies. As a result, the cartographic section of the *Königlich Preußische Landesaufnahme* (Royal Prussian Survey) received a number of new orders post-1910:

9. Reprint of the map of Belgium 1:60,000.
10. Reprint of the French 1:80,000 map of Northeastern France, including Paris. In Berlin the individual map sheets were reprinted in two groups. The first group was distributed to the troops, as has been described above (Fig. 1), the

Fig. 5 All local printing facilities were involved in order to obtain a comprehensive supply of maps

second group (including the area around Paris) was held in reserve to be distributed later. It was these sheets which were lacking at the Marne. In addition, the *Planabteilung Straßburg* and *Planabteilung Metz* (map depot for Strasbourg and Metz respectively) (see Fig. 5) also distributed larger amalgamated prints.

11. Reprint of the "Topographische Specialkarte von Mittel-Europa 1:200,000 (Reymann-Karte)" (Special Topographical Map of Central Europe 1:200,000 (Reymann map)) for the West and the East. The map was issued as large sheets each combining four maps.
12. A "Karte des westlichen Russlands 1:100,000" (map of Western Russia 1:100,000), comprising 437 sheets, which had been produced since the end of the nineteenth century (Reichsamt für Landesaufnahme 1931, p. 279). This series was attached to the General Staff Map in the index and continued to be produced until 1919.
13. Reprint of the map of European Russia 1:126,000 (Three-Verst map).

In 1902, Admiral von Tirpitz had commissioned a comprehensive German chart series of the oceans for the use of the Navy. This work initially focused on maintaining connections with German colonies in Africa and the western Pacific. However, in the years 1906–1908, in response to a special order, the *Nautische Departement des Reichs-Marine-Amtes* (Nautical Department of the Imperial Navy Office) concentrated its efforts on the Dutch-Belgian coast of the North Sea. Altogether some 508 naval charts had been completed by the outbreak of World War I. This enabled the German High Seas Fleet to operate on a global scale while at the same time securing

the coasts of the North Sea down to the English Channel. The British coastline was also well documented (Schmidt and Zacharias 1921, pp. 77–82).

In addition, the Prussian Army General Staff apparently also had a fairly accurate and classified map of the French fortified lines in the Vosges on the scale of 1:25,000 that had been produced prior to the war (Boelcke 1921a, p. 122).

Within the first few weeks of the war it quickly became apparent that the available maps were neither quantitatively nor qualitatively adequate. Even worse was the disaster that resulted from the Belgians opening the canal sluices leaving large portions of the advancing German army literally standing in water. It turned out that the German operation organisers had misread the sea level contours on the Belgian maps (Meyer 1937, p. 371).

It is against this background that the scathing critique of A.R. Hinks is to be understood. In 1919, the British geographer gave a lecture at the Royal Geographical Society on German cartographic preparations, which he characterised as a disaster (Hinks 1919, p. 30–44; Bertrab 1919, p. 166–167; Winterbotham 1919, pp. 253–276). The implications of the preparations which had been made were not thoroughly considered and the quantitative requirements which were estimated were totally incorrect. The fact that detailed military-geographical studies had previously been undertaken for Belgium and Northeastern France in (N.a. 1908) and Russia in 1913 (Schmidt 1913), made no difference.

A certain amount of pre-war cartographic work on the part of countries that later became enemies of the German Empire is known. In 1903 the Belgian Military-Cartographic Institute began work on a new 26-sheet map at a scale of 1:100,000 which was published in 1909–1912 (Hammer 1909, p. 241 f.). In 1910 the Geographical Section of the British General Staff published a copy in eleven large sheets, which also covered wide stretches of Northeastern France (GSGS No. 2364). The fact that the British map was printed on reinforced linen paper proves that Britain was preparing for any eventuality. It follows that the British had more current maps of the later theatre of war than the Germans, and they also managed to correctly interpret the rather confusing Belgian water level indicators (Albrecht 1969, p. 30). The Russians adapted copies of German maps of East Prussia and Pomerania (Boelcke 1921b, p. 446). In 1913 the French General Herment authored a memorandum outlining the possible threat to France of a German attack on their northeastern flank through Belgium (Immanuel 1913). In 1912 the Military Geographical Institute in Vienna published a study on "Cartography of the Balkan Peninsula in the 20th century."

Despite all this activity one cannot conclude that plans for a war of aggression were being actively developed. Instead, the mapping efforts should be billed as the 'normal' war game under the military motto: "be prepared." It is therefore not surprising that the German reprint of Belgian and French maps already began in 1907, only 1 year after the German General Staff in 1906 adopted the Schlieffen Plan as the basis for their military strategy which, *inter alia*, conceptualised an attack on the French northeastern flank. It remains debatable, however, whether one should conclude that the British copies of the Belgian maps shortly thereafter should be seen as a targeted answer to the German plan.

It is hard to assess whether, cartographically speaking, Germany was by the summer of 1914 adequately prepared for a major military conflict. Maps were available, yes, but they had been compiled without any special care or attention to their quality. Even the annual maneuvers of the Prussian army were, from a cartographer's point of view, better organized and prepared. In contrast the situation at the beginning of World War II 25 years was entirely different as the strategists had by then learned their lessons from the shortcomings in the built-up to World War I and were well aware of the importance of thorough cartographic wartime preparation.

1.2 The Organisational Structure of Official Cartography in Germany

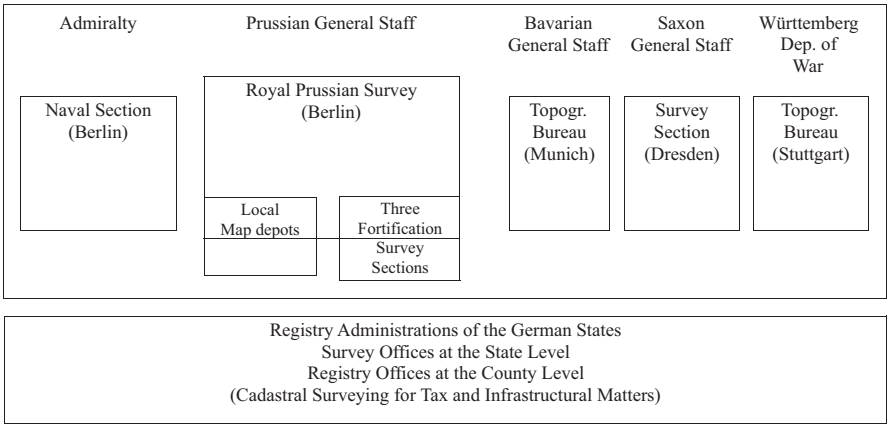
Before turning to the war-time mapping, a brief look into the federalised peacetime structures of official German mapmaking provides a better understanding of the situation in the field in 1914 and how Germany reacted to it. One needs to remember that the "German Empire" (Deutsches Reich), founded in January 1871 in Versailles while confederated German troops were besieging neighbouring Paris, was a "federation of princes" in which certain members had reserved special rights. Thus, in peacetime, the kings of Bavaria, Saxony and Württemberg retained supreme command over the troops of their respective kingdoms. Only in time of war did the German Emperor, in personal union also the King of Prussia, gain supreme command over all German forces. Mirroring this delicate and problem-prone setup, civil surveying remained the responsibility of the individual member states. It was not until 1919 that a *Reichsamt für Landesaufnahme* (National Survey Office) was created to coordinate and ultimately centralise cartographic activities. As a result, basic geodetic data on maps of the various German federal states were grossly inconsistent. This was especially true for plane table sheets (1:25,000) since there was no uniform system of coordinates.

Member states with peace-time military command authority also had extensive cartographic organisations. Except for Prussia, which made up more than half of the German Empire, they remained as follows throughout the First World War (see Table 1) (Hafeneder 2004):

- *Kartographische Abteilung der Königlich Preußischen Landesaufnahme* (Cartographic Section of the Royal Prussian Survey)
- *Topographisches Bureau des Königlich Bayrischen Generalstabes* (Topographical Bureau of the Royal Bavarian General Staff)
- *Abteilung für Landesaufnahme des Königlich Sächsischen Generalstabes* (Survey Section of the Royal Saxon General Staff) (Treitschke 1921, pp. 47–60)
- *Topographisches Bureau des Württembergischen Kriegsministeriums* (Topographical Bureau of the Wurttemberg Ministry of War)

By far the largest organization was the *Königlich Preußische Landesaufnahme* which, by 1914, comprised of four sections:

Table 1 OFFICIAL GERMAN MAP AND SURVEYING ORGANIZATION IN PEACETIME



1. Trigonometric section for the determination of trigonometric points.
2. Topographic section for the depiction of terrain characteristics and the recording of manuscript field maps striving to be as accurate as possible.
3. Cartographic section for getting the maps ready and for overseeing the actual printing.
4. Map Depot (*Plankammer)* for the storing and distribution of maps to military and civilian users alike.

In addition to the Berlin-based Map Depot there were decentralized depots associated with major fortifications because of the special need to provide support to the fortification's artillery. The map depots in the western fortifications at Metz and Strasbourg, both in Alsace-Lorrain close to the French border, also provided combined prints of large areas in their vicinity.

Since official mapmaking in Germany was embedded in military structures—as was the case in other European states—it is also necessary to examine the structural outline of the German army. For peacetime we can be brief since there was none except for the separated armies of Prussia, Bavaria, Saxony and Württemberg. Only the navy was a unified body in peacetime with its own department to provide nautical charts and surveys (Albrecht 1969, p. 12). The aviation units which were just emerging were almost entirely part of the various armies, except for a small number of naval aviation units.

Despite this polycratic organisational structure, most of the pre-war military maps do bear the following notation in the center of the lower edge of the map: *Kartogr[aphische] Abt[eilun]g d[er] K[öni]gl[ich] Preuß[ischen] Landesaufnahme*, portraying them as made by the Prussian Military Survey. Maps copied from foreign sources, however, do not carry this annotation, even when copied by the Prussian army, save a few exceptions from 1917 onwards.

For organisational purposes Germany was divided into 25 military districts. Each district had its army corps and each corps was made up of a number of divisions. The officer in charge of each corps was called *Generalkommando* (General Com-

mand). The paramount importance of Prussia is evidenced by the fact that it had 19 military districts while Bavaria had three, Saxony two and Württemberg only one.

Much of the peace-time fractioning was to disappear in the case of war, when troops were mobilized and sent out to the front lines, each army corps with its designated *Generalkommando* now under the single (and de-facto Prussian) high command of the *Generalstab des Feldheeres* (General Staff of the Field Army), to which the Prussian, Bavarian, Saxon, and Wurttemberg forces (and attached mapping units) reported. A *Stellvertretende Generalkommando* (Deputy General Command) was to oversee home operations including the recruitment of reserves.

To address the needs of the Schlieffen Plan which sought to strike decisively and fast in the west to win the war before any enemy could pose a threat in the east or south, the army corps were combined into eight armies. Seven of these were stationed in the west, and only one in the east. When the actual war of August 1914 did not evolve as planned by Schlieffen but was prolonged into a multi-year carnage, additional corps and armies were formed. This is not the place to elaborate on this constant addition of new units. We merely want to state the crucial fact that German military surveying and mapmaking throughout the Great War remained organised and thus fractionised at army level.

With the outbreak of hostilities in August 1914 the *Königlich Preußische Landes-auf-nahme* (Royal Prussian Survey) ceased to function as part of the General Staff. Only the groups involved in the printing of maps and their distribution remained operational. The Chief of Survey, General Hermann von Bertrab (1857–1940), took over the command of an army division (Albrecht 2004, p. 144) and many of his topographers likewise rushed to the flag. The General Staff left Berlin and moved to the *Große Hauptquartier* (Supreme Headquarters) together with the *Obersten Heeresleitung* (Army High Command) which soon took residence in Spa in eastern Belgium for most of the war.

The *Stellvertretende Generalstab* (Deputy General Staff) remained in Berlin but only in an administrative capacity. However, with the war not being over in weeks as assumed in all pre-war plans, this originally make-shift stand-in unit gradually resumed the discontinued mapmaking activities while the armies were out in the field. Thus, whenever a map reads *Stellvertretender Generalstab* (Deputy General Staff) it signifies that the map was produced during wartime in Berlin and not by an army map unit in the field (see Fig. 7). In addition, pre-war maps were reprinted but without updating the peacetime source notation. Due to the peacetime infrastructure and military organization, maps were also printed in Dresden, Munich and Stuttgart during the war and credited accordingly. The maps printed in these locations did not need continuous updating. These were primarily small-scale overview maps while large-scale maps were printed close to the front and marked “feldmäßig” (field suitable). Communication between the offices in Berlin and at the fronts was not well organised (Cruickshank 2006, p. 10). For example, German army units supporting the Ottoman troops in Palestine needed basic maps which were available in Berlin, but which were not forwarded to units in the Holy Land where the commanders mostly did not know about their existence and therefore did not ask for their delivery.

Fig. 6 Maps produced in various military regions differed from one another and each army had to find a way to familiarize newly arriving recruits with the geodetic principles used on their maps. This classified brochure (16.5 × 11.5 cm) was produced by the *Vermessungsabt. 3rd (preuß.)* der 5. Armee (Survey 3 (Prussia) of the 5th Army) and contained many sample maps

It was not until April 1917 that the *Landesaufnahme* was reactivated in Berlin under the direction of General von Bertrab who was ordered back from his field assignment (Albrecht 2004, p. 145). However, it still had no formal jurisdiction over frontline cartography units (Albrecht 1969, pp. 48–49). The only means to somehow organise the de-facto independent army cartographies was the custom to date maps. Indeed most army unit maps provide information as to the date of their original survey, the date of revisions, and the year (and often the month) of printing. While the first two dates are most of the time printed in easily legible fonts in the margin of the map, the printing date frequently appears in a very small font squeezed into or under the lower right corner of the map.

Apart from the centralized organization of the *Landesaufnahme,* each of the many armies had at least one, and sometimes even two, *Vermessungsabteilungen* (VA or Survey Sections) (see Fig. 6). It therefore should not come as a surprise that by the end of the war some 10,000 soldiers or the equivalent of a combat ready division were involved in the various cartographic units of the German armies (Albrecht 1969, p. 18).

Fig. 7 An example of the pragmatic cooperation between Deputy General Staff in Berlin and a front unit. At the request of AOK 6 (*Armeeoberkommando 6*) (Army High Command 6), printing plates for "Carte de France 1:80,000" (Map of France 1:80,000), which were available in Berlin, were sent to a map unit of a Bavarian army to be revised into new plates. These maps were printed immediately behind the frontline

Before the war the military had had little experience with such an organisational structure. The first three VAs were established in March 1914 at the principal fortifications in Cologne, Metz and Strasbourg. They were referred to as *Festungsvermessungsabteilungen* (Fortification Survey Sections). These VAs were created for the sole purpose of supporting the artillery based in these fortifications. As the front quickly moved forward, eight more VAs were added to smaller fortifications located closer to the frontlines.

Despite the fact that nobody in the pre-war period had thought about creating mobile versions of the VAs for deployment in seized enemy territory (Albrecht 1969, p. 7) the number of these units had, by the end of the war, risen to 29 (Eckert 1925, p. 806). The scope of their work had also completely changed. It took until the end of September 1915 before the change in their organizational structure from *Festungsvermessung* (Fortification Surveying) to *Feldvermessung* (Field Surveying) had been completed (Albrecht 1969, p. 11) and echoed the erstwhile mobile and later more trench-line-than-fortress-centered character of military mapping needs.

Each of these survey sections were part of the staff of the army to which they were attached. From September 1917 onwards they were directed by a *Stabsoffizier für Vermessung (Stoverm)* (Staff Officer for Surveying) (Albrecht 1969, p. 12). At about the same time special commanders were installed to co-ordinate the military surveyors, topographers and mapmakers in the three most important front regions: West, Southeast (Balkans) and East (Albrecht 1969, p. 65).

In the initial months of the war, when frontlines were pushing rapidly beyond Germany's borders and where fluid as never again until shortly before the end of the war in the fall of 1918, cartography units of the individual armies had absolute

freedom to organize, staff, and define their tasks as they and their army commanders deemed effective. It was not until the middle of 1915 that the lack of coordination was recognized, albeit still reluctantly. To address the problem, the office of *Kriegsvermessungschef* (Chief of Wartime Surveying) was assigned to an officer with the rather lowly rank of Major. The first person to be appointed to this position was the organisationally talented Siegfried Boelcke (1876–1930) (Hafeneder 2004, pp. 93–94). As in any strictly hierarchically organised military environment, a Major could hardly by expected to influence map-relevant decisions made by the Generals of the plethora of field armies.

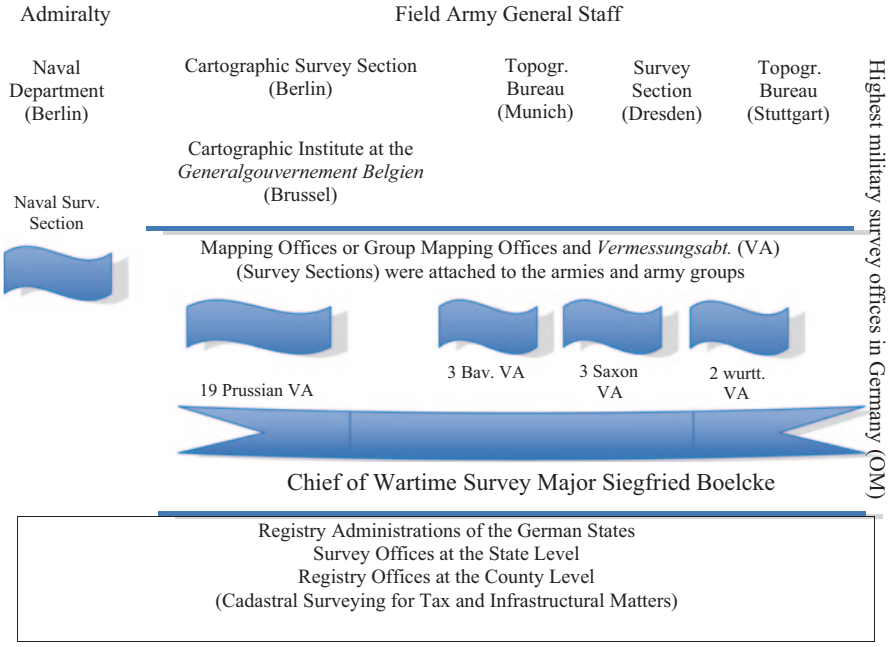
It was only in January 1918 that this organisational structure was adapted again. Whereas before a VA had only been responsible for the printing and distribution of maps, now an additional unit was created, responsible for updating existing maps using aerial photographs and other cartographic resources. These units were known as *Gruppenkartenstellen* (Group Mapping Offices) and were primarily attached to army groups (Albrecht 1969, p. 13). The regular VAs concentrated on improving trigonometric measurements and on making exact calibrations, particularly for the heavy artillery which was crucial in the trench warfare. Thus the notation *Gruppenkartenstelle* or *Divisionskartenstelle* on the margin of a map indicates that this map was published in 1918.

A fact not widely known is that the VA structure survived the Armistice in November 1918 and the subsequent disintegration of the German army units. The *Preußische Landesaufnahme* (Prussian Survey) (now no longer "Royal") had four *Grenzschutzvermessungsabteilungen* (Border Protection Survey Sections), emerging from the wartime VAs which continued to provide cartographic support to German militias in the guerilla war along the ethnically mixed eastern border regions until the end of 1919 (Albrecht 1969, p. 49).

When General von Bertrab was reappointed as chief of the *Landesaufnahme* in Berlin in April 1917, a dual system was created. The *Kriegsvermessungschef* (Chief of Wartime Survey) networked with the survey sections of the armies (which were still not placed under his command!), while the Berlin office took care of central affairs not directly related to the front. At the same time, Berlin also assumed responsibility for the coverage of the occupied territories behind the frontlines. Thus a map repository was established in the *Generalgouvernement Warschau* (German term for occupied Poland) and a *Kartographische Abteilung* (Cartographic Section) was created in the *Generalgouvernement Belgien*. As is easy to imagine, this dual structure created strains and tensions, a problematic situation that was not helped by the fact that the *Landesaufnahme* was a Prussian concept which was brought back to life (see Table 2).

General von Bertrab used his political connections to press for a parliamentary resolution, which called for the creation of an *Oberste militärische Vermessungsstelle im Deutschen Reich und in seinen Schutzgebieten (OM)* (Supreme Military Survey Office for Germany and its Protectorates). To that end he set up yet another office along with a set of operating procedures. Parliamentary hearings at the end of February and early March 1918 (N.a. 1918b) merely led to the acknowledgement of the already well-known fact that negotiations leading to a unification of geodetic

Table 2 Official German Map and Surveying Organization in Wartime



principles for Central European cartography were urgently needed (Albrecht 2004, pp. 144–145). If Germany had seriously intended to wage a preventive war on the basis of the Schlieffen Plan and had wanted to have a reliable cartographic base prepared, these Berlin hearings should have been held and according results been implemented at least a decade earlier. In 1914 however, military thinking was still entirely focused on a short and fast-moving campaign with the goal of "Christmas in Paris". No-one even considered the possibility that the front could come to a stalemate for years as ultimately happened on the Marne in September 1914.

In the course of the war the fragmented pre-war cartographic administration was replaced by an intentional short-term yet pragmatic war-time set-up of even greater complexity. This was due to the immense pressure to produce adequate maps for successful military operations at the widespread frontlines.

Even after 4 years of war, federalist structures superseded any practically demonstrated claim to reform. The *Kriegsvermessungschef* had little interest in setting aside the urgent needs of the front cartography in favor of long-range goals, regardless of how desirable they might have been. Nothing changed during the war—nor did much change after the war. A civilian authority, *Reichsamt für Landesaufnahme* (National Survey Office), was set up in Berlin, but the offices in Dresden, Munich and Stuttgart continued to operate not much differently than in the pre-war era (Penck 1920, pp. 169–179). Even in modern day Germany federalism is reflected in the fact that each of its states has an independently operating *Landesvermessungsamt* (State Survey Office).

Besides the (multiple) armies there was also the Navy, which operated under an independent *Reichs-Marine-Amt* (Imperial Marine Office or Admiralty) (see Table 2). One of its components was the *Nautische Abteilung* (Nautical Section) which was responsible for maps and handbooks for the navigation of the seas. Like its army cousin, the *Nautische Abteilung* was also shut down at the beginning of the war, even though map-printing activity intensified. New charts were needed especially for the deployment of the submarine fleet, for example in the Aegean to fight back against the Allied ANZAC landing on the Gallipoli peninsula. Altogether some 900,000 charts were printed by the Navy during the war (Schmidt and Zacharias 1921, pp. 82–83). The Navy also deployed separate survey groups which were particularly active along the Baltic Coast and in Finland (Schmidt and Zacharias 1921, p. 97).

2 War Maps by German Survey Offices

2.1 Overview

Looking back in 1920, Siegfried Boelcke, former *Kriegsvermessungschef* (Chief of Wartime Survey), observed: "Not only were German surveying sections located along all French and Russian fronts, they were also positioned in Galicia, the Carpathians, Romania, Italy, Macedonia and Palestine in support of German, as well as Austrian, Hungarian and Turkish troops,…" (see Fig. 8) (Boelcke 1920b, p. 7).

The total number of military maps produced during the war cannot be determined today with some certainty, but Boelcke estimates that the German forces alone printed more than 500 million map sheets in the field (Boelcke 1921b, p. 463). In addition, another 275 million map sheets were printed back at home (Chasseaud

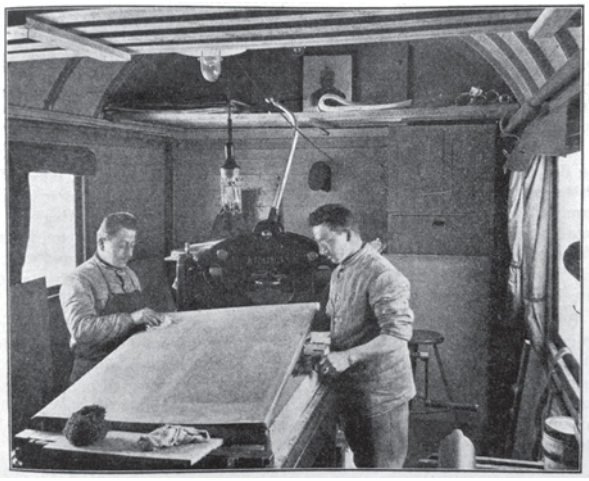


Fig. 8 Near-the-front printing was sometimes done in railway cars. Complete with their own locomotives such units were self-sufficient and mobile, allowing the facility to quickly relocate and rapidly resume service to their armies. (Albrecht 1969, p. 12)

2013, p. 19). However, despite these impressive numbers, the quantity of sheets actually surviving today are astonishingly small. By the end of the war in November 1918 the German cartographic records were either lost or had to be surrendered (Boelcke 1921b, p. 473), and only a small number were given to the *Reichsarchiv* (National Archive). The military portion of these records, which would have included cartographic material, was transferred to the *Heeresarchiv* (Army Archive) in Potsdam in 1936. There they were subsequently destroyed by allied air raids in World War II, and particularly during the disastrous archive fire at the Brauhausberg in Potsdam on April 14, 1945. It is therefore possible that today more German cartographic material is residing in foreign archives than in Germany itself.

This is even more regrettable when considering that the survey sections themselves were aware throughout the war of the historical significance of the events that were being recorded. Following the end of the war, battlefields were photographed. There was even a *Kriegs-Vermessungsmuseum* (Wartime Survey Museum) set up in Sedan (Albrecht 1969, p. 13). The only remaining records of this activity are two photo albums which are currently held at the *Deutsches Museum* (German Museum) in Munich.

The word "Kriegskarten" (Wartime maps) never appeared in any official documents or correspondence. In the initial decades of the twentieth century this term was only used in the sciences and by private map publishers. In official cartography—the focus of this chapter—this term was not used during the war. Thus the army had no *Kriegskarten- und Vermessungswesen* (War Maps and Survey Office), but instead a *Kriegsvermessungswesen* (War Survey Office). It was not until World War II that the terms *Kriegskarten- und Vermessungswesen* were used officially. Whenever coming across the term "Kriegskarte" in German cartographic publications up to 1930, it refers to the work of private publishers (Flemming, Velhagen & Klasing, Wagner & Debes, Ravenstein, i.a.). These works normally contain no military related information whatsoever. The concept "Kriegskarte" was used solely for sales promotion purposes. As an alternative term one could use "Militärkriegskarte" (Military war maps) for official maps.

2.2 Maps of the Western and Eastern Fronts

As late as 1906 Emperor Wilhelm II famously maintained that the horse would soon re-establish itself as a means of transportation and drive out the newly introduced automobile. This failure to foresee the direction of technological developments is unfortunately quite symptomatic of the relationship of the Prussian military to science and technology. Indeed, there were a few places where automobiles, airships, and even an occasional airplane were being used by the army, but by and large, the ideal profile was that of the dashing officer leading his men, preferably on horseback, into man-on-man combat as in previous centuries.

However, World War I rapidly developed into modern, technologically driven and increasingly industrialized warfare that demanded a high level of organization

and communication, not brave but outdated mounted Hussars. In short, the officer corps was mentally totally unprepared. The artillery, for example, was used only for firing at targets “in sight.” But in the fall of 1914, as the moving fighting changed into trench lines, enemy artillery installations became hidden and firing had to be done based on data taken from large-scale maps (so-called “Planschießen”—map-based firing) rather than by direct sighting of the target. There had scarcely been any training for this type of engagement, and there were no usable maps for this type of deployment. This would become the main focus of improvised wartime map making.

It is not widely known that within only 6 h following the announcement of imminent hostilities (thus prior to actual mobilization), border patrol troops were ordered to assigned posts. For these early response units a set of classified maps of Germany at a scale of 1:100,000 marked “Grenzschutzzwecke” (Border Security Purpose) was available. The example shown in Fig. 9 of the East Prussian border area was created in 1913 and printed in 1914 (presumably in July of that year).

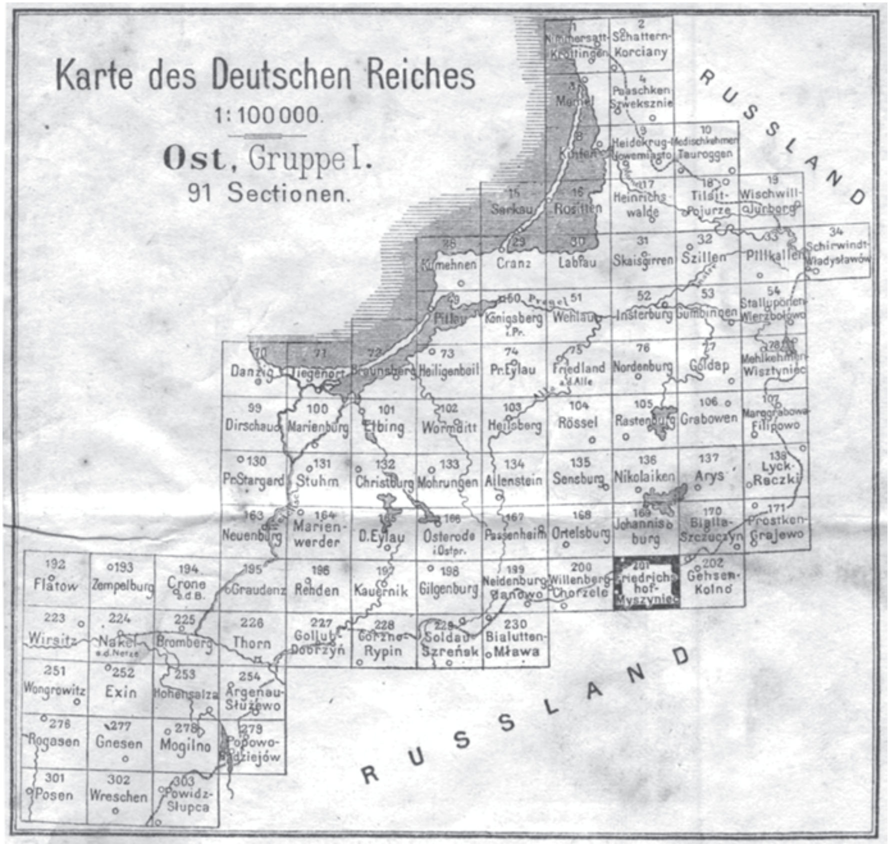


Fig. 9 Index of the northeastern sections of a classified map at a scale 1:100,000 created for border control troops that were activated as a result of the growing threat of war

Fig. 10 The 7th Army was able to take a monochrome French map and turn it into a tri-color print (1:100,000), which was much easier to read. Mountainous terrain was shaded in *brown*, although there were no elevation annotations. Grid lines, each 1 km apart, made it possible to identify specific areas for reporting purposes

In the summer of 1914 a map series covering the area west of Paris in 1:300,000 was successfully delivered. It consisted of 24 sheets and was frequently reprinted during the war. There were even special versions of this map for long-distance communication units and for aircraft pilots. However, the withdrawal from the Marne and the development of trench warfare presented an entirely different set of requirements. Now large-scale maps were needed, which would make it possible to identify the most favorable terrain for one's own defenses and for attacking the dug-in enemy.

For Belgium there was a map at 1:20,000 that could be used by the Germans, but for France there were only a few fortification plans ("plans directeurs") available at a scale of 1:20,000 and they were not drawn in any sort of consistent style.

Since no-one believed that this trench warfare situation was going to last long, each of the seven German western armies used whatever material became available to draw up their own sketches of the section of the front they occupied (see Figs. 10 and 11). Photographs taken by surveillance aircraft often formed the basis for these maps. There was no office which could have coordinated these efforts since the *Preußische Landesaufnahme* (Prussian Survey) had been dissolved for the period the war would last (as stated above). The inevitable result was a crude patchwork of maps of the front created by the troops themselves which greatly contributedto the very confused communications between the armies (Albrecht 1969, pp. 23–29).

The maps of the front and of the enemy territory beyond had to be continuously expanded and improved. As this became a defining role for the aviation units, the Hussars, or traditional reconnaissance units on horseback, were no longer being asked for reports. Numerous aircrafts were launched in the initial months of the war, many of them for surveillance purposes. It quickly became apparent that an aerial photograph contained more information than the best report from a trained observer

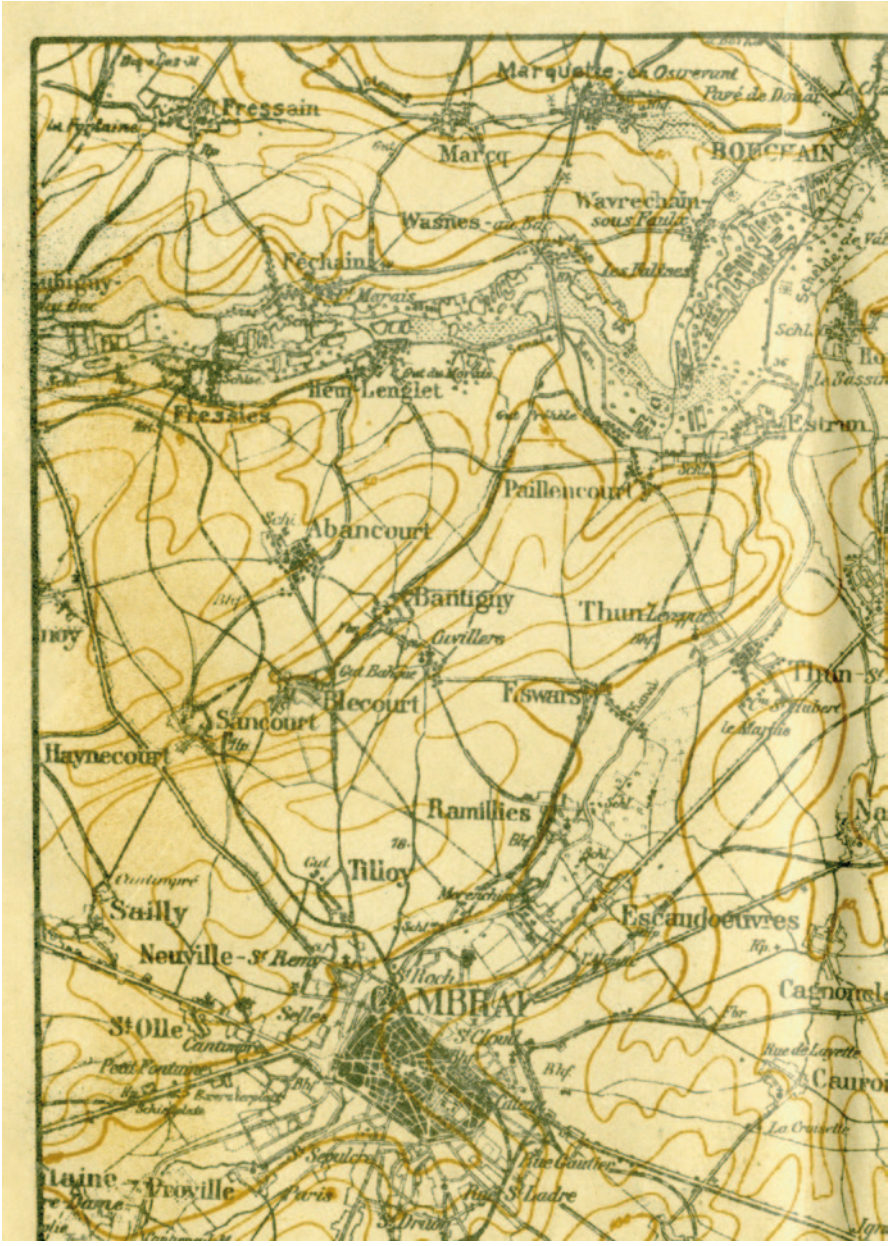


Fig. 11 By 1917/1918 it had finally been agreed that all general survey maps should have a single unified scale of 1:100,000, like this segment from a general survey map for the 18th Army, produced in December 1917. Note how elevations are no longer indicated by *shading*, but by *contour lines*. Although such lines were less visible, they were far more precise. There were also no more *grid lines*

on the ground. As a direct result, aircrafts were equipped with cameras, and these aerial photographs were then patched together in groups to form "Luftbildkarten" (aerial image maps). "These simple means provided at least some help with the situation. Etching all the unimportant material off the printing plate and leaving only the militarily valuable information, created maps of the trenches. […] Approximate dimensions could also be determined from these map-like images, since the altitude at which the picture was taken, and the focal length of the camera lens were known, and pictures taken at different altitudes could be either enlarged or reduced to create a uniform scale" (Neumann 1920, pp. 164–165). However, for a professional cartographer these make-shift procedures were considered to be nothing more than emergency assistance measures (Eckert 1925, p. 765).

By the spring of 1915 the *Oberste Heeresleitung* (Army High Command) had recognized that there was an urgent need for coordination and therefore the new position of *Kriegsvermessungschef* (Chief of Wartime Mapping) was created. Its first chief Boelcke soon had to recognize that there was no way that the chaotic mapping system which had evolved within the armies could be unified, simply because replacing the maps that were in daily use by new unified ones was not possible. Boelcke refused to use the newly developed "Luftbildkarten" (aerial image maps) of the aviation units. His argument was that they lacked exactitude to be used to guide artillery fire, and far more precise instruments were needed. Individual artillery batteries had to have plans to guide their firing in correspondence with their positions. It would have been possible to update them by means of aerial photographs, but then these had to be trigonometrically calibrated. The main question was how the aviation units would be able to achieve that.

It is interesting that these aviation units were later able to produce "Luftbildkarten" (aerial photograph maps) which were prepared for printing in their own facilities by using copper engraved plates. These maps were numbered to indicate the army to which they were given. In some instances these products were referred to as "Geländebildkarte" (Terrain Image Maps). The disadvantage of these maps was the fact that there were no contour lines, thus making it difficult to determine elevations. Their advantage, however, lay in their ability to portray rough terrain with a degree of detail no other map was able to achieve (see article "The Eye of the Army", Fig. 15, 16).

The trench warfare that developed in the fall of 1914 demanded maps of the largest possible scale. which could only be produced by using aerial photographs (Korzer 1939, pp. 202–207). Initially, the cameras could only take pictures at an angle, but the process of reconciling variations in camera angles was very difficult. To remedy this problem, the photographic process was converted as quickly as possible to take vertical photographs. By 1916 this allowed for the creation of continuous strip images as well as the development of three-dimensional stereo images (stereo-photogrammetry) (Steeb 1911, pp. 92–94). On the western front, maps which were good enough for use by the artillery were gradually developed out of rough photographic enlargements (Chasseaud 2001, pp. 119–134). With the help of this technology it finally became possible to create a sufficient number of accurate maps for areas where there was no basic pre-war map material as for example on the

Macedonian front (Boelcke 1921b, pp. 465–466). Altogether over a million aerial photographs were taken on the German side for various purposes during the war (Fels 1919, p. 89).

In many instances it was necessary to create an entirely new photographic image of the terrain. Addressing this problem, Boelcke wrote: "Above all it must be remembered that the normal photographic procedure fails in those battle zones where there is active firing. One can sometimes identify details using sound measuring equipment, but attempts to piece together adjoining images was an extremely time consuming and inaccurate process. Apart from the numerous special requests which the troops demanded be addressed, the deflections on the compass needles by the ever-present iron structures frequently led to unacceptable errors. The result was increased reliance on aerial photography to portray the trenches and barbed wire in the battle zones on both the enemy and allied sides" (Boelcke 1920b, pp. 7–8).

Looking back in 1921, Boelcke described the situation as follows: "Map making activities on the western front could be divided into three groups: Belgium, Lille to Verdun and Verdun to Mühlhausen. All of the printing plates for official maps of the Belgian surveying unit at La Cambre were seized. The 1:20,000 map […] had already been drawn with grid lines and could be used immediately without any further work" (Boelcke 1921a, pp. 121–122).

For the central part of the western front around Lille-Verdun there were a few small French fortification plans ("plans directeurs"), most of which had their own grid lines. Using whatever supplementary material which was available, maps were created at a scale of 1:25,000 by adding to these plans. Sometimes this was achieved by enlarging sections of the well-known "Carte de France 1:80,000." The resulting map was unfortunately so inaccurate that the artillery was not able to use it. Moreover, the French map sheets were often drawn in different, incompatible styles and, in most cases, without contour lines. As long as nothing better was available, these sheets were sent to the front as "Leerkarten" (basic monochrome maps without special military overprinting) in the hope that they could be updated in-situ (see Fig. 12).

Particularly challenging was the determination of elevations and their depiction on the maps. Such information was an essential precondition for accurate artillery firing. The ultimate goal was to create contour lines in 5-m increments throughout enemy territory. As the war progressed, the results of these efforts improved, and the maps became gradually better.

On the left flank of the western front, between Verdun and Mühlhausen, the military had the advantage of being able to rely upon map material that Germany had already prepared in secret before the war (see Fig. 13) (Boelcke 1921a, p. 122).

These "Stellungskarten" (trench maps) contained not only the usual topographical elements, but also depicted the system of protective trenches, both on German (in blue) and on enemy (in red) sides (see Figs. 12, 14 and 16). At the same time new German toponyms were created to designate locations. Where the situation was too complex, but was deemed important enough to warrant the effort, plans were drawn at a scale of 1:10,000, and even on occasion at 1:2000.

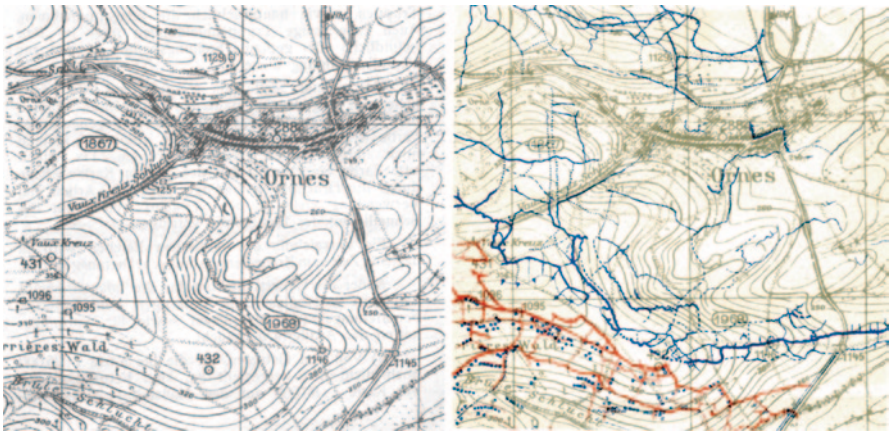


Fig. 12 These samples are taken from the map stock held by the 5th Army northwest of Verdun. The extract on the *left* is part of a basic monochrome map at 1:25,000. On the *right* is the same map showing military positions. German lines are shown in *blue*, enemy lines in *red*. The buildings of Ornes have been deleted because, apparently, the village had been destroyed. Even though the 1 km grid lines have been retained, the symbols have been changed to reflect a different system (N.a. 1916)

Against this backdrop it is understandable that in 1914/1915 each army in the west was forced to develop its own coordinate reference system. For this reason the creation of a comprehensive and integrated image of the front was not possible (Eckert 1925, pp. 775–782). Boelcke could do nothing to change this when he was appointed *Kriegsvermessungschef* in July 1915 as he was not in a position to force the high commanders of the various armies to agree on a uniform scheme of grid coordinates (Boelcke 1920b, p. 8). People were apparently still convinced that the war would not last long enough to warrant such an effort. The best that could be done, was to agree on some common ground in the imprinted grids: the grid lines were to be uniformly set 1 km apart, with alpha-numeric identifiers in the margins so that reports could be located with reasonable accuracy (see Fig. 13).

Then, in the 6th Army, under the direction of Max Eckert, brown overprinting for elevated areas was added to maps at a scale of 1:80,000. With valleys shown in green and elevated areas shown in brown, the maps were much easier to read for cartographically untrained soldiers (see Fig. 17; Eckert 1925, p. 789) (Fig. 15).

It was not until 1917/1918 that an attempt was made to create a coherent map of the entire western front at a scale of 1:100,000 (see Fig. 18). The basis for this effort was a reduction of the “Carte de France 1:80,000.” This task was taken over by the revived *Preußische Landesaufnahme* in Berlin which incorporated the French cartographic work into the system used for the German General Staff map series 1:100,000. Plans were also made for a map series of the front at a scale of 1:25,000, and it was created using Gauß-Krüger coordinates. This work was, however, never completed and it was not until World War II that a corresponding German army grid was developed.

Fig. 13 An extract from an artillery observation map of the region west of Verdun showing an unusual printing notation. The map was produced by the *Kart. Abt. der Landesaufnahme* in 1912. Of course, this notation only refers to the basic *black* and *white* map. The coloured imprint was added in 1917 by a Bavarian survey unit. It is an example of German spy activity, which concentrated on the fortification belt in eastern France, but did not extend its coverage into the northeastern area of the country

Fig. 14 The 4th Army at Ypres could draw upon existing Belgian maps. The extract shows a trench map on a scale of 1:20,000. The 1 km grid lines indicate the use of a coordinate system designed specifically for army use. Upon examination of the index map, however, it is evident that the scale of 1:20,000 was still much too small for accurate operation planning at the front

Fig. 15 During the early years of the war basic "Leerkarten" had no coloured areas. Later, valleys began to be overprinted in *green*. The extract shown is at a scale of 1:80,000

Even more significant was the achievement of introducing multi-coloured depictions of elevation on maps at a scale of 1:25,000. Green and brown were each divided into three levels, thereby creating a three-dimensional coloured (*farbenplastische*) map (see Fig. 17). In this case too, it proved difficult to achieve a uniform method of representation. As in other areas, decisions were made on a pragmatic basis, and almost every army had its own system for designating elevations (see Fig. 19 and 21; Eckert 1925, p. 789).

In March 1917, at the time of the withdrawal to the "Siegfried-Stellung" (referred to in the British literature as the "Hindenburg Line") a multi-coloured map of northeastern France at a scale of 1:50,000 was created which included the areas west of the front. Millions of copies were printed and used as a guide for the attempted break-through battles in the spring of 1918 (Boelcke 1920b, p. 9; Jochim 1930). No one wanted to relive the disaster of 1914 when, standing on the banks of the Marne, no adequate map material was available.

While the validity of the data of the reprinted maps of Western Europe was apparently trusted, the Russian map material of the eastern front was treated with more skepticism. Berlin had therefore already decided before the war to expand the German general staff map (1:100,000) eastwards to encompass what was then Russian

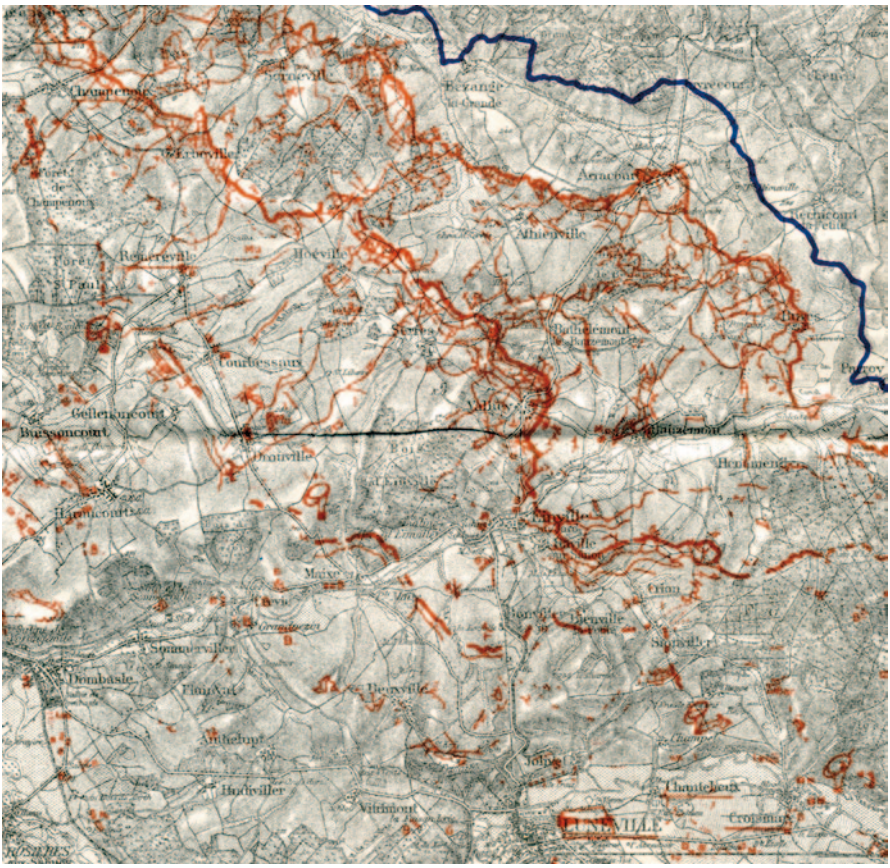


Fig. 16 Detailed depictions of Allied positions were printed in *red* on the map series of 1:100,000. Not only were the trenches indicated, also the infrastructure of the area behind the lines was shown, including the locations of airfields and observation balloons. In contrast, the German lines were only roughly indicated in *blue*

Poland and the Baltic area. This map, entitled "Karte des westlichen Russlands" (Map of Western Russia) included all regions up to the area just east of Minsk.

The *Kartographische Abt. der Preuß. Landesaufnahme* had produced the map series since 1897, relying on both Russian and Austrian maps. From August 1914 onwards, large map sheets were created by amalgamating nine individual sheets. From 1915 onwards, most of these large sheets were printed by the Deputy General Staff in Berlin. For the remainder of western Russian territory the "Drei-Werst-Blätter" (Three-Verst sheets) at a scale of 1:126,000 were reprinted.

Overall, the military campaigns on the eastern front moved in phases, especially in Poland and the Baltic. To support actions there the survey sections produced large area maps. Thus, for example, maps were created for Kurland (Courland) and Livland (Livonia) at a scale of 1:50,000. This illustrated the special strategic interest in

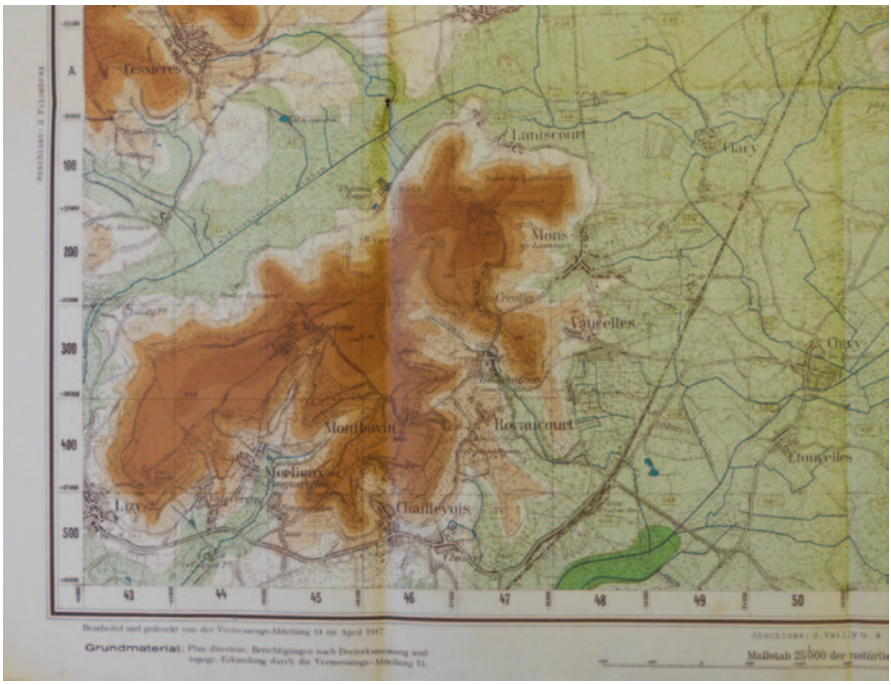


Fig. 17 With great energy and determination the surveying sections sought to make their maps more informative and easier to read. Sometimes they were able—as seen here—to use a basic monochrome French map (*plan directeur*) as a basis. This is an extract of a 1917 map by the 7th army of the Laon region. Although designed and printed in the field, behind the front, it shows the most advanced cartographic method of depicting contours using 14 colors to indicate elevations, at a scale of 1:25,000

the Baltic region where there was a significant German heritage and estate-owning elite. As in the West, where the fighting evolved into trench warfare (as for example on the Daugava front near Riga), situation maps were created at a scale of 1:25,000. In addition, a part of this area was covered by an "Übersichtskarte der 8. Armee" (General Survey Map, 8th Army). All of these maps were based on updated Russian map material.

While the maps of the Baltic were reworked to scales normally used for German maps, the same was not true for the reprinted Russian "3-Werst-Karte" (Three-Verst map), drawn at a scale of 1:126,000. In essence, the *Kartographische Abteilung des Stellvertretenden Generalstabes* did not do much more than transcribe place names.

At first there were no maps available to cover the Macedonian front in the Balkans. For this area a completely new map series at a scale of 1:25,000 was created under the guidance of Curt Treitschke, using state-of-the-art stereophotography. "Numerous photographic units using the very good portable "Kammern" (cameras) made by Zeiss continuously explored the desolate wastelands. The photographic plates were then shipped back to Germany via the Orient Express, where they were

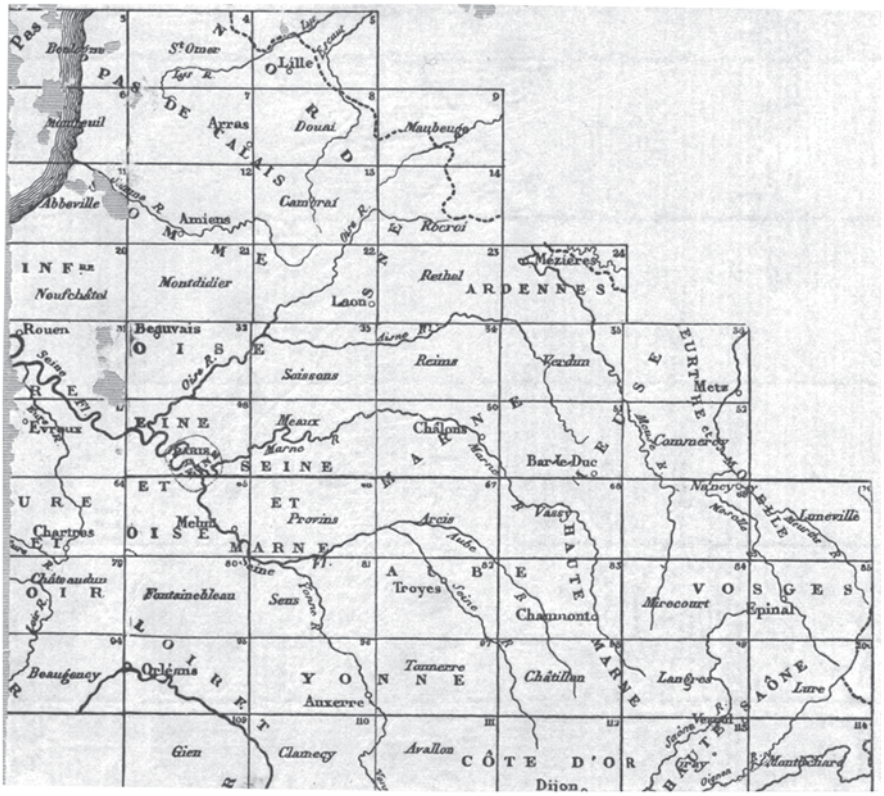


Fig. 18 The index map of the 100,000-series shows 55 sheets

overlaid with contour lines using professional cartographers who were familiar with the areas" (Boelcke 1921a, p. 123).

2.3 Specialty Maps

In addition to general topographic maps, a number of specialty maps were developed over the years. From the beginning there were maps at a scale of 1:300,000 which showed the telephone lines to be used in enemy territory. Later, in times of positional warfare, there was a demand for geological maps for deploying mines (N.a. 1918a). As a result departments of War Geology were set up within military survey units (Albrecht 1969, p. 10). Hydrology and geology maps were also important in supporting the efforts to supply the troops with potable water. In the end a multitude of specialty maps were developed. Albrecht (1969, p. 46) lists no fewer than 19. Some of the more significant ones were:

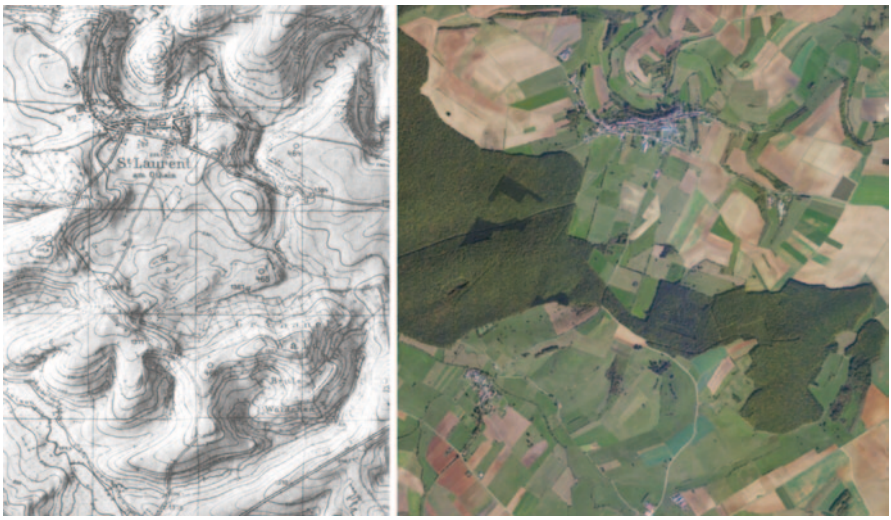


Fig. 19 In the course of the war the demands for tactical engagement maps steadily increased. It was therefore decided that for certain specific areas plaster relief maps of 1:25,000 would be created. These models were then illuminated at an angle and photographed, and topographic details such as streets and houses then added. Finally, contour lines were drawn, not only to achieve a three-dimensional-like representation, but also to add exact elevation data. How important that was, can be seen upon comparison with modern satellite images. The features of the area may be recognizable in the photograph, but the contour lines cannot be determined from it. In World War I this would remain a major problem of aerial maps until the advent of stereophotography

- Artillery observation maps (1:25,000), showing locations of enemy positions.
- General survey map (1:80,000) for German long-range artillery, showing locations of targets.
- Battery plans (1:25,000) with firing plans for each German artillery piece.
- Maps (1:25,000) showing trigonometric locations of specific objects.
- Infantry and artillery location maps (1:25,000) with pre-printed forms for messages.
- Sight-line maps showing areas of the terrain which could not be seen from enemy observation balloons.
- Maps of military storage sites showing storage capacities.
- Wartime logistics maps (1:80,000) showing locations of purposely built military logistics facilities (bakeries, vehicle parking areas, warehouses etc.).
- Transportation maps showing railway connections, landing fields for aircraft, and automobile road networks, etc.
- Charts for aircraft pilots also played a special role. Please refer to the other article “The eye of the army” of the author in this volume.

In addition, starting from 1917, there was a degree of co-operation between the *Stellvertretender Generalstab* and the reconstituted *Preußischer Landesaufnahme* in Berlin. The maps produced in Berlin were primarily of a small scale, usually

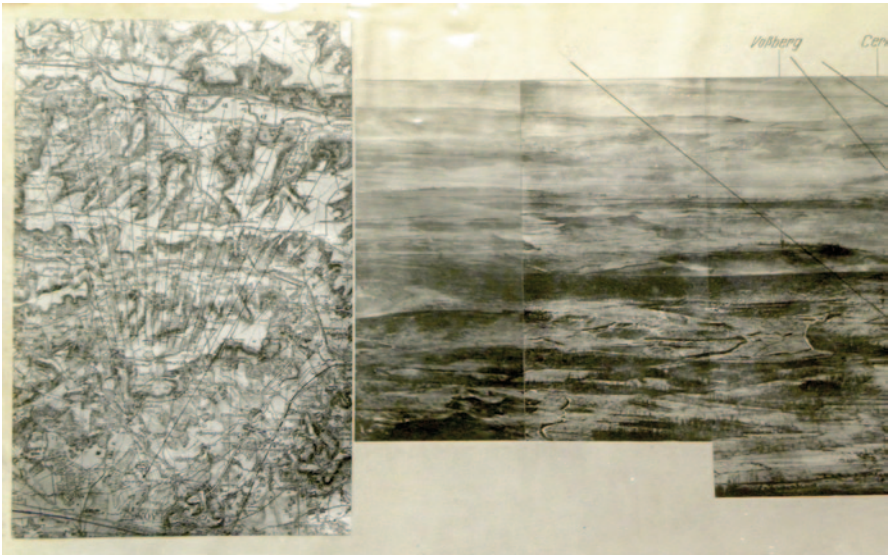


Fig. 20 Extract taken from a panoramic image. The picture extends a full 60 cm further to the *right*. The map, which has been affixed on the *left* (at a scale of 1:100,000), shows the location of the camera and the perspective lines corresponding to the image (Courtesy of the Staatsbibliothek zu Berlin, Map Collection)

1:300,000 or smaller. Berlin, as well as the larger stationary army printing units such as the *Planabteilung Metz* (Metz map depot) (see Fig. 5), also delivered the so-called "Leerblätter" to the field installations. These maps "contained simple, lightly printed, mostly monochrome grid lines and contour information (see Figs. 12 and 19). As a rule they were not fit to use until buildings, roads, geological features and other details had been added in color" (Boelcke 1920b, p. 9). These "Leerblätter" which are generally difficult to recognize mostly lack margins and labels.

Another unique instrument was the "Rundbild" (panoramic image) (see Fig. 20). They were taken from balloons and encompassed an entire horizon line (Neumann 1920, p. 166). A corresponding extract from a map of the area was affixed to the margin of the photograph so that the map and the image supplemented each other. These images demanded first class equipment of the highest precision and personnel who had been specially trained in heliography. They were initially only made, developed or printed only at a heliographic printing facility in Berlin (Boelcke 1920b, p. 9), but later a second such printing installation was established in the citadel at Mézières (Albrecht 1969, p. 34).

In addition, each army headquarters had large relief maps made of plaster for their section of the front (see Fig. 23). These models measured 4×2 m at a scale of 1:25,000 and were mounted vertically. It is almost certain that none of these 3-D models have survived. In special circumstances three-dimensional relief maps of particular sections of the front could be created which made it possible to take advantage of the protection offered by hilly terrain. The maps could be photographed

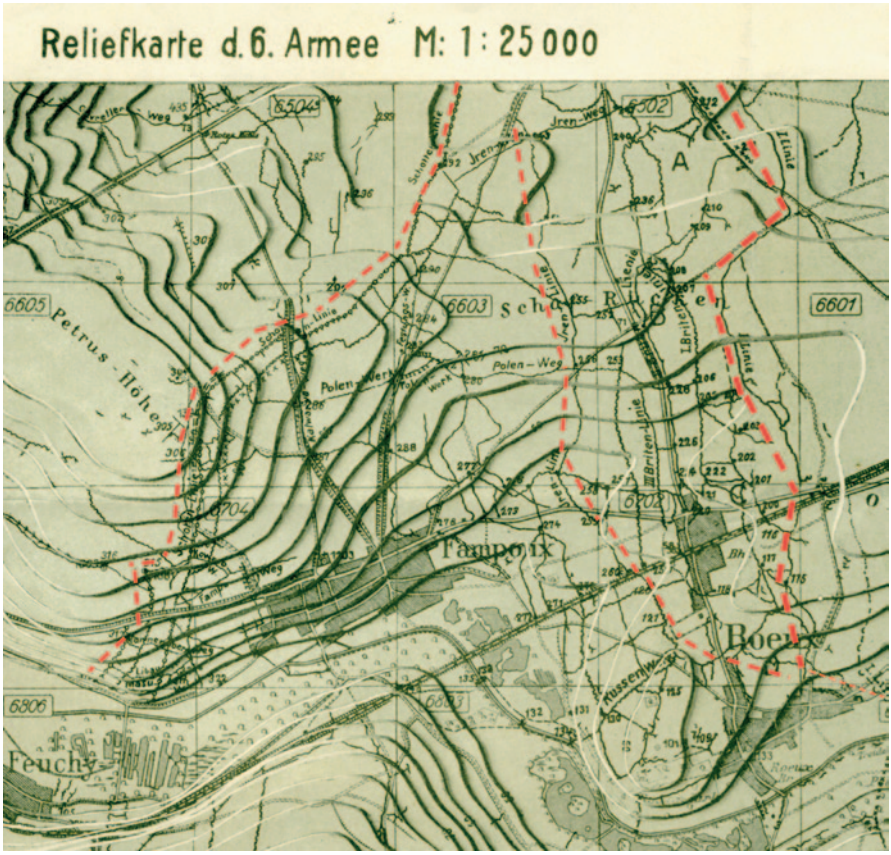


Fig. 21 The use of the relief technique varied and each army developed its own style. Within the 6th Army the terrain was reproduced by putting together thin sheets of wood whose thickness was determined by the contours of the terrain ("Stufenrelief"—step relief). The resulting model was then photographed using slanted illumination from the west. Next, topographic elements were imprinted on the image. Special attention was given to the location of the deployed lines. The British lines in this monochrome print are difficult to discern. For this reason they were highlighted by the author with *dashes* (1st British Position, Irish Line, and further to the *left* the Scottish Line). The German position was further to the east, outside the area depicted here. Note the numbered 1 km *grid lines*, which have been added. The Bavarian *Feldlichtdruckerei 4* (Field Printing Facility 4) did the printing in the hinterland of the front

using slanted lighting and the images were then copied and reproduced. The relief maps were welcomed with enthusiasm by the troops and following the war, Karl Wenschow (1884–1947), one of the professionals involved in making these maps, expanded the process for civilian use (Eckert 1925, pp. 797–798).

The German war effort was not limited to a two-front conflict in West and East. Over the years, new fronts developed in northern Italy, the Balkans and in the Middle East. To maintain a strategic overview of the situation the "*Kartographische Abteilung des Stellvertretenden Generalstabes der Armee*" in 1914 began working

on a general survey map series at a scale of 1:800,000. During the war this map was referred to simply as "Operationskarte" (operational map) and was classified as "Nur für den Dienstgebrauch" (For Official Use Only). By 1920 some 80 sheets had been produced covering the entire theatre of war from Ireland to western Iran.

In addition, in 1917 a special "Wegekarte von Westrussland" (road map of Western Russia) was created on the basis of this map. It not only indicated which roads were fortified, but also contained notations indicating the surface conditions of the land, which facilitated the mobility of troops across areas in which there were no roads.

Whenever troops were transferred from Germany to South(east)ern Europe and the Near East in order to stabilise the front lines of German allies, aviation units and survey units often accompanied them in order to support the effective use of artillery. This was an indication that the cartographic material needed for the creation of firing plans was often less adequate than on the western and eastern fronts.

3 The Balkans, Middle East and Africa

3.1 Military Map Making in the Austro-Hungarian Double Monarchy

In principle, Germany should have had limited its military activities to the western front and, on the eastern front, to Poland and the Baltic area. But when in 1914 the extensive yet weak Austria-Hungary failed to conquer small Serbia, and the Russians seized Galicia (or Halychyna, a region in modern-day Poland and Ukraine) and reached the Carpathian mountain passes, ready to invade the plains of Hungary, the German high command quickly came to the conclusion that their ally needed immediately help. In the years that followed, German troops again and again were called upon to provide "corset stays" to stabilise the fronts. As a result the "k.u.k. Monarchie" (Imperial and Royal Monarchy) was quickly reduced to the role of junior partner in the war as the Germans insisted on having the overall command. This situation was also reflected in the maps of this area. The Germans used Austrian map material, but improved and expanded it where necessary. This was true for the entire area of the Balkans, where local map resources were lacking as there were no reliable large scale maps of Bulgaria (another German ally) produced before the war.

The situation in Austria-Hungary differed from the one in Germany in that there had been a number of battles within Austro-Hungarian territory which made adequate map material available. The *Militärgeographisches Institut* (Military Geographical Institute) in Vienna had also estimated the Balkans to be a region into which the war could potentially expand, and had therefore made every effort to develop their map coverage of that area, using also Russian drawings. however, This material ultimately proved to be of little use as it was often imprecise and inaccurate for modern warfare.

Similar to what had happened in Germany, large parts of the Viennese *Militärgeographisches Institut* were dissolved at the outbreak of the war and its personnel reassigned to regular field units. The rump institute concentrated on the printing of maps that were already available and altogether some 65 million sheets were printed (Mühlberger 1929/1930, pp. 208–209). This comparatively small number of printed sheets was an indication that for the army of Austro-Hungary, map production played a much less important role than it did in Germany.

Following the outbreak of hostilities, it soon became clear that the Austro-Hungarian forces were not adequately prepared in terms of either their survey technology or their cartography. As a result, in early 1914 they created a *Kriegsphotogrammeterabteilung* (Wartime Photogrammetry Section) and, in the spring of 1915, three *Kriegsmappierungsabteilungen* (Wartime Survey Sections) and a *Photokartographenabteilung* (Photo Cartography Section). In September 1915 they introduced a comprehensive new organization of wartime mapping activities following the pattern used by the German army and renaming the result the *k.u.k. Kriegsvermessungswesen* (Imperial and Royal Wartime Survey). Hubert Ginzel (1874–1950), an officer of the General Staff Corps, was chosen as commandant of this new organization. He was later promoted to the rank of colonel and held this position until the end of the war. (Mokre 2013, p. 51)

During the war, the work of the Austro-Hungarian Survey concentrated on three priorities: the printing of maps needed at the front, continuous improvement of map material, and new topographic mapping of the occupied foreign territories in the Balkans which had not previously been possible (Ginzel 1921, pp. 130–131).

For Austria-Hungary itself maps were available at a scale of 1:25,000. However, in contrast to Germany these maps were only at hand as original drawings, not as prints. When the troops needed them at several front lines, the sheets first had to be prepared for printing and then repeatedly updated. In some cases even three-dimensional reliefs were added (see Fig. 23).

There was an "Operationskarte 1:400,000" (Operational Series 1:400,000) which was restricted to military use only. In addition a program was developed that included a variety of sheets, some of which were at scales of 1:10,000 and 1:5000 (Ginzel 1921, pp. 132–138).

In contrast to the western front, the warfare on the front lines with Russia and Romania was a war of movement, which went through several lengthy phases. Small-scale maps were available for use in those areas, including a "Spezialkarte 1:75,000" (Special Map 1:75,000). This military mapping effort had already created some 714 sheets by 1888 (Mühlberger 1929/1930, p. 203) and was expanded to 805 sheets following the occupation of Bosnia and Herzegovina. Since this set of maps also included all of Galicia, it offered a certain amount of support for the troops at the Russian front. However, it had a number of disadvantages as it was in many ways obsolete. It had no contours and was printed in black and white, which made it difficult to read in mountainous areas (Mühlberger 1929/1930, p. 205).

In 1916, following the occupation of Serbia, several *Kriegsmappierungsabteilungen* (Wartime Mapping Sections) were established in Vienna. "Within two years (1916/1918) some 63,000 km^2 of Serbia and Albania were geodetically and

Fig. 22 Extract from a sheet of the Austrian General Survey Map 1:200,000 showing a well-designed four-color image (junction of the San and Weichsel Rivers near the Russo-Polish border). A hand-drawn *yellow line* indicates the border itself. Although the overall appearance of the map is appealing, the cartographic quality of areas outside Austrian territory was definitely poor, a fact which led to many military difficulties, especially in the southern Balkans

topographically mapped with exemplary quality, in many cases with the use of stereophotogrammetry. These images formed the basis upon which wartime mappers produced the original drawings for a multi-colored special map at a scale of 1:75,000, which was then copied by the *Militärgeographisches Institut*…. Unfortunately part of the mappers' valuable work was lost with the collapse of the front (in 1918) and has not been seen again" (Mühlberger 1929/1930, p. 209).

A "Generalkarte von Mitteleuropa 1:200,000" (General Map of Central Europe 1:200,000) (see Fig. 22) was initially intended for use by higher staff levels to provide direction to the troops. Just as the German army had learned that aerial reconnaissance was essential, this one was also given a make-over as an aerial chart. "Later, in peacetime, as studies were undertaken concerning the development of flight charts, it became evident that as flying evolved, flight charts could be made simpler. This led to limiting the flight version of the general map to heavy emphasis

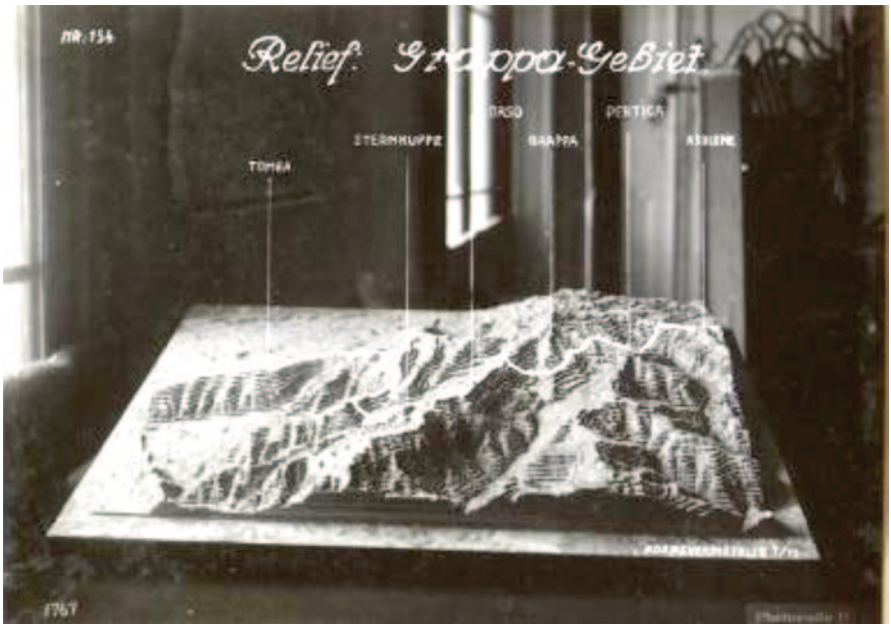


Fig. 23 The Austro-Hungarian surveying units too used terraced three-dimensional relief models for especially difficult mountainous terrain. Shown here is the Grappa-Massif, which the Italians made into a cornerstone of their defenses. It was here that the Austrians and the Germans tried to make a breakthrough in December 1917 during the first battle of Piave in a drive towards Venice. The line marking the extent of their advance is shown in *white*. Following the second battle of Piave in June 1918 the Grappa Massif continued to be in the center of major fighting that continued until the end of the war. (Courtesy of Europeana)

on wooded areas using a soft green color and areas of water using a dark blue, together with spot elevations in mountainous areas printed in red and, on some sheets, red lines to highlight the road network" (Ginzel 1921, p. 134).

It is interesting that in both Germany and Austro-Hungary flight charts were created using the same scale. As a comparison of these charts has not been possible thus far it is impossible to say whether this was due to a co-operative effort.

There are very few examples of joint cartographic ventures between the Germany and Austria. One such involved the Berlin cartographers sharing with the *Militärgeographische Institut* in Vienna sheets of the map "Westliches Russland 1:100,000" (Western Russia 1:100,000) from which Vienna could, through enlargement to 1:75,000, create their own maps of the eastern areas (Ginzel 1921, p. 133). Sheets from a German map in 1:400,000, which had been produced by the German survey sections, were also reprinted. In return, Vienna gave the German troops a stock of some 2 million Austrian maps of the Balkans which they had acquired following the conquest of Romania, and which they continued to augment (Ginzel 1921, p. 131). The Germans were, however, still not content. Writing in 1921, Boelcke maintained that these old Austro-Hungarian maps were not useful, especially in the Carpathian Mountains, and needed to be completely replaced

(Boelcke 1921a, p. 121). In his opinion: "German troops needed German maps. Indeed, they could read the Austrian works, but essential elements of German military maps were missing, in particular the grid lines which formed a network with a 1 km mesh. As a result, the work of the royal and imperial survey troops was scarcely good enough even for their own army" (Boelcke 1921a, p. 120).

An example from the Alpine front: "When at the end of September 1917 the 14th German army in the Save valley […] attempted to determine what was known about the terrain and the enemy positions for use in planning their offensive, it became apparent that the Austrian maps of the Julian Alps […] which they had were not adequate. All that was available was a map at a scale of 1:200,000, which, while barely adequate on the level of a flat plain, would hardly satisfy a tourist in the mountains. […] It fell to the leadership of the aviation units assigned to the German army to help out in this difficult situation. […] They were able to quickly photograph the areas on both sides of the front. […] On the basis of the improved maps that were then made, it was possible to make timely disposition of the forward artillery for the attack, as well as to assign targets to the individual batteries, guided by observation aircraft" (Neumann 1920, pp. 514–515).

Overall, it would appear that the relationship between the chiefs of the Austrian and German wartime survey units were not very co-operative. Each side was proud of its own achievements and thought little of the other's, and one misses words of thanks for whatever co-operation there was. Instead one can find notable examples of duplicative mapmaking efforts even as far away as the Middle East.

3.2 Military Map Making in the Middle East

At the end of October 1914 the Ottoman Empire entered the war on the side of the Central Powers. The Turks seek participation and support in various technological areas. These interests could be seen prior to the war in the planning and construction of the Berlin to Baghdad railway, but they also included military assistance (Mühlmann 1927, pp. 13–42).

Turkey fought on four fronts: against the western allies on the Dardanelles (Gallipolli), against the Russians in the Caucasus, against the British in Mesopotamia, and on the Suez Canal (see Fig. 24), and German troops and cartographers were often present on each of these fronts.

Along with the first German troops, survey technicians were also sent to Turkey. In Mesopotamia Prof. (Albert) Tafel (1877–1935) began the cartographic mapping of the course of the Euphrates River while in the Turkish-Egyptian border area. Capt. (Hans) von Ramsay (1862–1938) undertook the first preliminary work for cartographic imaging of the area. In Baghdad and Erzurum German mapping units were created. (Holzhausen 1937, p. 166)

The material created by these efforts was processed at the *Stellvertretende Gene-ral-stab* in Berlin. In 1915 a short "Kurze militärgeographische Beschreibung von Mesopotamien" (Brief Military Geographical Description of Mesopotamia) and

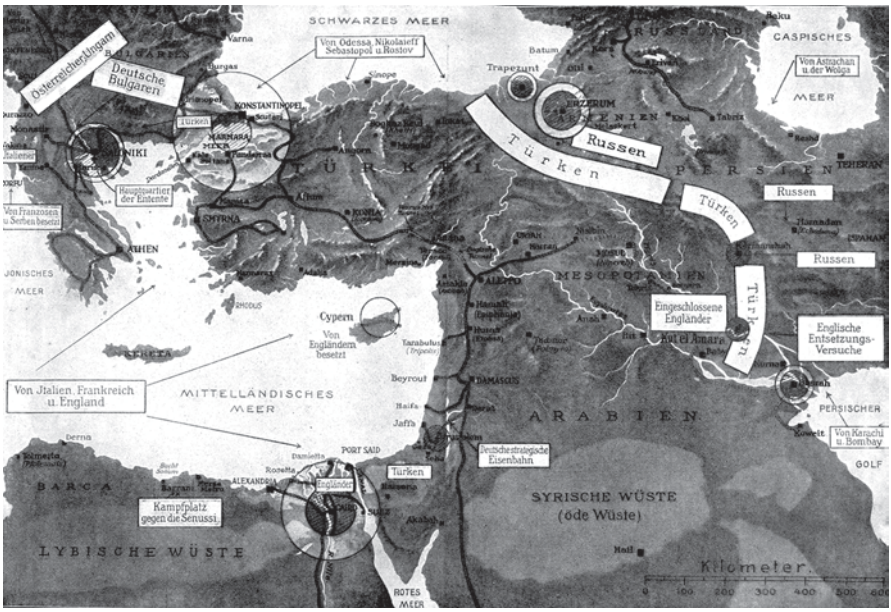


Fig. 24 This map dating from the first half of 1916 was based on British intelligence. It gives an overview of the strategic situation in the Middle East. The importance of the railway lines is clearly emphasized

a "Karte von Mesopotamien in 1:400,000" (Map of Mesopotamia on 1:400,000), which was intended to comprise 24 sheets, were put into production. By the fall of 1917, 11 of these sheets had been published (Uhlig 1917, p. 102). The work was continued until February 1918 when the plan was altered to produce a total of 29 sheets. How many of these sheets were actually completed has yet to be investigated (see Fig. 25).

Parallel to these developments the idea arose of a spectacular attack by German and Turkish troops on the Suez Canal (see Fig. 27) which was controlled by the British. In preparation for this offensive, Turkish and German personnel undertook a joint exploration of the Sinai with special emphasis on identifying sources of water which the troops would be able to use. Included in this effort were a number of water diviners. After several months marching through the desert this water divining expedition actually reached Ismailia on the Suez Canal on February the 6th, 1916 (N.a. 1989, p. 72). Cartographic support for this project was presumably the British map "Eastern Turkey in Asia, 1:250,000" which was published in 1901 by the *Intelligence Division, War Office* in London (GSGS 1522).

On the basis of the British map and the information provided by the exploratory expedition, the *Kartographische Abteilung des stellvertretenden Generalstabs der Armee* (Cartographic department of the deputy general staff of the army) in Berlin "at the request of the Turkish Ministry of War" produced a "Karte des Türkisch-Ägyptischen Grenzgebietes (Vorläufige Ausgabe)" (map of the Turkish-

Fig. 25 This index map from 1918 shows how eager Berlin was to continue their cartographic work in preparation for the conquest of the Middle East despite the realities on the front. One has to remember that in the summer of 1918 a German expedition was sent to Georgia

Egyptian border area (Preliminary Version)) in 1915/1916 at a scale of 1:250,000 (see Fig. 26). It was classified as "Nur für den Dienstgebrauch" (For Official Use Only) and contained notations in both German and Turkish (the latter in Arabic script). The map comprised four sheets. It covered the area from the mouth of the Jordan River at the Dead Sea in the north to the Gulf of Aqaba in the south. Parallel with this effort, a map of the Suez Canal at a scale of 1:200,000 was produced by the *Militärgeographische Institut* in Vienna (Ginzel 1921, p. 135) to aid a small contingent of troops with light howitzers which the Austro-Hungarians had provided (N.a. 1915, 1916). Why there was not more adequate consultation on cartographic matters between Berlin and Vienna with regard to this area remains a mystery.

The attempt to seize the Suez Canal failed, and by 1917 it proved impossible to keep control of Baghdad as well. The German forces sought to maintain at least the Palestinian front, and a joint German-Turkish army group called *Ildirim* ("lightning") was formed (Steuber 1924). It was accompanied by a modern support unit called *Vermessungsabteilung 27* (Surveying Sect. 27) which had been newly created by Berlin and which published a "Kurze Militärgeographische Beschreibung von Palästina" (Short Military Geographical Description of Palestine) (N.a. 1917).

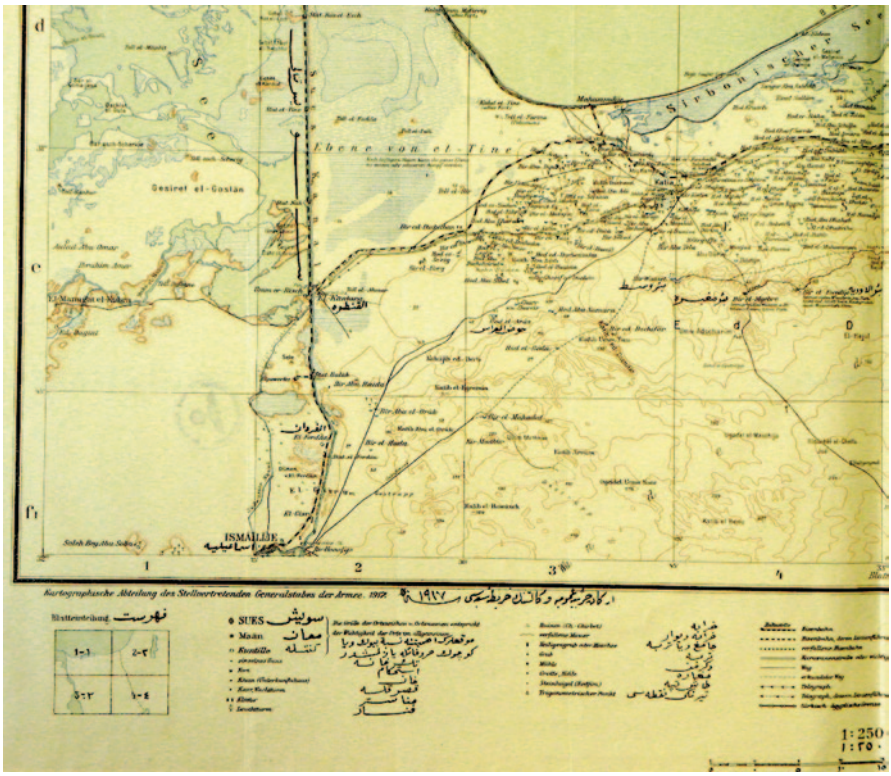


Fig. 26 An extract from the map of the Suez Canal with German and Turkish notations in Arabic characters. (Courtesy of the Staatsbibliothek zu Berlin, Map Collection)

The military was apparently not satisfied with this and also expected the *Vermessungsabteilung 27* to produce maps on a larger scale. In 1937 Holzhausen published a short report which indicated that work on this publication which was badly needed, had begun in September 1917 as there was no German or Turkish material available that could be used by the military. "It was characteristic of the situation that, when the *Ildirim*-Fliegerabteilungen (*Ildirim* pilot sections) stationed in Aleppo asked for maps of the Gaza front at the beginning of the operation, not a single map of Palestine was provided" (Holzhausen 1937, p. 167).

Although there was a map of the Ottoman-Egyptian border area, no useful cartographic documentation for Palestine itself was available and the German troops had to make do with copies of old British maps until finally more up-to-date information was obtained from captured sheets of the British General Staff Map at a scale of 1:250,000. From this material two sheets entitled "Palästina Südlicher Teil (Samaria)" and "Palästina Nördlicher Teil (Galiläa)" (Palestine Southern Part (Samaria) and Palestine Northern Part (Galilee)) were published in mid-December 1917 (Holzhausen 1937, p. 170).

The situation improved in 1916 with the discovery in Haifa of a copy of the British *Palestine Explorations Funds* map at a scale of 1:63,300 in 26 sheets (Chasseaud 2013, pp. 99–100). This map was enlarged to a scale of 1:50,000 and by

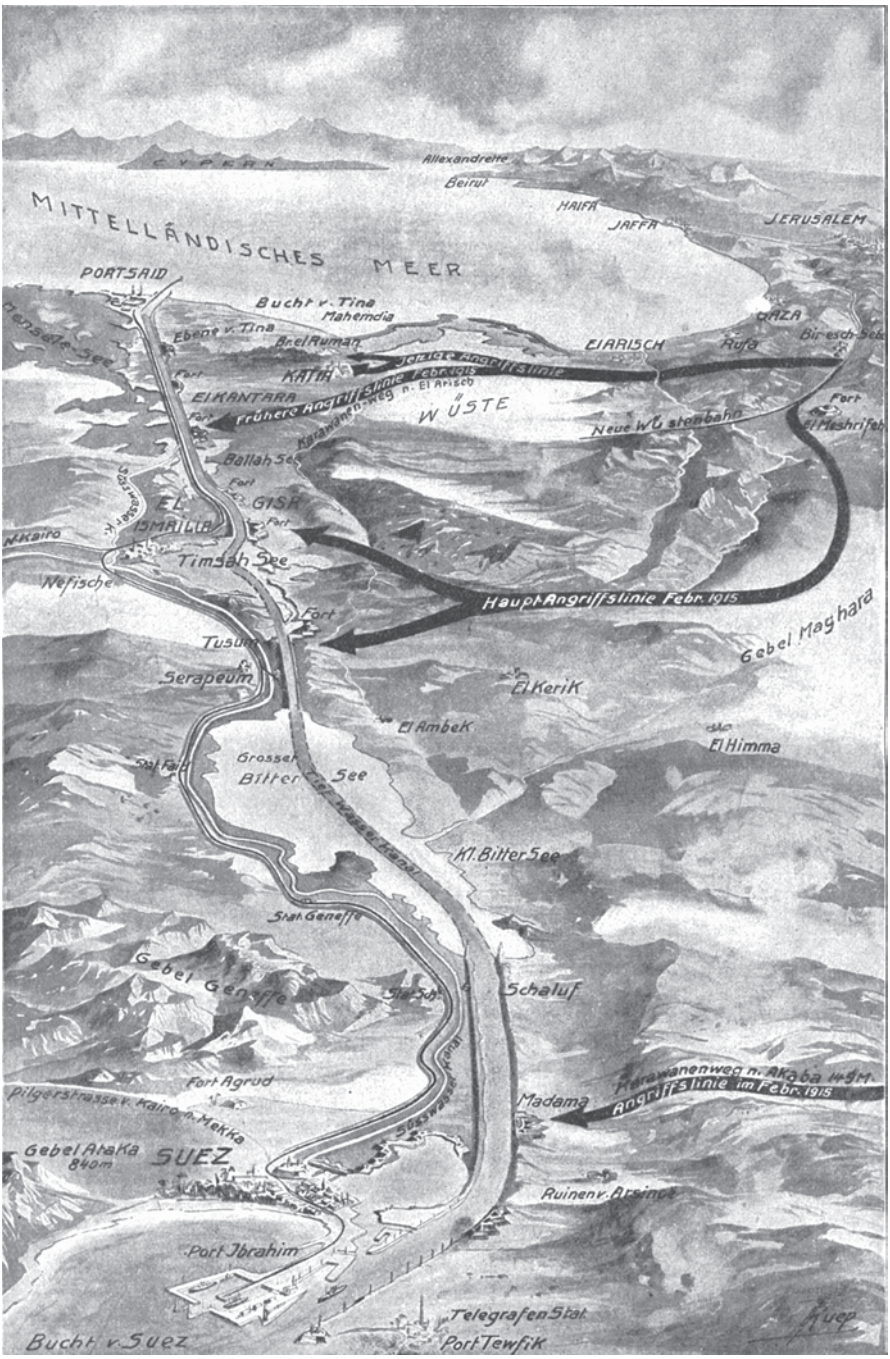


Fig. 27 At that time so-called "Vogelschaukarten" (bird's eye view maps) were a highly valued means of orientation. They were important, not so much for operational purposes as for the psychological element in the conduct of the war. This image shows the planned attack by Ottoman troops on the Suez Canal in February 1915. This example demonstrates how important maps were in areas other than direct military operations. The German High Command had long been aware that there was also a home front, which needed to be supported

the middle of February 1917, 39 sheets covering Palestine (including areas east of the Jordan) had been printed and distributed to the troops. Additional maps of Syria followed later (7 sheets on a scale of 1:25,000, and 1 map on a scale of 1:100,000) (Holzhausen 1937, p. 171).

Assistance towards this effort was provided by the Bavarian *Fliegerabteilung 304*, (Flying Sect. 304) which produced numerous aerial photographs. Today there are some 2872 glass plates of cities and rural areas in Palestine in the Bayerische Hauptstaatsarchiv*, Abt. IV* (Bavarian Main Archives, Sec. IV Bavarian War Archives) in Munich. The scientific examination of this war relict proves important today for the assessment of the status of early twentieth century aerial archaeology in a landscape that has since changed dramatically. The aerial reconnaissance troops created their own sketch images at a scale of 1:100,000 of the areas where they were flying. These sketches were then assembled during week-long sessions of detailed work (Neumann 1920, p. 527). Strictly speaking the *Vermessungsabteilung 27* (Surveying Sect. 27) should have been responsible for this work, but they were elsewhere employed.

In the spring of 1918 work had begun on the creation of "Stellungskarten 1:25.000" (tactical maps at a scale of 1:25,000) for the moving front. By the fall of 1918 seven of these sheets had been completed (Holzhausen 1937, p. 172). They are characteristic for the way in which the survey sections operated under wartime conditions: improvisation, use of captured maps and aerial photographs and the tendency to make maps in ever larger scales, were predominant. With the acceleration of the withdrawal at the end of September 1918 all the remaining map material was burned (Holzhausen 1937, p. 175).

On the Turkish side three further fronts were of special cartographic interest: the Dardanelles, the Caucasus, and Persia. On the Dardanelles front the Turkish forces used maps at a scale of 1:25,000 (see Fig. 28). Some of these fell into British hands who used them to make their own maps (Chasseaud 2013, pp. 76–77). Interestingly, the relationship was in some cases reciprocal as the Central Powers had maps which they had reprinted from British maps (see Fig. 29): "Beginning with the copying of English maps, excellent map material covering the Dardanelles theater was created with both Turkish and German notations. Because of the lack of accurate documentation for the rest of the Turkish areas, the domestic Turkish units had to make do with small-scale general survey maps. Between these maps, which had "Operationskarte des Orients 1:800,000" (Operational Map of the Middle East at a scale of 1:800,000) imprinted, and the large scale maps of local conflict areas, which were created at the front, there was a huge gap" (Holzhausen 1937, p. 167).

It remains to be investigated in what form the Turkish troops acted independently to fill this gap, especially in the Caucasus area. It is possible that they used Russian map material, similar to the way the Germans reproduced so many British maps.

Austrian activities in the Middle East should not go unmentioned, especially those that are related to Alois Musil (1868–1944). Just as Lawrence of Arabia did, Musil sought to win the confidence of the Arab tribes, an effort in which he was successful for a considerable time. Musil became a member of the official Austro-Hungarian mission to the Middle East and produced a number of maps of Arabia

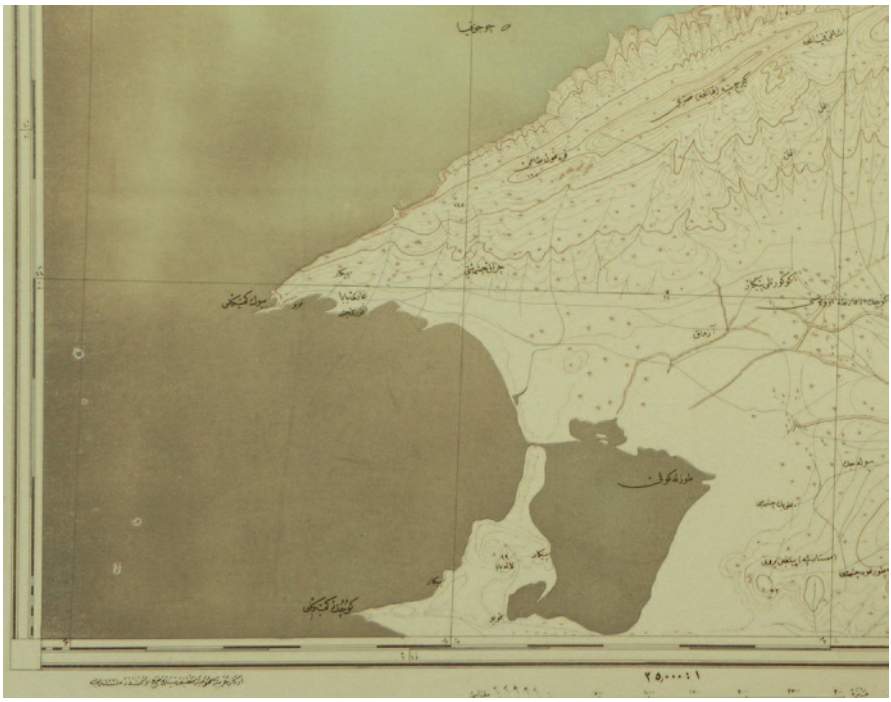


Fig. 28 The Ottoman map of the Dardanelles at a scale of 1:25,000 had a very detailed depiction of elevations. Unfortunately, they were only shown using contour lines. No attempt was made to improve the images through the use of hachures. Notations in Arabic were used to indicate water sources and to mark peaks and valleys. By the end of 1918 the map comprised of 46 sheets. The sheet labeled Anafarta shows the area of the Suvla Bay, where in August 1915 Entente troops, together with ANZAC forces, made a landing. Even though the Ottoman army only had 1500 troops on the Anafarta front, under the command of a Bavarian major, the landing attempt failed. (Courtesy of the Staatsbibliothek zu Berlin, Map Collection)

(Bernleithner 1978, pp. 1–2) Whether they were useful for military purposes remains unclear.

3.3 Military Mapping of Africa

When the war broke out in August 1914 Germany immediately lost contact with its colonial empire. The Pacific islands, Tsingtao in China and Togo were lost to Allied invasions within weeks, South-West Africa by 1915 and the Cameroons by 1916. This meant that the war in the colonies was primarily fought in the protectorate of German East Africa. Beginning in 1896 Richard Kiepert (1846–1915) and Max Moisel (1869–1920) worked on creating a map at a scale 1:300,000. This "Spezial-kar-te von Deutsch-Ostafrika" (Special Map of German East Africa) comprised

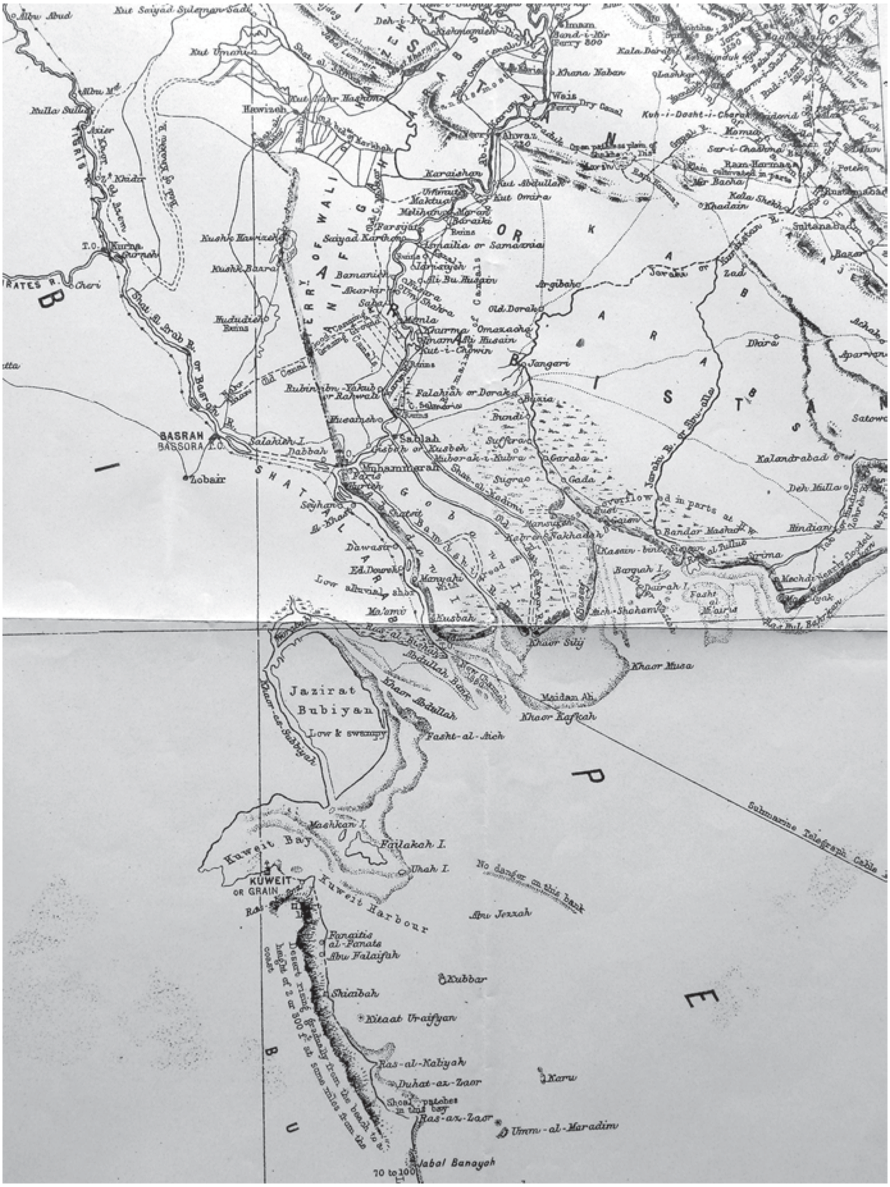


Fig. 29 The German General Staff had far-ranging plans to take the war to Persia, Afghanistan, and India, in order to challenge the British Empire and relieve the pressure on the European fronts. Because no German cartographic material existed for these distant areas, Berlin copied British maps. Shown here is an extract of the map of Persia covering the area from south of Kuwait City north to the Shatt-el-Arab and Basra

of 29 sheets and was completed in 1911. The British had a copy of this map at the scale 1:250,000 (Obst 1921, p. 109). A revised version covering the areas along the railway lines was ready for publication in Berlin when the war broke out (Sprigade and Moisel 1914, p. 541). Although the protectorates had their own survey offices (Sprigade and Moisel 1914, p. 542), it is highly unlikely that they produced any military maps during what was for most of them a rather brief course of the war. In any case the military had their own field survey units: "The defense forces in German East Africa had produced maps that served solely to provide information to the troops as to the locations of water and food supplies and road maps between military installations at a scale of 1:1 million that would serve to indicate the length of time needed to march from one to the other" (Sprigade and Moisel 1914, p. 542). These maps proved to be of unusual importance in the colonial war, and might explain in part why the German forces in East Africa were able to hold out against the British for so long.

3.4 Post-war Versions of Overseas and Western Front Maps

Smaller scale and special maps printed in Germany could still be obtained after the war. Such was the case, for example, with the "Operationskarte 1:800,000" (Operational Map 1:800,000) from which an "Übersichtskarte 1:800,000" (General Survey Map 1:800,000) was created. This 80-sheet survey was still available at the beginning of World War II. It should be noted, however, that updating this series terminated in 1928 (Reichsamt für Landesaufnahme 1931, pp. 277–278).

Until then the *Reichsamt für Landesaufnahme* also continued to offer the "Karte von Mesopotamien und Syrien (vorläufige Ausgabe) 1:400,000" (Map of Mesopotamia and Syria (preliminary version) 1:400,000) in 20 double and 9 half sheets. Three of the double sheets even had Turkish notations (N.a. 1928, p. 17).

Much more noteworthy is the fact that private map sellers continued selling surviving stocks of military maps on the open market. This was especially the case for map material of the western front. The firm *Carl Kuhn Verlag München* for instance offered a "Gelände-Karte von Frankreich (Generalstabskarte) 1:100,000" (Map of the Terrain of France (General Staff Map) 1:100,000). These sheets probably were derived from maps produced for the last German attack of 1918 and was a reduced copy of the "Carte de France 1:80,000." *Theodor Riedel's Buchhandlung and Domina-Verlag* in Munich also sold these maps. They are undated and carry no printing notations, which makes them difficult to identify. One clue to identify post-war prints is the fact that they do not carry a censor's notation on the title sheet. The requirement that such an imprint be included was strictly enforced for all printed materials from mid-1916 until the end of the war. The target audience for these offers were probably former military personnel who had fought in these regions.

4 Conclusion

Altogether, some 1,000,000,000 map sheets were created by all combatant nations involved in World War I. Boelcke estimates that Germany alone accounted for about 800 million (Boelcke 1921b, p. 463). Other estimates put the number at 775 million (Chasseaud 2013, p. 19) or 750 million (Eckert 1925, p. 806). Austria-Hungary produced about 65 million. No numbers are available for Bulgaria and the Ottoman Empire, but it is safe to say that altogether the Central Powers produced some 880 million map sheets.

Far fewer map sheets were created on the Allied side. Peter Chasseaud estimates 34 million for the United Kingdom, 30 million for France and 20 million for Italy. For Russia he sets the total at 320 million (Chasseaud 2013, p. 19). However, this number seems improbably high. It presumably refers to the number of print runs and not the number of map sheets. When we compare it with other data, we believe that 65 million map sheets is a figure consistent with the others, making a total for all the Allied nations of some 150 million.

The Central Powers thus produced almost six times as many maps as the Allies. Since the front lines were of equal length for all parties, and the British, for example, were involved in almost as many fronts as the Germans, there must be other reasons why the militaries of the Central Powers, and of Germany in particular, were so obsessed with maps. What could explain this difference? Four factors could be pointed to:

1. The use of maps is consistent with the desire for **order and regulation** inherent in the German national character. On a good map things are clear and concise. They form an indispensable foundation for planning and organization. Having good maps becomes a measure of a well-organized state and army. Cartography thus contains an element of national identity, something which the states which were brought together to create the German Empire in 1871 were reluctant to forgo.
2. From a military point of view a map is an important aid in the effective conquest, control and defense of territory. At one and the same time it documents a claim to the **achievement of power** and a **promise of its exercise**. In all the wars since 1864 Prussia had recognized the importance of maps in imposing order and enforcing its claims to power. A map was an essential instrument of Prussian, and later Imperial German war efforts: “A good map is half the battle” was a widely accepted slogan. This resulted in a huge demand for maps of all kinds. Without maps it was impossible to wage war in an organized and effective manner. The September 1914 disaster on the Marne was a consequence of an unusual absence of maps. Thereafter, every effort was made to prevent this from happening again. For the sake of security ever-larger numbers of maps were created.
3. The decentralized structure of the German Empire made it difficult to respond rapidly to unexpected developments on the far spread battlefields. Sufficient maps were made available to the troops for the initial phase of the attack in the West. But events moved far faster than had been anticipated, and logistic

arrangements for further map distribution could not be revised quickly enough. The further evolution of the conflict into trench warfare was equally not anticipated. The need for new maps to meet these new requirements was critical and every effort was made to produce them. The result were **numerous map production facilities** immediately behind the front, a development which produced many more maps than even a well-organized centralized production and distribution system could have made and distributed. France and England had centralized facilities from the beginning and hence required far fewer maps to meet their needs.

4. Both the trade blockade imposed by the western allies and the number of superior enemy forces faced by the Central Powers, meant the latter found themselves in a dangerous position. It was essential that they managed to achieve a more efficient use of their resources if they were to get out of this unsustainable situation. This necessity set free huge technical and organizational potential, especially in Germany. This is made evident by the **effectiveness of the German military deployments** in the Middle East and the eastern and southeastern areas of the Danube monarchy, which improved in a way that could not have been achieved merely by an increase in the number of troops. Maps were an essential part of this development. The greater the effort to achieve control, and the more difficult the situation, the more maps were created. The steadily increasing scope of the cartographic work towards the end of the war was more a sign of structural weakness in the organization of the military than it was of superior military leadership.

Because the authority of the administrations and the effectiveness of its wartime leadership were at stake, what began as a small administrative office, completely unprepared both organizationally and technologically to meet the challenges of a major war on foreign soil, gradually grew into a huge bureaucracy. In the course of the war the number of people working in the field of military cartography increased from just 911 to over 10,000. But still there was no unified leadership and central coordination seemed impossible. The short-term demands constantly put forward from the fronts made systematic growth of these facilities difficult. Cartographic resources, which in themselves would have been effective, could never be made available to the troops in an efficient manner and the insistence of the individual components of the structure on maintaining their independent control could never be overcome.

Against this background the achievements that were made, while not decisive for the outcome of the war, were nevertheless astounding:

1. An immense number of maps were produced in the most difficult circumstances and in some cases even updated on a daily basis.
2. Numerous maps were produced for a plethora of special purposes, from large-scale plans to small-scale overview maps: railway maps, flight maps, geological maps, artillery firing plans, maps for long-distance communication troops, for construction units and for furnishing missions by special forces.

3. Huge quantities of quality maps and aerial photographs were printed both at home and at the fronts.
4. The focal point for this work was the territory outside Germany which meant that many foreign maps were not only copied, but also often improved.
5. A very large number of new techniques were developed in a very short time. This was particularly true for aerial reconnaissance, photogrammetry and firing plans for the artillery.

Central to all these efforts was undoubtedly the technological development which occurred in wartime cartography. The pinnacle of that achievement was the contribution of long-distance cartography (Eckert 1925, pp. 784–787) in guiding the German heavy artillery outside Paris in the spring of 1918. It enabled 796 shells to hit the city from a distance of 80 km. To accomplish this, a special firing plan had to be created which even took into account the rotation of the earth. A description of how this was done goes beyond the scope of this paper.

In retrospect one question stands out: how are we to judge technological and scientific achievements that were developed solely in order to wreak destruction and kill human beings, as was the case with the firing on Paris? The entire wartime mapping enterprise had only one goal, and that was to kill more effectively. Ethicists found a way out of this dilemma by declaring that war was legitimate and justified as long as civilians were not attacked. With air raids on cities—begun by the French in 1914 with an attack on Freiburg im Breisgau, a German town just beyond the French border—this boundary had already been breached. Today more than ever in most areas of armed combat it is no longer possible to maintain a distinction between organized uniformed combatants and the civilian population. It becomes apparent how artificial and unrealistic it is to attempt to maintain a separation between acceptable acts of war and unacceptable civilian acts of violence. As we look back on the atrocities of the two World Wars it becomes increasingly difficult to close our eyes to these realities and award the highest military honor, Pour-le-Mérite, the Imperial German equivalent of the Victoria Cross and the Legion d'Honneur, to the trigonometers, the topographers and the cartographers who did this work.

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References

Albrecht O (1969) Das Kriegsvermessungswesen während des Weltkrieges 1914–1918. Deutsche geodätische Kommission bei der Bayrischen Akademie für Wissenschaften, Reihe E: Geschichte und Entwicklung der Geodäsie, vol 9. München

Albrecht O (2004) Beiträge zum militärischen Vermessungs- und Kartenwesen und der Militärgeographie in Preußen (1803–1921). Schriftenreihe Geoinformationsdienst der Bundeswehr Nr. 1, Euskirchen

Bernleithner E (1978) Musil, Alois. Österreichisches Biographisches Lexikon 1815–1950, vol 7. VÖAW, pp 1–2
Bertrab H von (1919) Der engl. Angriff auf die deutsche Landesaufnahme. Petermanns Geogr Mitt 65:166–167
Boelcke S (1920a) Kriegsvermessung und ihre Lehren. Mittler und Sohn, Berlin
Boelcke S (1920b) Die Engländer und das deutsche Kriegsvermessungs-Wesen. Petermanns Geogr Mitt 66:6–9
Boelcke S (1921a) Die erdkundliche Bedeutung von Kriegskarte und Geländebild. In: Praesent H (ed) Beiträge zur deutschen Kartographie. Akademische Verlagsgesellschaft, Leipzig, pp 119–129
Boelcke S (1921b) Das Kartenwesen. In: Schwarte M (ed) Der Weltkampf um Ehre und Recht, vol. 8. Die Organisationen der Kriegführung. Johann Ambrosius Barth, Leipzig, pp 443–474
Chasseaud P (2001) German maps and survey on the Western Front, 1914–1918. Cartogr J 38:119–134
Chasseaud P (2013) Mapping the First World War. Collins, Glasgow
Cruickshank JL (2006) Kaiser Bill thought he knew where you lived. Sheetlines 77:5–20. http://www.charlesclosesociety.org/files/Issue77page5.pdf
Eckert M (1925) Die Kartenwissenschaft. Forschungen und Grundlagen zu einer Kartographie als Wissenschaft, vol 2. Walter de Gruyter & Co, Berlin
Eckert-Greifendorff M (1939) Kartographie, ihre Aufgaben und Bedeutung für die Kultur der Gegenwart. Walter de Gruyter & Co, Berlin
Fels E (1919) Das Kriegsvermessungswesen im Dienste der Geographie, Erfahrungen und Anregungen. Petermanns Geogr Mitt 65:81–89
Ginzel H (1921) Das Kriegskartenwesen der ehemaligen österreichisch-ungarischen Monarchie. In: Praesent H (ed) Beiträge zur deutschen Kartographie. Akademische Verlagsgesellschaft, Leipzig, pp 130–148
Hafeneder R (2004) Überblick über das Militärische Geowesen Deutschlands im 19. und 20. Jahrhundert. Schriftenreihe Geoinformationsdienst der Bundeswehr Nr. 2, Euskirchen
Hammer E (1909) Die neue Karte von Belgien 1:100,000. Petermanns Geogr Mitt 55:241–242
Hinks AR (1919) German war maps and survey. Geogr J 53:30–44
Holzhausen (1937) Die Tätigkeit der Vermessungsabteilung 27 in Palästina. Mitt Reichsamt für Landesaufnahme 13:170–175
Immanuel F (1913) Besprechung von. (Herment (1913) Considerations sur la défense de la frontière du nord. Chapelot, Paris). Petermanns Geogr Mitt 59 II:295
Jochim Th (1930) Die Vorbereitung des deutschen Heeres für die große Schlacht in Frankreich im Frühjahr 1918, 2: Grundsätze für die Einzelwaffen:… Kriegsvermessungswesen. Mittler und Sohn, Berlin
Korzer K (1939) Der erste Versuch einer Landesvermessung aus der Luft. Mitt Reichsamt Landesauf 15:202–207
Meyer HHF (1937) Die Bedeutung der Karte für Staat und Wirtschaft. Mitt Reichsamt für Landesaufnahme 13:368–390
Mokre J (2013) Karten im Krieg. In: Rauchensteiner M (ed) An meine Völker, der Erste Weltkrieg 1914–1918. Amalthea, Wien, pp 50–55
Mühlberger J (1929/1930) Die Entwicklung der österreichischen Staatskartographie. Mitt Reichsamt für Landesaufnahme 5:193–213
Mühlmann C (1927) Der Kampf um die Dardanellen 1915, Schlachten des Weltkrieges in Einzeldarstellungen bearbeitet vom Reichsarchiv, vol 16. Gerhard Stalling, Oldenburg
Müller Th (1990) Die Wegekarten 1:300,000 der Preußischen Landesaufnahmen. In: Scharfe W, Musall H, Neumann J, Kretschmer I, Kadmon N (eds) Kartographiehistorisches Colloquium Karlsruhe, Bd 4. Dietrich Reimer, Berlin, pp 59–66
N.a. (1908) Militär-geographische Beschreibung von Nordost-Frankreich, Luxemburg, Belgien, dem südlichen Teil der Niederlande und dem nordwestlichen Teil der Schweiz. Großer Generalstab, Berlin

N.a. (1915) Militär-geographische Beschreibung von Nordost-Frankreich, Luxemburg, Belgien, dem südlichen Teil der Niederlande und dem nordwestlichen Teil der Schweiz, 2nd edn. Großer Generalstab, Berlin
N.a. (1915/1916) Militärgeographische Beschreibung von Vorderasien, Bearb. im Landesbeschreibungsbureau des k.u.k. Generalstabes, Wien
N.a. (1916) Das Wichtigste über das Kriegs-Vermessungs- und Kartenwesen der 5. Armee
N.a. (1917) Kurze militärgeographische Beschreibung von Palästina. Kartographische Abteilung der Königlich preuß. Landesaufnahme, Berlin
N.a. (1918a) Kriegsgeologie. Herausgegeben im Auftrage des Chefs des Generalstabes des Feldheeres durch den Chef des Kriegs-Vermessungs-Wesens am 15. Januar 1918. Chef des Kriegs-Vermessungs-Wesens, Berlin
N.a. (1918b) Ausführlicher Bericht über die Verhandlungen der Obersten militärischen Vermessungsstelle im Deutschen Reiche und in den Schutzgebieten während der ersten Gesamtsitzung vom 25. Februar bis 1. März 1918. Obersten militärischen Vermessungsstelle im Deutschen Reiche und in den Schutzgebieten, Berlin
N.a. (1928) Amtliche Kartenwerke des Deutschen Reichs, 48. Jahrgang, Reichsamt für Landesaufnehme, Berlin
N.a. (1989) Chronik 1916, 2nd edn. Chronik Verlag, Dortmund
Neumann GP (ed) (1920) Die deutschen Luftstreitkräfte im Weltkriege. Mittler und Sohn, Berlin
Obst E (1921) Die deutsche Kolonialkartographie. In: Praesent H (ed) Beiträge zur deutschen Kartographie. Akademische Verlagsgesellschaft, Leipzig, pp 98–118
Penck A (1920) Landesaufnahme und Reichsvermessungsamt. Zeitschr Gesellsch Erdkunde zu Berlin 1920:169–179
Reichsamt für Landesaufnahme (1931) Das Reichsamt für Landesaufnahme und seine Kartenwerke. Verlag des Reichsamts für Landesaufnahme, Berlin
Schmidt L (1913) Kurze militärgeographische Beschreibung Rußlands. Nach russischen und deutschen Quellen bearbeitet. Zuckschwerdt, Berlin
Schmidt L, Zacharias G (1921) Die Entwicklung des Deutschen Seekartenwerkes. In: Praesent H (ed) Beiträge zur deutschen Kartographie. Akademische Verlagsgesellschaft, Leipzig, pp 73–97
Sprigade P, Moisel M (1914) Die Aufnahmemethoden in den deutschen Schutzgebieten und die deutsche Kolonial-Kartographie. Zeitschr Ges Erdk Berlin 1914:527–545
Steeb C von (1911) Der Stereoautograph und die Kartographie. Petermanns Geogr Mitt 57II:92–94b
Steuber (1924) "Jildirim" Deutsche Streiter auf heiligem Boden, Schlachten des Weltkrieges in Einzeldarstellungen bearbeitet vom Reichsarchiv, vol 4. Gerhard Stalling, Oldenburg
Treitschke C (1921) Die Landesaufnahme Sachsen von 1780 bis 1931. In: Praesent H (ed) Beiträge zur deutschen Kartographie. Akademische Verlagsgesellschaft, Leipzig, pp 47–60
Uhlig K (1917) Kurze militärgeographische Beschreibung von Mesopotamien, 2nd edn. Kartographische Abteilung des stellvertretenden Generalstabs der Armee, Berlin
Winterbotham HSL (1919) British Survey on the Western Front. Geogr J 53:253–276

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