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Military Cartography

EDITED BY MIRELA ALTIĆ

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3-foot ramsden theodolite from 1791 used during the principal Triangulation of Great Britain. Noe in the Science Museum, London.
Photo by User.geni, December 2008. CC-BY-SA GDFL

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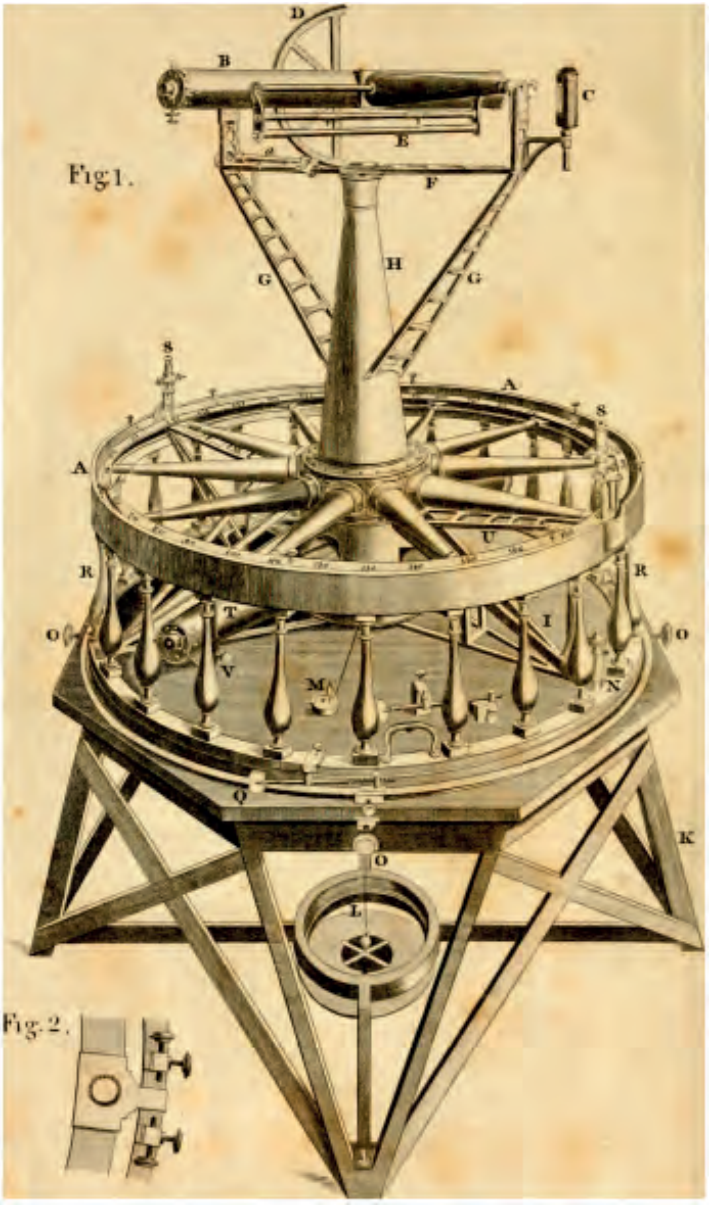

George Adams (1750-1795) and William Jones (1763-1831), Geometrical and graphical essays, containing a general description of the mathematical instrument used in geometry, civil and military surveying, levelling, and perspective, with many new practical problems, London, Printed by W. Glendinning, for, and sold by W. and S. Jones, 1803 [University of California Libraries. Image originally taken in 2014 from Flick's The Commons, and licensed under the terms of the No known copyright restrictions. Commons wikimedia]

Military Cartography

by Jeremy Black

This important collection underlines a key element in military cartography, its range, its variety, and the two related, but different directions of causality and consequence, that from the military to cartography, and that from cartography to the military. The classifications of the various links can then be presented in terms of a series of grids or matrices. Principally, there are those of geography, chronology and types of conflict and cartography, although that does not exhaust the situation for we are confronted with palimpsests of both war and cartography. The typology given excludes for example personnel. The key typology, however, is that imposed by the needs of war, notably tactical, operational, strategic, geopolitical, reportage and propaganda; and with the land, sea, air typology offering crucial variations.

It is overly easy, as so often with military history, to provide a developmental account of the subject that is 'Whiggish,' notably in the senses of being unidimensional, teleological and judgmental; each of those being aspects of the other. In such an approach, we adopt an approach in which there is a paradigm of progress and, as a result, an apparent guide to assessing significance, effectiveness and achievement, a guide, moreover, that enables us to consider relative importance both geographically and chronologically, and, thereby, to direct those matrices and determine attention. This is an aspect of the naïve usage of the somewhat bogus notion of military revolution, and it is no accident that similar assumptions and language can be found, as with the consideration of institutionalisation and bureaucratisation as also unequivocal progress.

This approach is naïve, but so also is that which assesses the subject in a positivist fashion, one based on the survival of maps and, separately, on their inherent quality. This begs the question of the relationship between mapping as a process and maps as a product. In reality, mapping as an aspect of situational location

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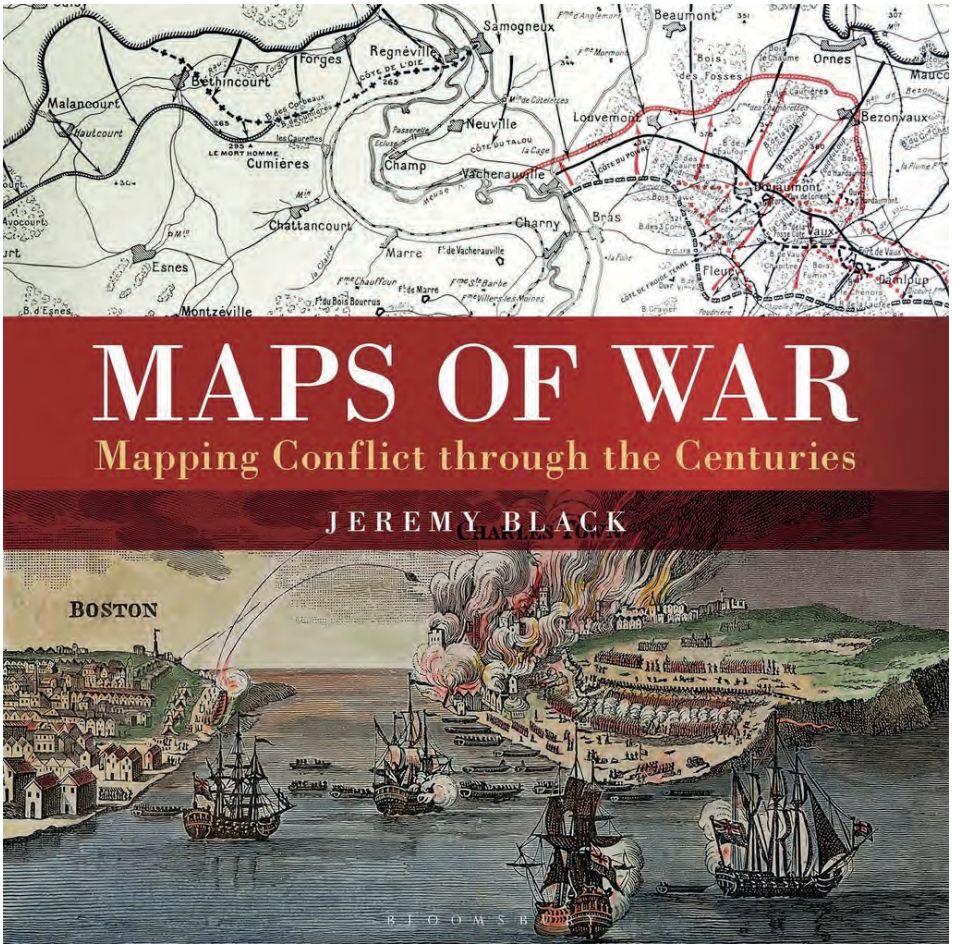


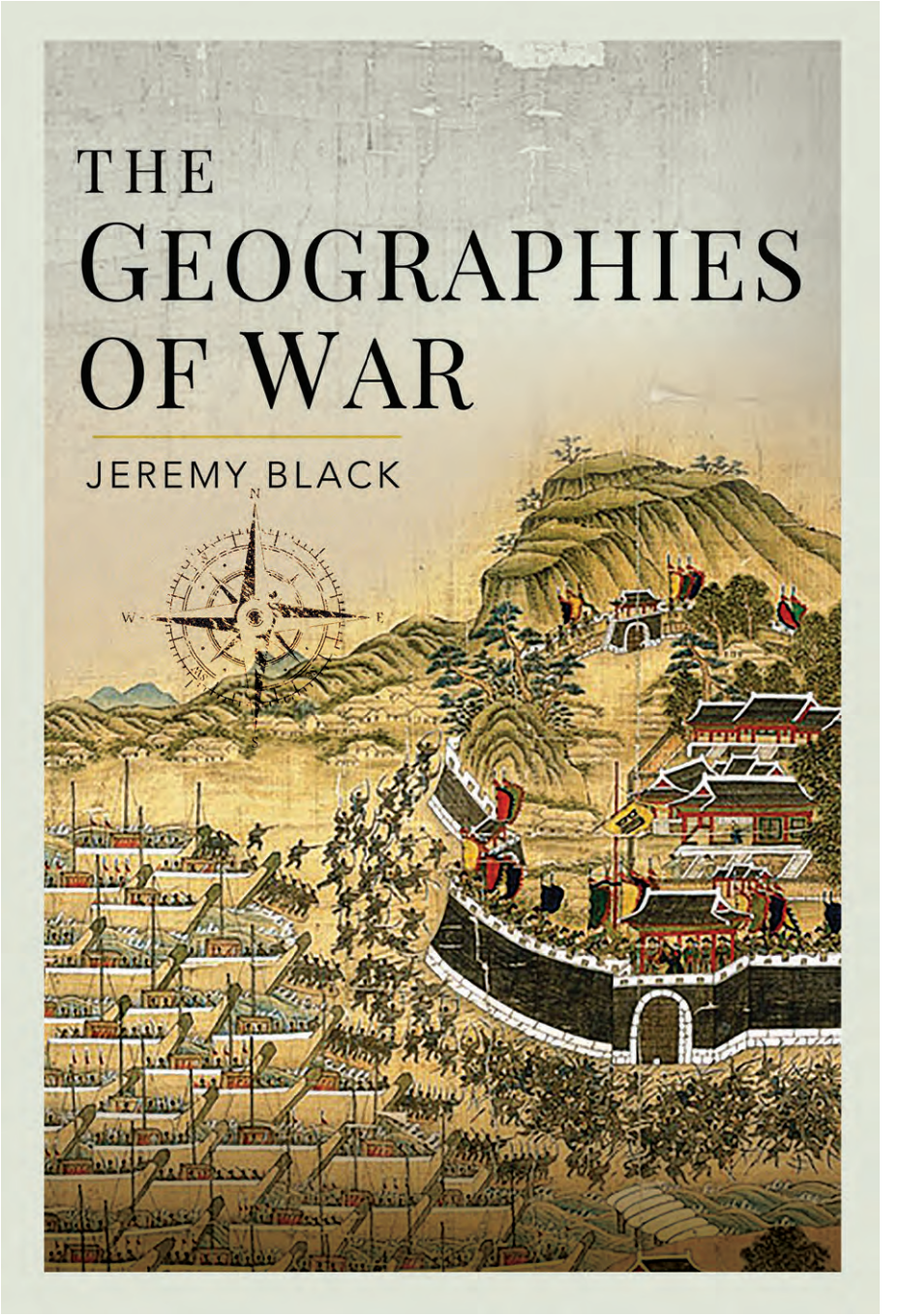
Jeremy Black, *Maps of War: Mapping Conflict Through the Centuries*, Conway, 2016.

and understanding is largely a mental process and, if not that, one that left an ephemeral presence as in indicators in the dirt, for example with a stick, usually of terrain and locations. These are maps, but not ones for which we have much, if any, survival, and notably so before the age of photography. Sketch maps on paper are a different variant, one of which we must be wary of saying that it is more developed lest we lapse again into a teleological model.

So, for most of the history of military cartography, we would need to consider geographies primarily of the mind, and how space and distance accordingly were assessed.

These factors remain pertinent for the essays discussed in this volume reflecting as they do largely state activity over the last 120 years, and not, for example, the cartography of military ngos, notably insurrectionary movements such as Shining Path in Peru. As the contributors show, institutional provision provides the resources and need to offer more programmatic mapmaking. That means different but not necessarily more 'developed,' as all forms of mapmaking should be judged in terms of fitness for purpose.

The recent history of historical cartography is made more concrete in this collection by consideration of particular case-studies, more specifically from the two world wars and notably aspects of the Allied invasion of Italy in 1943. These are all valuable, but also atypical. They relate to periods in which the resources of the major societies were uniquely focused on war, as opposed to periods of lesser activity. Moreover, there were unprecedented new requirements and opportunities, notably with air warfare and reconnaissance. The particular nature of air activity, and, notably, the location in three dimensions, ensured that location-finding, the key element in cartography, was given a new direction in range, scale and speed. The classic response, the feeding of information as to speed and height onto navigation maps, was a new version of naval mapping, but in a very different context. So also with the three-dimensional requirements for amphibious invasion mapping. These challenges provide a particular historical interest for the contents of this collection.



Jeremy Black, *The Geographies of War*, Pen & Sword Books Limited, 2022.

Defending Europe: Habsburg Military Cartography of the Croatian Borderland

by Mirela Altić
Institute of Social Sciences, Zagreb, Croatia

Abstract. In this paper we analyze the development of Habsburg military mapping in the area of the Croatian borderland as well as in neighboring Bosnia in the period of the Ottoman-Habsburg Wars from the mid-16th to the late 18th century. We demonstrate how military maps were created, who compiled them, which data collection strategies were applied apart from the survey, what was the subject of mapping, what types of maps were produced and how, given their status of secrecy, they influenced the development of military cartography in general.

Keywords. Military Cartography, Ottoman-Habsburg Wars, Habsburg Monarchy, Topographers, Military Engineers, Cartographic Education

Introduction

Today we cannot imagine a military operation in the absence of maps or geoinformation system. Yet, in the previous centuries maps were a relatively rare high-value commodity that was difficult to obtain. Consequently, armies fought campaigns with few maps and little geographical knowledge, or even with no maps at all. This would begin to change during the Early Modern Period when, under the pressure of protracted wars and new war techniques, the (artillery) relationship between warfare and cartography became very close. Long war campaigns encouraged the use of maps and also served as a catalyst for their improvement. Numerous innovations in mapping and cartographic production appeared as a result of military needs. However, among numerous maps used in the warfare since the 16th century it is hard to draw a clear line between military and non-military ones. To define military cartography of the Early Modern Era we have to consider both, their production and their use. In that regard, according to John Hale, an essential distinction should be made

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between the cartographic aspect of attack and those of defense. Both attack and defense cartography was drawn on printed early sixteenth century maps such as town views, commemorative prints of sieges and battlefields. Yet, none of that material was produced as an aid to military planning. Only after the distinction between attack and defense arose, the distinctive genre of military cartography can also be recognized with more certainty.[1] The military cartography of defense drawn on a rich surviving body of maps and plans concerned with fortification schemes evolved in the 16th century and was able to take advantage of regional maps produced for other purposes. On the other hand, attack cartography led to the conduction of reconnaissance activities of a wider area, which enabled the advancement of regional military mapping and flourished only since the mid-17th century.[2]

Another fundamental issue to understand the relationship between military affairs and cartography is to acknowledge that secrecy played a role in this relationship. Many technical advances in mapping were driven by military requirements, but the need for secrecy meant that knowledge of those technical advances was restricted to a small group of people. The secrecy policy had two major consequences: innovations of military cartography were slowly applied in other branches of cartography, while geographical knowledge recorded by military maps was inaccessible to the general public or to cartographers outside military circles.[3] Moreover, cartographic campaigns for collecting data in the field (simple reconnaissance or more extensive survey activities) were often secret and taken under cover.

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1 In the early war chronicles, there are more references to the employment of local guides than to the use of maps. John Hale, « Warfare and Cartography, ca. 1450 to ca. 1640 », in David Woodward (ed.), *The History of Cartography, Volume 3: Cartography in the European Renaissance, Part 1*, The University of Chicago Press, Chicago, 2007, p. 724.

2 There is no consent among map historians what makes a military map or since when military cartography has made a distinctive genre. E.g. Hodson considers the establishment of the General Quartermaster's Staff in 1758 as a beginning of Habsburg military cartography. Yolande Hodson, « Military Cartography and Topographic Surveying in Austrian Monarchy »,, in Matthew H. Edney and Mary Sponberg Pedley (eds.), *The History of Cartography, vol. IV, Cartography in the European Enlightenment*, The University of Chicago Press, Chicago 2019, p. 967.

3 Peter Collier, « Warfare and Cartography », in Mark Monmonier (ed.), *The History of Cartography Volume Six: Cartography in the Twentieth Century,* University of Chicago Press, Chicago, 2015, p. 721.

Habsburg cartography is one of European cartographies that in great extent grew out on military needs during the Habsburg-Ottoman Wars. Its development and characteristics clearly maintain the spirit of the time and the circumstances under which the military cartography of the Early Modern Era developed. Military mapping advanced most strongly in the areas of greatest geostrategic importance, along the borderlands with the Ottoman Empire (on both the Habsburg and Ottoman sides). Borderlands thus became a major zone of military cartographic activities, spurring development of military mapping and turning the Military Frontier into the largest outdoor education center for surveying and mapping.

Organization of New Defense System: Borderlands as Cartographic Laboratory

The Ottoman occupation of Bosnia (1463) and the final invasion of Hungary after the Battle of Mohács (1526) marked the turning point in the Habsburg-Ottoman Wars. The Ottoman conquest of a significant part of Southeast and Central Europe (Greece, Albania, Bulgaria, Walachia, Moldova, Serbia, Bosnia, large parts of Hungary, Croatia, and Dalmatia) alerted the Habsburg authorities to introduce a new defense strategy against the Ottoman Empire. Instead of brief military incursions toward enemy lines, applied by invaded countries themselves, they decided to establish permanent fortified stations accompanied by heavily armed military troops along the entire borderline with the Ottoman Empire. Thus, a wide belt of Habsburg territory along the Ottoman border was placed under military administration and served as a shield against further Ottoman incursions. It is known as the Military Frontier or Military Border (*Miltärgrenze*).[4] After its

4 The Military Frontier was not established by a single act but was created gradually. In Croatia, its formal beginnings can be traced back to 1527, when Ferdinand of Habsburg was elected Croatian king, after which the organization and financing of defense against the Ottomans gradually passed into the jurisdiction of the Habsburg military authorities. The first significant provisions on the organization of the Military Frontier in Croatia and Hungary were made in 1553. A stronger organization of defense and overall territory under the jurisdiction of the Habsburg military begins only after the Congress of Inner Austrian Lands in Bruck an der Mur in 1578, when defending strategy and territorial organization for all borderlands were defined. For more on the establishment and organization of Military Frontier see, Karl Kaser, *Freier Bauer und Soldat: die Militarisierung der agrarischen Gesellschaft und der kroatisch-slawonischen Militärgrenze (1535–1881),* Böhlau Verlag, Vienna, 1997; Gunther Erich Rothenberg, *The Austrian Military Border in Croatia, 1522–1747*. University of Illinois Press, Urbana, 1960 and Dragutin Pavličević (ed.),

establishment in the mid-16th century when it was limited to Croatia and Hungary, in the 17th century, its coverage was significantly extended, stretching from the Adriatic Sea in the west to Transylvania in the east, and including parts of present-day Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Romania, and Hungary.[5] The Military Border consisted of several borderlands (Croatian, Slavonian, and Hungarian, i.e. Banat and Transylvania), and was further divided on generalates and captaincies (later, regiments).

The Military Frontier was placed under direct control of the Habsburg military authorities in Vienna, the *Hofkriegsrat* (a forerunner of the Ministry of Defense), which kept the main role in all military affairs until 1848. Founded in 1566, the Aulic War Council, consisted five generals and senior civil servants who oversaw the entire Habsburg military system in war and peace, deciding on fortress construction, army equipment, salary issues, and purchase of supplies, as well as on the planning and implementation of wars.[6] It also handled the civil and military administration of the borderlands. Thanks to joint coordination and funding until the late 16th century, there were already around 22,000 soldiers stationed along the Hungarian and Croatian Military Frontiers (compared to only 7,000 before 1526). These numbers are impressive even in the European context.[7] Although the Military Frontier underwent numerous reorganizations (including territorial ones), until its final dissolution in 1881 the centralized military administration would remain its constant. Decisions on military actions as well as all accompanying activities concerning the organization of life in the borderlands would be made exclusively by the Aulic War Council located in Graz and Vienna (after 1709), respectively.

Vojna krajina: Povijesni pregled – historiografija – rasprave [Military Border: Historical Review, Historiography, Studies], Sveučilišna Naklada Liber, Zagreb, 1984.

5 In the 1560s the Military Border consisted of several borderlands (Captain Generalcies): Croatian, Slavonian, Kanizsa, Györ, the Captain Generalcy of Mining Towns (along the Garam River), and Upper Hungarian, or Kassa Captain Generalcy. Géza Pállfy, « The Habsburg Defense System in Hungary Against the Ottomans in the Sixteenth Century: A Catalyst of Military Development in Central Europe », in Brian Davies (ed.), *Warfare in Eastern Europe, 1500–1800*, Brill, Leiden, 2012, p. 44.

6 For more on the Aulic War Council see, Oskar Regele, *Der österreichische Hofskriegsrat, 1556–1848,* Verlag der Österreichischen Staatsdruckerei, Vienna, 1949.

7 Pállfy, 2012, p. 52.

The establishment of the Military Frontier did not only contribute to the advance in government affairs and military administration, but it also gave a substantial boost to the military cartography. With the expansion of the Ottoman Empire in the early sixteenth century, the countries of East and Central Europe became a great European battlefield. Owing to the military strategic importance that East-Central Europe gained with the invasion of the Ottomans, countries that otherwise had not attracted much attention of the cartographers suddenly found themselves in the focus of their interest. From the mid-sixteenth century, the maps of countries such as Croatia, Slavonia, Dalmatia, or Bosnia, which had previously been represented only on small-scale general maps, became the subject of detail military mapping. Units of trained topographers (regularly from the ranks of military officers) soon began to operate along the borderlands, working continuously in the field and producing maps for the needs of generalates or individual captaincies. Numerous lower-ranking soldiers also took part in field work, thus learning the art of surveying and mapping directly in the field. Thus, the frontiers became a large cartographic laboratory where not only mapping was conducted, but also practical education on military cartography took place that eventually grew into schools of formal education. Military maps of the borderlands produced by the army forces since the late 16th century onward represent the first regional maps of these areas based on the principles of modern surveying and cartography.

From Military Engineers to Military Topographers: Early Cartographic Campaigns Ordered by the Aulic War Council

The implementation of the new defense strategy, organized through a system of military frontier fortresses, turned the borderlands into a huge construction site. Old feudal fortresses (burgs) needed to be rebuilt to meet the demands of the warfare. Burgs were not adapted to long-term wars, especially to the threat of a new weapon – the siege cannon. The biggest disadvantage of the old burgs was their location. Built in naturally protected positions, they corresponded to the organization of feudal administration, but not to the monitoring of enemy movements, as well as to easy and fast supply. Another disadvantage was their small surface, which often could not accommodate a sufficient number of soldiers. Finally, the essential difference between the old burgs and a renaissance military fort was in the defensive strength of the fortification system itself. Feudal burgs

relied on the height of their walls, while Renaissance fortifications on a system of lowland fortifications, moats, and bastion systems that together formed a complex defense system.[8] The increase in fortress building for the newly established defense system brought about the establishment of a new military architectural organization. During the 1550s and 1560s the Aulic War Council engaged dozens of architects, mostly Italians, who were contracted by Habsburg military authorities.[9] Their activities were supervised by a Superintendent of Construction (*Bausuperintendant*) of each Generalcy. After 1569 their activities were coordinated by the Vienna-based Fortress Construction Commissioner.

The appearance of a significant number of military engineers and architects who worked on military border fortifications played a key role in the development of Habsburg military cartography. Their knowledge of mathematics, geometry, and technical drawing proved to be key skills needed for surveying and mapping.[10] In the absence of other technically educated staff, they soon turned into military topographers.[11] In fact, as fortifications were to form an organized system of military defense of the entire Monarchy, it was concluded that, in addition to fortifications, the surrounding terrain connecting the fortifications needed to be mapped as well. The mapping of fortifications carried out by engineers for the purpose of their reconstruction or extension thus gradually grew into a cartographic campaign, which resulted in the first military maps of the region.

The first such campaign was conducted already in the 1560s. Its main actors were Natale and Nicolò Angielini, architects of Milanese origin who were

8 Milan Kruhek, *Krajiške utvrde Hrvatskog Kraljevstva* [Military Frontier's Fortifications of the Croatian Kingdom], Institut za suvremenu povijest, Zagreb, 1995, pp. 13–18.

9 At that time, Italy was the leader in almost all arts and sciences. Italian cities, experiencing the devastating effectiveness of French artillery from 1494 onward, required engineers for constructing and fortifying the cities. Italian military engineers were recognized as building authorities throughout Europe where they were often invited as experts. E.g. Italian engineers were employed by Henry VIII in the 1540s. Marcus Merriman, « Italian Military Engineers in Britain in the 1540s », in Sarah Tyacke (ed.), *English map-making 1500–1650*, British Library, London, 1983, pp. 57–67.

10 The first more elaborated manuals for military engineering and drawing appeared already in the 15th century. See Mariano Taccola, *M. De rebus militaribus (De machinis, 1449),* National Library of France, Codex Parisinus Latinus 7239.

11 The same phenomenon can be noticed in other countries like Italy, France, Spain, and England. For the French case see, David Buisseret, *Ingénieurs et fortifications avant Vauban: L'organisation d'un service royal aux XVIe –XVIIe siècles,* Éd. du CTHS, Paris, 2002.

contracted by the Aulic War Council as *Baumeisters*.[12] In the period between 1560 and 1567, the two masters, possibly accompanied by Natale's son Paolo, visited more than 50 fortresses along the Croatian and Hungarian borderlands and produced dozens of fortification plans and a few maps. The series of fortification plans made by the Angielini brothers until 1566 were the oldest such series showing the condition and structure of fortifications along the entire Habsburg borderlands in Croatia and Hungary.[13] For many forts and fortified cities, these are also their oldest cartographic representations (e.g. for Zagreb). The forts were mapped in their floor plan or in the bird's-eye perspective. Plans drawn at a large scale usually show the current layout of the fort and the proposed modernization (in a different color or by a different type of line). Although the Angielinis' fortification plans have a strong artistic touch atypical for military cartography (special attention was paid to aesthetics and colors), the plans have distinct engineering-military features: they focus on the display of fortifications and terrain topography, while elements of inner (civilian) cities are completely omitted.

Their three maps, those of Hungary, Croatia, and Upper Hungary have distinctive military features as well (Fig. 1).[14] The maps that were based on the reconnaissance of the terrain conducted between 1563 and 1566 brought significant advance, comparing the existing maps of the region.[15] Their focus on the elements of terrain configuration (passability!) and vegetation (visibility!) clearly

12 From the Angielini family came as many as three engineers who were also involved in military construction and mapping – brothers Natale and Nicolò and Paolo, Natale's son, who were all involved in military affairs of the Habsburg Monarchy. Among them, Nicolò was the most recognized and best paid. Ferdinand Opll, Helke Krause and Christoph Sonnlechner, *Wien als Festungsstadt im 16. Jahrhundert. Zum kartografischen Werk der Mailänder Familie Angielini,* Böchlau, Vienna, 2017, pp. 21–38.

13 All his manuscript work is contained in a single bound volume dated 1566. One copy of the Angielinis' volume is kept in the Austrian National Library (Cod. 8609), another in the Archives of Baden-Württenberg (Hfk, Bd/XV), while two copies are kept in the Archives of Saxony in Dresden (Sch. XXVI F. 96, N. 6 and XXVI F. 96, N. 11).

14 Maps of Croatia and Slavonia and a map of Upper Hungary were drawn at a scale of 1:500,000, while a map of entire Hungary was compiled at a small scale, serving as an overall map of the region.

15 In addition to their own observations, they relied on existing maps of Hungary by a Hungarian civil mapmaker Lazarus (*Tabula Hungariae*, 1528), by map of Wolfgang Lazius, a court counsellor of Ferdinand I, (*Regni Hungariae*, 1556), and those by Augustin Hirschvogel, a cartographer in the service of Ferdinand I (map of the borderland from ca. 1539, and *Zu Herr der Römischen zu Hungaren*, 1565) which all served them as a starting point in their work.

differs from all existing general maps, reflecting their military purpose. Particular progress was made in the presentation of reliefs, where the still dominant method of stylized moles was abandoned in favor of a so-called cavalier perspective.[16]

Their effort in showing afforestation was also significant. By varying the size and shape of the tree-shaped symbol, they were able to evoke different densities and heights of vegetation. In addition, they marked communications (alert system) along the border, affiliation of each fortification to the Habsburg or Ottoman side, and the exact extent of Ottoman conquest. Since the map also shows a part of the Ottoman territory with an indication of whether there was a military crew in their fortress or they were abandoned, it is clear that the data were collected not only by observation but also by intelligence work.[17] The maps are accompanied by scale, which enabled the calculation of distances, but with no graticule of latitude and longitude. Although clearly compiled to meet the requirements of warfare, the maps are characterized by high aesthetics, which would suggest that one of the brothers might have had some kind of artistic education. The two traditions, those of the land surveyor and the artist evidently overlapped here.[18]

16 The cavalier perspective shows the objects as they would be seen from this high point. The representation was initially used for the presentations of military fortifications. In French, the 'cavalier' is an artificial hill behind the walls that allows to see the enemy above the walls.

17 Abandoned fortifications on the Ottoman territory are marked without a crescent and those with a Ottoman military crew are presented with a crescent.

18 That was often the case in the 15th-century visuality represented in the works of Leonardo da Vinci and Albrecht Dürer.

Fig. 1 A detail of a map of Croatia and Slavonia compiled by the Angielini brothers about 1566. It shows a part of the Croatian Military Border (green) and a part of Slavonia under Ottoman control (reddish). An innovative method of displaying relief and vegetation was applied. Note the alert system marked along the border (a thin dashed line at the edge of Habsburg territory that connects the border posts).
(Austrian National Library, Cod. 8609, fol. 2)

Military Topographers of the Seventeenth Century: The Beginnings of the Professionalization of Mapmaking

The epochal success of the brothers Angielinis' cartographic campaign, which provided the Habsburg army with much-needed geographical information about the border area, was not soon repeated.[19] Frequent Ottoman incursions followed by a new Habsburg-Ottoman War (1593–1606), which largely took place in Croatia, hampered the possibility of field mapping of the Croatian borderland for a long time.[20] At that time, the territorial extent of Ottoman conquests in SE Europe reached its peak and the territory of Croatia and Hungary were reduced to a narrow belt known as remnants of remnants (*reliquiae reliquiarum*).

Despite the undeniable quality of brothers Angielini's work, which provided the army with information on the position of the fortifications and the possibilities of the army's movement along the border, the lack of larger-scale maps was still a major issue. This is evidenced by an initiative of Ferdinand II, Archduke of Austria, who was charged with the command of the defense of Croatia and Hungary. In the lack of other options, he ordered Ivan Klobučarić, a prior of the Augustinian monastery in Fürstenfeld, otherwise known for his drawing skills, to perform a topographic mapping of the inner Austrian countries for strategic purposes.[21] Between 1601 and 1606, Klobučarić conducted a reconnaissance and

19 The stalemate occurred primarily in Croatia. In Upper Hungary some cartographic activities continued. Sometime after 1580, Giovanni Jacopo Gasparini, an Italian military architect in charge of the modernization of forts of Upper Hungary, produced a map of Hungarian borderlands, while about 1600, Ferenc Batthány produced a defense map of the region between the Mura and the Rába rivers. Zsolt Török, « Renaissance Cartography in East-Central Europe, ca. 1450–1650 », in David Woodward (ed.), *The History of Cartography, Volume 3: Cartography in the European Renaissance, Part 1*, The University of Chicago Press, Chicago, 2007, pp. 1847–1848.

20 The long-lasting Habsburg-Ottoman conflict, also known as the Long War or the Thirteen Years' War, was concluded with the Peace Treaty of Žitva (Zsitvatorok) in 1606, with meager territorial gains for the two main empires. The treaty confirmed the Ottomans' inability to penetrate further into Habsburg territories. It also demonstrated that Transylvania was beyond Habsburg power. Though Emperor Rudolf had failed in his war objectives, he nonetheless won some prestige thanks to this resistance to the Ottomans, by presenting the war as a victory. The treaty stabilized the conditions on the Habsburg-Ottoman frontier.

21 Ivan Klobučarić (ca. 1150–1606), a Croatian Augustinian priest and painter. After receiving his education in Rome, he served as a prior to the Augustinian monastery in Rijeka. At the time he was engaged in mapping, he was a prior of the Augustinian monastery in Fürstenfeld (Styria). Fritz Popelka, *Die Landesaufnahme Innerösterreichs von Johannes*

drafted about a hundred sketches that were to be used to compile a topographic map. His rough sketches, drawn only with the help of a compass and a drawing table, testify to the hands of a talented painter (his presentations of forts and bird's-eye views of towns were exquisite) without any military or engineering education (Fig. 2). Unfortunately, due to Klobučarić's sudden death in 1606, the map was never compiled.[22] Klobučarić's engagement in military mapping testifies to the absence of military personnel trained in surveying and mapmaking. The professionalization of military mapping can to some extent be noticed only since the 1630s. Although, even then, most cartographic campaigns were still undertaken by engineers in charge of the maintaining of fortifications, they now regularly came from the ranks of officers in permanent military service.[23] The position of the engineer as a professional in charge of military mapping would be maintained until the late 17th/early 18th century when the terms topographer and field engineer became more frequently used.[24]

The first major campaign to map the military frontier in the 17th century was undertaken by the colonel Giovanni de Galliano Pieroni (1586–1654), a military engineer specialized in the construction of fortifications.[25] He spent a lot of time working for General Albrecht of Wallenstein in Vienna and Prague. After successful work on a set of fortifications in Prague he was engaged by the Aulic War

Clobucciarich 1601–1605, Verlag Url. Mossers Buchhandlung, Graz, 1924, pp. 1–20.

22 Klobučarić's numerous sketches are still preserved in the Steiermärkisches Landesarchiv, Graz Sammlung Clobucciarich.

23 The status and military rank of engineers involved in early mapping is sometimes hard to reconstruct. Most of them were appointed to the Aulic War Council and officially contracted into the service. In doing so, they were given a military degree, in most cases the Hauptmann, and sometimes the rank of Lieutenant Colonel, even a General. Joseph Paldus, « Johann Christoph Müller. Ein Beitrag zur Geschichte vaterländischer Kartographie », *Mitteilungen des k.u.k. Kriegsarchivs* 5 (1907), p. 15.

24 In 1694, the French Academy of Sciences defined the term engineer as one who invents, sketches, and conducts the works and instruments for the attack and defense of fortifications. Ken Alder, *Engineering the Revolution: Arms and Enlightenment in France, 1763–1815,* Princeton University Press, Princeton, NY, 1997, pp. 56–57.

25 Giovanni de Galliano Pieroni (1586–1654), a Florentine architect, mathematician and astronomer specialized in fortifications, author of *Trattato delle fortificazioni moderne*. His father was an architect at the court of the Medicis. Giovanni Pieroni studied law, earning a doctorate in law in Pisa. He is also known for his cooperation with Galileo Galilei and Johannes Kepler. Guido Carrai, « Giovanni Pieroni: un informatore medico al seguito del générale Wallenstein », *Esamizdat,* II (2004), pp. 175–180.

Council to conduct a survey of Croatian borderland and its fortresses. Between 1636 and 1639 he made the inspection of Croatian forts, writing an extensive report accompanied by numerous fortification plans and proposals for their extensions.[26] Beside the standard ground-plan of a fortification, Pieroni introduced the use of panoramic bird's-eye views of forts, which, in addition to the physical appearance of the fort, also evoked the overall ambience of the place.[27] This type of military plan drew on two interacting genres: the town view and the landscape panorama, which provided a panoramic background to a military post.

A relatively long period of truce between the Thirteen Years' War (1593–1606) and the Great Turkish War (1663–1699) enabled the development of more extensive cartographic campaigns that would bring further advances to military cartography. In this regard, a significant step toward regional military mapping was made by Martin Stier (1630–1669).[28] His maps clearly show how much military mapmaking developed since the Angelinis' time. As a trained officer in the rank of captain, he first served in the infantry, and about 1654 transferred to the construction section. In 1657 Stier was appointed chief engineer (*Oberingenier*) and assigned by the Aulic War Council with the task of military inspection of the forts in Carniola and Styria and of the Hungarian and Croatian borderlands. Stier spent the period from 1657 to 1660 in a field trip, conducting the inspection of forts, mapping them and proposing plans of modernization for each of them.[29] In contrast to his predecessors, he also conducted an extensive survey of the bor-

26 State Archive of Slovenia, Manuscript Collection, Cod. 1073. For Pieroni's published reports and fortification plans see, Helena Seražin, *Poročila in risbe utrdb arhitekta Giovannija Pieronija,* Arhiv Republike Slovenije, Ljubljana, 2008.

27 This genre grew out from the tradition of the late 16th-century commemorative siege maps that were usually compiled in the bird's-eye view perspective.

28 Surprisingly little information is known about Martin Stier. Just a few records in letters to the War Council and his last will from 1669 provide only elementary information. Because of the contribution to the modernization of the fortresses, his career is usually compared to famous Sébastien Le Prestre de Vauban (1633–1707). But unlike the latter, Stier never gained his fame and status. One of the reasons is certainly his early death (he died at 39).

29 His extensive report comprises 147 folio sheets and more than 40 plan and maps. One copy is kept in the Austrian National Library (Cod. 8609), and other in the War Archive in Vienna, Map Collection, Gi.a.220. For Stier's report and reproduction of his maps see, Ljudevit Krmpotić, *Izvještaji o utvrđivanju granica Hrvatskog Kraljevstva od 16. do 18. stoljeća* [Reports on the Fortification of the Borders of the Croatian Kingdom from the 16th to the 18th Century], Nakladni zavod Hrvatski zapisnik, 1997, Hannover – Karlobag – Čakovec, pp. 1–172.

Figure 2 A newly erected fort of Karlovac, a site of the Croatian borderland and its vicinity on a sketch by Ivan Klobučarić (ca. 1605). The lines between the fortifications and the radial lines from the hills testify to the use of a compass in the reconnaissance of the terrain. (Steiermärkisches Landesarchiv, Graz Sammlung Clobucciarich, Blatt 82a).

derlands, based on which he compiled several manuscript maps at a relatively large scale: a map of the Hungarian borderland,[30] a map of the Varaždin and Petrinja borderland,[31] a map of the Croatian borderland,[32] and a detailed map of the central part of the Karlovac Generalate (Fig. 3).[33] These maps are considered the first mid- to large-scale military maps of the Croatian borderland. Drawn at a scale (yet, still without a grid), they provided a detailed insight into the topography of the terrain and the spatial layout of all military installation such as forts, watchtowers (*chardaks*), safe river crossings, and abandoned military posts. As the then method of warfare included extensive use of natural land barriers, especially rivers, swamps, and mountains, the terrain and the objects are mostly given in the cavalier perspective, which gives a three-dimensional insight into the theater of war. Stier's maps were designated as military secrets and were never published. Yet, the comprehensive topographic material compiled by Stier was not entirely without echo outside military circles as well. In 1664 he compiled an overview map of Hungary, which, unlike his military maps was published in Vienna at a reduced scale of 1:1,000,000.[34]

30 Mappa über die Steierische Frontier Plätze gegen der Türkischen Poste Canischa. Austrian National Library, Cod. 8608, fol. 4

31 Mappa über die Windische, Petrinianische und Banatische Granitzen. Austrian National Library, Cod. 8609, fol. 32

32 Mappa über die Croatische und Meer Gränitzen sammst den Cameralischen Stätten. Austrian National Library, Cod. 8608, fol. 62.

33 Karlovac was the site of the Generalate and the most important military fort in Croatia that was built as a planned city in 1579. Abriss der Festung Carlstadt sammt den vorliegenden Wachten und Passen. Austrian National Library, Cod. 8608, fol. 74.

34 Vermehrte und Verbesserte Landkarten des Königreichs Ungarn und denen andern angräntzenden Königreichen… Copperplate in 12 sheets. Croatian State Archives, Map Collection, D.XIV.3.

Fig. 3 A detail of Martin Stier's large-scale map of the central part of the Karlovac Generalate compiled in 1657. The scope of the map is the fortified town of Karlovac (built in 1579) and the defense strategy of its immediate surroundings (note the watchtowers and river crossings!). Karlovac was one of the most important strongholds of the Croatian border. (Austrian National Library, Cod. 8608, fol. 74)

Under the Cannon Fire: Mapping the Great Turkish War (1683-1699)

While most of the early military maps of Habsburg borderlands appeared in the truce, the next Habsburg-Ottoman War would urge the practice of extensive mapping in the wartime. The circumstances of the war would introduce many changes not only in the way of mapping but also in the organization of cartographic works. Until then, the mapping was mostly conducted periodically through campaigns ordered by the Aulic War Council. However, the Great Turkish War (1683–1699) that was fought in conjunction with the Ottoman-Venetian War had an extremely large frontline that stretched from Poland to Dalmatia, so the strict centralized organization of mapping was not effective, leading to a much larger initiative of generals in the field. Aware of the military implications of mapmaking in the warfare, Raimund Montecuccoli, the president of the Aulic War Council, issued a set of instructions in 1673 that were intended for all engineers in the imperial services, clarifying their role as experts in military mapping.[35]

War offensives and incursions into the Ottoman-held territory were now used to reconnoitre the terrain and map even behind enemy lines. After the Ottomans retreated from Vienna (1683), the Habsburgs pressed forward, rapidly taking Hungary (1686–1697), north Serbia (1689), Slavonia, and most of Croatia (1687–1691). During military operations or immediately after the ceasefire, military topographers would come to the field to map the newly taken or temporarily occupied terrain. Thus, in the 1690s, a large number of operational and marching route maps appeared, as well as siege plans drawn by military topographers operating within military units.[36] At the same time, the first mid-scale regional military maps of borderland zones were created for the purpose of strategic planning.[37]

35 As part of military engineers' work on the maintenance of fortifications, they had to prepare drawings and architectural plans. During wartime operations, the military engineers deployed with the imperial troops had to draw maps showing the encampment of troops, marching routes, and especially the territory of newly acquired lands. These maps incorporated all the settlements, rivers, streams, mills, forests, mountains, swamps, lakes, and other significant geographical features. The engineers sent one copy of each map to the Aulic War Council and another copy to the commanding general. The drawings could not be shared with anyone else. Heinrich Blasek and Franz Rieger, *Beiträge zur Geschichte der K. u. K. Genie-Waffe*, vol. 1, L.W. Seidel, Vienna, 1898, pp. 8–9, 217–218, 221–222.

36 Cf. some examples: Lagers der Truppen des Kurfürsten Max Emanuel von Bayern vom 22. Juni bis 4. September 1687…(H.III.c.98-4), Generalkarte der Kriegs Operationen der Kayserl. Armee in Jahr 1688 (H.III.c.99), Operationskarte in südostlichen Theils von Ungarn in 1697, (H.III.c.101-1).

37 Carte von dem Theile Croatiens welcher durch die Sava, Kulpa, Unna und Zermania Flüs-

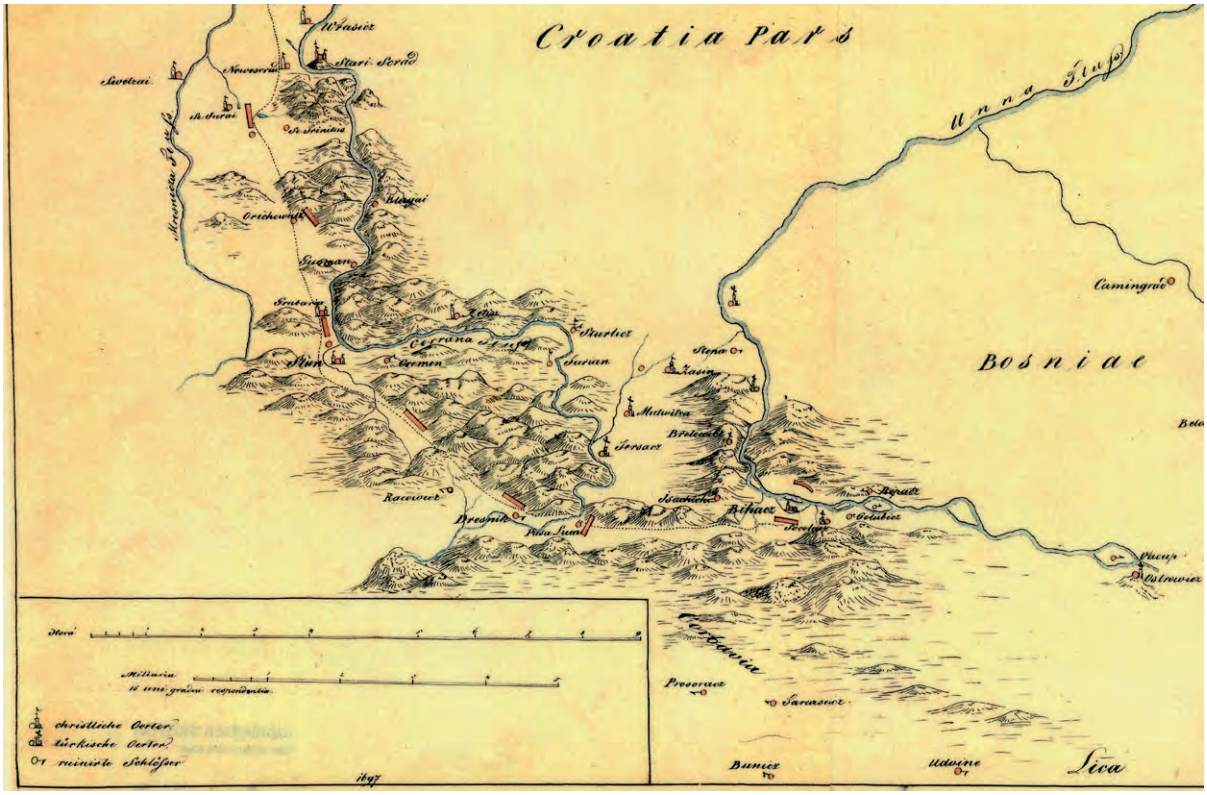

Fig. 4 An operation map (*Operationskarte*), which shows the movement of Habsburg troops from Karlovac (Croatia) to Bihać (Bosnia) in 1697 at a scale of 1: 240,000. Notice the advanced presentation of the hills. (Museum of Military History, Budapest, H.III.c.292)

Maps compiled during the Great Turkish War were used in the field, but they also often served to illustrate battlefield reports and thus had a dual role: to record geographical information required for military control of the newly ceased territory and, no less important, to demonstrate their victory over the Ottomans (sketches of siege plans and operational maps were often honorably given to generals). These maps were partially based on an instrumental survey, but were compiled at a relatively large scale (Fig. 4).[38] Beside their improved mathematical

se und dem Adriatischen Meere eingeschlossen ist, und worauf die befestigten Städte und Schlösser, dann die Pässe angegeben sind (von 1690–1700) /Johann Friedrich Hollstein. [S.l., 1690]. Manuscript in color; 58 6 x 43.1 cm. G.I.a-102, Plan 34.

38 E.g. [Operationskarte von Karlstadt bis Bihacs]. Scale ca. 1:240,000. [Sl.l.], 1697. Manuscript in color; 40 × 26 cm. Museum of Military History, Budapest, Map Collection, H.III.c.292, or Partes Croatiae circiter spatio 5 horarum ab Unna a nemine post expugnatam anno 1688 Costaniczam inhabitatae/ desseinié Joseph de Leonyt. Scale 1:223,000.

base, they are characterized by an advanced presentation of the terrain: hills given in the cavalier perspective are now supplemented with vertical lines of different densities (slopes!), thus representing a transition toward the method of hatching. However, several facts reveal that military mapping was still in its early stage: there is no elaboration of army-specific symbols (symbolization applied on military maps is still very similar to those for civilian use), mapmaking was limited to only a few map types (operation maps, march route maps, siege maps), while non-standardized symbols are still widely used (cf. pictorial representation of the forest barrier on a 1688 map) (Fig. 5).

During the Great Turkish War, the military and cartographic campaigns of the Habsburg army for the first time extended to Bosnia. During two offensives in 1697, one under the command of General Carl Auersperg on Bihać and the other under the command of Eugene of Savoy on Sarajevo, Habsburg topographers conducted the first military mapping of Bosnia and its key fortifications.[39] In terms of cartography, Eugen of Savoy's offensive was particularly successful. He was accompanied by a number of military topographers who, in only a few weeks, in difficult war conditions, drew numerous topographical sketches and siege plans of the forts, which were later used for the compilation of a military map of Bosnia, the first of that kind for this region.[40] Compiled at a scale of

[S.l., 1688]. Manuscript in color; 75.5 x 49 cm. National Library Budapest, TK 530.

39 For the plans made during the siege of Bihać, cf. For the War Archive in Vienna, Map Collection, H.III.c146 to H.III.c.148.

40 Very often the maps and plans made during the campaign of 1697 are mistakenly attributed to the surveying work of François Nicolas Sparr de Benstorf. Namely, Benstorf was born only in 1696 and could not attend the campaign of Eugene of Savoy. The confusion arose because Sparr de Benstorf, who later became a prominent military officer and engineer in the Habsburg army, around 1740 multiplied the

Fig. 5 A detail of the military map of Croatian borderland along the river Una that was drafted in 1688, immediately after the suppression of the Ottomans. The defense of the border with Bosnia (Turkey) relied on natural barriers, and thus a dense forest belt is marked along the border line (*Waldverhacke*). (National Library, Budapest, TK 530)

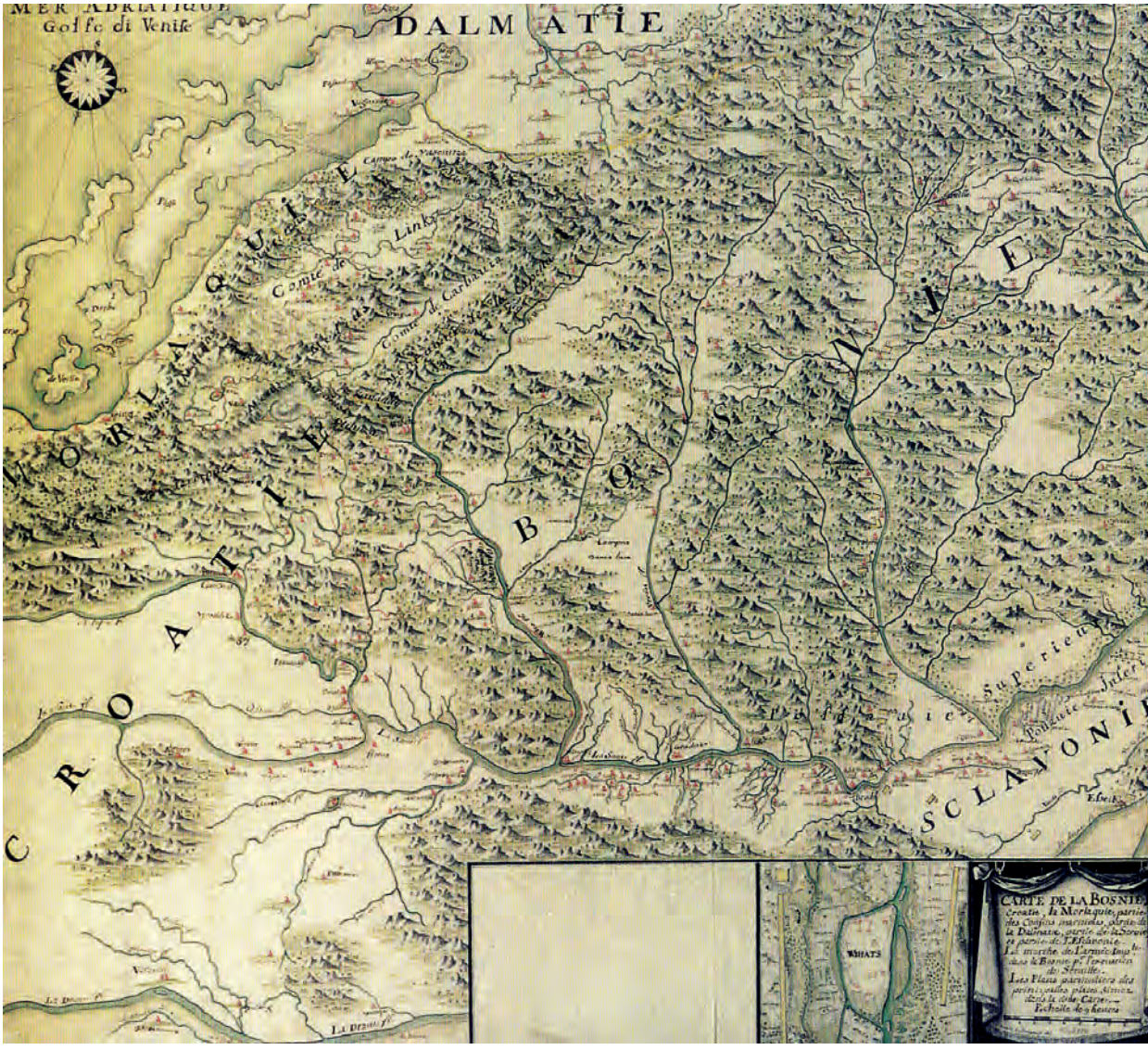

Fig. 6 The first Habsburg military map of Bosnia based on the reconnaissance made during Eugen of Savoy's offensive in 1697. The map is reversed in the way that it can be read accurately only by reading it in a mirror. (War Archive, Vienna, B-IX-a-934)

cartographic material created in 1697. Sparr de Benstorf is best known as the author of a series of siege plans from 1739. Erich Hillbrand and Friederike Hillbrand, « Ein Lothringer zeichnet die niederösterreichische Donauregion Ein Beitrag zum Leben und Werk François Nicolas Sparrs », *Jahrbuch für Landeskunde von Niederösterreich*, 59 (1993), p. 94.

1:440,000, the map shows only the general configuration of the terrain, the position of the forts and the marching route of Savoy's troops (Fig. 6).[41] This map was designated as highly confidential and was never printed. The fear of a possibility that the enemy could get hold of such a valuable cartographic document spurred the cartographer to draft the map in such a way that it could only be accurately read with the help of a mirror.

Turning Point of 1699: Interference of Military and State Cartography

The Great Turkish War in which the Ottoman Empire was heavily defeated by the Holy League was concluded with the Karlowitz Peace Treaty in 1699. Its conclusion marked the formal end of Ottoman control over a large portion of Central Europe as well as their first major territorial losses after centuries of expansion.[42] The Peace Treaty of Karlowitz was in many ways the beginning of a new era not only in the military history, but also in the history of cartography, announcing a new paradigm in military mapping. Since then military cartographers would be directly involved in numerous state affairs.

At the down of the 18th century there was an increasing number of affairs, which required military mapping, and which were not directly related to warfare, but had a high strategic value. One of the most

41 Carte de la Bosnie, Croatie, la Morlaquie, partie des Confins maritimes, parte de la Dalmatie, partie de la Servie et partie de L'Esclavonie. Scale 1:440,000.-1697. Manuscript in color; 61 x 93.5 cm. War Archive Vienna, Map Collection, B-IX-a-934.

42 The Ottomans were forced to surrender much of Hungary (including Transylvania), Croatia, and Slavonia, but kept the Banat of Temesvár and Moldavia. Venice regained the Morea (the Greek Peloponnese) and large parts of Dalmatia, while Poland retook Podolia.

important such affairs was the demarcation of the new Habsburg-Ottoman border established by the Peace Treaty of Karlowitz. The mapping of the borders was managed by the War Council, which assigned the job to Count Luigi Ferdinando Marsigli, then the adviser of the Habsburg army with the rank of colonel (*Obrist*).[43] Accompanied by a number of staff of officers and engineers, including the 26-year-old officer Johann Christoph Müller,[44] they conducted a survey and produced the first large-scale maps of the borderland. Supervised by Marsigli, Müller, who was appointed chief field engineer (*Feld-ingenieur*), produced an overview map at a scale of 1:500,000, which represented the position of the whole boundary as well as detailed sheets at a scale of 1:37,500, 24 sheets for the Habsburg-Ottoman boundary in Croatia and Slavonia and another 15 sheets for a portion of the boundary in Hungary, altogether 39 detailed sheets.[45] Although compiled for the purpose of demarcation, all sheets were clearly drawn in military style, with relief and vegetation given in the cavalier perspective, with watchtowers and the position of cavalry and infantry troops marked according to military conventions (Fig. 7). No less important, each sheet was accompanied by a graticule of longitude and latitude.

43 Count Ferdinando Luigi Marsigli (1658–1730) was born into a noble family in Bologna. He did not receive formal education. Instead, he preferred to gain empirical knowledge. Thus, after taking numerous lessons and courses in mathematics, astronomy, biology, and medicine, he started to travel extensively. Already at an early age he became a very keen map collector with strong interest in surveying and mapping techniques. His good social skills enabled him to join a Venetian diplomatic delegation sent to Constantinople in 1679. During the Siege of Vienna in 1683 he was captured by the Ottomans and kept in prison for almost a year. After being released in 1684, until the end of the war, Marsigli was engaged as a military adviser of the Habsburg army. For more about Marsigli's work see, John Stoye, *Marsigli's Europe, 1680–1730: The Life and Times of Luigi Ferdinando Marsigli, Soldier and Virtuoso,* Yale University Press, New Haven, 1994.

44 Johann Christoph Müller (1673–1721), one of the most prominent Habsburg military cartographers and surveyors of the late seventeenth and early eighteenth centuries. Already in 1696 he came into contact with Marsigli at whose initiative he was hired as the chief cartographer of the Peace Treaty of Karlowitz. In addition to a series of large-scale demarcation maps, he also produced a general map of Hungary (Hungariae Regi invictissimo mappam hanc Regni Hungariae, 1709), a map of Moravia (Tabula generalis Marchionatus Moraviae, 1720), and a map of Bohemia (Mappa geographica Regni Bohemiae, 1722). Paldus, 1907, pp. 11–13, 53, 73.

45 Mappa Geographico-Limitanea in qua Imperiorum Caesarei et Ottomanici Confinia in almae pacis Carlovitzensis Congressu decreta. Johann Christian Müller, 1699. Scale 1:500,000. Manuscript in color; 111 x 51 cm. The detailed manuscript sheets (68 x 51 cm) have a common numeration, 1–39; each sheet, however, has its own title. War Archives in Vienna, Map Collection, B.IX.c.634.

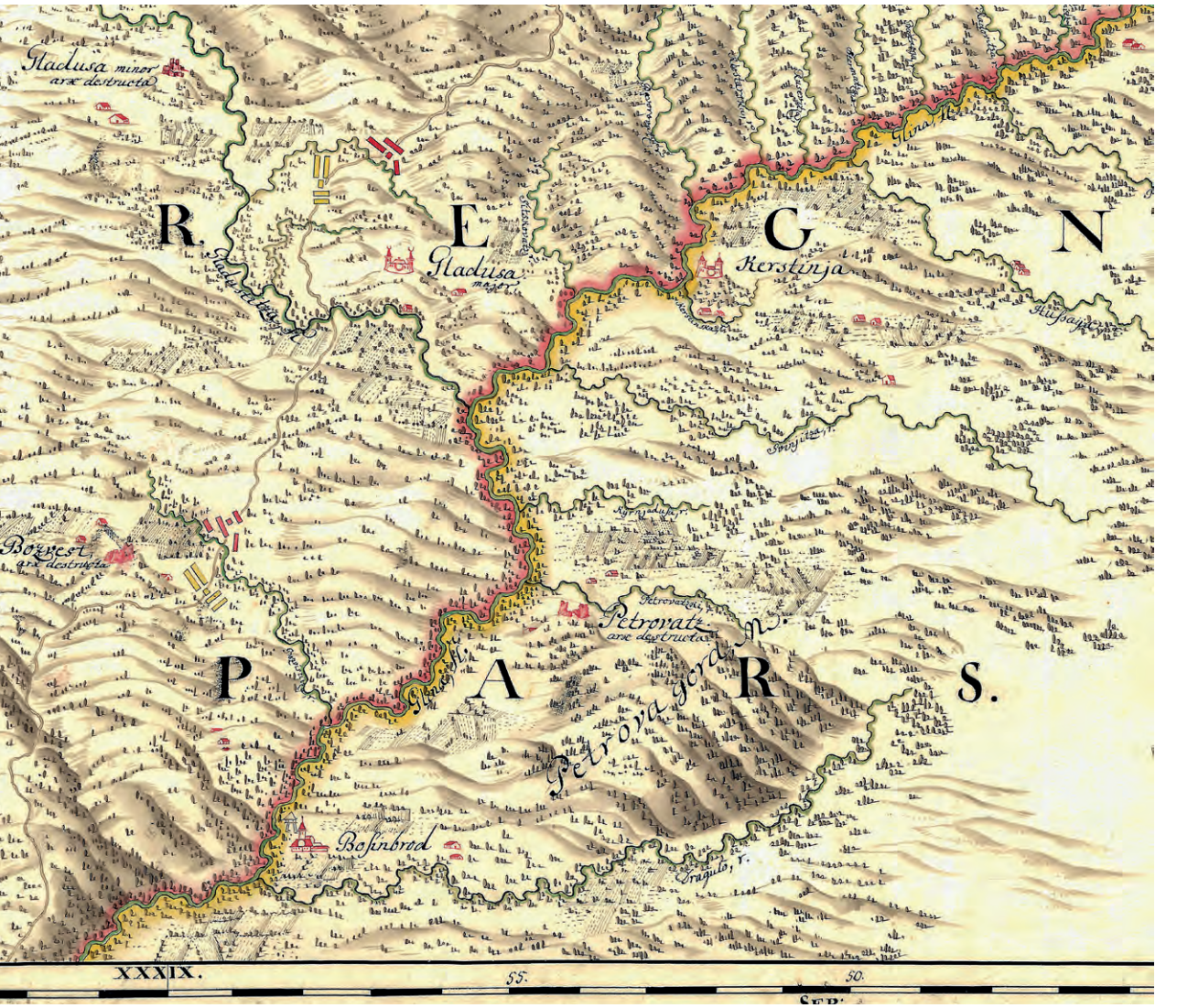

Fig. 7 A detail of the demarcation map of the Habsburg-Ottoman borderline in Croatia, compiled by Johann Christoph Müller in 1699 under the supervision of Count Marsigli. (War Archive, Vienna, B.IX.c.634, sheet XVII)

Under the agreement, the boundary was mapped from both sides up to a distance of two hours' walk. That fact made it possible to actually turn the demarcation of the boundary line into the surveying of the wider borderland, which allowed Habsburg cartographers to gain legal entrance to the Ottoman territory

and thus map their military frontier zone.[46] Mapping was done with the help of available measuring instruments, among which the compass was the most useful one. Only horizontal angles were measured with no high-altitude elevations. Distances were obtained by intersecting horizontal angles or by measuring time. The extensive project of boundary mapping was, without any doubt, the teamwork of a group of surveyors and cartographers, but the maps were almost without exception signed by Müller and Marsigli. Because of that fact, many participants in this mapping campaign remained anonymous.

The great success of the cartographic campaign of 1699 and numerous maps that appeared represent a significant step in the development of both military and commercial cartographies. The Karlowitz Peace Treaty of 1699 and the suppression of the Ottomans from Central Europe was a great sensation throughout Europe. Although detailed demarcation maps were maintained in the manuscript as a confidential government and military document, some geographical knowledge acquired by military staff would appear on a printed commercial map for the very first time. Since 1699, some of the first-hand knowledge on the borderland, at a reduced scale and content, would be available for the general public, informing them on the theater of war and the position of the Habsburg-Ottoman border.[47]

The engagement of military topographers in the conduction of the demarcation proved to be very effective. Since then military cartographers were regularly involved in the demarcation mapping of the Habsburg-Ottoman border (1718, 1739, 1791), confirming the close link between state and military cartographies. The connection between military and state cartography would strengthen over time, and the army would soon make use of not only the topographic but also of the cadastral survey of the entire Monarchy.

46 During the demarcation of the boundary, for the first time, legal Habsburg maps of countries under Ottoman rule, such as Bosnia, Moldova, Serbia, Bulgaria, and Romania, appeared as well. They were also produced by Marsigli and Müller.

47 As early as 1701, a map by Christoph Weigl was published in Nuremberg with an accurate representation of the Ottoman border of 1699 and accompanied by plans of all key border fortifications. See, Mappa der zu Carlovitz geschlossenen und hernach durch zwey gevollmaehtigte Commissarios vollzogenen Kaiserlich Tuerkischen Graentz Scheidung: so in dem Frueh Jahr 1699 angefangen und nach Verfliesung 26 Monaten vollendet worden. Copperplate in color; 37 x 30 cm.

Diversification of Military Mapmaking – From Warfare to Economic Sustainability

Due to the further Habsburg-Ottoman Wars (1716–1718, 1737–1739) that would take place along the Croatian borderland, for some time Habsburg military cartography would stay focused on mapping the fortifications and on the production of medium-scale operational and route maps, and plans for the fortifications. Although the cartographic campaigns after the Peace Treaty of Passarowitz (1718) and the Peace Treaty of Belgrade (1739) would no longer be as extensive as those of 1699, a new series of maps depicting the border and key fortifications made by Habsburg military topographers and field engineers emerged after each of the armistices.

The Ottoman-Habsburg wars of the first half of the 18th century further confirmed the importance of the acquired advantage in the field of cartography.[48] This fact prompted the Austrian military authorities to realize how useful it would be to have reliable maps available for the entire borderland, or even for the whole the Monarchy, and not just for a narrow strip of land along the border. Military reasons began to be joined with economic ones, such as better control of resources like forests and agricultural land. Thus, from the 18th century military maps were understood not only as a tool of warfare but also as an instrument for the implementation of a much needed tax reform and achieving of greater economic self-sustainability of the borderlands, whose financing from the central treasury became increasingly difficult. The implementation of the reforms that would take place during the 18th century would largely depend on the training of new personnel, so greater attention began to be paid to military education, including that in the field of cartography.

In the 1720s the number of staff trained in surveying and mapping began to grow significantly. The increase in officers with training in mapmaking was particularly spurred by the establishment of the Imperial and Royal Technical Military Academy (*K.u.k. Technische Militärakademie),* a military training facility

48 In contrast to Habsburgs, the Ottoman army did not use maps in the warfare. Due to the secrecy policy (maps could always get into the hands of the enemy), they preferred using local people to guide them through the unknown terrain. For more on the Ottoman policy of mapping see, Altić, « Nineteenth-Century Ottoman Topographic Mapping of the Balkans », *The Cartographic Journal* 55/4 (2018), pp. 326–340.

founded in 1717 for the officers of the Habsburg Monarchy. It was established on the initiative of Eugen of Savoy who, recognizing the shortage of military engineers in the Habsburg army, urged Emperor Charles VI to set up corresponding training facilities.[49] Only in the period between 1718 and 1743, some 300 students attended the academy. Another important impetus to the development of military cartography occurred in 1747, when Maria Theresa ordered the formation of the imperial Genie Corps (Corps of Engineers) with the primary task of surveying and mapping for military purposes. By centralizing military engineers under a common leadership, the Aulic Council could allocate officers more effectively all over the Empire. The Genie Corps consisted of four brigades, each in charge of a certain part of the Empire: German (for German hereditary lands), Hungarian (for Hungary, Croatia, Slavonia, Banat, Transylvania), Italian (for Italian lands), and the one of the Low-Countries (for Austrian Netherlands).[50]

Yet, it seems that a larger number of military engineers involved in surveying and mapping along the borderlands were trained more in the field than in schools. During the 18th century, special topographic departments were established in the headquarters of the Generalates, as well as in some regiments whose task was to conduct local surveys and mapping. Eventually, some of those departments grew into outdoor schools for mapping. This is especially the case for Karlovac, which became an important educational center for officers stationed locally. Their activity would be especially intensified at the time of the juridical and territorial reorganization of the Military Frontier (1737–1746), when the old captaincies were replaced by regiments that, in addition to military, also received significant economic responsibilities. In order to carry out the reorganization, precise maps were much needed. Already in 1746, under the leadership of Lieutenant Johann Andreas Schillinger, a Royal Military Engineer of the Hungarian Brigade of the Genie Corps, begins a detailed topographic survey of all former captaincies of the Karlovac Generalate. In only three years time, assisted by numerous officers of the Karlovac Generalate trained in field mapping, Schillinger successfully con-

49 Gunther Erich Rothemberg, « Some Observations on the Evolution of Technical and Scientific Education in the Austrian Army during the Eighteenth Century », in Monte D. Wright and Lawrence J. Paszek (eds.), *Science, Technology, and Warfare: the Proceedings of the Third Military History Symposium*, *United States Air Force Academy, 8–9 May 1969*, U.S.G.P.O, Washington, DC, 1971, p. 77.

50 Madalina Veres, *Constructing Imperial Spaces: Habsburg Cartography in the Age of Enlightenment*. PhD diss., University of Pittsburgh, 2015, 49–50.

Fig. 8 A section of a topographic map of the former Karlovac Captaincy drafted in 1748 by Johann Andreas Schillinger at a scale of 1:43,200 (explanation key enlarged by author). Compiled almost thirty years before the first military survey, it represents one of the pioneering works of the Genie Corps accompanied by local staff. (War Archives, Vienna, B.IX.a.859-02)

ducted the survey and produced maps of each captaincy at a scale of 1:43,200 (Fig. 8).[51] Upon the survey of the captaincies, he summarized his results into a topographic map of the whole Karlovac Generalate at a scale of 1:100,000 (Fig. 9).[52]

51 War Archives in Vienna, Map Collection, B.IX.a.851, B.IX.a.853, B.IX.a.854, B.IX.a.856, B.IX.a.857, B.IX.a.859.

52 E.g. Mappa Geographica von dem Carlstädter Generalat, welches die Meer-Gränitz, bis an die Licca und Carbavia… von Schilinger aufgenohmen worden. Scale: 1:100,000. [S.l., 1748]. Manuscript in two sheets, 87 x 64 cm each. War Archive, Vienna, Map Collection, B.IX.a.783.

Schillinger's large-scale maps of the captaincies, as well as the map of the Karlovac Generalate, show a great progress of Habsburg military cartography. These detailed topographic maps are based on an instrumental survey by triangulation and astronomical observations. The maps show settlements at the level of individual households, all watchtowers (*chardaks*), sanitary check points (*contumanze*), mills, stores (magazines), churches, and the complete traffic network (roads are categorized). The presentation of the physical-geographical features of the terrain also experienced a significant progress. Not only relief is now marked by a new method of hatching, but land use of terrain is elaborated in detail as well. Thus, forested parts are clearly distinguished from those that are cultivated, as are individual areas under meadows, pastures, vineyards, and orchards. In addition, the maps of captaincies were regularly accompanied by auxiliary plans of forts and cities. Although undoubtedly produced as maps intended for strategic planning and management of the Generalate, their highly aestheticized visual identity confirms that they were also prepared for the central military authorities in Vienna. Most of them are equipped with decorative cartouches with strong symbols of Habsburg imperial power. Yet, none of these maps was accompanied by a grid of latitude and longitude.

Fig. 9 A section of Andreas Schillinger's military map of the Karlovac Generalate compiled in 1748 at a scale of 1:100,000. Physical geography is presented in the same style as would be applied on Josephinian topographic maps (War Archives, Vienna, BIX.a.783-02)

Schillinger's maps represent the pinnacle of Habsburg military cartography of the mid-18th century. Compiled more than thirty years before the first military survey of the Habsburg Monarchy, his maps testify to the strong advancement of military cartography enabled by the synergy between royal officers sent by central authorities and local staff stationed in the Generalates. No doubt, the participation of local officers alongside Schillinger meant for them additional training and experience that would allow them to continue cartographic work on their own for the needs of individual regiments. Locally organized mapping activities particularly contributed to the diversification of military mapmaking in the borderland. Using Schillinger's maps as a basis, local officers continued to produce maps, compiling a series of thematic large-scale maps mainly focused on border control and the economic valorization of land. Thus, a series of maps of sanitary cordons,[53] maps of pastures,[54] as well as maps of forests of individual regiments were created,[55] all of which compiled before the first military survey that would start there in 1774.

First Military Survey under General Quartermaster's Staff and Secret Mapping of Bosnia

The changes that started with the reorganization of the Military Frontier were only the beginning of Maria Theresa's extensive reforms (1747–1780) that would completely change the legislative framework of the Monarchy. To strengthen the military and bureaucratic efficiency of the Empire, she introduced radical centralization and extensive legislative changes, which also included financial reforms that deeply affected the serfdom and taxation system (taxation of the nobility and

53 Ideal Plan der Liccaner Granitz von Lopmardenichka Polliana bis an das Triplex confinium mit dem Turcico und die Venetianische Granitz von Triplex confinium bis Varzca…/ aufgenommen und gezeichnet Fahnrich Gary. Scale 1:180,000. [S.l.: ca. 1769]. Manuscript in color; 50 x 34 cm. Croatian State Archives, Map Collection, B.I.19.

54 E.g. Mappa geometrica des jenigen Terains Travarinae genannt auf welchen denen Venezianer gegen Bezahlung die Waide vor das Viech zugelassen wird…/ A. Waldschütz.- Scale 1:360,000. [S.l.]: 1753. Manuscript in color; 83 x 54 cm. Croatian State Archives, Map Collection, B.I.15.

55 E.g. Mappa deren K.K. an der See in litorali Austriaco liegenden Waldungen des löbl. Liccaner Gränz Regiment welche auf Allerhöchste Befehle Annis 1764 accourat und Geometrisch aufgenommen und nach der Wahren Laage der Gegend entworffen worden/ Dienzel, Penco, Pierker. Scale 1:43,200. [S.l.]: 1764. Manuscript in color; 160 x 260 cm. Croatian State Archives, Map Collection, B.III.3.

clergy was instituted for the first time). The reforms would have a particularly strong impact on the military, its funding and internal organization. In general, the Habsburg Monarchy during Maria Theresa and Joseph II went through a process of militarization, in which the fiscal and the economic systems more effectively supported war and defense. Although the funding of the army was still the responsibility of the central government, more and more insistence is placed on greater self-sustainability of the region, on the development of more sufficient agrarian production and crafts in the cities. Those changes would have a deep impact on military mapping, encouraging thematic cartography and production of maps focused on the economy of the Military Frontier.

During the Seven Years' War (1756–1763), another institution took an important role in the production of military maps. The General Quartermaster's Staff, until then organized only as a wartime body assigned with the tasks of logistics in military campaigns, relied heavily on maps and plans. Due to its immense utility for the defense of the Monarchy, by the end of the Seven Years' War, the General Quartermaster's Staff had become a permanent military mapping institution of the Monarchy with Field Marshal Franz Moritz von Lacy (1725–1801) as a chief of staff. Much like the Corps of Engineers, the General Quartermaster was subordinated to the Aulic War Council.[56] They employed elite mapmakers recently graduated from the Academy of Engineering in Vienna, which enabled a full professionalization of military mapmaking. The transformation of the General Quartermaster's Staff into the mapmaking engine of the Monarchy soon resulted in a great increase of staff officers trained in survey and mapping. In 1757, only a small group of officers had the training in mapping, but by 1766, more than half of the senior officers and 40% of the subalterns received some training in mapmaking. By 1786, 100% of the staff officers had the ability to contribute to the mapping operation.[57] At the same time, the transformation of the General Quartermaster's Staff into the imperial mapping institution allowed members of the corps of engineers to focus more on rebuilding the fortresses.[58]

56 Hubert Zeinar, *Geschichte des österreichischen Generalstabes,* Böchlau, Vienna, 2006, p. 113.

57 Veres, 2015, p. 55.

58 The relationships between the General Quartermaster's Staff and the imperial Corps of Engineers is not clear. Some authors state that the Corps of Engineers were subordinated to the General Quartermaster's Staff.

A series of Austrian military defeats, in the War of the Polish Succession (1733–1738), the Habsburg-Ottoman War (1737–1739), the War of Austrian Succession (1740–1748), including both the Silesian and the Seven Years' War (1756–63) led to the decision on a topographic and cadastral survey of the entire Monarchy, which would finally provide the army with detailed and completely reliable maps. The poor outcome of these wars was namely attributed to the lack of geographical knowledge and the lack of reliable maps. Thus, the new military survey of the empire was meant to provide maps specifically designated for the military's requirements. The First Military Survey of the Habsburg Empire (*Josephinische Landesaufnahme*), together with the cadastral survey (*Ökonomische Landesaufnahme),* were carried out between 1763 and 1787 and were based on the experiences of the 1756–1789 topographical surveys of France, led by Cassini de Thury. Thus, the first military survey did not result only in topographic sheets at a scale 1:28,800 (1 Zoll = 400 Klafters), but also in cadastral maps at a scale of 1:3,600.

For strategic reasons the surveying activities started in the borderlands and only after that moved to the inlands. The survey of the Croatian Military Frontier started in 1774 with the mapping of its central part (*Bannal Grenze*),[59] then extending westward to the Karlovac Generalate, which was surveyed between 1775 and 1777,[60] followed by the Varaždin Generalate (central Croatia),[61] and the Slavonian Generalate (eastern Croatia),[62] surveyed between 1781 and 1782. Simultaneously, a cadastral survey was conducted based on which the first land registers were established, enabling detailed insight into the ownership and land use of the properties. Only two copies of each map were made. Maps compiled by the first military survey were considered strictly confidential and kept as mil-

59 Militär-Charte der Banalgrenze samt denen inclarierten Privatherrschaften, aufgenommen unter der Direktion des Oberwach. von Brady vom Grossen Generalstab. Scale 1:28,000. Manuscript map in 25 sheets. War Archive, Vienna, Map Collection sign. B.IX.a.771.

60 Originalaufnahme der Karlstädter Generalats oder Grenze, bestehend aus dem Liccaner, Oguliner, Otočaner und Szluiner Grenz-Infanterie-Regiments, bearbeitet unter der Direktion des Major, später Oberleutenant Jeney in den Jahren 1775–1777. Manuscript map in 64 sheets. War Archive in Vienna, Map Collection, B-IX-a-786.

61 Militär-Mappa des Warasdiner Generalats. Aufgenommen unter Direktion des Obersleutenant Jeney in den Jahren 1781–1782. Scale 1:28,000. Manuscript map in 26 sheets. War Archive, Vienna, Map Collection, B.IX.a.799.

62 Militär-Mappa des Sclavonischen Generalats, verfasst in Esseg 1782. Scale 1:28,000. Manuscript map in 61 sheets. War Archive, Vienna, Map Collection, B.IX.a.878.

itary secret until 1864. The officers from the General Quartermaster's Staff who directed the survey were assisted by numerous officers stationed in the Military Frontier who spoke the local language and knew the terrain well.

Although the maps of the first military survey of the Habsburg Monarchy did not achieve the excellence of their French role model, those maps provided the army with the first standardized large-scale military maps for the whole Monarchy. The survey was not based on a unique geodetic basis of trigonometric points (each country developed its own triangulation network), but it still enabled a significant mathematical accuracy of maps, which was particularly important for an artillery of improved mobility and specifications that saw the increased use (though maps were not accompanied by a coordinate system nor by height points).[63]

They provided detailed presentation of the terrain configuration presented by hatching, a concise categorization of roads, so important for estimating the movement of the army, an accurate view of the hydrographic network with indicated flood ranges, bridges and possible river crossings, insight into vegetation density and land use, as well as an accurate view of settlement structure (including their capacity in housing the army). Each sheet was accompanied by a military description of the terrain (*Militär Beschreibung*), which contained information important for the movement of military troops and the conducting of operations. All of that finally enabled effective and timely planning of military operations. No less important, maps by the first military survey were used as a base for the production of other military zone maps like those of the regiments and companies as well as thematic maps required locally. That especially refers to the time of the last Habsburg-Ottoman War (1788–1791) when particularly large quantity of thematic military maps appeared (Fig. 10).[64] Those maps were regularly produced by officers stationed and trained locally.

63 Maps were particularly important for the use of artillery, not at the tactical level (because of the problems of mapping height), but, instead, at the operational one, as maps provided indications of where artillery could be transported. Jeremy Black, « A Revolution in Military Cartography?: Europe 1650–1815 », *The Journal of Military History,* 73/1 (2009), pp. 51–52.

64 E.g. Plan der Szluiner Regiments Cordons Strecke welche der Obristlieutenant Baron Bajalich de Bajahacz von Erklaerung des Krieges bis Ende Februari 1789 unbeschaedigter in Vertheitigungs Stand hielt. Scale 1:73,000. 1798. Manuscript in color; 36 x 31.5 cm. National Library Budapest, TK 220.

Fig. 10 A map of the eastern part of the Karlovac Generalate (Slunj Regiment) drafted in 1789 during the Habsburg-Ottoman War (1788–1791). Based on the first military survey it was compiled to show the position of local troops. Scale 1:73,000. (National Library Budapest, TK 220)

The established network of surveyors and draftsmen in the field encouraged the Habsburg military authorities to, after surveying the Monarchy, expand the cartographic work to areas under Ottoman rule, most of all to neighboring Bosnia from where most of the attacks came from. The plan for secret reconnaissance was personally prepared by Field Marshal Lacy. According to his instructions, it was necessary to collect extensive information on geography, economy, culture, politics, and ethnography of the region. Data were to be collected by field observation and by intelligence. In 1777, the General Staff accepted Lacy's proposal and authorized Lieutenant Colonel Mihály Janos Jeney to conduct a field campaign in Bosnia.[65] Jeney was one of the officers who played a leading role in the first military survey of the Monarchy and had a wealth of knowledge and experience.[66] Disguised as merchants, as early as 1778, Jeney and his staff entered Bosnia near Jasenovac, continued along the Una valley to Bihać, and penetrated all the way to Sarajevo, visiting Banja Luka on their way back. During the trip, Jeney and his officers collected abundant intelligence material and made several topographic sketches based on which they compiled several maps.[67]

Marshal Lacy was satisfied with Jeney's initial campaign, so in 1783 he entrusted a further survey of Bosnia to Colonel Zechenter. He travelled to Karlovac, where he was assigned two officers, Major von Held and Captain Schmidt, as well as several other lower officers as support staff. During 1783, they surveyed almost the whole of Bosnia at a scale of 1:115,200.[68] Mapping was done secretly and quickly, while information was collected from informants and monks, mostly

65 Instruktion für der Obstlt. Jeney, entworfen von Feldmarchal Graf von Lacy (1777). War Archive, Vienna, Map Collection, K.VII.m.3.

66 Mihály Janos Jeney (1723/4-1797), a military engineer and cartographer who worked for the General Quartermaster's Staff. He served at least three powerful states, France (1758–1763), Prussia (in the 1760s) and the Habsburg Monarchy. He was born in a Protestant noble family. He participated in the 1737–1739 Habsburg-Ottoman War and in the War of the Austrian Succession (1740–1748). In 1759, Jeney published a tactic manual for conducting irregular operations, Mihály Janos Jeney, *Le Partisan Ou L'art De Faire La Petite-guerre Avec Succès Selon Le Génie De Nos Jours,* H. Constapel, Hague, 1759. After serving for a few years in the Prussian army in the 1760s, he returned to Vienna in 1768, just in time to take a prominent place in the first military survey. He directed the first military survey of inner Austria, Croatia, and Slavonia, as well as Transylvania. Veres, 2015, pp. 94–95.

67 Most of his material is considered lost. Two 1780 maps are preserved in the National Library of Austria, Map Collection, FKB Q.6.4 KAR MAG and AA-XXIV-(2)-369.

68 War Archive, Vienna, Map Collection, K.VII.m.6 – K.VII.m. 14.

the Franciscans. The reconnaissance was not conducted instrumentally but visually (*a la vue*) and the distances were estimated with regard to walking hours. A partial triangulation was carried out only in northern Bosnia, where Captain Maković managed to mark 31 trigonometric points and connect them with the neighboring network established in Croatia.[69] The accompanying military descriptions also resembled those of the first military survey. Special attention was paid to data important for the movement of the army, potential shelters, such as caves and lonely houses, water sources, river crossings, etc. At the same time, a significant progress was made in the surveying of Bosnian towns, especially those of strategic importance. Lieutenant Lidescron drew up a plan of Sarajevo at a scale of 1:7,200, as well as those of Tuzla, Srebrenica, and Višegrad at a scale of 1:5, 300,[70] while the petty officers Golubović and Matuč drew up plans of Travnik and Stolac at a scale of 1:14,400.[71]

Over time, the survey of Bosnia was increasingly left to local officers stationed on the Croatian Military Frontier, so in 1785, further mapping was carried out by the ensign Boxich from the Brod Regiment. He managed to compile no less than 16 topographic sheets at a scale of 1:115,200, as well as plans of several fortifications. The survey was performed by visual observation and a compass.[72] Finally, the last Habsburg-Ottoman War (1788–1791) would provide the officers with an opportunity for a more extensive instrumental survey of entire Bosnia, and, by 1789, the General Quartermaster's Staff collected enough topographic material to compile a complete map of Bosnia at a scale of 1:115,200. Compiled in 12 sheets, this map is in the full sense a continuation of the military map of Croatia, only at a four times reduced scale.[73] The sheets were compiled according

69 Plan von denen jenigen Gebirgen und fixierten Puncten in Königreich Bosnien und türkisch-Croatien, über den Sau Strom welche von der diesseitigen Gemeinden längst der löblichen Gradiskaner und Broder Regimenten. Nummer haben können aufgenommen und figuriert werden. Anno 1783, aufgenommen und gezeichnet durch I. von Makovich, Hptm. Von General Stabb. War Archive, Vienna, Map Collection B.IX.a.945.

70 War Archive, Vienna, Map Collection G.I.h.621-10; G.I.g.727-10, G.I.h.648-10.

71 War Archive, Vienna, Map Collection G.I.h.654-10 and G.I.h.693-10.

72 War Archive, Vienna, Map Collection K.VII.m.20.

73 Militärische Karte jener Bezirke in türkisch-Croatien, welche durch die den 26. August 1788 erfolgte Einnahme der Festung Dinica und der am 3. October 1788 beschehenen Eroberung der Festung Novi durch das k.k. croatische Truppen-Corps in Besitz genommen. War Archive, Vienna, Map Collection B.IX.a.959.

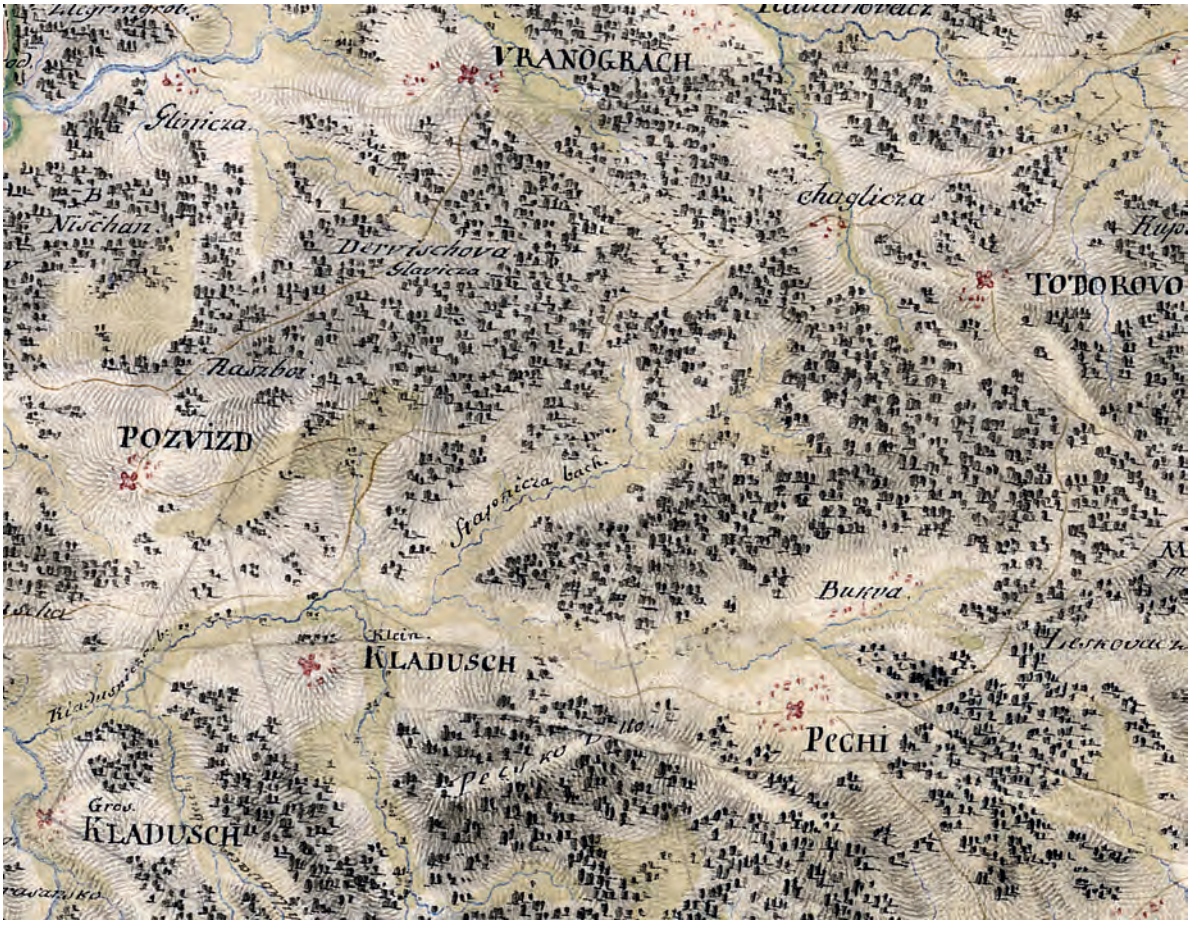

Fig. 11 SW Bosnia on a topographic map compiled based on a secret mapping campaign in 1784. This is a copy from 1794 with new borders established after the Treaty of Sistova. Note the trigonometric network in the back that was drawn in pencil. (War Archive, Vienna, B.IX.c.932)

to the same cartographic key and drawn in the same style as the maps of the first military survey, yet with less accuracy. In 1794, another copy of the same map was compiled that showed the newly established border upon the Peace Treaty of Sistova (1791) that ended the war (Fig.11).[74]

74 Situations-Karte der Kais. Königlich. und Türkish-Croatien Graenze ...welche aus der Veranlassung eines Höchlöblich Kaiser. König. Hofkriegsrath in Jahre 1794 oeconomich augenohmen auch die im grösseren Masstab eingedructe Festungen aus einem Bereisungs

By conducting a secret mapping of Bosnia by the end of the 18th century, the Habsburg military authorities acquired considerable geographic knowledge that was required for the maneuvering of the troops and military planning of the operation in Bosnia. Although directed by the staff of the General Quartermaster, the undercover mapping campaign would not had been possible without a number of officers stationed and trained in the centers of the Croatian Military Frontier who played an important role in the surveying and mapping of the Ottoman territories of interest to the Habsburgs. Ironically, just when they drew up reliable military maps, there were no more wars with the Ottomans. The Habsburgs gained Bosnia without a war by a decision of the Berlin Congress of 1878.

Concluding Remarks

The Habsburg military cartography of the Early Modern Period, developed under the circumstances of the Habsburg-Ottoman Wars, underwent significant changes that were reflected in advance of the quality and quantity of maps, the diversification of map types, as well as in the training of mapmakers and the organization of cartographic work in the field. Despite significant changes that marked the development of Habsburg military cartography from the 16th to the end of the 18th century, its constant was its subordination to the Aulic War Council, which controlled the organization and financing of mapping as well as the education of officers.

The beginning of organized Habsburg military mapping in the area of the Military Border coincides with the period of the Military Revolution, which is usually dated to 1560–1660.[75] In the period of the 16th and the first half of the 17th century, military maps differed from civilian maps mainly in their purpose,

Ideal-Karten unter Direction des Major Boxich… War Archive, Vienna, Map Collection, B.IX.c.932.

75 The term of Military Revolution as defined by Michael Roberts and Geoffrey Parker saw lots of criticism. There is no consent what makes the Military Revolution and how the military change should be periodized. In contrast to Roberts and Parker, Jeremy Black sees the truly revolutionary changes in European military affairs occurring only during the decades after 1660. Moreover, Black suggests that it was the development of the State that allowed the growth in size of the armies, not the other way around. Yet, most of the scholars agree that changes that took places in the 17th century were made possible by innovations in the organization of the army and techniques of the warfare that occurred in the 16th century.

while their content and symbolization largely coincided. However, even in the early period of military cartography, maps intended for military needs contain more data (including confidential ones) and are generally based on recent field observations (as opposed to civilian maps where this is an exception).

A more significant profiling of military cartography begins with the professionalization of mapmaking. As long as maps were made by architects and engineers under contract, the line between military and general cartography was very elusive. From the mid-17th century, when cartographic works were taken over by military topographers and field-engineers from the ranks of military officers in permanent service (in contrast to contracted military engineers in charge of fortifications), military maps receive more distinctive features. Yet, due to the lack of trained staff, their production is still limited to siege plans (*Belagerungs Plan*), war theatre maps (*Schauplatz Karte*), operation (*Operationen Karte*), position (*Positionskarte*) and dislocation maps (*Dislokation Karte, Marschroute Karte*).

The full professionalization of Habsburg military cartography began in the early 18th century when the central authorities established the Royal Technical Military Academy for the purpose of educating officers. Technical and military education of officers particularly encouraged map culture whose growth was part of the intellectual shift in which information, rather than received wisdom, had greater prevalence in military planning. Technical education and scientific methods entailed not only the concern of generals with artillery and sieges, but also the use of scientific knowledge at the operational level, with the need to plan foraging and marches requiring an understanding of agronomy, surveying, celestial navigation, botany, and forestry.[76]

No less important, these processes were accompanied by the development of local educational centers, especially in the headquarters of the generalates and regiments of the Military Border, which became an important generator of officers, including those with training in survey and cartography. Due to the increasing needs for large-scale zone maps, the Military Frontier soon became a large cartographic laboratory where mapmaking was trained and practiced in the field.

76 Erik A. Lund, *War for the Every Day: Generals, Knowledge, and Warfare in Early Modern Europe, 1680-1740,* Connecticut, Westport, 1999 and Erik A. Lund, « The Generation of 1683: The Scientific Revolution and Generalship in the Habsburg Army 1687–1723 », in Brian Davies (ed.), *Warfare in Eastern Europe, 1580–1800*, Brill, Leiden, 2012, pp. 200–211.

It is also a time when international conventions in military cartography in regard of topography and symbolization become more distinctive, emphasizing normative, rather than simply functional mapping.[77]

The relationship between war and cartography can thus be traced to developing consciousness about planning, with warfare providing instances of using information for both policy prescription, in the shape of planning, and policy discussion. Military technology and practice were thus influenced by a larger economy of knowledge, which expanded considerably, helped by the diffusion of information through the culture of print. Locational skills were important to the staff-planning that was at an increased premium, for example with the Austrian army during the Turkish War in 1737–1739.

Another important impetus appeared in 1747 with the establishment of the imperial Genie Corps and with the permanence of the General Quartermaster's Staff (1758), which together become the main engine for the production of all maps needed for military operations. Their activities lead to a significant increase in the quantity and quality of maps as to their standardization with more distinctive symbolization. Also, due to the centralization of the state and a strong connection between the financial and the military issues of the Monarchy in the time of Maria Theresa and Joseph II, the military cartography of the late 18th century had a significant impact on financial and tax reforms throughout the empire. Thus, in addition to standard operational and zone maps intended for warfare, an important quantity of maps that appeared within military cartography refers to military topographic maps (the first military survey), cadastral plans (the first economic survey), as well as to increasingly diverse thematic maps related to the issues of economic sustainability of the countries, especially their borderlands (forest maps, pasture maps, sanitary cordon maps, etc.). This kind of militarization of cartography was not a process limited to the Habsburg Monarchy, but was a direct result of a rising interest in maps as planning tools among military officers at a global scale.

77 Black, 2009, pp. 49–50.

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Il fronte del fiume Piave dalle carte militari del 1917-18.
Aggiornamenti topografici e militari attraverso l'occhio del cartografo

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Abstract. In this paper we analyse the military maps of the Archivio di Stato di Firenze (ASFi), collected in the Miscellanea di Mappe Militari (MMM) that cover the frontline along the Piave river from December 1917 to October 1918. These maps are more than 100 sheets and cover the middle and final course of the Piave river, from Pederobba - Vidor to the Venice lagoon and the Sile River, drawing a frontline of 70 km. The military maps show a different military disposition of the two Armies, which deployed their units according to defensive (Italian Army) and offensive (Austro-Hungarian Army) purposes. In the maps we can clearly observe the process of the continuous cartographic update, derived from aerial and terrestrial recognition that capture new military settlements completing or changing the frontline. Moreover, the course of the river was continuously updated, as well as other strategic land cover elements (i.e. vegetation, trafficability, buildings etc.). Italian and Austro-Hungarian maps were compared to calculate the effectiveness and the difference in priority of mapping.

Keywords. World War One Maps, Piave River, Montello Hill, Battle of the Solstice, Battle of Vittorio Veneto

Introduzione

L'Archivio di Stato di Firenze conserva tra i suoi pregevolissimi documenti anche una miscellanea di carte militari della Grande Guerra, provenienti dalla smobilitazione delle unità militari combattenti dopo la cessazione del conflitto. Queste carte illustrano le disposizioni e gli apprestamenti militari durante l'ultimo anno della Grande Guerra - almeno per la mag-

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gior parte di questi documenti - e i territori più rappresentati sono l'altopiano di Asiago, il Massiccio del Monte Grappa e il Fronte del Piave. Su quest'ultimo svolgeremo un'analisi della rappresentazione sia della topografia che degli apprestamenti e disposizioni militari durante l'intera durata di quel fronte, da novembre 1917 ad ottobre 1918. La Miscellanea contiene documenti di almeno tre eserciti lì impegnati: quello italiano, l'Imperiale e Regio esercito austro-ungarico e l'esercito britannico.

Il fronte del Piave

La riuscita offensiva dell'ottobre 1917 sul fronte dell'Isonzo comportò una grave crisi militare da parte italiana e l'arretramento del fronte di circa 100 km dal punto di sfondamento effettuato dagli eserciti austro-ungarico e germanico. Una volta scelto con successo di resistere lungo il Piave per fermare l'avanzata (prima Battaglia del Piave o Battaglia d'arresto), i comandi italiani si trovarono nella necessità di organizzare tutto il necessario per mettere in funzione ed alimentare il poderoso sistema di questa nuova linea di resistenza. Anche la cartografia dovette essere approntata e aggiornata e, tramite essa, è possibile cogliere molte fasi evolutive dei diversi schieramenti militari. Nei seguenti paragrafi analizzeremo questi momenti secondo la cronologia delle tre battaglie (Battaglia d'arresto, Battaglia del solstizio, Battaglia di Vittorio Veneto) svoltesi in questo settore del fronte. Un'ampia raccolta di cartografia militare di questo tipo è conservata presso l'Archivio di Stato di Firenze (ASFi) ed è nominata Miscellanea di Mappe Militari. Il fondo consiste in 6 rotoli di carte (R1, R2, …, R6) e una grande scatola dove sono conservate carte piane (P)[1].

La Battaglia d'arresto o Prima battaglia del Piave. Nuove carte per gli eserciti.

La topografia di base del nuovo fronte era già stata realizzata dopo l'Unità d'Italia, con i rilievi dell'Istituto Geografico Militare Italiano (IGMI). Gli ultimi aggiornamenti variavano - a seconda dei luoghi - dalla prima levata (cioè rilievo

1 Aldino Bondesan & Mauro Scroccaro (cur.), *Cartografia Militare della Prima guerra mondiale. Cadore Altopiani e Piave nelle carte topografiche austro-ungariche e italiane dell'Archivio di stato di Firenze*. Antiga Edizioni, Regione Veneto, Archivio di Stato di Firenze, Università di Padova, Marco Polo System, Cornuda, 2016.

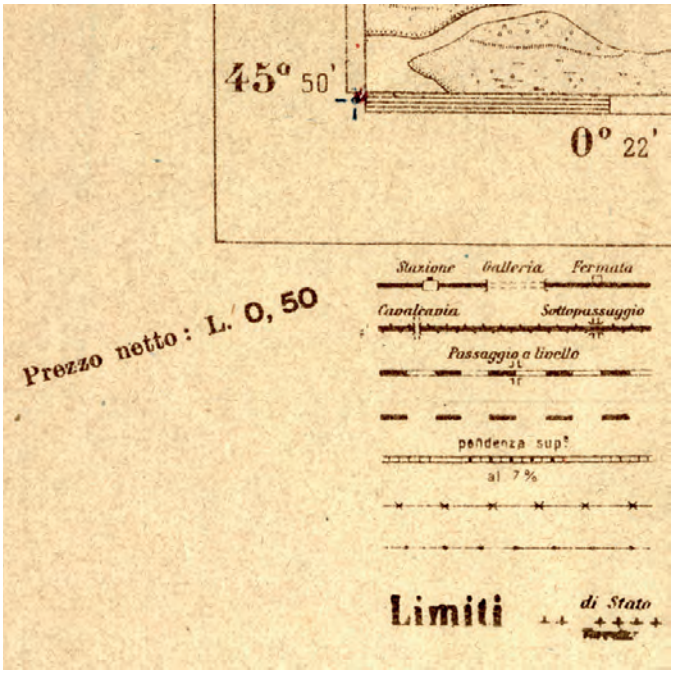

Fig. 1 Particolare di carta militare del Comando della 2ª Armata di marzo 1918. I temi militari sono sovrastampati alla Tavoletta 38 IV SE su cui, nell'angolo inferiore sinistro, si legge il prezzo essendo in origine, evidentemente, destinata al commercio pubblico (ASFi MMM P305/14).

Fig. 1 Zoom of a military map of the 2nd Italian Army, March 1918. The military features are overprinted on the "Tavoletta" (Italian 1:25.000 sheet) 38 IV SE on which, in the lower left corner, is printed the map price as it was originally intended for public trade (ASFi MMM P305/14).

topografico) del 1890 fino alle più recenti edizioni aggiornate al 1916, in particolare dove erano intervenute importanti modifiche alla viabilità e ad altre infrastrutture di importanza strategica (ad esempio, il nuovo tronco ferroviario, che univa le stazioni di Montebelluna e di Susegana, fu mappato nelle nuove edizioni delle Tavolette IGMI). L'esercito italiano disponeva di questa cartografia, ma tale fu la repentina e inattesa ritirata dal fronte dell'Isonzo che non fu facile disporre in breve tempo di un numero adeguato di copie di Tavolette topografiche. Tant'è che sulle prime mappe militari del nuovo fronte si possono leggere diciture del tipo "Prezzo netto: L. 0,50", denunciando il ritiro dal commercio di quelle carte di cui la nuova situazione militare aveva forte necessità.

Esigenze analoghe incontrò anche l'esercito austro-ungarico che si accingeva a combattere su di una nuova linea di fronte che, nelle sue speranze, non avrebbe dovuto essere quella finale. I continui attacchi sul Monte Grappa e sul Piave, alle pendici del massiccio stesso, si protrassero per tutto novembre e un ulteriore tentativo fu compiuto ai primi di dicembre[2, 3]. Non riuscendo a sfondare il fronte del

2 Enrico CAVIGLIA, *Le tre battaglie del Piave,* Mondadori, Milano,1934.

3 Peter FIALA, *1918 il Piave. L'ultima offensiva della duplice monarchia*. A cura di Giulio

Grappa e del Piave, anche l'esercito austro-ungarico iniziò l'allestimento della cartografia per il nuovo fronte. Una carta, sempre tra quelle conservate nell'Archivio di Stato di Firenze (ASFi), ci presenta un piano per la cartografia a scala 1:10.000 dell'intero fronte italiano (figura 2), in cui sono evidenziati i fogli disponibili. (ASFi MMM P297/2). Proprio questa carta ci indica della necessità per l'esercito di disporre di mappe a grande scala dove poter raffigurare gli obbiettivi tattici e strategici in vista di un ulteriore sfondamento del fronte: infatti, l'esercito italiano è sulla difensiva – dopo due anni di attacchi continui – ed è decimato e col morale in crisi. Ma la resistenza sul Piave e sul Monte Grappa sta cambiando quest'aspetto e, mentre le divisioni germaniche ritornano in patria per esser condotte sul fronte occidentale, nuove divisioni italiane si vanno formando, cui si aggiungono 11 divisioni alleate qui inviate in seguito agli accordi della Conferenza di Rapallo (6-7 novembre 1918)[4]. La situazione, pur numericamente ancora a favore degli attaccanti, non è più così propizia e lo slancio dell'offensiva di ottobre perde la sua efficacia. Si impone quindi un periodo di stasi, fatto di guerra di posizione e preparativi per le prossime possibili azioni che, comunque, restano nelle mani degli attaccanti, i quali sfruttano l'indiscutibile vantaggio ottenuto dalla riuscita offensiva. È in questo contesto che si configura l'esigenza di una nuova produzione cartografica.

Allestite in velocità dall'Istituto Geografico Militare Imperiale e Regio, le carte per il nuovo fronte sono disegnate con la topografia delle "Tavolette" IGMI italiane, per lo più, però, della prima edizione, la levata del 1890 circa. Questo implica che i mutamenti avvenuti nelle due-tre decadi precedenti l'inizio della guerra non sono riportati e l'esercito Imperiale e Regio dovrà provvedere da sé agli aggiornamenti. Comunque, la topografia delle Tavolette italiane, viene ricollocata nelle due principali cartografie adottate dall'Imperial e Regio esercito[5, 6]: il

Primicerj. Con annessa relazione ufficiale austriaca, Arcana, Milano, 1982.

4 Caviglia, 1934.

5 Wilfried BEIMROHR, « *Tirol und die Dritte oder alte* österreichische *Landesaufnahme 1:25.000 »,* Tiroler Landesarchiv, 2007. (Memento vom 1. Oktober 2007 im Internet Archive, tirol.gv.at).

6 Mauro Scroccaro, « Sui cieli del nemico »*,* in Aldino Bondesan & Mauro Scroccaro (cur.), *Cartografia Militare della Prima guerra mondiale. Cadore Altopiani e Piave nelle carte topografiche austro-ungariche e italiane dell'Archivio di stato di Firenze,* Antiga Edizioni, Regione Veneto, Archivio di Stato di Firenze, Università di Padova, Marco Polo System, Cornuda, 2016, pp. 41-54.

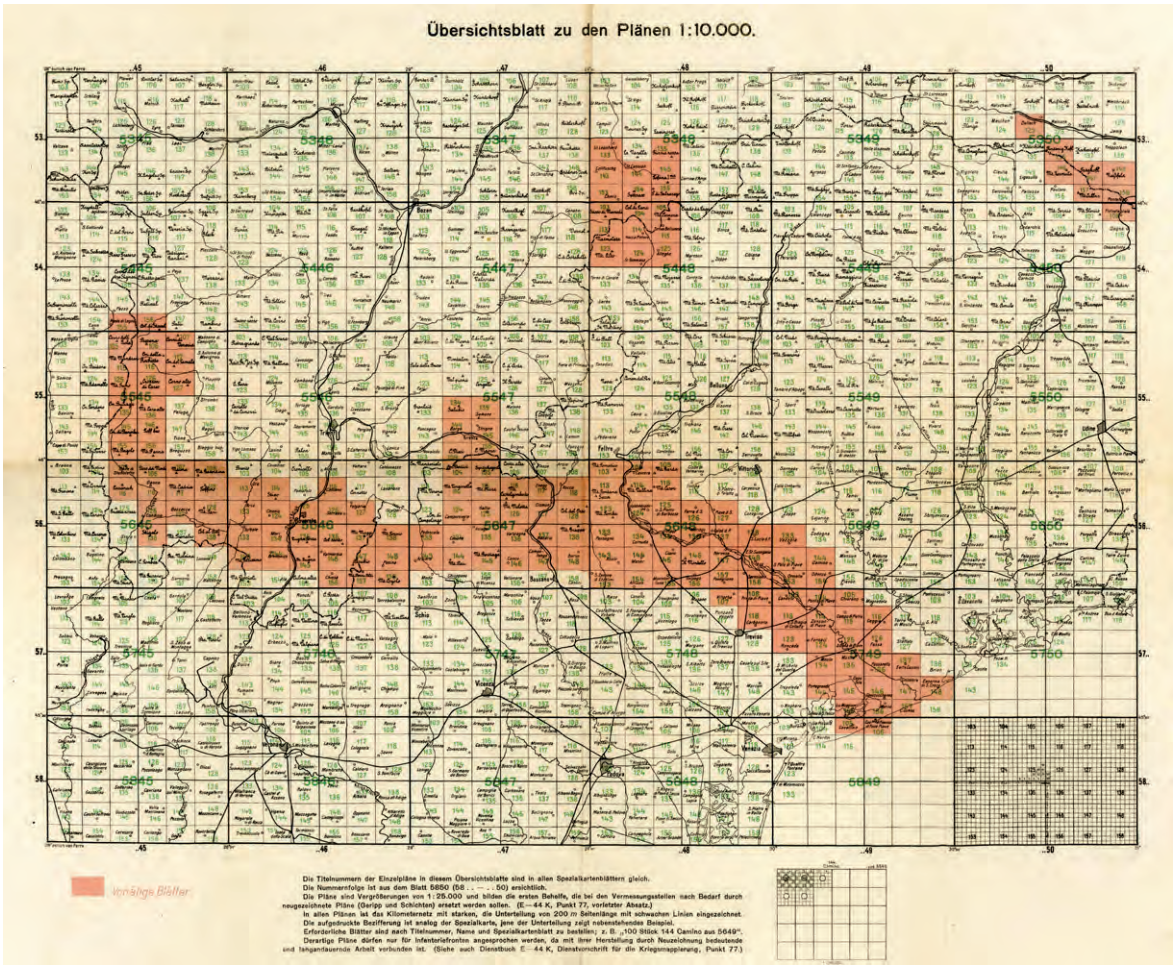

Fig. 2 Piano austro-ungarico per la cartografia a scala 1:10.000. In arancione i fogli disponibili e, tra essi, tutto il territorio del Piave da Caorera (BL) alla foce di Cortellazzo (VE) (ASFi MMM P 297/2).

Fig. 2 Austro-Hungarian plan for cartography at 1:10,000 scale. The available sheets are in orange and, among them, the entire territory of the Piave river from Caorera (Belluno) to the mouth of Cortellazzo (Venice) (ASFi MMM P 297/2).

Foglio (*Blatt*) a scala 1:75.000 e la Sezione (*Sektion*) a scala 1:25.000, quest'ultima corrispondente ad un quarto del Foglio. Su queste basi topografiche vengono sovrimpresse le informazioni di interesse militare, il reticolato geografico, la legenda, etc. Nella Miscellanea due carte del fronte del Piave redatte dal comando austro-ungarico sono della prima edizione (*1 Auflage*) di cui una (figura 3) della zona Montello orientale e medio Piave, addirittura del 28 novembre 1917, un

paio di settimane dopo lo schieramento sul nuovo fronte. Questa carta mostra le deficienze tipiche di un territorio appena raggiunto e ancora "inesplorato", con pochi temi disegnati e una topografia derivata da fonti non verificate.

Di questa sezione è molto interessante la seconda edizione datata a circa un mese dopo, il 22 dicembre, riportante la situazione al 14 dello stesso mese (carta ASFi MMM 206/6 in figura 4). Le informazioni aumentano, di pari passo con le osservazioni aeree e terrestri e con l'allestimento e completamento delle disposizioni da parte dell'esercito italiano e dei suoi alleati[7]. Le linee che erano tracciate nel settore sud est della carta si completano, unendo elementi prima distanziati e facendo apparire tratti di seconda linea e infrastrutture come *decauville*. Soprattutto, gli apprestamenti italiane di prima linea sono mappati con continuità lungo tutto il Piave nella scena di questa Sezione. La topografia non subisce variazioni tra queste due edizioni, eccezion fatta per il Piave stesso che, nella porzione di sud est, viene aggiornato disegnando le disposizioni dei suoi canali intrecciati con un tratteggio orizzontale blu, sovrimpresso alla base topografica. Un elemento senz'altro da aggiornare, data l'elevata dinamicità di un ambiente geomorfologico come questo, in grado di cambiare i suoi tracciati dopo ogni piena stagionale o addirittura temporanea. Un altro luogo da aggiornare, di cui i comandi si sono presto accorti una volta stabilizzato il fronte lungo la nuova linea, riguarda il colle del Montello. In queste due edizioni esso ci appare come dalle levate IGMI del 1890, che ritraevano un bosco in via d'estinzione, con la tipica simbologia ad esso dedicata (il puntinato sparso) solo nell'angolo nord-orientale del colle. Le vicende storiche stavano, in quell'epoca, avviando l'area collinare verso un'intensa trasformazione che prevedeva la privatizzazione della collina e il passaggio da silvicoltura ad agricoltura, con costruzione di strade e insediamenti: una radicale trasformazione topografica imposta dal nuovo paesaggio agrario che verrà delineandosi nei successivi 27-28 anni. Infatti, è del 1892 la "riforma Bertolini", dal nome del deputato montebellunese che portò a legge il progetto di riforma[8, 9]. La topografia del 1890 ne rappresenta il solo punto di partenza; i necessari aggiornamenti delle carte IGMI verranno editi nel 1910, cui seguiranno quelli del 1916 per il solo tracciato del nuovo tratto ferroviario Montebelluna – Susegana

7 Luigi CADORNA*, La guerra alla fronte italiana,* Treves, Milano, 1921.

8 Benito BUOSI, *Maledetta Giavera,* Amadeus, Montebelluna 1992.

9 Benito BUOSI, *Montello, l'America d'Italia*. Terra Ferma, Antiga Edizioni, Cornuda, 2018.

e quelli del 1918 per evidenti esigenze belliche. Queste carte, però, non erano pervenute in mano austro-ungarica e sarà grazie alle osservazioni e alle foto aeree che l'esercito Imperiale e Regio individuò i nuovi particolari topografici del Montello in modo da attualizzare le proprie mappe. E questo aggiornamento da osservazione indiretta sarà uno dei primi casi di carta topografica disegnata o, meglio, aggiornata tramite fotogrammetria di riprese aeree e, in minor misura, tramite telerilevamento aerostatico[10, 11].

Nella Collezione di Miscellanea Mappe Militari è conservata anche una seconda edizione di carta austro-ungarica del tratto più a valle del corso del Piave, rappresentato nella Sezione 5749/$_1$. Anche in questa carta (ASFi MMM R4 205/1) compare con la stessa simbologia e dicitura il "parziale aggiornamento del flusso del Piave", a testimoniare l'importanza tattica e strategica del fiume stesso e il desiderio, almeno nelle intenzioni e nel morale dell'esercito austro-ungarico, di conoscere quest'ostacolo per poterlo attraversare nel migliore e più rapido dei modi.

Questo tipo di aggiornamento del corso del fiume si diraderà, nella cartografia austro-ungarica, dopo la Battaglia del Solstizio del giugno 1918[12]. È interessante, in questa carta, che il Piave della base topografica è stato colorato in celeste, per una più immediata lettura: pertanto solo in un secondo momento il *cliché* del blu tratteggiato, rappresentante il corso aggiornato dei rami fluviali, è stato sovrastampato alla base topografica così colorata. Nello stesso *cliché* del blu, sempre in questa carta, appare anche la disposizione delle artiglierie osservate allora, suddivise in leggere, medie e pesanti. Con un *cliché* destinato al colore rosso è stata rappresentata la disposizione di trincee, camminamenti, posti di vedetta, osservatori e alloggiamenti; di quest'informazione si possiede anche una prova di stampa, in nero su carta bianca (ASFi MMM P214/1).

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10 Elena TORRETTA, Alessandro DI RITA, « L'evoluzione della fotogrammetria da terrestre ad aerea », *La Cartografia* 17 (2008), pp. 20-29.

11 Mauro Scroccaro, « Sui cieli del nemico », in Aldino Bondesan & Mauro Scroccaro (cur.), *Cartografia Militare della Prima guerra mondiale. Cadore Altopiani e Piave nelle carte topografiche austro-ungariche e italiane dell'Archivio di stato di Firenze,* Antiga Edizioni, Regione Veneto, Archivio di Stato di Firenze, Università di Padova, Marco Polo System, Cornuda, 2016, pp. 41-54.

12 Francesco Ferrarese, « *Il Montello nella Miscellanea di mappe militari della Prima guerra mondiale »,* in Aldino Bondesan & Mauro Scroccaro (cur.), *Cartografia Militare della Prima guerra mondiale. Cadore Altopiani e Piave nelle carte topografiche austro-ungariche e italiane dell'Archivio di stato di Firenze*. Antiga Edizioni, Regione Veneto, Archivio di Stato di Firenze, Università di Padova, Marco Polo System, Cornuda, 2016, pp. 87-114.

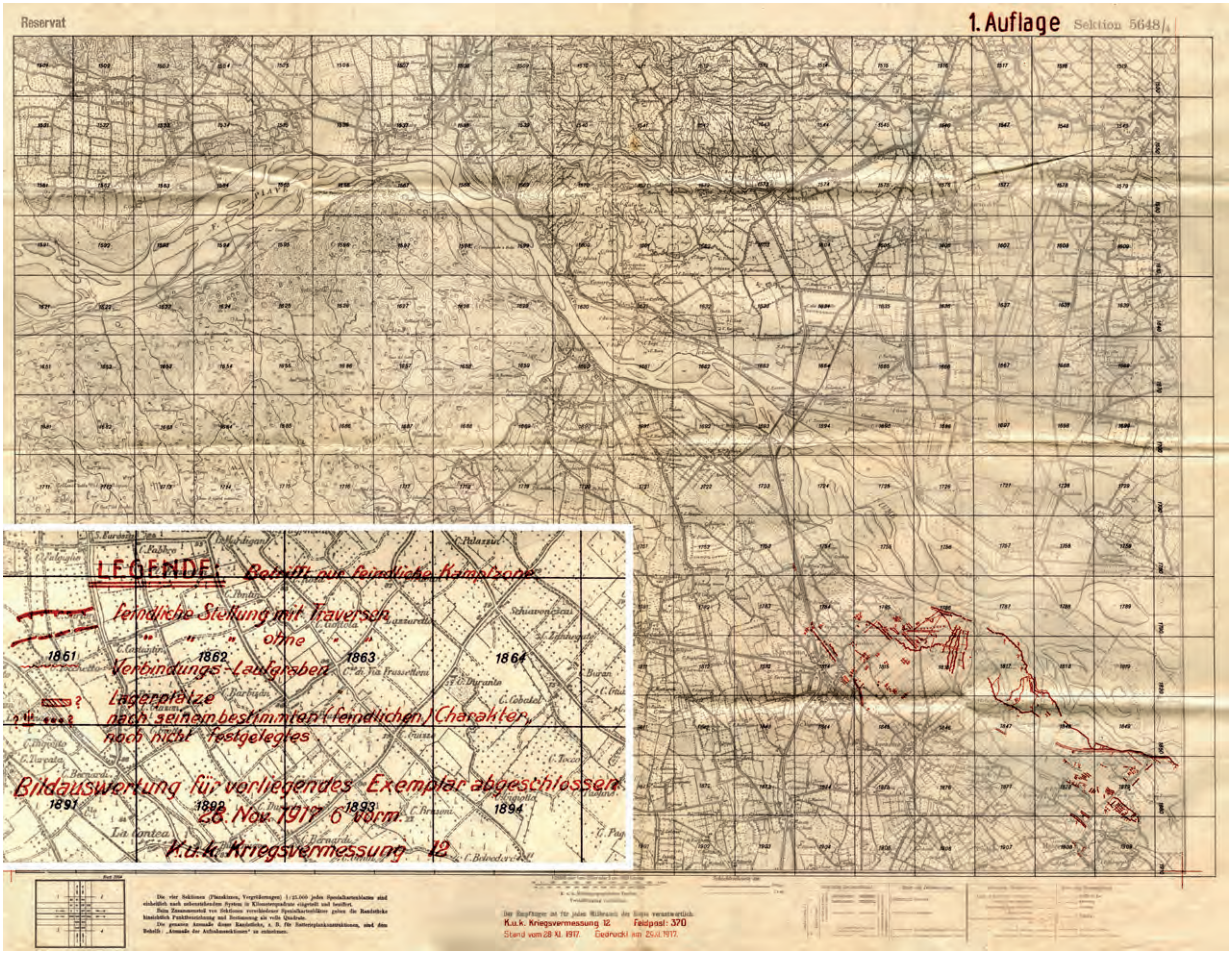


Fig. 3 Montello e medio Piave nella Sezione austro-ungarica 5648/$_4$. La carta è spoglia di informazioni eccettuati il reticolo chilometrico (in legenda esplicato il suo funzionamento) e alcuni apprestamenti italiani nella parte di sud-est, territorio di competenza della 5ª Armata "Isa" (*Isonzo Armee*). La topografia è quella delle Tavolette italiane della prima levata (1890 circa). La legenda è qui ingrandita per agevolarne la lettura: le ultime due righe recitano che la validazione di questo esemplare è stata fatta il 28 novembre 1917 alle 6 del mattino (ASFi MMM 206/6).

Fig. 3 Montello hill and the Piave river in the Austro-Hungarian Section 5648/$_4$. The map is devoid of information except for the kilometric grid (explained in the legend) and some Italian dispositions in the south-east part, the territory of the 5th Austro-Hungarian Army "Isa" (Isonzo Armee). *The topography drawn is that of the first Italian maps (about 1890). The legend is enlarged here to facilitate its reading: the last two lines state that the validation of this specimen was made on November 28, 1917, at 6 am (ASFi MMM 206/6).*

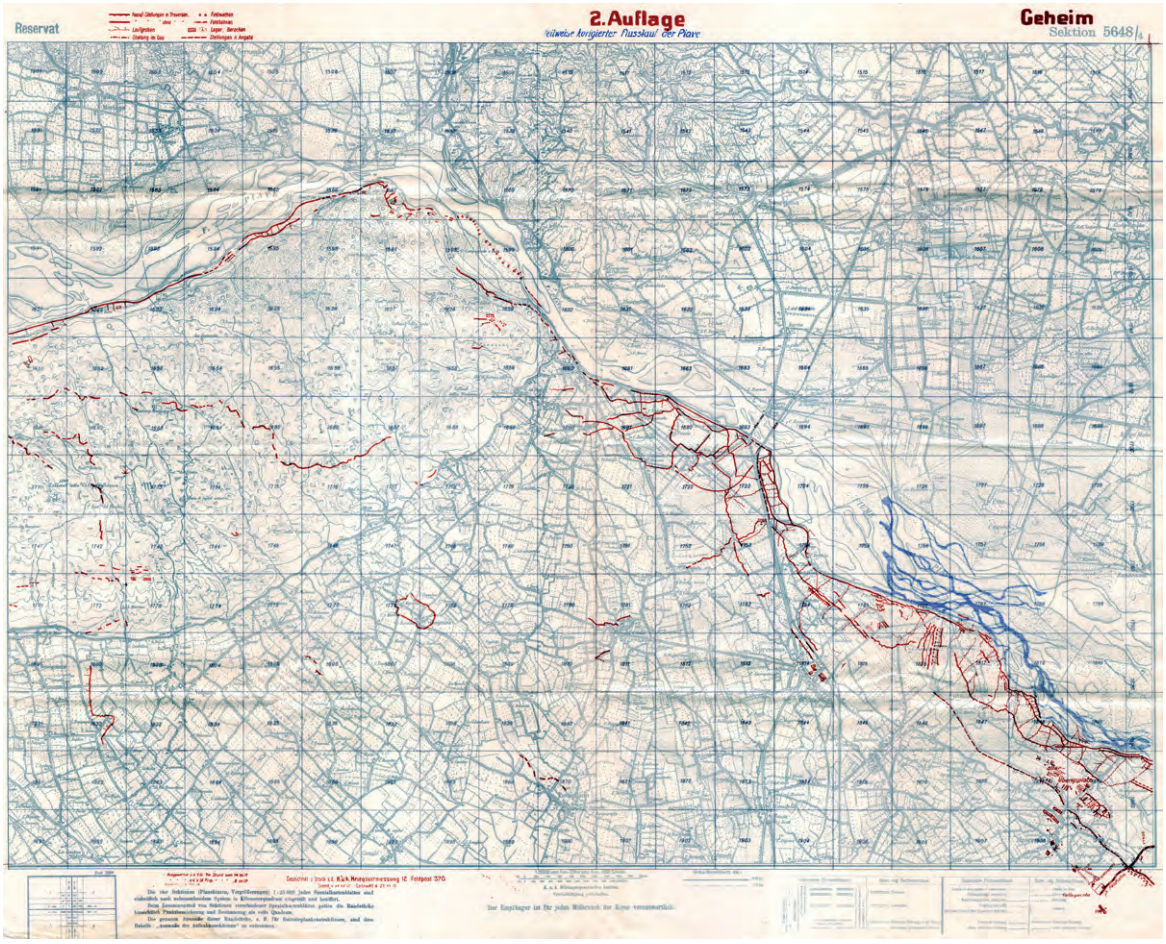


Fig. 4 Seconda edizione della Sezione austro-ungarica $5648/_4$. Questa segue la precedente (figura 1) a poco meno di un mese di distanza. In rosso gli apprestamenti italiani, ancora rappresentati in modo incompleto ma perlomeno lungo tutta la sponda destra del Piave. In blu, ed esplicitato con lo stesso colore in legenda, il "corso parzialmente corretto del Piave". La base topografica non è dell'ultima edizione (1916) e pertanto mostra evidenti lacune, soprattutto sul colle del Montello (ASFi MMM P 206/5).

Fig. 4 Second edition of the Austro-Hungarian Section $5648/_4$. This follows the previous one (figure 1) just a month later. In red the Italian dispositions, still incomplete but at least along the entire right bank of the Piave river. The "partially correct course of the Piave river" is shown in blue in the map and in the legend. The topography drawn is not from the last Italian edition (1916) and therefore shows obvious gaps, especially on the Montello hill (ASFi MMM P 206/5).

Verso l'ultima offensiva austro-ungarica. La seconda battaglia del Piave

Dopo alcuni rinvii, l'ultimo dei quali voluto dall'imperatore Carlo per rimettere letteralmente in forza l'esercito con 15 giorni di vitto migliorato[13], l'esercito Imperiale e Regio attacca su tutto il fronte italiano a metà giugno 1918. L'offensiva fu preparata con molta cura e diverse fonti italiane[14, 15] citano il ricco corredo cartografico di cui era dotato ogni reparto e persino ogni singola squadra. Lo sforzo per giungere a questa accuratezza fu notevole e per certe zone si disegnarono mappe ex-novo, aggiornando la base topografica anche per una produzione a grande scala, 1:10.000 e 1:5.000. Già in aprile 1918, come illustra la carta ASFi MMM P 206/1 in figura 5, lo stato delle acquisizioni e dell'adeguamento cartografico è completo o in via di completamento, e le basi topografiche hanno colmato le lacune delle prime edizioni. Solo i *cliché* a colori dei temi di apprestamento militare subiscono gli incessanti e cadenzati aggiornamenti (per le artiglierie sarà di 15 giorni) imposti dal rischieramento avversario. Inoltre, compaiono carte speciali derivate dall'unione di parti di Sezioni contigue, atte a visualizzare in un'unica mappa un territorio con particolare specificità, come nel caso del Montello, o degli spazi affidati ad un Corpo d'Armata o Divisione o Brigata e Reggimento. Anzi, in questo scender da unità maggiore a minore, solitamente il supporto cartografico tende ad aumentare di scala, per dare la maggiore informazione possibile agli obiettivi specifici delle singole unità combattenti, via via più ristretti e puntuali al decrescere del numero di effettivi inquadrati. L'esercito Imperiale e Regio avvia fin da subito una produzione speciale di carte a grande scala per questi scopi. Ne è un ottimo esempio la serie a scala 1:10.000 del fronte da Pederobba ai Ponti della Priula, che, iniziata in modo puntuale, presto assume un disegno organico con la produzione di fogli contigui raccolti in un quadro d'unione. Questa cartografia, ridisegnata nella topografia secondo le simbologie dell'Imperiale e Regio Istituto Geografico Militare, hanno una nitidezza del disegno e una precisione del tratto che ne fanno non solo dei pregevoli documenti storici, ma anche degli apprezzabilissimi disegni artistici. In figura 6, la carta ASFi MMM P 224/1 è uno di tali documenti e risale all'inizio dell'ultimo anno di guerra, il 31 gennaio del 1918. In poco meno di due mesi non solo il territorio

13 Fiala, 1982.

14 Gianni Baj Macario, *Giugno 1918,* Corbaccio, Milano, 1934.

15 Luigi Gasparotto, *Rapsodie, diario di un fante,* Treves, Milano, 1924.

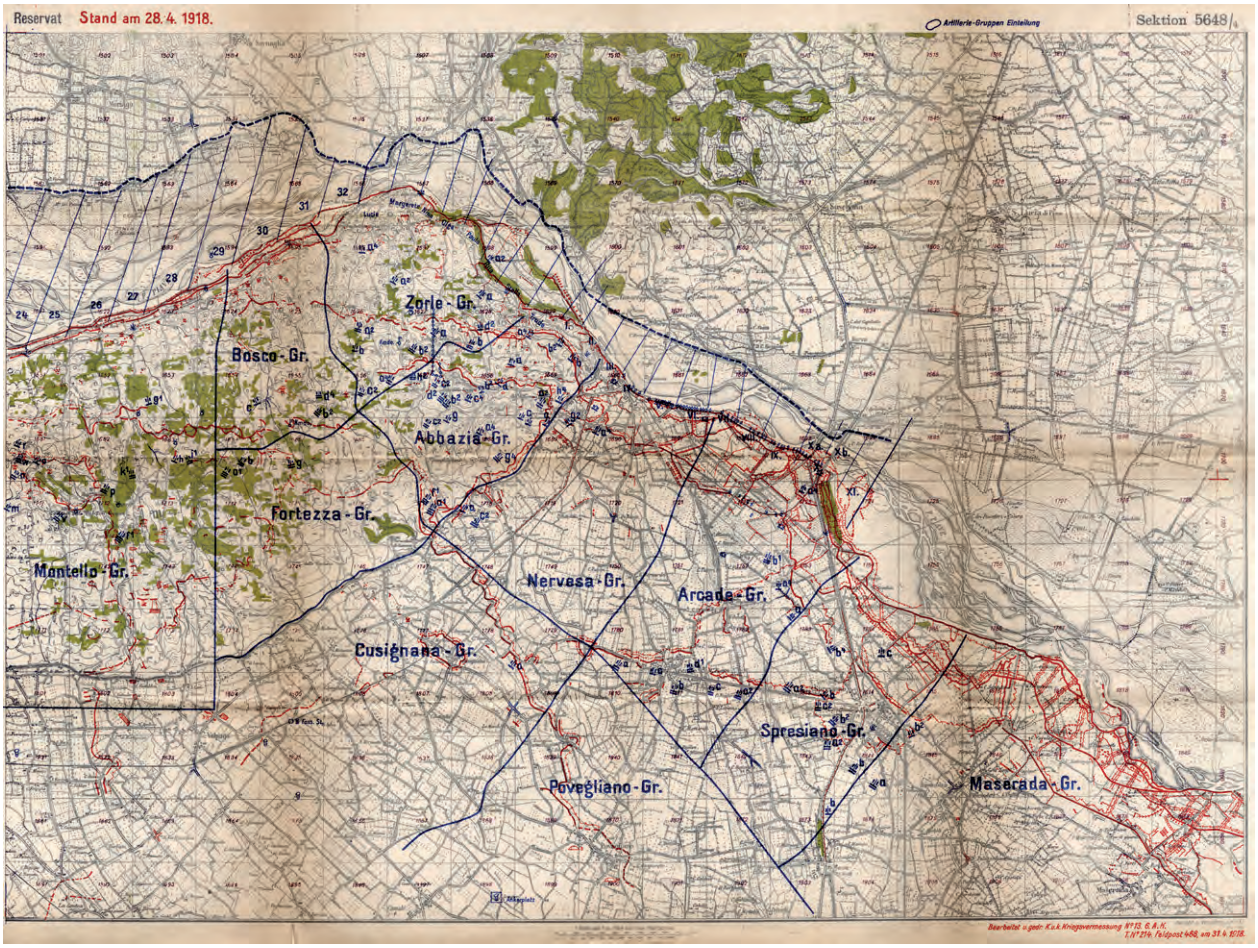


Fig. 5 Ancora la Sezione austro-ungarica 5648/$_4$. In questa edizione è riportata la disposizione difensiva italiana al 28 aprile 1918. I progressi informativi sono notevoli e i temi di interesse militare sono rappresentati in rosso per trincee, camminamenti, reticolati, postazioni, magazzini e accampamenti. In blu le artiglierie e la suddivisione dello spazio nei diversi gruppi d'artiglieria. In verde i boschi più fitti. Anche la base topografica ha subito un pesante aggiornamento, con tutti i temi antropici del Montello, la nuova ferrovia e il corso del Piave aggiornato secondo l'ultimo rilievo da foto aerea (ASFi MMM P 206/1).

Fig. 5 Here again the Austro-Hungarian Section 5648/$_4$. In this edition is reported the Italian defensive deployment as of April 28, 1918. The progress of the information acquired is remarkable, and the themes of military interest are drawn in red for trenches, pathways, fences, posts, warehouses, and camps. In blu the artillery and the zonal division for the different artillery groups. The thickest woods are green. The topographical base has also undergone a heavy update, with all the anthropic themes of Montello, the new railway, and the course of the Piave river updated according to the latest aerial photo survey (ASFi MMM P 206/1).

Nella pagina a fianco: Fig. 6 Carta a scala 1:10.000 del Settore di Pederobba datata 31 gennaio 1918. La base topografica è stata ridisegnata sui tipi delle Sezioni austro-ungariche con gli opportuni aggiornamenti. Essa presenta un taglio ancora sperimentale che sarà ridefinito una volta confermato un quadro d'unione per il settore del fronte da Pederobba ai Ponti della Priula (ASFi MMM P 224/1).

In opposite page: *Fig.6 1:10.000 scale map of the Pederobba sector dated January 31, 1918. The topographical base has been redrawn using Austro-Hungarian map symbology. It presents a still experimental tile that will be redefined once a framework of tiles is confirmed for this sector of the frontline that is extended from Pederobba to Ponte della Priula (ASFi MMM P 224/1).*

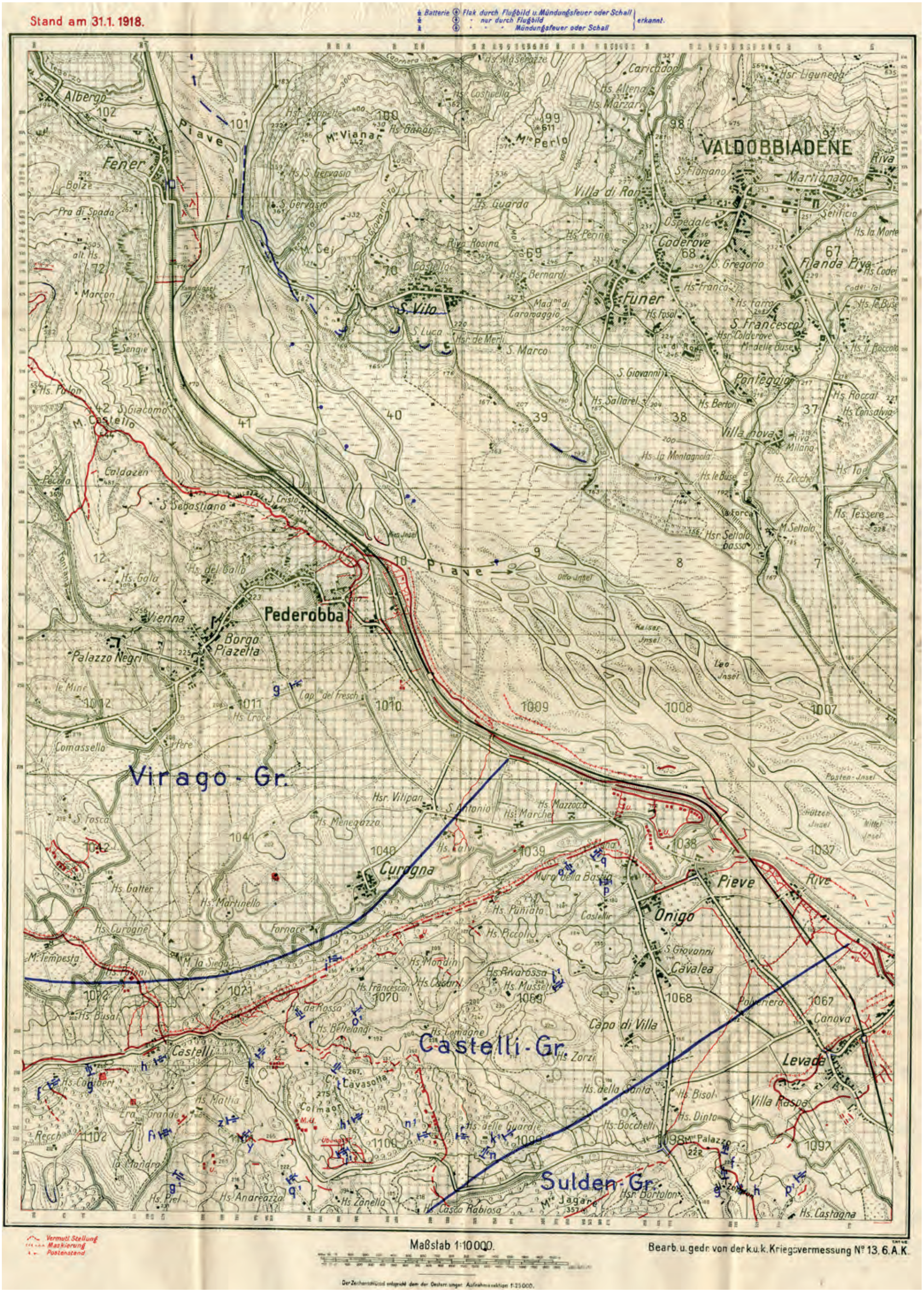
del fronte avversario era stato mappato e aggiornato, ma anche delle nuove produzioni cartografiche iniziavano ad affiancare le serie più classiche e diffuse dei Fogli e delle Sezioni.

Sul fronte alleato l'unico vantaggio fu forse quello di disporre di topografie aggiornate, risparmiandosi così il lavoro impegnativo dell'aggiornamento. Anche gli inglesi – che tennero il fronte da Pederobba al Ponte della Priula da dicembre 1917 a marzo 1918 con la 41ª e 23ª Divisione[16, 17, 18] - produssero della propria cartografia basandosi anch'essi sulle Tavolette dell'Istituto Geografico Militare Italiano. Interessante la carta di fine febbraio 1918 (ASFi MMM P 178, figura 7) che illustra la zona delle Grave di Ciano, con il corso del fiume aggiornato: le carte italiane procederanno all'aggiornamento, in questo settore, solo dopo la Battaglia del Solstizio. In questa carta le isole fluviali dell'alveo a canali intrecciati, che qui raggiungeva dimensioni ragguardevoli (nel punto massimo di estensione supera i 3 km) sono riportate col nome gergale dato dai militari. Anche ogni tratto di trincea e camminamento riporta il nome gergale, come sempre in uso presso l'esercito britannico. La scala è di 1:20.000 comune per la cartografia militare britannica dell'epoca. Uno dei pregi di questa carta è che riporta gli apprestamenti di entrambi gli eserciti, cosa non comune, in quanto di solito, almeno per la cartografia destinata alle prime linee, venivano rappresentati solo gli apprestamenti avversari, nel caso la carta fosse caduta in mano opposta.

16 Caviglia, 1934.

17 Giovanni Cecchin (cur.), *Le strade bianche. Diari di ufficiali inglesi in Italia nella Grande Guerra,* Collezione Princeton, Bassano del Grappa, 1996.

18 Roberto Tessari, Paolo Gaspari & Corrado Callegaro, *Il Montello,* Vol. 1 e 2, Gaspari, Udine, 2008.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VALDOBBIADENE
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Pieve
Levada
Cavalea
Capo di Villa
Villa Raspa
Albergo
S. Vito
Coderove
Martignago
Villa nova
Borgo Piazetta
Palazzo Negri
Vermuti Stellung
Maskierung
Postenstand

Già dal mese di dicembre 1917, dato che questo tratto di fronte era abbastanza tranquillo, gli inglesi si tennero comunque attivi impegnando l'avversario di notte con frequenti attività di pattuglia volta a molestare e catturare le vedette austro-ungariche. Era un'attività che richiedeva coraggio e ardimento perché implicava traversare a nuoto più di un ramo del Piave, nelle notti invernali. Tale attività si svolgeva proprio nel territorio di questa carta, con partenza da Ciano del Montello, in direzione nord, verso i posti di vedetta avversari sull'altra riva del Piave[19]. Essa fu così molesta che la cartografia austro-ungarica la segnalerà nei propri elaborati (figura 8): già la Sezione a scala 1:25.000 $5648/_3$ (ASFi MMM R4 205/2) mostra sia il sentiero percorso dalle pattuglie, sia il punto di arrivo, con dicitura bilingue, tedesco e ungherese: *Anglosziget* e *Englandernest*, ovvero l'isola degli inglesi o il nido degli inglesi. Questa carta ha pure la peculiarità di avere stessa data di edizione e stessa data di riferimento delle disposizioni di quella di fattura britannica: 26 e 28 febbraio 1918. Questa contemporaneità permette di avere un dato sulla capacità di coglier con accuratezza le disposizioni avversarie, confrontando i due disegni.

Sono bastati pochi mesi di assestamento e di osservazione per tratteggiare con cura sufficiente le disposizioni avversarie e queste carte ce ne danno riscontro.

Avvicinandosi alla data della battaglia la cartografia austro-ungarica intensifica la sua produzione, finalizzandola all'evento stesso, mentre quella alleata si mantiene su una produzione di routine, aggiornando i suoi elaborati come da calendario, con scarse divagazioni dalle carte ufficiali, se non per l'allestimento di tagli speciali derivati dall'unione di Fogli o Tavolette contigue. E questo forse anche perché non vi è molto da mappare sul fronte avversario che ha una disposizione tipica di chi sta per attaccare, con pochi trinceramenti e abbondanti capisaldi e posti di osservazione, al contrario delle linee italiane, formate da più serie di trincee, anche in profondità, a parecchi chilometri dal fronte, proprie di chi sta arroccato in difesa. A questo scopo è esemplare la carta ASFi MMM R5 180/2, a scala 1:25.000, taglio speciale derivato dall'unione parziale di due Tavolette (figura 9). Il territorio in questione è il Quartier del Piave, di fronte al Montello, con pochi sparsi elementi mappati ma che riempiono lo spazio secondo uno schema abbastanza regolare su tre linee successive. La carta è del 30 maggio 1918, solo 15 giorni prima dell'offensiva. Il corso del Piave è quello riportato nelle Tavolette del 1910.

19 Cecchin, 1996.

Fig. 7 Stralcio di carta britannica di fine febbraio 1918. Topografia IGMI 1:25.000 con aggiornamenti al corso del Piave e qualche odonimo in inglese. Si noti la ricchezza di nomi gergali dati sia alle isole fluviali che ai tratti di trincea. In blu le disposizioni proprie, in rosso quelle avversarie. La zona è quella delle Grave di Ciano dove gli inglesi effettuarono intense, ardite e moleste attività di pattuglia (ASFi MMM P 178).

Fig. 7 Part of a British map of the end of February 1918. Italian topography 1: 25,000 with updates to the course of the Piave river and names of the roads in English. Note the wealth of slang names given to both river islands and trench sections. Own dispositions in blue, opposing ones in red. The area is that of the Grave di Ciano where the British carried out intense, daring, and annoying patrol activities (ASFi MMM P 178).

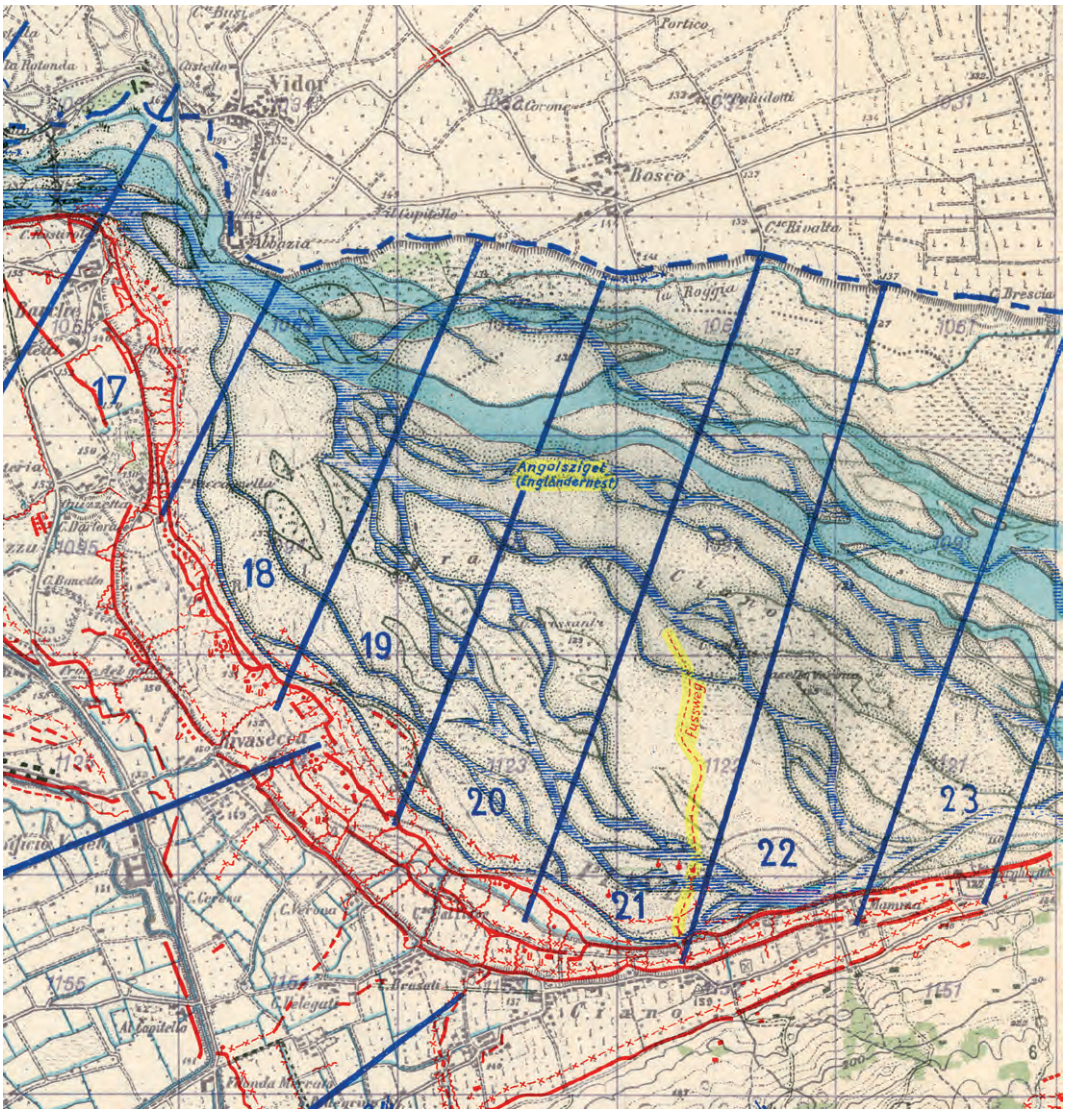
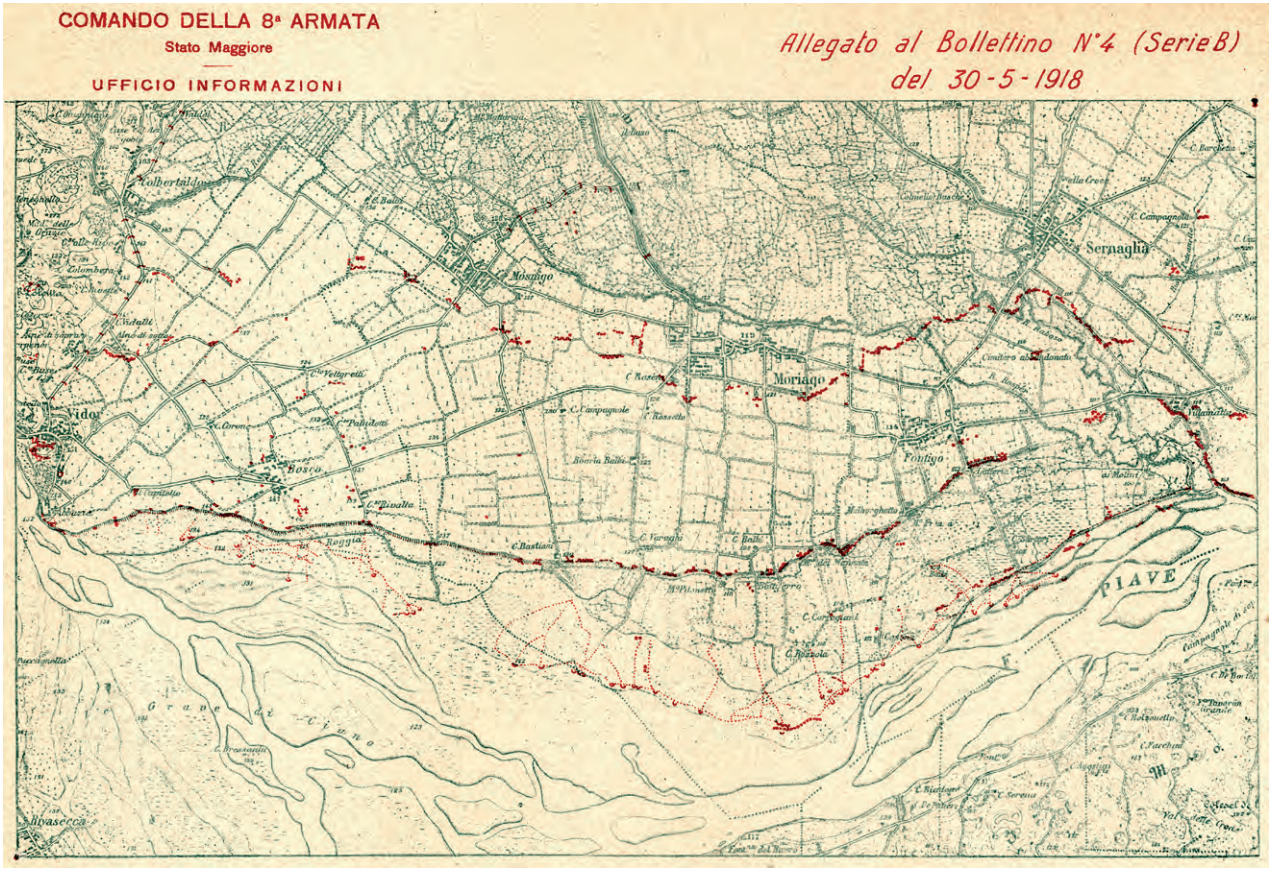


Fig. 8 Stralcio della Sezione 5648/$_3$ dell'Imperiale e Regio esercito austro-ungarico. La data della situazione e quella di edizione sono curiosamente identiche a quelle della carta britannica di figura 7: apprestamenti al 26 febbraio, edizione del 28 febbraio 1918. In rosso le disposizioni effettive di trincee, camminamenti etc., in blu le zone di competenza dei vari gruppi di artiglieria. Evidenziati il sentiero (*fussweg*) e l'isola fluviale citata sia in ungherese che in tedesco (Isola degli inglesi, Nido degli inglesi) da cui partivano le scorrerie notturne delle pattuglie inglesi. Rarissimo caso di carta con riportati segni delle attività di pattuglia. Si noti anche qui il corso corretto del Piave col tratteggio blu (ASFi MMM R4 205/2).

Fig.8 Part of Section 5648/$_3$ of the Imperial and Royal Austro-Hungarian Army. The date of the situation and that of edition are curiously identical to those of the British map in figure 7: provisions as of ▶



February 26, edition of February 28, 1918. In red the actual dispositions of trenches, pathways, etc., in blue the zonal divisions of the artillery groups. Highlighted the path (fussweg) *and the river island mentioned in both Hungarian and German (English island, English nest) from which the night raids of the English patrols departed. Extremely rare case of map with signs of patrol activities. Also note here the correct course of the Piave river, drawn with the blue hatch (ASFi MMM R4 205/2).*

In alto: Fig. 9 Carta a scala 1:25.000 del Comando dell'8ª Armata italiana descrivente le disposizioni avversarie al 30 maggio 1918. Si noti la soluzione di continuità degli apprestamenti austro-ungarici, propri di un atteggiamento offensivo nell'attesa dell'imminente balzo in avanti al di là del Piave. Il tracciato del fiume stesso risale alla cartografia del 1910 (ASFi MMM R8 180/2).

Above: *Fig. 9 1:25,000 scale map of the Italian 8th Army describing the adversary deployments at May 30, 1918. Note the solution of continuity of the Austro-Hungarian dispositions, typical of an offensive deployment in anticipation of the imminent leap beyond the Piave river. The Piave river drawn dates to the 1910 maps (ASFi MMM R8 180/2).*

Dopo la Battaglia del Solstizio. Verso Vittorio Veneto

Gli esiti della battaglia di giugno, col mancato sfondamento austro-ungarico, mutarono anche le produzioni delle cartografie degli eserciti che si erano affrontati sul Piave per la seconda volta. Gli italiani, come già citato sopra, notarono nel personale militare catturato la grande quantità di materiale cartografico, molto accurato e prodotto a scale diverse a seconda degli obbiettivi[20, 21]. Ciò dovette impressionare e ispirare i vari comandi italiani che da allora intensificarono la produzione cartografica, aumentando le carte tematiche e approntando aggiornamenti alla topografia oltre che agli apprestamenti. Il comando dell'8ª Armata italiana rinnova la produzione cartografica, anche con la realizzazione di una carta del Montello a scala 1:10.000, in quattro fogli contigui, dove si tenta di dare maggiore attenzione a tutti gli elementi per l'orientamento topografico, che fu estremamente difficoltoso durante la battaglia[22, 23, 24, 25]. Viene dato riscontro alla disposizione dei filari e delle siepi, seppure in modo schematico, e a quella dell'estensione delle macchie boschive e addirittura dell'intensità di piantumazione degli alberi. L'altimetria a punti quotati e curve di livello è quella delle Tavolette IGMI, ma vi sono aggiunte - con la tipica rappresentazione a cunei concentrici - 206 doline, potendone così contare 952 in tutto, anche se questa informazione ancora si allontana dalla complessa topografia reale che conta poco più di 2000 depressioni di tale tipo[26, 27, 28]. La toponomastica è accurata e a quella

20 Baj Macario, 1934.

21 Gasparotto, 1924.

22 Caviglia, 1934.

23 Carlo Meregalli, *Grande Guerra sul Montello. Sul "Carso verde", l'ala infranta di Baracca,* Tassotti, Bassano del Grappa, 2000.

24 Tessari et al., 2008.

25 Basilio Di Martino, Paolo Gaspari & Roberto Tessari, *La Battaglia dl Montello e la leggenda del Piave,* Gaspari, Udine, 2019.

26 Francesco Ferrarese, Ugo Sauro & Christian Tonello, « The Montello Plateau. Karst evolution of an alpine neotectonic morphostructure », *Zeitschrift für Geomorphologie*, supp. Band 109 (1998), pp. 41-62.

27 Nico Dalla Libera, « L'influenza della geomorfologia carsica del colle del Montello negli eventi della Battaglia del Solstizio (1ª Guerra Mondiale) », *Speleologia Veneta* 21 (2013), pp. 125-145.

28 Aldino Bondesan, Simone Busoni, Valentina Ciulli, Andrea Dalla Rosa, Enrica De Luchi, Massimiliano Favalli, Francesco Ferrarese, Roberto Francese, Adriano Garlato, Massimo Giorgi, Ilaria Isola, Chiara Levorato, Francesco Mazzarini, Monica Petta, Ne-

ufficiale delle Tavolette viene aggiunta quella del gergo militare, vera e propria coordinata geografica di uso quotidiano e di immediato riferimento mentale. Infine, la lettura è facilitata dall'uso di quattro colori dedicati ai diversi temi topografici. Questa carta senz'altro si ispira non solo alle esperienze della battaglia combattuta sul colle, ma anche al reperimento dell'analoga cartografia austro-ungarica, in cui il Montello con i relativi apprestamenti militari è stato rappresentato in sei fogli contigui, nella serie di carte 1:10.000 del fronte di competenza della 6ª Armata austro-ungarica. Dopo giugno, inoltre, anche la cartografia italiana inizia ad aggiornare il corso del Piave ogni qualvolta le morbide o le piene cambiano il tracciato dei canali intrecciati[29, 30].

Anche il settore del fronte del medio e basso Piave conosce una produzione cartografica maggiore e più diversificata, con carte a scala 1:10.000 e carte tematiche diverse dalle classiche disposizioni fisse sul terreno. Esemplare, in tal senso, una carta a scala 1:100.000 del 15 ottobre 1918, dove vengono descritte sia a parole, in cartiglio, che nel disegno le prime tre linee dello schieramento avversario, le zone allagate o allagabili del basso Piave e, soprattutto, la disposizione dei molti ponti disseminati nei vari corsi d'acqua di cui è ricco il basso Piave[31] (figura 11). Ma accanto a documenti di visione sinottica come questi, altri ne vengono prodotti per gli obiettivi singoli e puntuali, proprio come già fecero i comandi austro-ungarici per l'offensiva di giugno. Carte a scala 1:10.000 e 1:5000 con l'esatta ubicazione dei filari e delle siepi cui viene dedicata simbologia differente a seconda siano di alto fusto o basse siepi da vite maritata e addirittura – nonostante la distruzione di tali monumenti – col disegno del profilo di chiese e campanili per un immediato orientamento sul terreno.

La cartografia austro-ungarica, invece, affina la parte informativa generale delle mappe, adottando un nuovo reticolato chilometrico, aggiungendo l'orien-

reo Preto, Giovanni Rigatto, Diego Salvador, Valter Saran, Andrea Simionato, Paolo Sivieri, Veronica Tornielli, Arianna Vettorello*, Carta geologica della provincia di Treviso. Il Montello*, scala 1:25.000, Grafiche Antiga, Crocetta del Montello, 2015.

29 Simone Busoni, « *Geologia e guerra: il fronte del Piave »,* in Aldino Bondesan & Mauro Scroccaro (cur.), *Cartografia Militare della Prima guerra mondiale. Cadore Altopiani e Piave nelle carte topografiche austro-ungariche e italiane dell'Archivio di stato di Firenze*. Antiga Edizioni, Regione Veneto, Archivio di Stato di Firenze, Università di Padova, Marco Polo System, Cornuda, 2016, pp. 115-130.

30 Ferrarese, 2016.

31 Busoni, 2016.

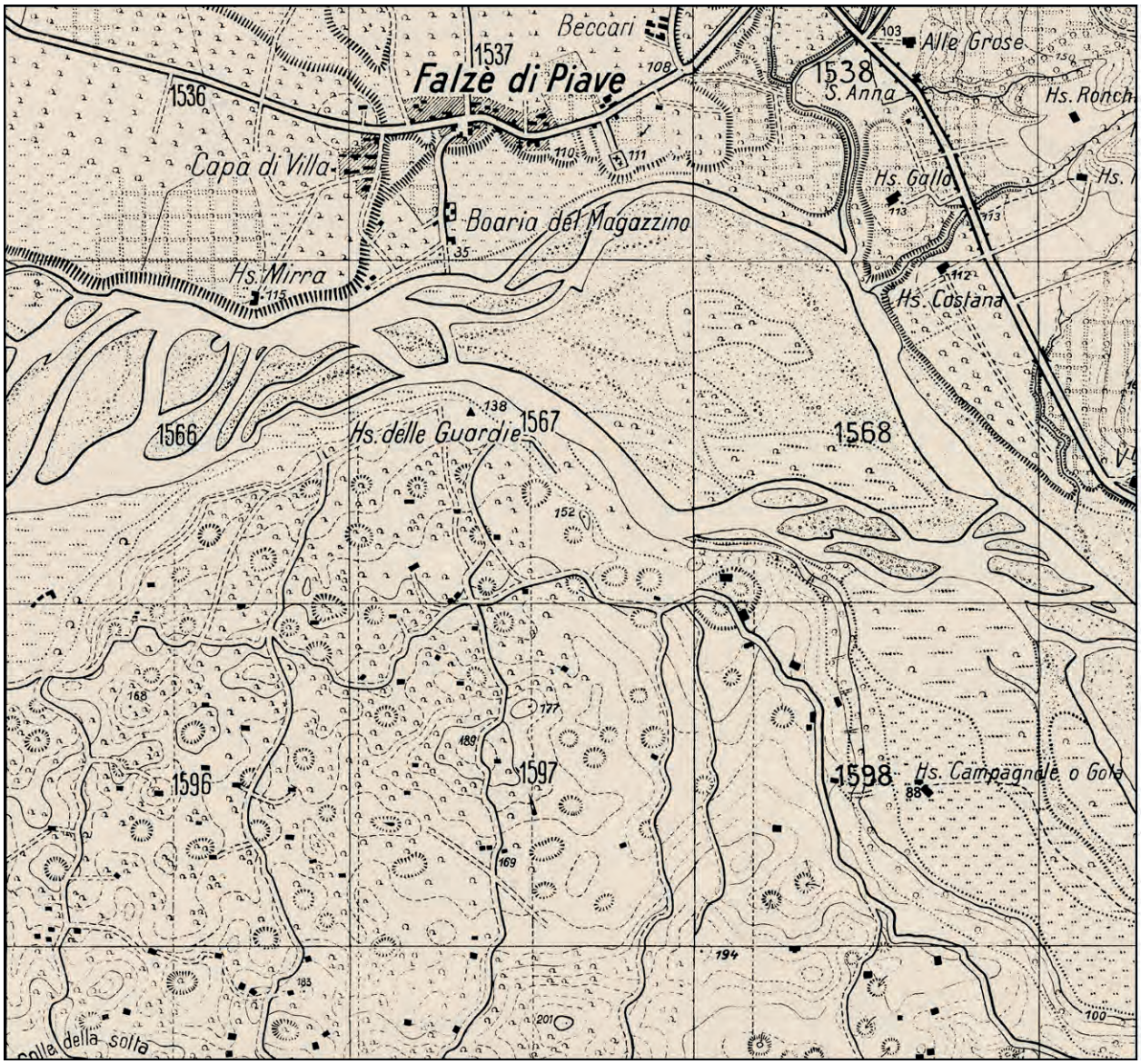


Fig. 10 A sinistra, stralcio di base topografica austro-ungarica a scala 1:10.000. La carta, nella zona del Montello e dell'alveo del Piave, è uno dei primi esempi di restituzione telerilevata per le informazioni di uso del suolo e infrastrutture. La realizzazione di questa serie cartografica fu propedeutica all'offensiva di giugno (ASFi MMM R4 225). A destra, stessa zona e scala nella carta della Sezione Cartografica dell'8ª Armata italiana edita nel settembre 1918, in vista della prossima offensiva italiana. Si noti la disposizione simile, ma con alcune differenze, del Piave, soggetto ad una forte dinamicità del suo tracciato in quest'ambiente (ASFi MMM P 310).

Fig. 10 Left, part of Austro-Hungarian topographical base at a scale of 1: 10,000. The map, in the Montello hill and Piave riverbed area, is one of the first examples of remotely sensed restitution for the land use and the trafficability information. The map is a tile of a cartographic series drawn for the June offensive (ASFi MMM R4 225). To the right, the same area and scale in the map of the Cartographic Section of the Italian 8th Army, published in September 1918, drawn for the Italian offensive of October 1918. Note the similar - but with some differences - layout of the Piave river, due to a continuous moving of the braided channels (ASFi MMM P 310).

tamento rispetto al nord magnetico coi relativi valori di declinazione. Tenta di aggiornare gli apprestamenti difensivi avversari, rispettando i 15 giorni di validità di una carta che poi verrà sostituita dalla successiva. Però, si coglie anche dalla cartografia come l'atteggiamento dell'esercito Imperiale e Regio sia mutato, passando ora ad uno schieramento difensivo, quasi di attesa della fine. In figura 12, si riporta la quinta edizione della Sezione austro-ungarica 5749/$_1$ (ASFi MMM P 339/8), col tratto del medio-basso Piave. La carta ritrae le disposizioni e lo schieramento delle artiglierie italiane, come osservato al 20 settembre 1918. Un'avvertenza sul lato sud della carta informa che la topografia risale allo 8 settembre, mentre la situazione del Piave risale ben all'8 giugno1918: un segno, anche questo, del cambio di schieramento delle forze in campo.

Conclusioni

Anche la Miscellanea dell'Archivio di Stato di Firenze, pur essendo un campione piuttosto limitato della produzione cartografica totale sul fronte del Piave, riflette molto bene questo aspetto che abbiamo delineato nell'esame della cartografia attraverso le tre battaglie del Piave: le carte italiane sono molto più numerose e diversificate nel periodo luglio-ottobre 1918 che in quello precedente, dal novembre 1917 al giugno 1918. E, di contro, l'inverso succede per le carte austro-ungariche, con un andamento di produzione – e di continuo miglioramento sia dei supporti che dei temi – in fase crescente da novembre a giugno, per poi assestarsi in un andamento abbastanza di routine, rispondenti agli aggiornamenti quindicinali previsti. Inoltre, l'esercito Imperiale e Regio, dopo giugno 1918, accelera la crisi materiale e morale in cui versava dopo quattro anni di guerra. Una spia non secondaria di questo fenomeno è la stampa di molte carte austro-ungariche effettuata sul retro di carte non più valide (declassificate dalla sovrastampa dell'avviso: *ungultig*): l'Impero è allo stremo e scarseggiano tutti i materiali, dal cibo per i soldati e per la popolazione al piombo per gli armamenti, dal fieno per gli animali alla carta per le mappe.

La cartografia redatta ed edita dai due schieramenti attestati sulle due sponde del Piave ci narra in modo sorprendente, per la quantità di aspetti della stessa narrazione, le vicende che si sono susseguite nell'ultimo anno di guerra. Da parte austro-ungarica, la parabola cartografica ci ha illustrato la necessità di conoscere

Fig. 11 Stralcio di carta a scala 1:100.000 curata dal Comando della 3ª Armata italiana. Spostandosi verso est dal Piave, sono indicate tre linee di trincee di prima difesa (linee e zona rossa), poi vengono evidenziate zone, in beige e tratteggio, di resistenza a capisaldi e di presenza di artiglierie. Segue una seconda linea (linea continua e puntinata a seconda della certezza del rilevo) e una zona a tratteggio immediatamente dietro a questa, dove si spiegano altre difese a nuclei e capisaldi. Immediatamente dietro a questa la posizione dei ponti principali. L'angolo di sud-est, delimitato dal terrapieno ferroviario, è zona parzialmente allagata o di possibile allagamento da parte dei difensori. È chiaro lo scopo di questo documento, propedeutico all'offensiva italiana dell'ottobre 1918 (ASFi MMM P 299).

Fig. 11 Part of a 1:100,000 map edited by the Italian 3rd Army. Moving east from the Piave, three lines of trenches and their zone are drawn with red lines and red area, then areas of resistance made by strongholds and the presence of artillery are highlighted in beige and hatched beige. A second line follows (solid and dotted line, depending on the certainty of the survey) and a hatched area immediately behind it, where there are pillboxes and strong points: immediately behind this, there is the position of the main bridges. The south-east corner, delimited by the railway embankment, is an area partially flooded or one of possible flooding by the defenders. The purpose of this document is clearly preparatory to the Italian offensive of October 1918 (ASFi MMM P 299).

il nuovo territorio, superando i limiti di una topografia non aggiornata, limiti, evidentemente, non più accettabili per le esigenze militari e la condotta bellica del tempo. Il continuo aggiornamento degli elementi di una guerra di posizione, in cui ogni piccolo mutamento può essere rivelatore di intenzioni più ampie e comunque non può esser sottovalutato, porta all'edizione di nuove carte in modo sistematico. Quest'aspetto riguarda particolarmente la disposizione delle artiglierie che era in continuo rischieramento, poiché soggette a non difficile individuazione[32, 33]. Da parta italiana ed alleata, invece, si assiste ad un progressivo miglioramento dei prodotti cartografici, in cui alle consuete e collaudate rappresentazioni cartografiche degli apprestamenti sul terreno sorge progressivamente una serie di carte tematiche di informazioni sussidiarie, come viabilità, condizioni del terreno, attività aeronautica, etc.

Una menzione particolare merita il tracciato del Piave. Forse mai terra di nessuno fu oggetto di tanto interesse cartografico. I due eserciti hanno dato, in quest'anno di guerra, una scrupolosa rappresentazione della disposizione dei canali intrecciati e dell'alveo bagnato del fiume. Tra l'altro facendo praticamente staffetta tra i due servizi cartografici avversari: gli aggiornamenti austro-ungarici furono intensi e propedeutici all'offensiva di giugno, quelli italiani diventarono sistematici subito dopo, propedeutici all'offensiva di fine ottobre. Del resto, è l'attaccante, più che il difensore, ad avere interesse nel conoscere l'esatto stato della corrente del fiume, poiché è lui stesso che deve gettare i ponti per sferrare l'offensiva.

Ringraziamenti

Gli autori ringraziano l'Archivio di Stato di Firenze, in particolare la dr Francesca Fiori, per aver concesso la riproduzione della cartografia della Miscellanea di Mappe Militari (Aut.: MIC|MIC_AS-FI|06/04/2022|0001974-P|[28.28/348/2022]).

32 Caviglia, 1934.

33 Giovanni Comisso, *Giorni di guerra,* Mondadori, Milano, 1930.

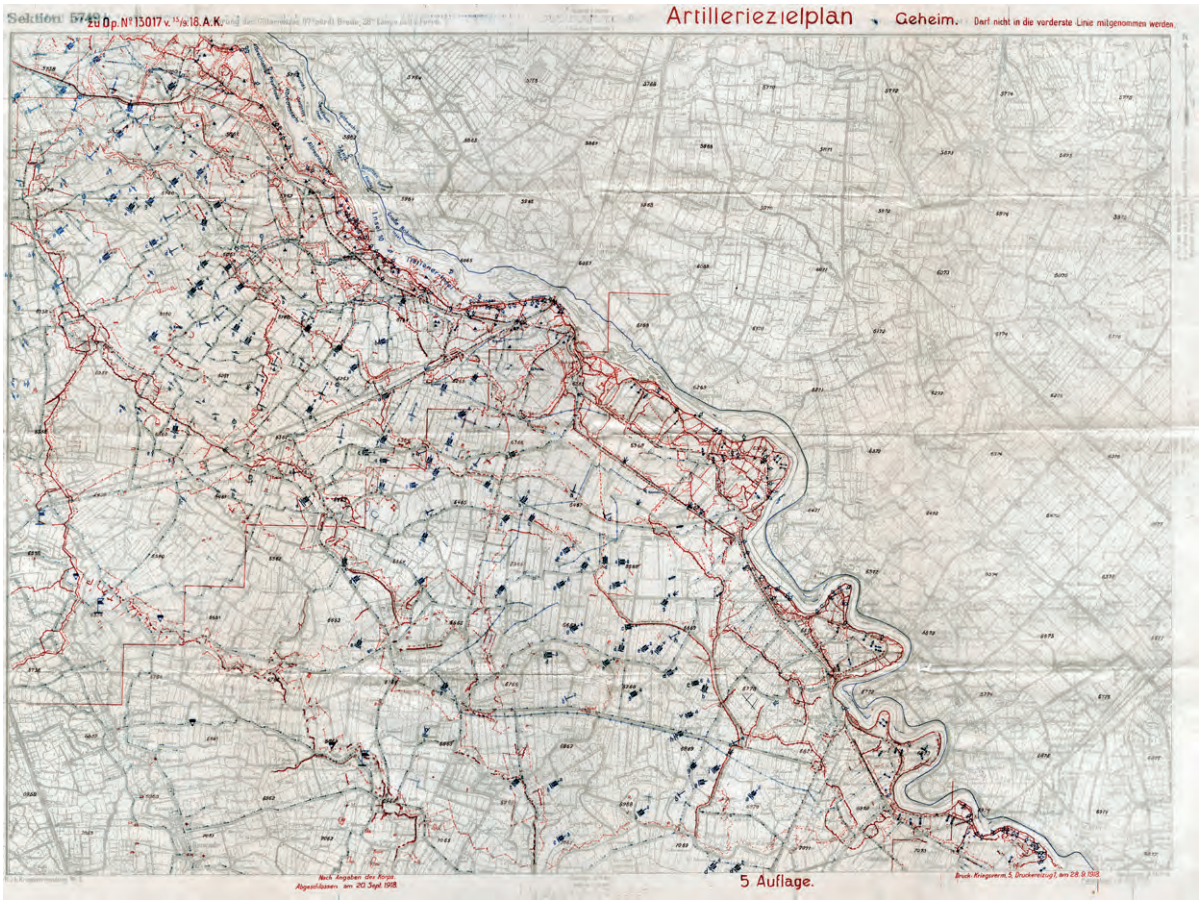


Fig. 12 Sezione austro-ungarica 5749/1, col tratto del medio-basso Piave. È un piano per i bersagli di artiglieria (*artilleriezielplan*) del 20 settembre 1918. In rosso gli elementi fissi, come trincee, magazzini, posti di osservazione, decauville, etc; in blu la posizione delle batterie avversarie. Rispetto alle precedenti edizioni, la carta è stata dotata di un reticolato chilometrico leggermente diverso, ed è dichiarato che l'aggiornamento della topografia risale al 8 settembre 1918, mentre quello del Piave all'8 giugno dello stesso anno, pochi giorni prima della Battaglia del Solstizio. Un avvertimento, in rosso in alto a destra, avverte che la carta non deve essere portata in prima linea (ASFi MMM P 339/8).

Fig. 12 Austro-Hungarian Section 5749/1, with the middle and low Piave river. It is a plan for artillery targets (artilleriezielplan) *of September 20, 1918. In red the fixed elements, such as trenches, warehouses, observation posts, decauville, etc; in blue the position of the Italian artillery. Compared to previous editions, the map has been equipped with a slightly different kilometric grid, and it is declared that the updating of the topography dates to September 8, 1918, while that of the Piave river dates on June, 8 of the same year, a few days before the Battle of the Solstice (June offensive). A warning, in red at the top right, warns that the card must not be brought in the first line of the front (ASFi MMM P 339/8).*

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KROMAYER-VEITH

SCHLACHTEN-ATLAS ZUR ANTIKEN KRIEGSGESCHICHTE

120 KARTEN AUF 34 TAFELN

MIT BEGLEITENDEM TEXT

VIERTE LIEFERUNG

GRIECHISCHE ABTEILUNG

I. VON MARATHON BIS CHAERONEA.

Blatt 1. Perserkriege: Feldzug 490 und Anfang 480 v. Chr.: Marathon. Thermopylae. Artemision.
Blatt 2. 480 Schluß und 479: Salamis. Plataeae. Mykale.
Blatt 3. Peloponnesischer Krieg: Sphakteria. Delion. Amphipolis. Mantinea. Syrakus.
Blatt 4. Zug des Kyros und Krieg des Agesilaos in Asien 401—395 v. Chr.: Kunaxa. Rückzug der Zehntausend. Sardes.
Blatt 5. 4. Jahrhundert v. Chr.: Nemea. Koronea. Kynoskephalae. Leuktra. Mantinea. Chaeronea.

LEIPZIG
H. WAGNER & E. DEBES
1926

War Atlases of World War I Germany:
Informing the Masses about the Global Battleground

by Eric Losang
Leibniz-Institute for Regional Geography, Leipzig

Abstract. This paper reflects the development of the demand for detailed information about the battlegrounds and the solutions of different publisher groups, e. g. newspaper publishers and specialized mapping companies and institutions in Germany, to meet the growing demand. The paper analyses the structure, content and visualization modes of selected atlases as well as the different European markets (with a focus on German publishers) for war atlases. The resulting tentative picture suggests that this otherwise neglected type of atlas contained early forms of on-demand publications for the public.

Keywords- War Atlas, WWI, Germany, Map Production

Introduction

When in 490 BC the messenger Pheidippides brought the news of the Athenian victory at the battle of Marathon to Athens, he fulfilled a task, that is nowadays covered by the media in almost real time. Informing people on what happened on the battlefields was the subject of contemporary oral narratives and diaries for long time. From hand-written *Avvisi* (newsletters) to printed newspapers, from paper to digital, the description of conflicts and wars have always been of interest for those who didn't directly take part in combat activities. To grasp the sense of war requires understanding its underlying spatial concepts, thus maps and war are inseparably linked in our thinking[1]. Even for the understanding of cyberwars, maps – of whatever type – are indispensable.

Maps have been used in different settings in war times, "notably for geopolitical consideration, strategic planning, operational purposes, tactical grasp, news

1 Oliver Kann, *Karten des Krieges. Deutsche Kartographie und Raumwissen im Ersten Weltkrieg*, Paderborn Ferdinand Schöningh, Leiden, 2020, p. 1.

reporting and propaganda"[2]. Accordingly, the types of maps used in wars considerably differ and need to be analyzed in relation to their communication objective. Atlases, however, are different. They are deliberate and systematic combinations of maps, that have been put together in order to reflect a specific view or to solve a specific task[3]. On the one hand their communicative ability tends to be far more sustainable, on the other they are inappropriate to disseminate spatial circumstances that change at short notice.

1 War atlases

There are multiple ways to systematize types of atlases. As the paper focuses only on German war atlases produced during WWI a functional, rather than spatial and temporal, approach seems appropriate.

1.2 Historic war atlases

Most war atlases are historic atlases, retrospectively arranging maps to comprehensively visualize the spatial aspects on origins, actions and outcomes of armed conflicts, very often omitting historic cartographic material in favor of modern maps, following the paradigm of "rough uniformity of map format, design, and presentation throughout"[4]. In this context historical maps often play a mere illustrative role and are rarely interpreted. Published shortly after a war, atlases embed predominant revanchist tendencies in texts and visualizations (e. g., the depiction of borderlands).

In French and German cartographic treatises about the Franco-Prussian War in 1870/71 maps on Elsass [Alsace]/Lothringen [Lorraine] are the most important cartographic content. These historic atlases, to an increasing extent, feature also propagandistic elements after 1890, thus predicting an upcoming conflict.

2 Jeremy Black, *Maps of War. Mapping Conflict through the Centuries*, Conway, London, 2016, p. 6.

3 Ferjan J. Ormeling, « Atlases », in Bengt Rysted B., Ferjan Ormeling (eds.) *The World of Maps,* International Cartographic Association, Stockholm, 2014.

4 James Akerman, « From Books with Maps to Books as Maps: The Editor in the creation of the idea », in Joan Winerals (ed.), *Editing early and historical atlases. Papers given at the 29th annual conference on editorial problems*, University of Toronto 5-6 November 1993, University of Toronto Press, Toronto, 2016, p. 4.

1.2 War atlases as a tool of warfare

Very seldom tactical, operational or strategic maps have been published during the war as atlases for further use in the field. In those cases, they merely function as container "to keep the maps all together in one convenient place, to reduce wear and tear, to know where they're at"[5]. Those kinds of "working atlases" have been known since maps became an indispensable part of spatial operations such as explorations. Very often, they have been published well before specific conflicts, e. g. as strategic spatial inventories of possible war theatres like the portolan atlases of the 16th century and the *Petit Atlas Maritime* that Nicolas Bellin produced on behalf of French naval ministry in 1764 in the aftermath of the Seven Years' War.

1.3 War atlases as propaganda tools

In war times published information is often used to influence the opinion of the public or of targeted readerships. Facts are generalized and visualized according to the needs of political influence, often emotionally charged and visually exaggerated. Many war atlases treated in this article show at least some of these characteristics: mainly through textual additions, such as rather patriotic prefaces or nationalist editorials (e. g., the first edition (1914) of the *Neuester Kriegs-Atlas*), and embellishing additions of militaria. Propaganda atlases, addressing strategic and geopolitical interests, flourished in the interwar period on the brink of, and during WWII. An interesting example is the War Atlas published by the Philadelphia Inquirer in 1942, just weeks after the attack on Pearl Harbor. Besides persuasive maps it provided information on planes, ships, weapons, military training and on the important targets in enemy states, expressing a pursued positive mood towards the upcoming war.

1.4 War atlases to imagine the "Kriegsschauplätze" (theatres of war)

These atlases were produced to inform about the different places and areas where the armed conflicts took place or places to which combat activities could possibly have extended. Such theatres of war maps were small-scale overviews

5 Denis Wood, « Pleasure in the idea. The atlas as narrative form », *Cartographica* 24/1 (1987), p. 29.

of spaces that were related to the conflict rather than precise depictions of front lines[6], that were - if information was available - the domain of short-term updated newspapers and magazines. Predecessors of this kind of war atlas were often produced to give newsreaders a visual reference, that complemented the rather large-scale information published on a daily or weekly basis. Comprising between 10 and 30 maps, they were cheaply produced and often costed less than one of the larger war maps by Flemming or Ravenstein that only covered one area. Such small atlases found a wider distribution, and existing copies often contain notes and remarks, either tracing family members or used by soldiers in the trenches as a "cartographic diary".

This paper will focus on the latter atlases produced during WWI with spatial emphasis on Germany, where high standard map production had already spawned an industry with important printing companies in Leipzig, Berlin, Gotha and Munich. With the beginning of the war in August 1914 those businesses often suffered from a loss of workforce due to troop mobilization, impeding publication of their traditional products. In fact, most traditional atlas businesses didn't publish new editions (except school atlases) between 1914 and 1920. Thus, to many lithographic and geographic institutes, the production of war maps and small war atlases became an important substitute source of income.

2 The development of war atlases to meet peoples' demand for information on the theatres of war.

2.1 Early war atlases for news seekers

One of the first atlases of this kind is Rizzi Zannoni's *Atlas géographique et militaire ou Théâtre de la Guerre présente en Allemagne* that was co-published in 1762 by Baillard (Paris) and engraver Lattré (Bordeaux); the titlepage, engraved by P.P. Choffard, was dated 1761. In contained several detailed maps of Germany depicting the battlefields of the Seven Years' War and was extended in several editions in the following years.

Another example was the *Kriegsatlas zum Gebrauch für Zeitungsleser*, published between 1794 and 1799 in Vienna. Distributed by Johan Otto and engraved by Johann Wenzel Engelmann, the atlas comprises 24 hand-colored copperplate

6 KANN, 2020, p. 318.

maps covering theatres of the French Revolutionary Wars. Again, the maps didn't take on the battles, retreats, and advances, but helped to locate news about combat operations. Besides overview maps of Europe and France (including a map of Corsica) the atlas' focus is on the regions of Northern France, the Rhine and Mosel area and the Franco-Italian and Franco-Spanish borderlands extensively depicting valuable topographic information.

With the development of faster communication modes distant, and even foreign, wars became the subject of daily/weekly news. In 1854 C.A. Hartleben's Verlags-Expedition in Pest [Budapest], Vienna and Leipzig published the *Kriegsatlas für Zeitungsleser* covering the historical circumstances as well as the geographic extent of the Crimean war. It contained six hand-colored small-scale maps covering the areas of fighting – again titled as "theatres of war".

Although intended to inform newspaper readers it took until the late 19th century that news publishers themselves started publishing war atlases intended to supplement their daily news with maps, often licensed by well-known cartographic publishers.

2.2 Maps for the masses

Wars always "heightened the peoples's appetite for news and challenged the ingenuity of the pictorial press"[7]. During the Crimean and the American Civil wars, newspapers and magazines started to publish battlefield sketches and maps on the combat zones on a regular basis. According to Monmonier, inexpensive and improving engraving and printing techniques – the basis for an establishing 'yellow journalism'[8] – paved the way for maps to become a regular part of war coverage[9]. Public empathy and the need for information about battlefield actions became especially strong arguments for changes in map production during and after the American Civil War.

7 Mark Monmonier, *Maps with the news. The Development of American Journalistic Cartography*, University of Chicago Press, Chicago, London, 1989, p. 39.

8 Yellow journalism and yellow press refer to sensationalistic or biased stories that newspapers present as objective truth. It was established in the circulation battle between Pulitzer's New York World and Hearst's New York Journal in the 1890's. The distinct use of pictures, imaginary drawings and maps supported the stronger use of the latter, especially in war reports, in years to come.

9 MONMONIER, 1989.

In the United States map publishers like Rand McNally and George F. Cram adapted their map production modes to a steadily growing demand by changing from copperplate and steel plate to far lower skilled wax engraving that revolutionized their publishing businesses.[10] Produced at low-cost, "penny atlases" became a widespread source of spatial knowledge. During the Spanish-American War, the first war atlases, cooperatively produced by news- and map publishers appeared and became the blueprint for most war atlases published during WWI. One of the first to appear was *The Washington Post Standard War Atlas* in the summer of 1898 produced by Rand McNally in Chicago. The maps reflected the strategy to extend the use of already existing (atlas-)maps in "special penny editions" produced for leading newspapers and focusing only on a geographic overview of war zones and often used as a bonus for subscribers.[11] This was taken up by German publishers and initiated opportunities to extend the map business and cooperative war atlases and maps reflected these upcoming joint ventures based on the swelling public interest in maps. Remarkably, the era of European war atlases in WWI ended around the end of 1916 when further large-scale military advances and retreats halted, and a rather stationary war started to cause a public war weariness. The entry to the war of the United States of America in April 1917 triggered a significant extension of the penny atlas production in the United States.

2.3 War maps and atlases: product diversification and publishing enterprises

At the beginning of WWI the atlas business became complicated. Besides the loss of employees due to general mobilization and the reduced availability of materials essential to the war effort, sales were risky: in Hannover, for example, atlases and maps were confiscated for security reasons (Börsenblatt des Deutschen Buchhandels)[12]. Interestingly the sale of less detailed (small-scale) maps was not

10 David Woodward, *The all-American map. Wax engraving and its influence on cartography*, University of Chicago Press, Chicago, 1977.

11 Eric LOSANG and Imre DEMHARDT, « Change of Sovereignty and Cartographic Advance: Cartographic Implications of the Spanish-American War of 1898 », in Mirela ALTIĆ, Imre DEMHARDT and Soetkin VERVUST (eds,) *Dissemination of Cartographic Knowledge,* Springer, 2018, pp 99–128.

12 The Börsenblatt des Deutschen Buchhandels (Trade exchange newspaper for the German book trade) was founded in 1834 by the Börsenverein der Deutschen Buchhändler zu Leipzig. It remains the magazine with the highest number of advertisements and circula-

forbidden, even in places close to the border[13].

The production of war atlases was driven by two business models. On the one hand traditional producers of knowledge media, such as encyclopedias and atlases tried to adapt their businesses to the growing demand of geographic information. German map makers led the field of atlas cartography before World War I.[14]. In his seminal two-volume compilation of German atlas production, Jürgen Espenhorst in *Petermann's Planet* provides a thorough overview of German atlas publishers and their products and importance to national and international markets. As mentioned above the production of maps/atlases for general use declined and projects were delayed until after the war that many thought would be in 1915. A second source of geographic information were encyclopedias, such as Meyers *Konversations-Lexikon* produced by the Bibliographic Institute in Leipzig and Vienna or the Brockhaus *Konversations-Lexikon* produced by F.A. Brockhaus in Leipzig. The two businesses were in a tough competition when WWI stopped their planning further editions for two reasons: lack of qualified work force, and a business program not deemed vital for war – thus lacking supplies of raw material[15]. With war euphoria the demand for geographic information rose and for those that either couldn't afford a conventional school; or world atlas or a comprehensive encyclopedia; or in need of a lightweight collection of maps for personal use, the upcoming war atlases filled the gap. Many traditional maps producers immediately started publishing war maps, quickly adapting their existing portfolio to publish map series or to compile rather small war atlases.

A second business model, taken up by general publishing and printing companies, was to change the production portfolio from general print products (e. g.,

tion in the German book-selling trade until today, informing both the professional trade and private readers about market news. The author looked through the volumes between 1914 and 1918 to obtain information on publishing dates, prices and editions of different war atlases of non-traditional knowledge media producers. In this regard, the Börsenblatt and its advertisements is an invaluable information source. All volumes between 1834 and 1945 are readily accessible through the digitizing service webpage of the Saxon State and University Library Dresden: https://digital.slub-dresden.de

13 BDB, No. 184, 11. August 1914, p. 1.

14 Marcus GREULICH, « Ideological Changes in Ethnic Atlas Mapping of East Central Europe During the Twentieth Century», in Elri LIEBENBERG, Imre DEMHARDT and Soetkin VERVUST (eds.), *History of Military Cartography*, Springer, 2016, p. 213.

15 Thomas Keiderling, *F.A. Brockhaus: 1905-2005. Mannheim*, Bibliographisches Institut & F.A., Brockhaus, 2005, pp. 7-11.

advertisement) to rather lightweight information products (with affordable prices for the masses) well calculated production settings and high circulation. Without the experience of map production, war maps and atlases of these non-traditional maps and atlas producers looked very different from those atlases produced by the aforementioned "knowledge brands". They were produced to focus the war events rather than providing a fundamental geographic background on which users could contextualize mass media news and reports. Thus, the contents of new editions considerably differed from their predecessors. Maps were accompanied by strategic interpretations by retired officers; statistics; number of weapons and militaria, such as uniforms and rank insignia, and often propagandistic forewords or comments. By outlining different war atlas projects of different publishers, the article will follow the deviating business models.

3. German war atlases of WWI

3.1 War atlases from traditional producers of knowledge media

At the end of the nineteenth century German knowledge media producers set the standard for either atlases or encyclopedias building on the high quality of engraving techniques, using visualization modes for spatial and pictorial information. As mentioned above, these "knowledge brands" were supposed to cope with new circumstances influencing their production modes and sales.

3.1.1 Kriegs-Atlas über sämtliche Kriegsschauplätze, Geographischer Verlag, Leipzig

One of the first and most successful war atlases was produced by the Geographischer Verlag GmbH in Leipzig. Containing 10 equal-sized folded maps, it came in a handy size of 12,5 by 19,5 cm (roughly the size of a today's paperback) and was produced unchanged until mid 1916. The atlas covered, regarding the constellation of coalitions in 1914, possible theaters of war, starting with a political overview map of Europe (unfolded 43 x 38 cm). All maps (and pretty much the title) were taken from the latest edition (1914) of the *Allgemeiner Handatlas über sämtliche Teile der Erde*, edited by Otto Herkt and published by the Geographischer Verlag. Regarding size and content, the folded maps of the war atlas were identical (size and content) to map sheets in the *Handatlas*. Only the map titles were changed e. g., from "Europe" to "Overview map of the European theatre of war", or from "German Reich" to "German Reich including the eastern theatre of war" (Figs. 1a and 1b).

Fig. 1 Map of Europe, a) taken from the Allgemeiner Handatlas über sämtliche Teile der Erde b) taken from Kriegs-Atlas über sämtliche Kriegsschauplätze (Author's collection)

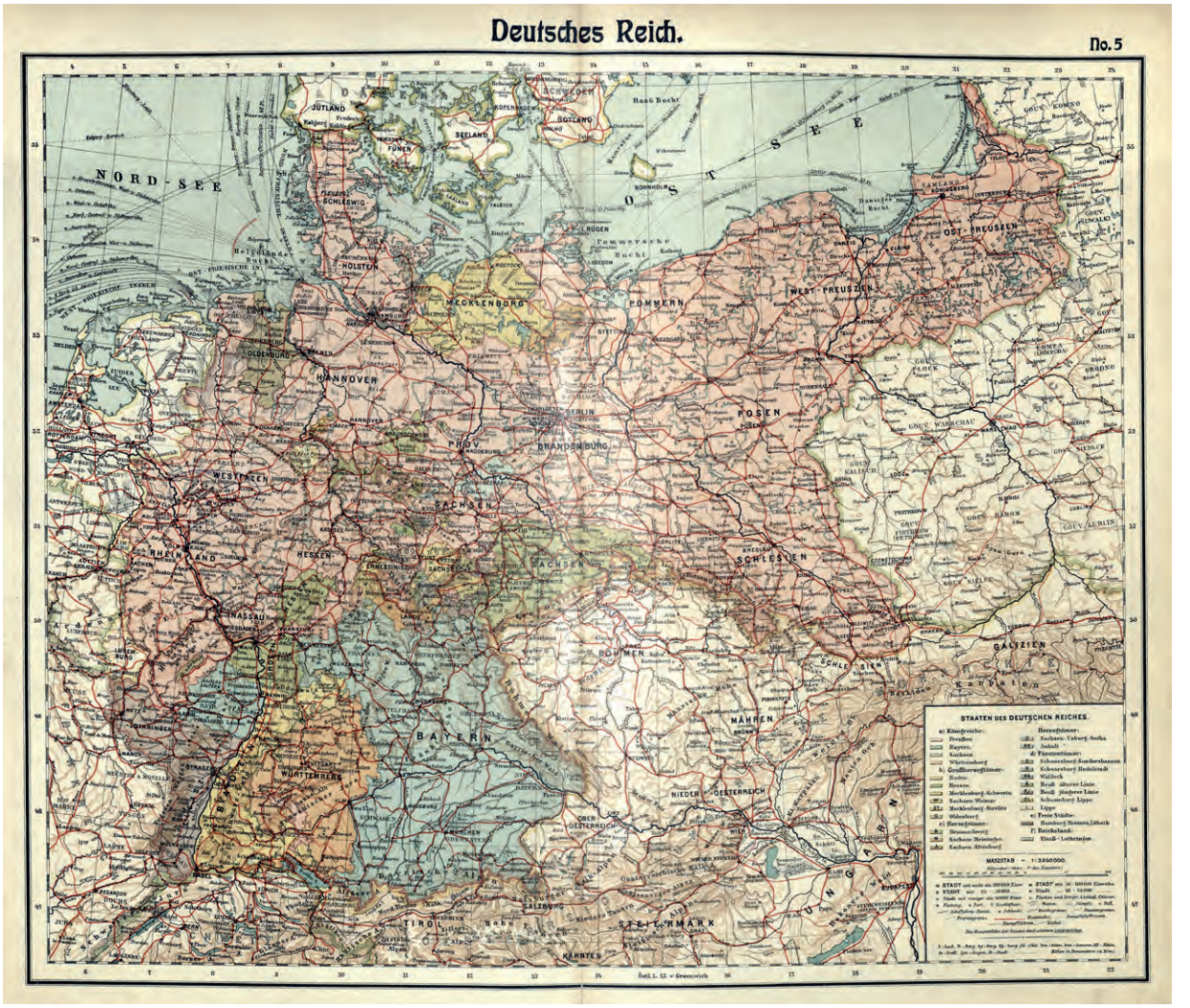


Fig. 2a. Map of Germany and the German Borderlands, taken from the Allgemeiner Handatlas über sämtliche Teile der Erde.

The only content-related difference was a change in the marking of fortified towns and cities and the addition of fortresses in surroundings of strategic places: a red lithographic layer was added as overprint to highlight the existing cities' black plates and to fill in loosely grouped fortresses, e. g., west from Warsaw or in the borderlands of Alsace-Lorraine (Figs. 2a and 2b).

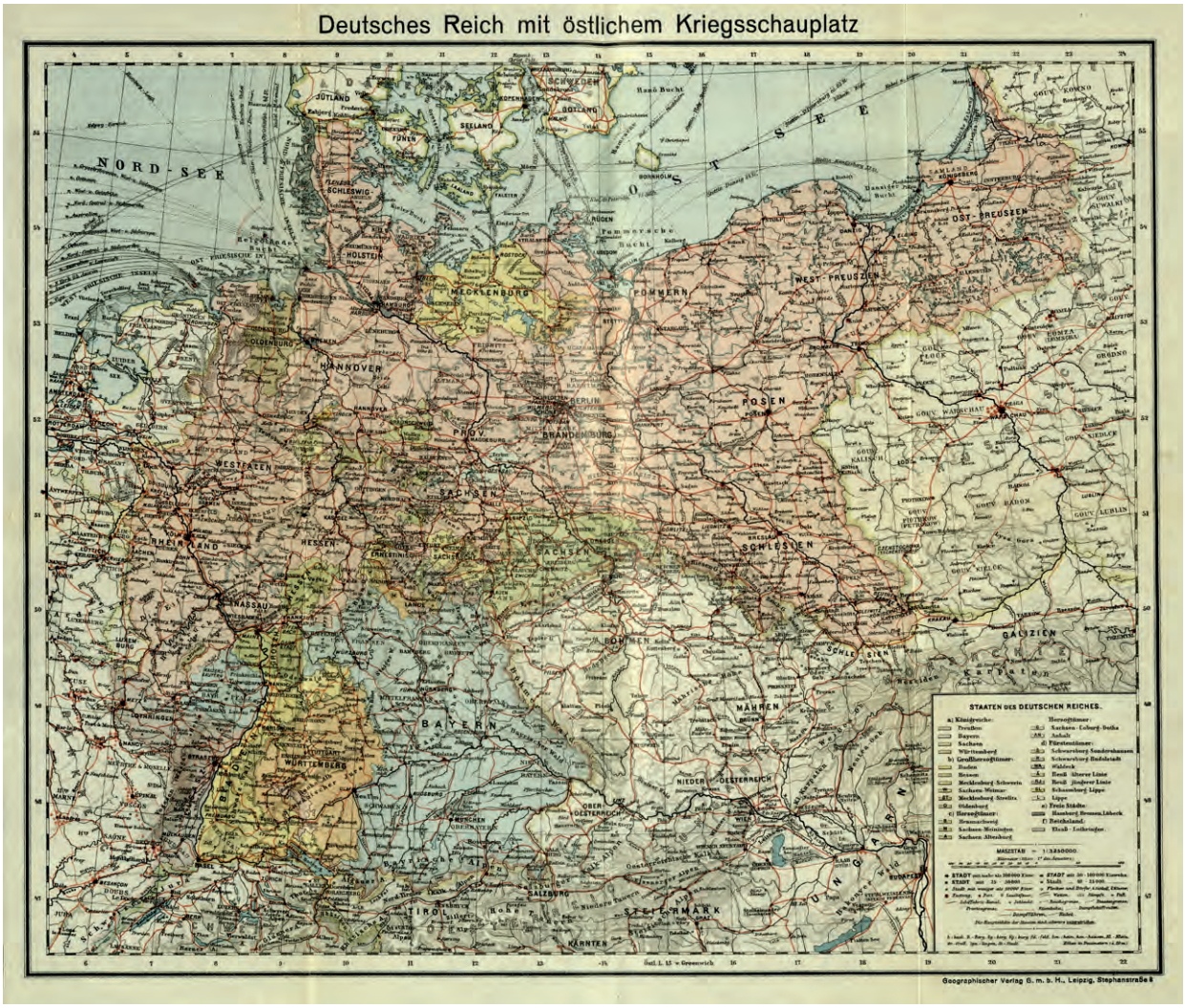


Fig. 2b. Map of Germany and the German Borderlands, taken from Kriegs-Atlas über sämtliche Kriegsschauplätze (Author's collection)

Not all maps of the *Allgemeiner Handatlas* contained fortresses: consequently, the symbols were omitted in their legends. Besides adding those fortresses with the red-colored additional overprint, a small additional legend was added to the map of "Great Britain and Ireland" (new title: "Overview map for the events in the Channel and on the English mainland"). It was placed just above the scale where space allowed for this one-line addition (Figs. 3a and 3b).

Fig. 3a. Map of Great Britain and Ireland, taken from the Allgemeiner Handatlas über sämtliche Teile der Erde

Fig. 3b. Map of Great Britain and Ireland, taken from Kriegs-Atlas über sämtliche Kriegsschauplätze (Author's collection)

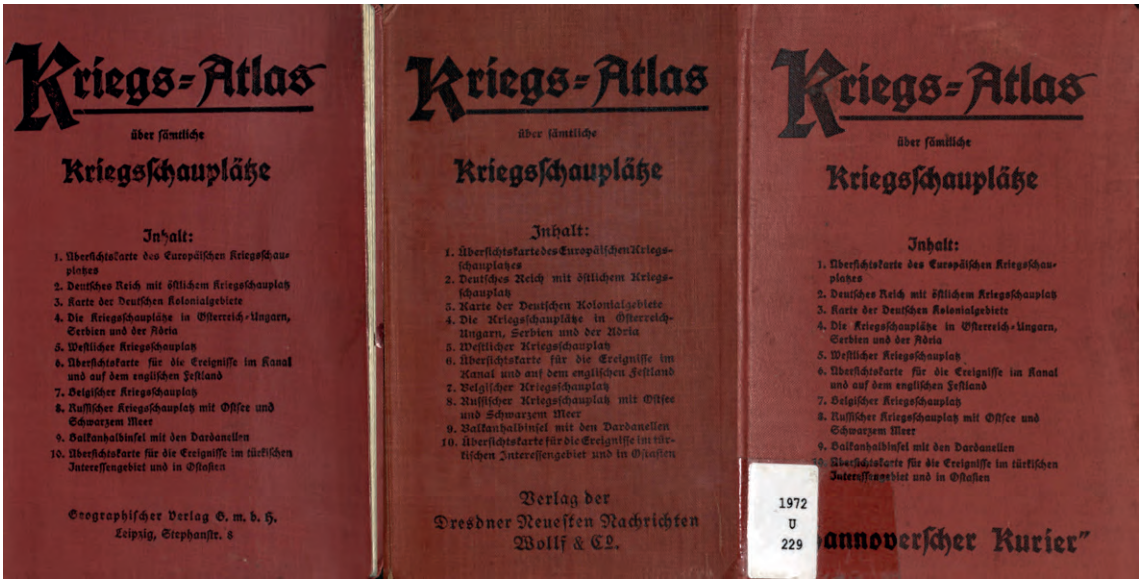


Fig. 4 Covers of the first and subsequent licensed editions of the Kriegs-Atlas über sämtliche Kriegsschauplätze (Author's collection)

Interestingly, neither a preface nor a list of placenames accompanied the atlas. The effort taken to produce the booklet exemplifies perfectly the re-utilization of existing print templates. The publishers must have been happy that there was no territorial change after publishing the latest *Allgemeiner Handatlas* in 1914, avoiding the production of corrected or new maps. The atlas was very successful because it was published within weeks after the war had started to meet the high demand for affordable spatial information. To maximize profit, it was licensed to German newspapers. For this, only the lower part of the cover was replaced by the respective name e. g., Hannoverscher Kurier or Verlag der Dresdner Neuesten Nachrichten (Fig. 4).

This marketing strategy followed the example of the US company Rand McNally, that had licensed their maps to various newspapers covering the Spanish-American War in 1898. Unfortunately, no publication statistics could be found in remaining production documents of the publishing house, nor a list of the newspapers. However, a review of existing collections on First World War publications in libraries, archives and in private collections yielded 17 different editions published by newspapers, all containing the same maps with no additions and changes over the whole publication period of the *Kriegs-Atlas*.

3.1.2 Der Weltkrieg - Karten aus Debes' Neuem Handatlas, H. Wagner & E. Debes, Leipzig

After loosening the co-operation with Karl Baedecker, where he was responsible for the cartographic content, Ernst Debes in the 1870s started publishing scholarly atlases that followed the examples of Andree's and Stieler's Handatlas. Having worked for Velhagen & Klasing and Justus Perthes, "Debes was thoroughly familiar with [all] conventional cartographic methods"[16] and tried to improve them. Debes & Wagner in Leipzig published several editions of "E. Debes' *Neuer Handatlas über alle Teile der Erde* of which the last, containing 65 primary and 131 secondary maps, was published in 1914. In contrast to Andree and Stieler, the Debes & Wagner's atlas was affordable, costing less than half the price of the former role models. In August 1914 Debes & Wagner immediately started producing war maps with a first run containing 7 maps taken directly from *Debes Handatlas*[17] (Fig. 5).

Börsenblatt für den Deutschen Buchhandel

Eigentum des Börsenvereins der Deutschen Buchhändler zu Leipzig

Umschlag zu Nr. 191. Leipzig, Mittwoch den 19. August 1914. 81. Jahrgang.

Verlag von H. Wagner & E. Debes in Leipzig

7 Karten

zum

Deutsch-Englischen Krieg

aus

E. Debes' Neuem Handatlas, 4. Auflage 1914

Unübertroffen an Übersichtlichkeit!

Karten: Nr. 11. Mittelländisches Meer 1:8250000, **Nr. 28.** Britische Inseln 1:2750000, **Nr. 44.** Ostasien 1:10000000 (Nebenkarte: Gouvernement Kiautschou 1:1500000), **Nr. 45.** Afrika 1:23000000 (Nebenkarte: Der östliche Teil von Deutsch-Ostafrika 1:5000000), **Nr. 46/48.** (1 Blatt) Atlasländer – Kapländer (Nebenkarte: Das Land zwischen der Küste und Windhuk 1:5000000) – Nilländer 1:10000000, **Nr. 49.** West-Afrika 1:10000000 (Nebenkarten: Die deutschen Schutzgebiete Togo und Kamerun 1:2500000), **Nr. 50.** Äquatoriales Afrika 1:10000000.

Bildfläche jeder Karte 38 × 50 cm

Preis jeder Karte: **70 Pfennig ord., 50 Pfennig no. bar** und **von 10 Exemplaren an mit 50 Prozent Rabatt**

Lieferung erfolgt nur gegen **vorherige Einsendung** des Betrages, gegen **Nachnahme** oder **bar** durch Kommissionär. In Kommission können wir nicht abgeben.

Hochachtungsvoll

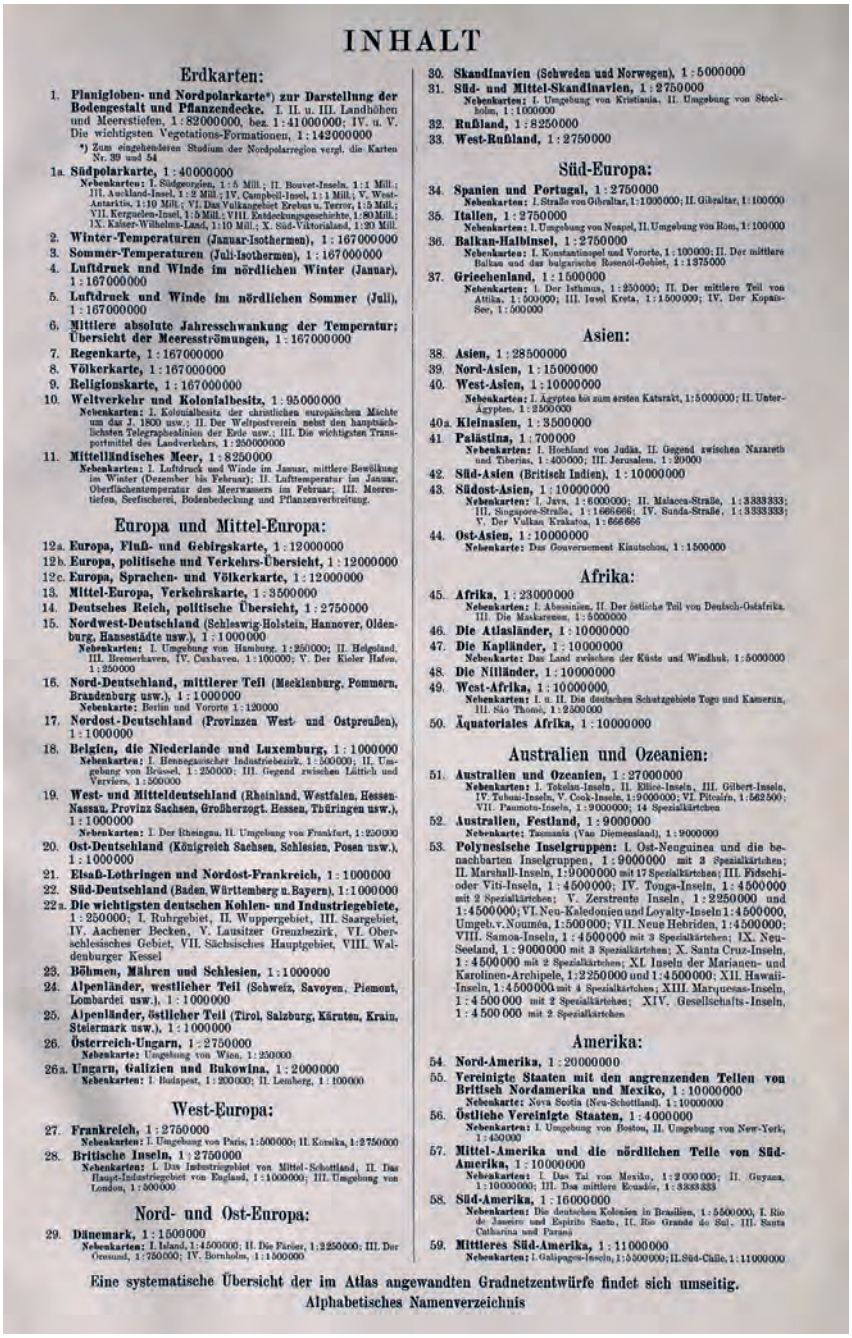
Leipzig, 17. August 1914.

H. Wagner & E. Debes
Geographische Anstalt.

Fig. 5 Advertisement for a selection of war maps taken from the Börsenblatt des Deutschen Buchhandels 1915 (Courtesy: Digitale Sammlungen der Sächsische Staatsbibliothek, Dresden)

16 Jürgen ESPENHORST, *Petermann's Planet, Volume 1: The great Handatlases, G. R. Crossman (ed. and translated),* Pangaea, Schwerte, 2003, p. 645.

17 BDB No. 191, 19 August 1914, p. 1.



INHALT

Erdkarten:

Europa und Mittel-Europa:

West-Europa:

Nord- und Ost-Europa:

Süd-Europa:

Asien:

Afrika:

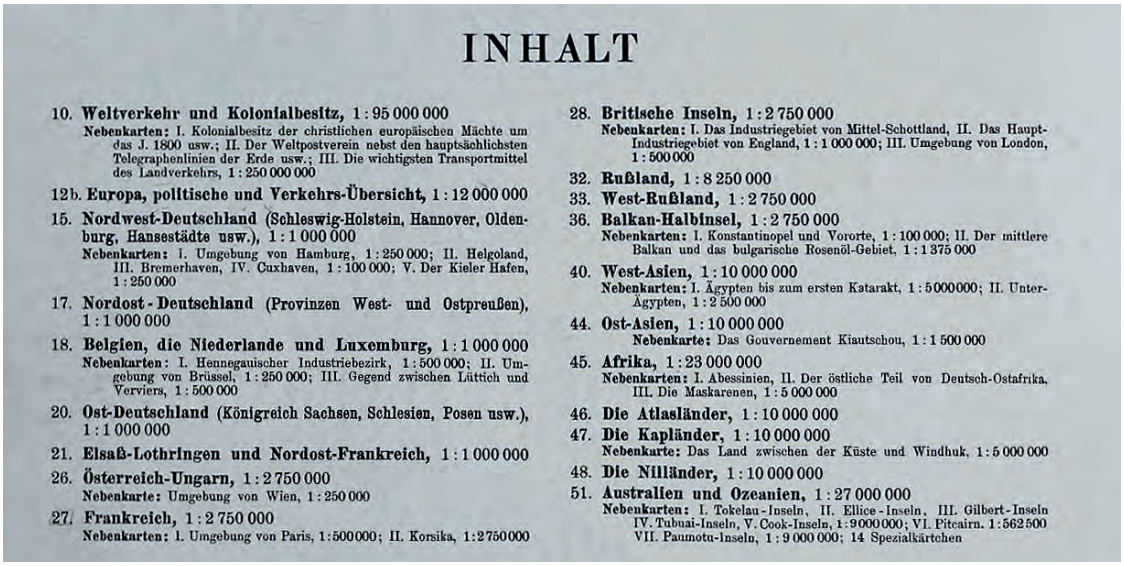
Australien und Ozeanien:

Amerika:

Eine systematische Übersicht der im Atlas angewandten Gradnetzentwürfe findet sich umseitig.

Alphabetisches Namenverzeichnis

Fig. 6 a. Table of contents taken from Debes Handatlas
(Author's collection)



INHALT

Fig. 6b. Table of contents taken from Der Weltkrieg 1914
(Author's collection)

Like the Geographischer Verlag the company started producing a war atlas – *Der Weltkrieg 1914* – that contained 20 lithographic maps on 18 sheets derived unaltered from the latest edition of *Debes Handatlas* (1914). It had a binding of flexible cardboard pasted over with yellow cloth, the front cover containing the German imperial coat of arms – the eagle – above the title. Well known for his cartographic accuracy, Debes added title and scale of the main and inset maps, the cartographer, date and the projection to all map sheets, and thus provided a unique documentation on the production modes. Interestingly, the numeration of the maps in the contents table of *Der Weltkrieg 1914* match the numbers in *Debes Handatlas* (Fig. 6a). The sequence of maps was hierarchical, starting with map No.10 on world transport (Fig. 6b) and colonial possessions, covering the regions that were then affected by WWI: Germany, Austria-Hungary, Russia, the Balkan Peninsula, Asia, Africa and Australia/Oceania.

In following editions, because of the unexpected prolongation (and spatial extension) of the war only the date was altered (2nd ed: *Der Weltkrieg 1914-1915*). The maps remained the same up to the third, and probably last, edition, *Der Weltkrieg 1914-1916*[18].

18 ESPENHORST, 2003, p. 666.

3.1.3 Atlas zum Kriegsschauplatz, Verlag des Bibliographischen Instituts, Leipzig und Berlin

Like traditional atlas producers, the makers of encyclopedias suffered heavily from collapsing markets. The last pre-war edition of Meyers *Konversations-Lexikon* (6th ed.) was published between 1902 and 1913, covering changes and additions from 1909 to 1911 in supplementary volumes. With the fifth edition, the publisher had started to publish a separate atlas (rather than a map volume) which had separate numbering of maps, thus breaking the relation to the (identical) maps and articles published in the *Konversations-Lexikon*[19]. In the run up to the First World War the Bibliographische Institut published three different "stand-alone" editions of Meyers Handatlas, containing maps from the *Konversations-Lexikon*. These maps also formed the basis for different editions of the *Atlas zum Kriegsschauplatz* published between 1914 and 1917. In 1914 alone, seven editions were published, slightly varying in the title[20] and number of maps. The seventeenth edition, published in 1917, still had 18 map sheets with the number of maps decreasing to 22 primary and 10 secondary maps. The twentieth and last edition, published 1918, had 19 sheets with 23 primary and 10 secondary maps. As in the above discussed Handatlases, the map layout and size were identically adapted from the encyclopedia's maps. Because of the portrait format of the Konversations-Lexikon's folded maps the atlas was published using a simple low-cost thread binding with unfolded maps measuring 31 x 25 cm. Only the maps of the Mediterranean countries and the World transport map were – as in the encyclopedia – twice the width and therefore a gate

19 Espenhorst, 2003, p. 503.

20 The first issue of the first edition in 1914 bore the title "Atlas zum Europäischen Kriegsschauplatz 18 Karten aus Meyers Konversations-Lexikon" (Atlas of the European theatre of war – 18 maps from …). The seventh issue was titled "Atlas zum Kriegsschauplatz 1914 – 18 Kartenblätter mit 27 Haupt und 16 Nebenkarten aus Meyers Konversations-Lexikon" (Atlas of the theatre of war 1914 – 18 map sheets with 27 primary and 16 secondary maps from Meyers Konversations-Lexikon).

fold (Fig. 7) was used. None of the 20 atlas editions contained any textual elements or lists of placenames.

The publishers didn't update any maps content in the twenty editions between 1914 and 1918 but replaced maps completely according to additional theatres of war, like the Isonzo front line that formed when Italy changed allies and joined the Entente in 1915. After the front line's stagnation in 1915, the following editions included more detailed maps on smaller areas like the Ardennes Forest or the Somme area. Unfortunately, the author has not yet been able to collect all editions. A list of contents of the different editions will be prepared for private collectors and public collections to fill those gaps.

Fig. 7 Map of the Mediterranean Sea taken from Atlas zum Kriegsschauplatz 1914 (Author's collection)

3.1.4 Kriegsatlas, F.A. Brockhaus, Leipzig

Unlike the Bibliographische Institut, F. A. Brockhaus - besides the lavishly illustrated *Illustrierter Handatlas für Freunde der Erdkunde* in 1863 and a supplement atlas with maps from the two-volume *Kleines Conversationslexikon* in 1880 - had not published their cartographic materials in separate maps and atlases before WWI. The outbreak of the war halted the project to publish the 15th edition of Brockhaus' *Konversations-Lexikon*[21]. Like the Bibliographische Institut, Brockhaus took advantage of a large pool of cartographic products that had been used and updated for the 14th edition and in the smaller editions of the renamed *Kleines Konversations-Lexikon* (5th edition 1914). Brockhaus started to produce the *Kriegsatlas* in late 1914 following the same patterns as the afore-mentioned atlases. It contained 13 map sheets containing 14 primary and 10 secondary maps starting with a world map (with insets of e.g., of the Suez Canal) followed by an overview map of Europe. All maps were derived from the *Konversations-Lexikon*; those containing the Balkans were taken from the latest supplement volume, reflecting the territorial changes as result of the Balkan Wars in 1912 - 1913. The Europe map derived from the political overview map in the 14th edition that had been changed slightly. Hachures and colored boundary bands had to give way for simply colorized territories and the addition of main railway lines.

In most maps a red-colored layer was overprinted to highlight wartime essentials, focusing on fortifications (e. g. a fortress-shaped red overprint of existing signs) and main railway lines. Surprisingly, the nautical chart of the North Sea, that already contained highly sophisticated strategic information (lighthouses, bathymetric information, scale 1:4 800 000) was not used. This underlines the purpose as a war atlas to inform the public, as the published map "North Sea and adjacent countries" focused only on territories and front lines (scale 1:4 000 000). The use of these kind of atlases is reflected in some exemplars acquired by this author, which contained personal markings like the addition of a rough front line in north-eastern France (Fig. 8): three editions contained the same maps unchanged in a 1914, a 1914/15 and 1914/16 version. Probably due to the public's 'war weariness' the publishing of the *Kriegsatlas* ceased in 1916, since later editions could not be found in libraries and archives, private collections or databases.

21 The 15th edition was published after the war as *Der große Brockhaus*. A comprehensive assessment of the (economic) impact of the war on F. A. Brockhaus publications is given by Keiderling, 2003, pp. 64 – 69.

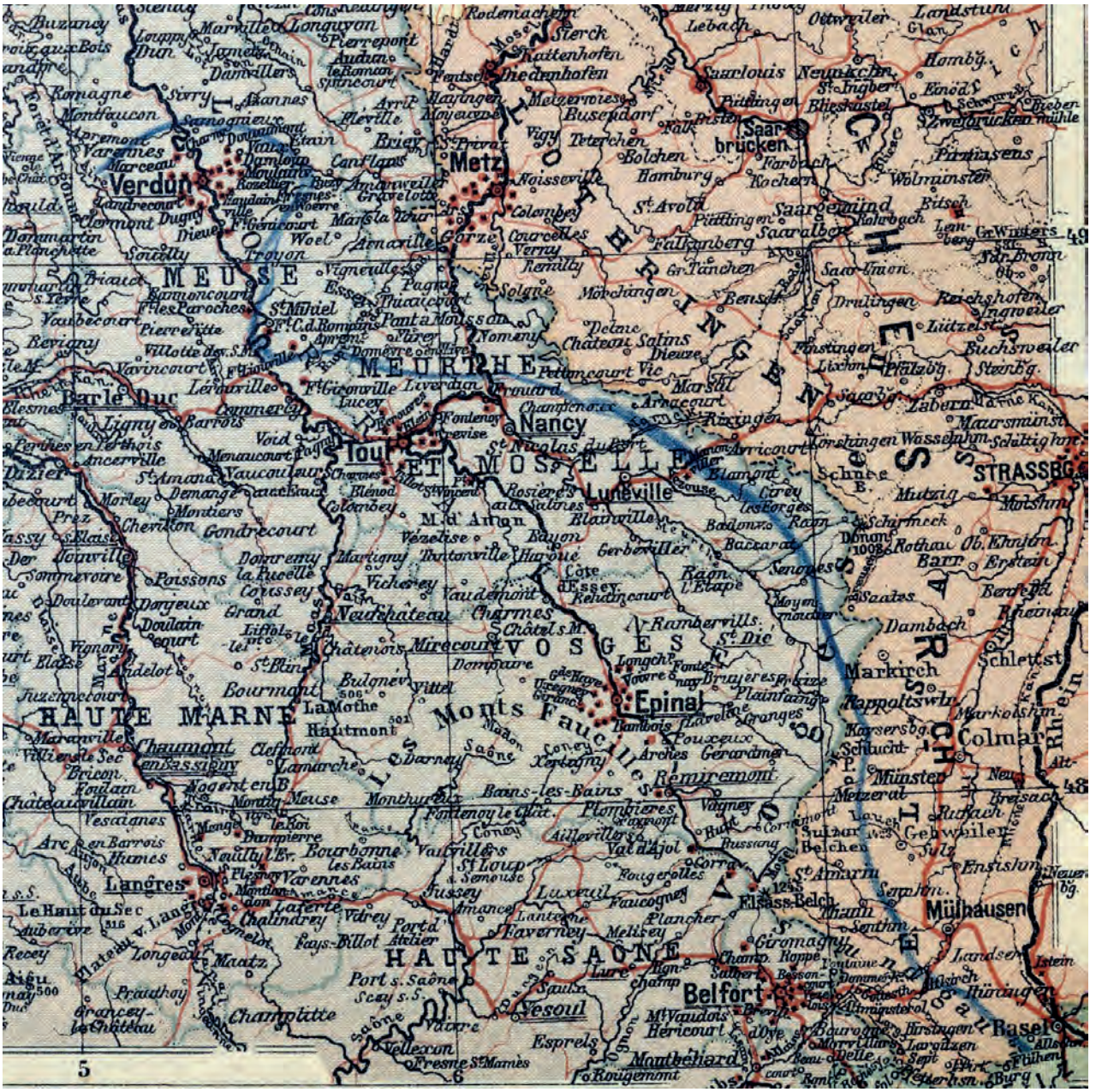


Fig. 8 Map of the Franco-German war zone, from F. A. Brockhaus Kriegsatlas. The blue line was added by the user to depict the front line in early 1915: this remained almost unchanged until 1918 (Author's collection)

3.1.5 Kriegs-Atlas, Verlag Ullstein & Co., Berlin

Having no experience in atlas publishing, the Ullstein Verlag joined the war atlas producers in late 1915. The *Kriegs-Atlas* started with 38 maps, which had been produced by the publishers whose expertise in map engraving came from the production and publication of the six-volume *Weltgeschichte* (World History) between 1907 and 1910. The high-quality maps of the war atlas were black and white that carried a number and the Ullstein logo as copyright notice. The sequence of the theaters of war considered was comparable with other atlases: the western front line (13 maps), the southwestern area with the Balkans (6 maps), the Italo-Austrian front line (3 maps), the Orient (5 maps) and the eastern front line (11 maps). Again, the focus was to depict as many placenames as possible, although finding those places in the atlases was rather difficult as they did not have a gazetteer. Ullstein published the atlas in several editions until 1918, thus being one of the most enduring producers. The last edition carried 66 very detailed and rather large-scale black and white maps.

3.1.6 Kriegsatlas – Chronologischer Atlas der Kämpfe des Weltkriegs, Velhagen & Klasing 1917

One war atlas stands out compared to the above, as it followed the demand for tactical/strategical information on the war events – a rather information vacuum. Newspapers tried to fill this gap by publishing weekly poster maps that followed the front lines' movements. The static warfare after 1915 was then more and more covered by very detailed maps of the respective battlefields that provided no strategic overview. Educational institutions increasingly felt dedicated to their patriotic mission and used medium-scale war maps from traditional map producers (see below) to inform and encourage their users to to join the military forces with comprehensive information on wartime operations. As spatial information was often kept secret by the authorities, and methods of battlefield survey lacked a standardization for further dissemination, faculties and instructors turned to the traditional producers of spatial knowledge media.[22] The first and only strategic atlas to publicly appear was published by Velhagen & Klasing, edited by the retired Bavarian Regiment Commander Max von Sartor. Lacking a foreword, the

22 KANN, 201, p. 223.

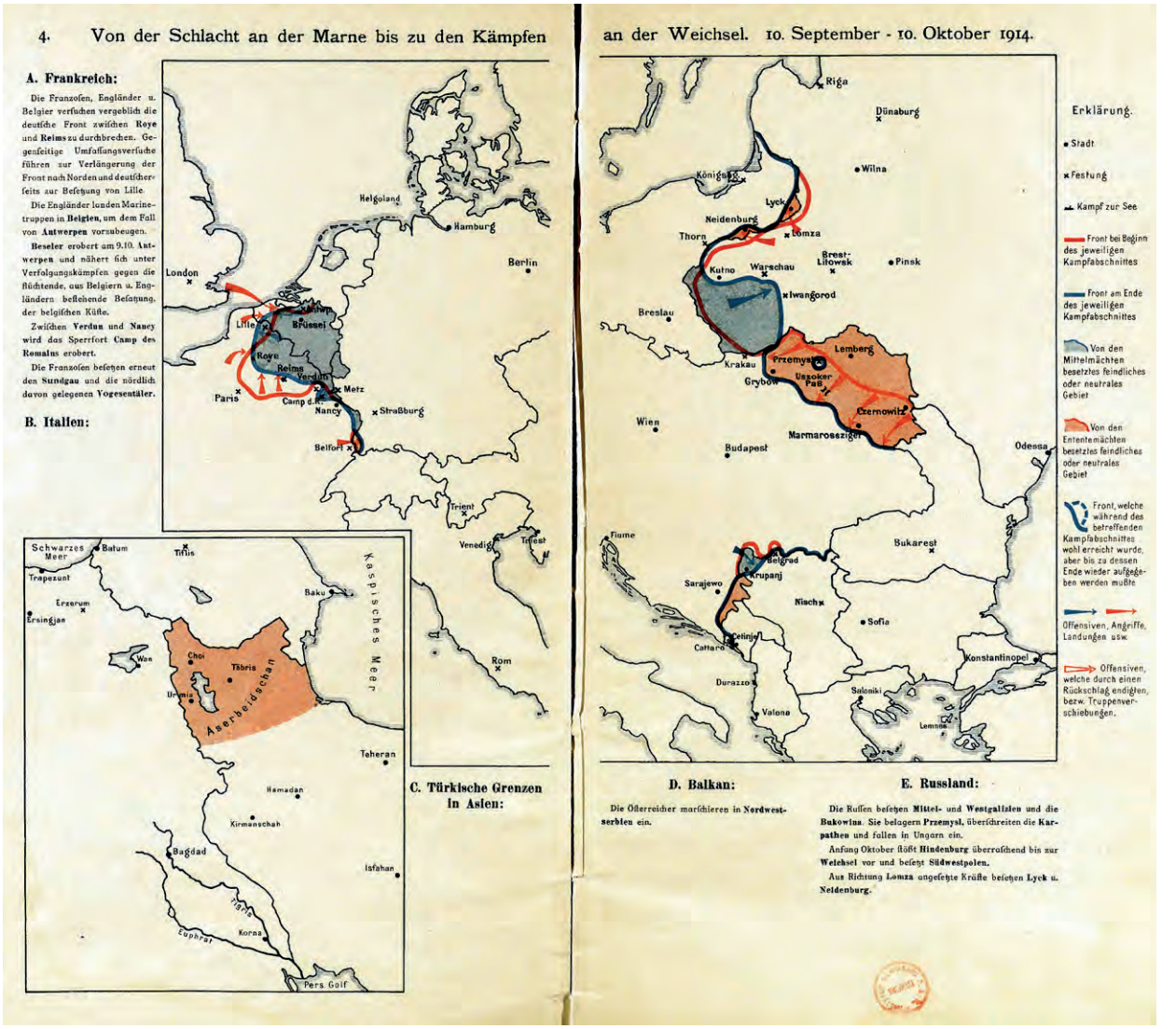


Fig. 9 Map taken from Kriegsatlas – Chronologischer Atlas der Kämpfe des Weltkriegs (Author's collection)

atlas starts with two maps: the larger showing the Central European, the other the Western Asia, theatres of war spread over a double page (Fig. 9).

The first map is titled "Von der Mobilmachung bis zur Schlacht in Lothringen" and covers the events between 1st and 20th August 1914. The simple base maps contain borders, primary cities and marine areas only; the West Asia, for

better orientation, includes some additional water bodies. The arrangement, size and scale (although none is indicated) of both maps is used throughout the atlas. The maps are accompanied by five descriptive text areas of depicted front line events in France, Italy, Asian Turkey borderlands, the Balkans and Russia; that for Italy staying empty until 23rd May 1915 when the country had declared war on Austro-Hungary and Germany. The atlas guides chronologically through the key events WWI beginning with the battles in Lothringen, ending with the Russian summer attack of 1916. It uses a simple binary color scheme (blue: Central Powers, red: Entente) to visualize advances and retreats employing area shading for conquered and lost territories; arrows to outline troops movements, and colored lines indicating front lines at the beginning and end of the stated period (Fig. 9). Hermann Haack in his 1917 literature review in the Geographischer Anzeiger particularly praised the simplicity of the visualization, that doesn't distract from the core of what had happened[23]. Because of the trench warfare the depiction of the frontline at the western theatre of war doesn't change from map 6 to 21 and only seasonal campaigns are depicted by arrows. Because of the small scale and simplicity an in-depth tactical analysis was only possible by consulting additional maps. The publication of an announced second edition never happened and would only have showed the gridlock of the opponents until the end of war. So, the atlas remains an exceptional example of a "thematic" war atlas.

3.1.7 Marsa (-Wona) -Atlas vom Westlichen Kriegsschauplatz, Marsa (-Wona) Kartenverlag[24]

A completely different approach to the aforementioned atlases from map publishers was taken by the Marsa map publishers R. Hauschting in Königswartha. The publishing house was specialized in the production of "Wona" maps – hinking and biking maps published in a typical postcard format (approx. 10x15 cm). Depending on the war atlas editions, the individual maps together covered the northern and the southern part, the comprehensive edition the whole western the-

23 Hermann Haack, « Geographischer Literaturbereicht », *Geographischer Anzeiger* 18 (1917), p. 49.

24 The publishing house was later renamed into Marsa-Wona publishers and the atlas - from the third edition onwards - became the Marsa-Wona Taschen-Atlas (Marsa-Wona Pocket Atlas)

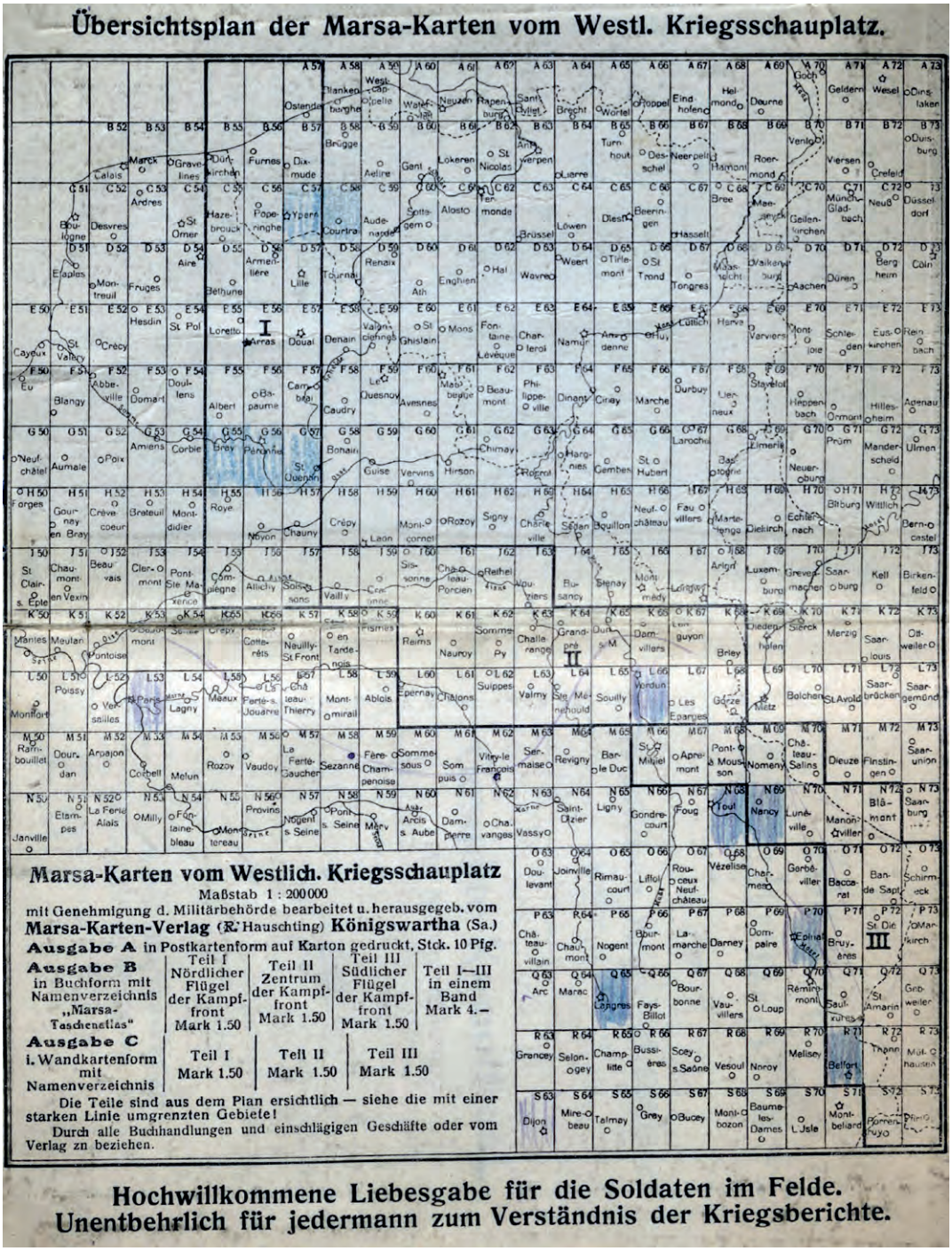
atre of war in single maps in a scale of 1:200.000. Figure 10 shows the index map of the comprehensive edition. The *Marsa- Taschenatlas des Westlichen Kriegsschauplatzes* (Marsa pocket atlas of the western theatre of war) contained 50 maps contiguously showing the battlefield areas from the western coastline (Ostende) to the south-eastern battlefields in Alsace (Pfirt). At the bottom of the map index page the slogan "Hochwillkommene Liebesgabe für die Soldaten im Felde" (Most welcome gift of love for the soldiers in the field) is emblazoned, indicating an essential purpose of use as soldier's reference atlas. In earlier editions this was supplemented by the line: "Unentbehrlich für jedermann zum Verständnis des Krieges" (Indispensable for everyone to understand the war).

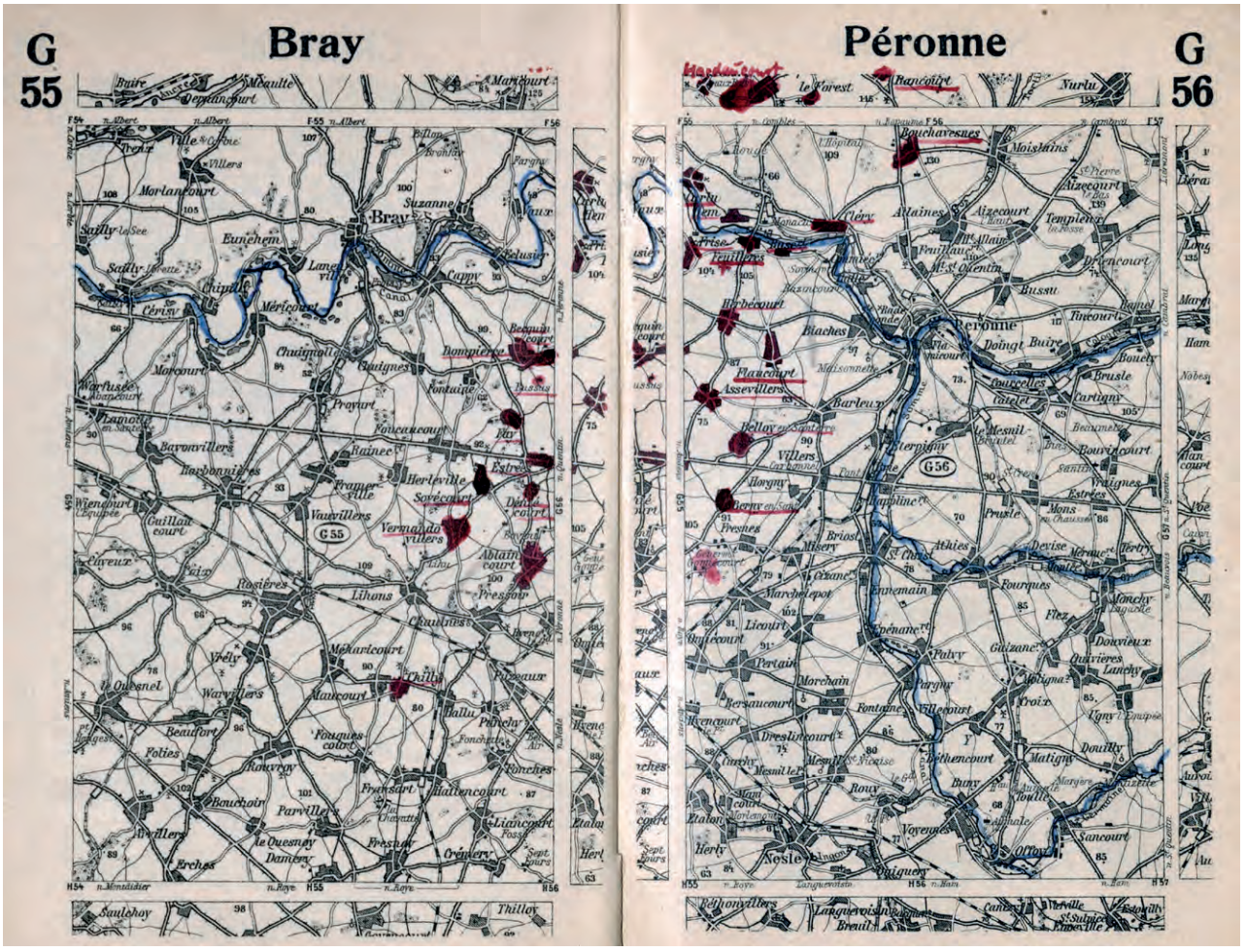
The uncolored maps - all in scale 1:200.000, the map cut-out seized 8,5x13 cm - show small sections of the adjacent maps and have a labeled map frame that helps to connect the single cut-out maps. They contain built-up areas categorized streets and railway track as well as a selection of topographical information, such as rivers and woods. The maps of Bray and Peronne in the Somme area (Fig. 11) taken from a much-used edition show entries reflecting the user's wartime experiences from 1916. Some strategic places of the battle at the Somme (1916) are indicated and even named in red ink, with the rivers highlighted with a blue copy pen. The pen was also used to highlight some of the map sheets, that again contained additional information (Fig. 11).

One of the most important additions to the maps was the comprehensive gazetteer (40 pages), which gave the place name, the type of place (e. g. city, township or building) and the number of the map sheet. The MW Atlas can thus be considered the most comprehensive atlas of the Western theatre of war. In collections, the author found several editions used by soldiers in the field during the war. These often contain additional detailed information e. g. on supply routes and even on trench lines.

3.2 War atlases from non-traditional cartographic publishers

With the beginning of WWI, smaller publishing and printing companies suffered even more from personnel losses and limited access to resources. In addition, the demand for general printing products declined. Some smaller publishers turned to maps and produced numerous editions of simple "penny war atlases" that were predominantly distributed through newsagents rather then bookstores.


Übersichtsplan der Marsa-Karten vom Westl. Kriegsschauplatz.
Marsa-Karten vom Westlich. Kriegsschauplatz
Maßstab 1 : 200 000
mit Genehmigung d. Militärbehörde bearbeitet u. herausgegeb. vom
Marsa-Karten-Verlag (R. Hauschting) Königswartha (Sa.)
Ausgabe A in Postkartenform auf Karton gedruckt, Stck. 10 Pfg.
Ausgabe B in Buchform mit Namenverzeichnis „Marsa-Taschenatlas"
Teil I Nördlicher Flügel der Kampffront Mark 1.50
Teil II Zentrum der Kampffront Mark 1.50
Teil III Südlicher Flügel der Kampffront Mark 1.50
Teil I—III in einem Band Mark 4.—
Ausgabe C i. Wandkartenform mit Namenverzeichnis
Teil I Mark 1.50
Teil II Mark 1.50
Teil III Mark 1.50
Die Teile sind aus dem Plan ersichtlich — siehe die mit einer starken Linie umgrenzten Gebiete!
Durch alle Buchhandlungen und einschlägigen Geschäfte oder vom Verlag zu beziehen.
Hochwillkommene Liebesgabe für die Soldaten im Felde.
Unentbehrlich für jedermann zum Verständnis der Kriegsberichte.



On opposite page: Fig. 10 Index map of the Marsa Taschenatlas vom Westlichen Kriegsschauplatz (Marsa pocket atlas of the western theatre of war), with some maps sheets highlighted by the former owner (Author's collection)

Above: Fig. 11 Double page depicting the maps on Bray and Peronne, the area of the heaviest fighting in the Somme region in 1916 containing highlighted and additional information of the former owner. (Author's collection)

3.2.1 Neuester Kriegs-Atlas, G. Schuh & Cie

The *Neuester Kriegs-Atlas* published in Munich in November 1914 by G. Schuh & Cie is one of the best examples of how the production of knowledge on the theatres of war opened possibilities to continue business throughout the war. G. Schuh was traditionally a lithographic institution (Lithographische Anstalt), had become well known for producing advertising posters, and owned the Vereinigte Druckereien & Kunstanstalten GmbH, that reproduced the well-known posters of "The Six", a pre-WWI association of graphic artists already focusing the idea of utilitarian art, later represented by the Bauhaus and were publishers of the then famous political humorous-satirical *Kikeriki Kalender*. During WWI G. Schuh produced a couple of propagandistic books, e. g., *Deutschlands Stolz* (Germany's pride), containing a thorough overview on the German army, navy and air force and their means of warfare, and books on the prehistory of the war illuminated from a strongly nationalist view- point. The seven editions of the *Neuester-Kriegs-Atlas* differ from those atlases produced by the aforementioned knowledge brands.

The first edition contained a propaganda text that blamed the Entente Nations as warmongers and set the stage for a glorious German victory which the atlas should document throughout the war – and, for when the heroes come home, "they will take the atlas in hand to follow their glorious routes into battle". The advertising in the *Börsenblatt des Deutschen Buchhandels* (Fig. 12) underlined the business model of the atlas with the slogan "Zur Massenverbreitung in allen Kreisen geeignet!" (Suitable for mass dissemination in all social groups) and focused on commercial success by offering attractive business conditions.

With a selling price of 20 Pfennig, the atlas was remarkably cheap regarding the comprehensive content and quality. Produced in form of a magazine (22 x 28 cm, with spine stitching, colored lithographics), it contained 10 maps of different origin[25]. The first four roughly covered the western theatre of war, with two railway maps of Belgium and Northeastern France and two surrounding area maps of Antwerp and Paris. Most of them are rather cheaply (re-)produced railway maps, that were common for contemporary travel books, with inconsistent spelling of placenames and hand-drawn signs for fortified places. The map of Antwerp and

25 Comparing typeface, content, graphical visualization of scale, colouring.

8162 Börsenblatt f. d. Dtschn. Buchhandel. Künftig erscheinende Bücher. № 255, 3. November 1914.

Zur Massenverbreitung in allen Kreisen geeignet!

Bis 50% Rabatt! **Hoher Verdienst!**

Soeben erscheint:

Neuester Kriegs-Atlas

Eine wahrhaft volkstümliche Sammlung von farbigen Karten und Plänen vom Schauplatz des Völkerkrieges nebst aufklärenden Erläuterungen und Statistiken. Umfang = 16 Seiten in Mehrfarbendruck. Der überaus handliche Atlas im Format von 23 auf 29 cm geschlossen, verspricht ein Zugartikel sondergleichen zu werden, da er durch seine Karten von verblüffender Uebersichtlichkeit, leichter Lesbarkeit und Deutlichkeit alle bisher erschienenen Kartenwerke vom Weltkrieg übertrifft. Der beispiellos billige Verkaufspreis von

20 Pfennig

erscheint geeignet den Atlas bei spielend leichtem Absatz zu einem lohnenden Massenartikel auch für den Sortimenter zu machen.

Aus dem Inhalt:

Große Uebersichtskarte des Weltkrieges
Farbige Karte vom Belgischen Kriegsschauplatz
„ „ „ Französischen „
„ „ „ Russischen „
„ „ „ Balkan- „ mit Adria
„ „ von der Nord- und Ostsee und von England
Pläne von Paris, Antwerpen usw.

Verkaufspreis des Atlas = 20 Pfg. Barpreis = 12 Pfg. 100 Exemplare mit 50% = 10 Mk.
Ausnahmslos nur gegen bar und nicht unter 15 Exemplare.
Bei vorheriger direkter Einsendung des Betrages erfolgt franko Lieferung.
Probe-Exemplare stehen für 10 Pfg. bar zur Verfügung.

Wir bitten um recht energische Verwendung und Benützung des Verlangzettels.

G. Schuh & Cie. G. m. b. H., Verlagsanstalt, München, Herrnstr. 6.

Fig. 12 Advertising of the Neuester Kriegs-Atlas, in Börsenblatt des Deutschen Buchhandels (Courtesy: Digitale Sammlungen der Sächsische Staatsbibliothek, Dresden)

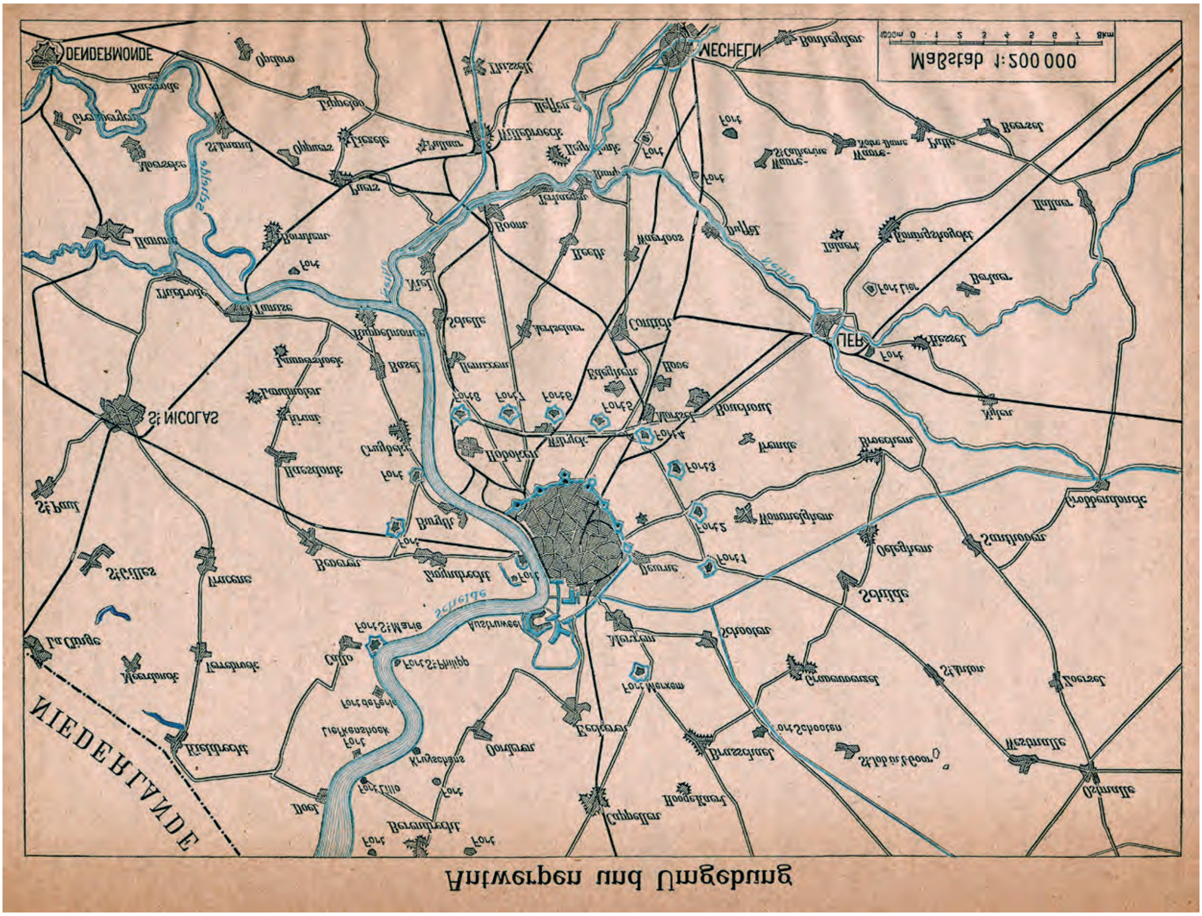


Fig. 13 Map of Antwerp and environs taken from the 1st Edition of the Neuester Kriegs-Atlas (Author's collection)

environs especially shows the poor addition of information as the colored water bodies overprint the placenames (Fig. 13).

The assembly and sequence of the first edition closely followed the given strategic war goals, thus creating the narrative of the atlas:

A) Short term success in the west: maps of Belgium (1), Northern France (2), Antwerp reflecting its strategic importance (3), Paris as final target (4),

B) After success in the west, moving troops to the east: map of Central Europe, connecting the theatres of war (5,6),

C) Controlling the efforts of England: maps of the coastline of the North Sea (7,8),

D) Final success on the eastern front: map of the German-Austrian border to Russia and of the Balkans (9,10).

This is a blueprint for most first editions of war atlases that, according to successive political and strategic events, later needed to be supplemented or replaced by more detailed maps. The second edition of the *Neuester Kriegs-Atlas* published in June 1915 was a completely new edition that took account of the entry of Italy into the war on the side of the Entente (23rd May 1915). One obvious addition was a notice on the cover: that this edition was not only an improvement on, but a continuation of, preceding editions. Thus, "who wanted to seamlessly follow the war events needs to buy the all editions" (*Neuester Kriegs-Atlas*, 2nd edition: cover page).

The main changes in the second edition (that became standard until the sixth) was engaging an author responsible for text passages (the former officer Leutnant A.D. Heinrich Hacke, who had already authored three publications for G. Schuh, presenting a thorough overview on the German military forces), and the improvement of maps in visualization mode and content (e. g., added colored hachuring). Large text passages, in propagandistic style, explained contexts and events. Again, the atlas followed the main events:

A) The building of a new theatre of war: double-page overview map of the Italo-Austro-Hungarian borderline,

B) The battle's advance in the East, April – June 1915: maps of Kurland and of the Carpathian Mountains,

C) The battles in the Forest of Argonne and the Vosges, September 1914 – June 1915: one overview and three detailed maps of the battle grounds,

D) The Battles of Ypern/Ypres, October 1914 – May 1915: large scale map of Ypern and surroundings.

This can be taken as a blueprint for many second and following editions of war atlases. They mainly started with small-scale overview maps (texts) on the newly added theatres of war, followed by status quo reports on the ongoing fights accompanied by improved large-scale maps of important areas. Although the Western front line was of main public interest, its change into a static battle without larger territorial gains didn't need any more overviews but, instead, improved and

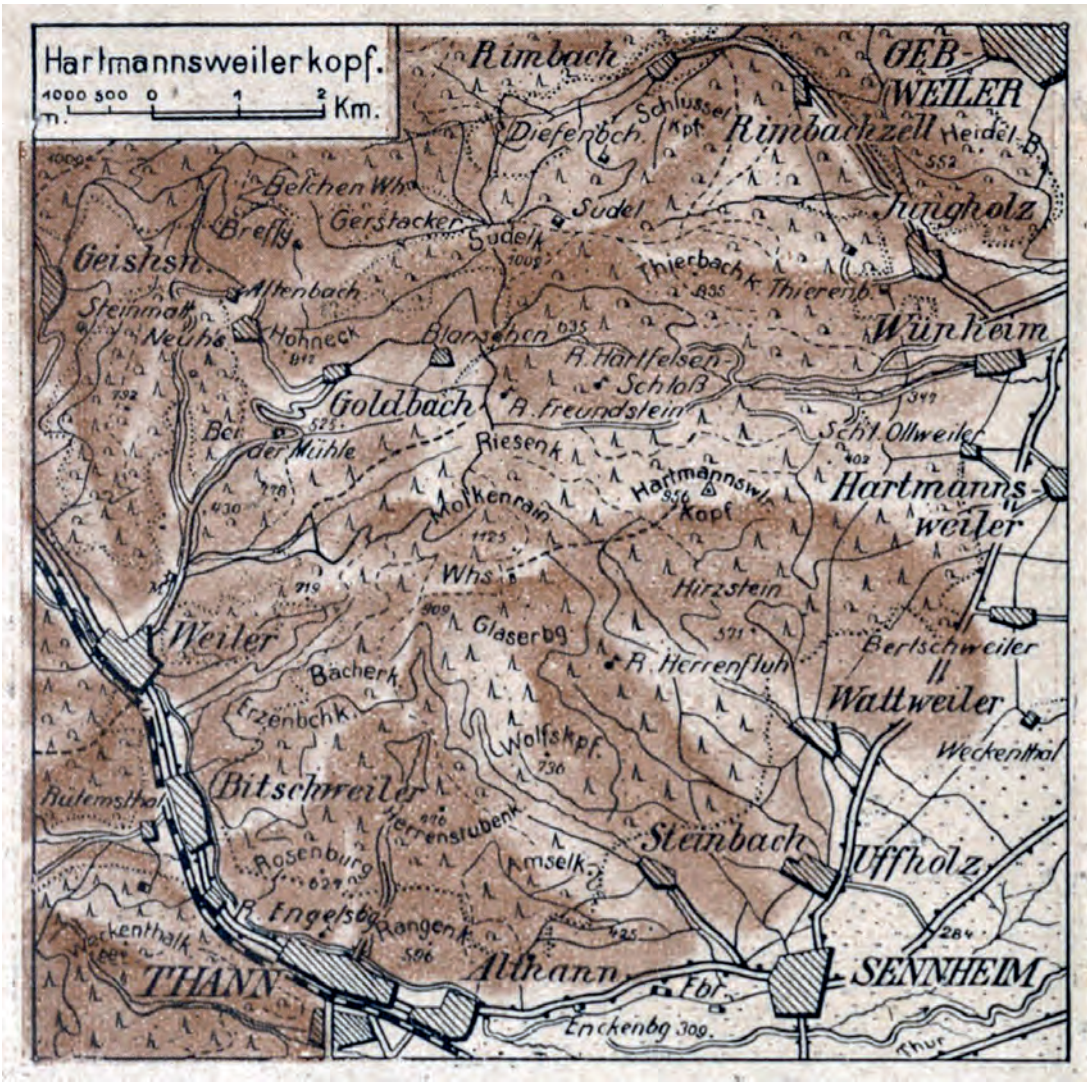
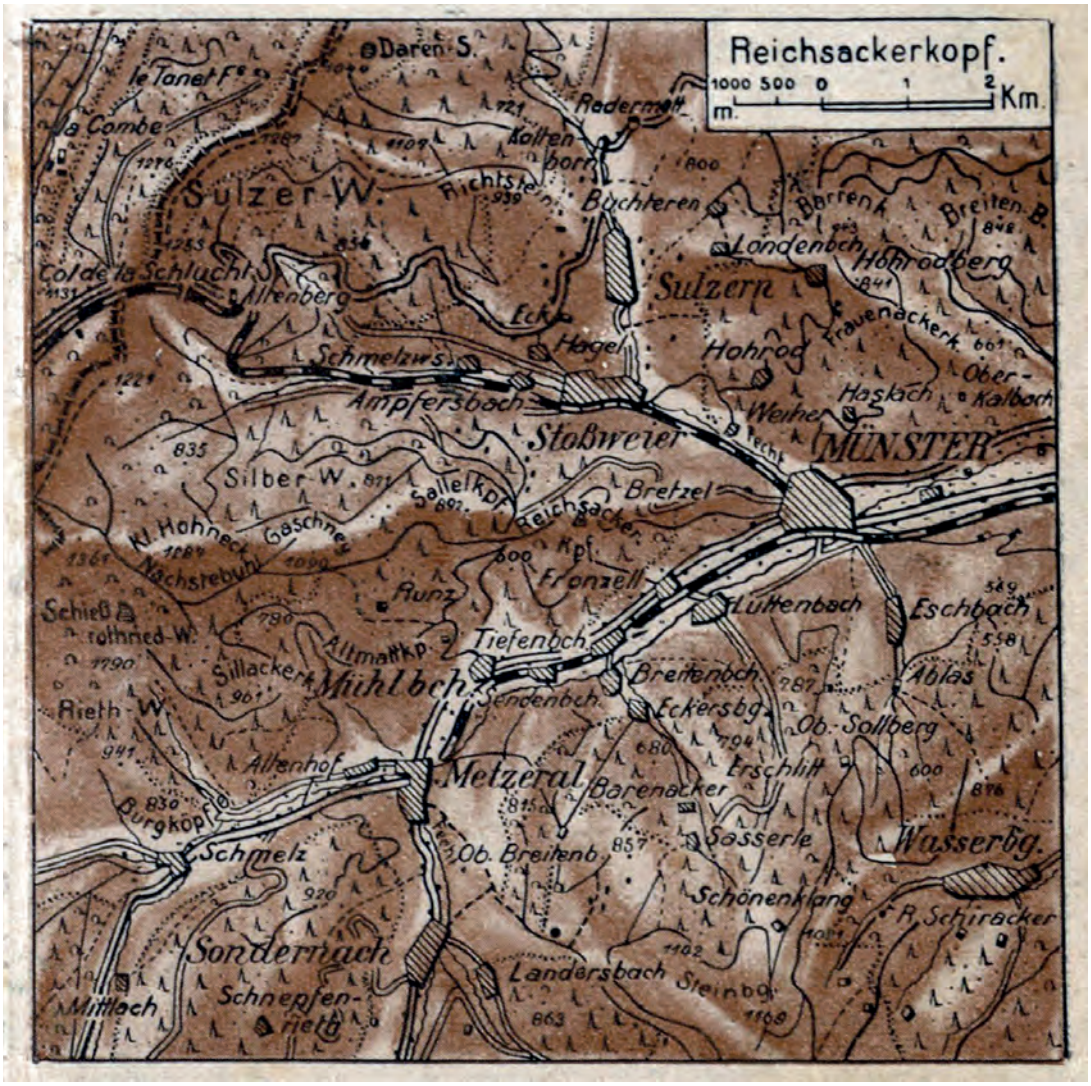


Fig. 14 (above and on opposite page) Maps of the front line at Hartmannsweilerkopf and Reichsackerkopf taken from the 2nd edition of the Neuester Kriegs-Atlas (Author's collection)

more detailed maps of locations of battles. Figure 14 includes two detailed maps of the second edition of the *Neuester Kriegs-Atlas* showing the static front line at Hartmannsweilerkopf and Reichsackerkopf, places that frequently changed hands in 1915. The static war situation, especially along the Western and Eastern fronts, led to more detailed descriptions of the whole variety of places militarily involved or politically on the brink of becoming just another theatre of war.



The 4th and 5th editions still had textual explanations and now contained overview maps of the eastern theatre of war and the colonies. The 7th (last) edition was published in November 1916; supply problems caused it to be printed on low quality paper and contained no texts. The spatial focus was very narrow, reflecting Romania's entry into the war on the side of the Entente with 13 maps of Romania and two of Macedonia, all of them typical regional railway maps with hachures.

3.2.2 Other war atlases

Different publishers entered the market in 1915 with similar atlases and multiple editions. Unfortunately, a more detailed overview needs to be part of a comprehensive research project as libraries, collections and archives often just provide single editions. These rather short-lived publication projects often can't be found in equally rare, or incomplete, publishers' archives. For example, the *Neuester Kriegs-Atlas* – because of the high paper quality of the first six editions – can be taken as blueprint for the classification of the following atlases of non-traditional map producers that is far from being complete.

Among the list of atlas producers the author could also identify short-term founded publishing ventures, such as the Kriegsverlag A. G. in Berlin, that produced booklets on different aspects of the war (e.g., *Deutsche Kriegsgedichte 1914* – German war poems) and, of course, atlases (*Taschen-Atlas der Kriegsschauplätze*) that in the first place were distributed to the front lines, where the need for spatial information was as important as back home.[26]

Thus, these booklets became valuable notebooks or diaries of personal war biographies and helped soldiers locate their own whereabouts. The famous *Taschen-Atlas der Kriegsschauplätze* was produced in different editions with the total run exceeding 1 million exemplars in 1916. All editions identified by the author contained uncolored maps of different content quality, mainly edited by W. Hinkelmann. Besides being ordered by several troop units, the handy and cheap (between 10 and 25 Pfennig) atlas was distributed in schools, factories, offices of public authorities, military hospitals, hospitals and sanatoriums (Taschen-Atlas 1917, cover page). As intended by the publishers, it became the "Volksatlas des Krieges" (People's atlas of the war). The different editions contained no text or statistics. The uncolored maps presented as many placenames as possible (Fig. 15) and included railway lines, rivers and water bodies. Orographic information was rarely used, only in detailed maps of mountainous combat zones like the Isonzo front line (Fig. 16).

On opposite page: Fig. 15 Typical uncolored map with a high density of placenames taken from the 2nd edition of the Taschen-Atlas der Kriegsschauplätze (Author's collection)

26 KANN, 2021, p. 218.

Französischer Kriegsschauplatz, Teilkarte III.
(Vogesen, Oberelsaß.)

Fig. 16 Detailed maps of mountainous combat zones of the Isonzo front line taken from the 2nd edition of the Taschen-Atlas der Kriegsschauplätze (Author's collection)

Of course, there are several more or less successful war atlases produced by different publishing houses, newspapers and printing companies lacking a cartographic background. However, the above examples show a generally valid pattern, in terms of production and visualization modes, that resembles the war atlases produced during the Spanish-American War in the US, with cartographic companies recycling their existing materials in licensed war atlases (Cram, Rand McNally) and the 'yellow press' trying to inform the people with cheaply produced (wax-engraved) map booklets.

3.3 A short reflection on German war maps

As described above, traditional map and atlas producers took the opportunity to supply the widening user group with highly sophisticated (information scope, presentation quality) depiction of the current and future theatres of war. Their intention of reusing their high-quality pools of maps and graphics, as well as their publishing techniques, experience and connections already having a high reputation, can also be identified with the producers of high quality (regional) war maps, like Flemming, Ravenstein or Perthes often at the same price for one map as for one of the above-mentioned atlases. The first "war map" to appear was already advertised on 4th August – one day after declaration of war on France – in the *Börsenblatt des Deutschen Buchandels*. Professor von Liebenows *Kriegskarte von Europa* (War map of Europe, 1:2 000 000), was a thorough copy of the "*Eisenbahn u[nd]. Reisekarte von Mitteleuropa*" (Railway and Travel map of Central Europe, 1:2 000 000) regularly updated and published by Gea Publishers since 1879 (BDB, 178, 4 August 1914, p.9). Flemmings war maps of the western and the eastern theatres of war followed on 7th August, also thoroughly based on the railway maps produced by the publisher based in Glogau (BDB 181, 7 August 1914, p.1). Map series like Flemmings 10-map series "*Flemmings Große Spezialkarte vom belgischen und französischen Kriegsschauplatz*" (10 sheets, scale 1:320 000) often were produced to be part of a map set: that in the case of Flemming could later be stored in a collector's box (Fig. 17) containing the whole series of 45 maps. Those maps had been very popular and were often used in educational contexts and, regarding their price, a typical product for the bourgeois middle class.

4 Instead of conclusion

The outlined examples of war atlases produced in Germany during WWI are only a sample of what spatial knowledge media was produced to answer the demand for information about the geographic characteristics of the theatres of war by people at home and in the trenches.

For traditional knowledge media producers, this opened the chance to re-use (recycle) already existing materials, e. g., from recently published atlases and encyclopedias or simply rebranded products (such as medium-scale travel maps) to tap into new buyer groups. The atlases of traditional map producers were high quality products with thoroughly investigated content and visualization modes, that were contemporary state of the art. Unfortunately, the events of the war after summer 1915 only produced large loss figures rather than significant territorial changes. This left the demand of the saturated market for small-scale maps to fall significantly and the production of this type of war atlases declined after 1916.

More sustainable was the market for ready-made, detailed information on the battlefields. This led to the production of rather cheaply produced and affordable war atlases for the masses, depicting geographic information taken from unnamed sources (often pre-war railway or travel atlases) and focusing the depiction of placenames mentioned in the news. The maps often lacked a uniform representation and their sequence in an atlas was mainly driven by the importance of the respective war zone in the newspapers. They became the ‘little geographic helpers’ of the war, enabling people back home to identify the whereabouts of their loved ones and for soldiers in the trenches to find their own location. Interestingly, only two of these atlases described contained a gazetteer and only some provided a table of contents – both indispensable parts of standard atlas productions.

Note

The author started collecting German war atlases some years ago to follow the centenary anniversaries of WWI events. What started as a small bookshelf steadily grew but is still far from being complete. Poor paper quality of the post-1915 atlases didn’t help to preserve them over time, even in library collections. Moreover, the archives of several publishing ventures were lost during WWI and WWII. Some newly digitized sources such as the Börsenblatt für den Deutschen

Fig. 17 A loose-leaf atlas? The collector's box and maps from the series Flemmings Große Spezialkarte des Krieges (Courtesy: Leibniz Institute for Regional Geography)

Buchhandel, or historic geographic journals containing literature reviews, might help to fill the gaps and permit a more complete characterization of war atlases as history-driven documents.

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Jeremy Black, *Maps of War. Mapping Conflict through the Centuries*, Conway, London, 2016.

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Kriegsatlas, Verlag F. A. Brockhaus, Leipzig. Three editions between 1915 and 1917 with slightly changing sets of maps could be identified. All maps are taken from pre-war editions of the Brockhaus Konversations-Lexikon and the Kleiner Brockhaus.

Kriegsatlas, P. J. Oestergard Verlag und kartographische Anstalt, Berlin. One edition in 1915 containing small scale maps taken from the publisher's pre-war production lines.

Kriegsatlas. Chronologischer Atlas bei Kämpfe des Weltkriegs in Europa und an den Grenzen der asiatischen Türkei. 1. Teil. Von der Mobilmachung bis zur großen russischen Sommeroffensive 1916. Ed. Oblt. Frh. M. v. Sartor. Velhagen & Klasing, Bielefeld, Leipzig, 1917.

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Kriegsatlas über sämtliche Kriegsschauplätze, Geographischer Verlag GmbH, Leipzig. Several editions (also licensed to newspapers) published between 1915 and 1916, all containing the same set of unchanged maps.

Kriegs-Atlas, S. Schnurpfeil Verlag, Leipzig. Two editions in 1914 could be identified, the second with a set of maps adapted to the war events. The first edition was also the first war atlas distributed in the Börsenblatt für den Deutschen Buchhandel 1914.

Kriegs-Atlas, Verlag Ullstein & Co., Berlin. Several updated and supplemented Editions from 1915 to 1918.

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Taschen-Atlas der Kriegsschauplätze, Deutscher Kriegsverlag A. G., Berlin. Seven editions published between 1915 and 1917 with later varying sets of maps could be identified. The first five edition contain the same set of unchanged maps. One edition was licensed to the German war disability aid.

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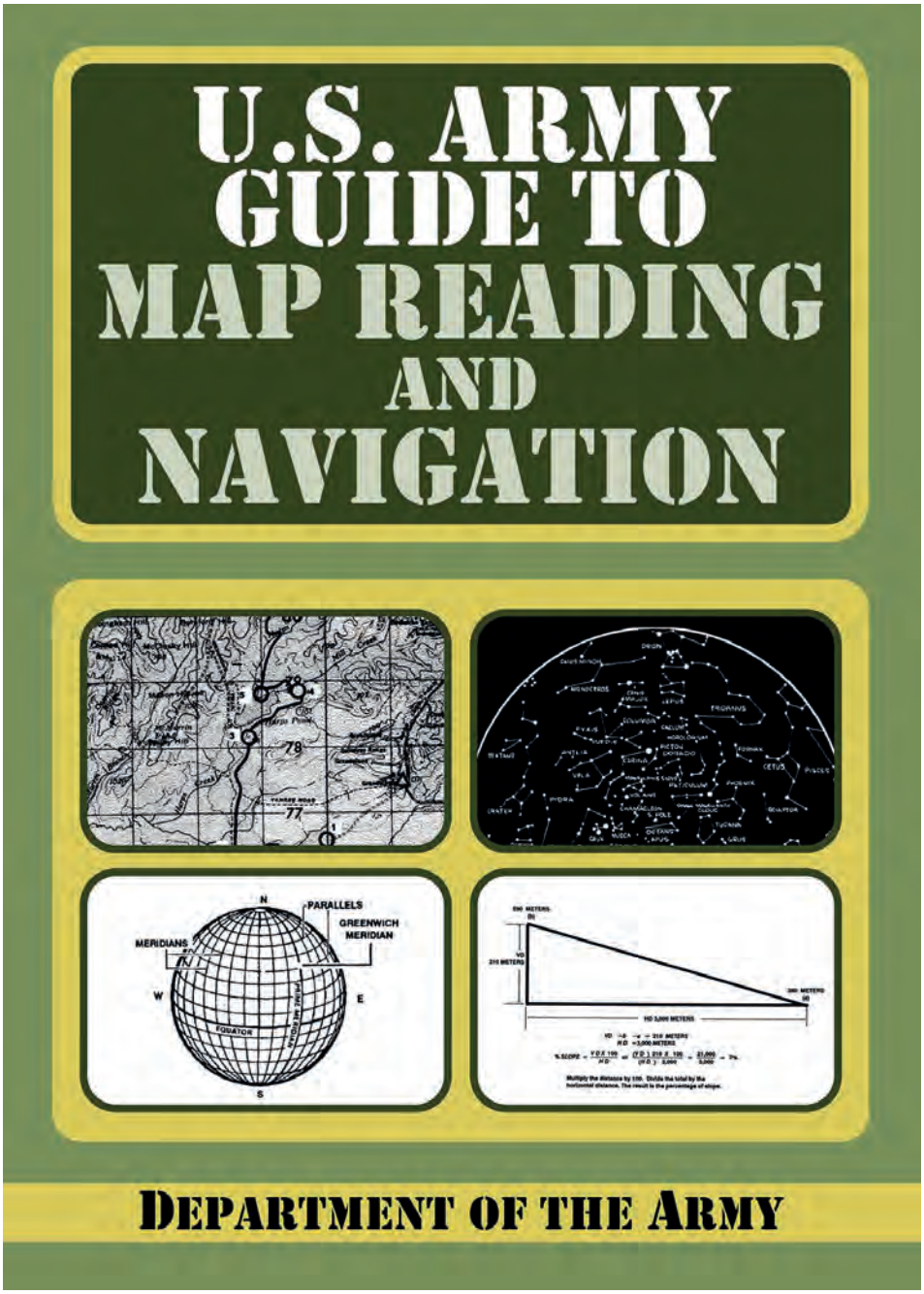
U.S. ARMY
GUIDE TO
MAP READING
AND
NAVIGATION
N
PARALLELS
GREENWICH
MERIDIAN
MERIDIANS
W
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DEPARTMENT OF THE ARMY

L'utilizzo dei colombi viaggiatori nella Prima Guerra mondiale

di Massimo Rossi
Fondazione Benetton Studi Ricerche

Abstract. The military use of pigeons dates back to antiquity, and still had great strategic importance during the First World War. Unpublished documents from the Historical Archive of the Italian Army Staff and from the Museum of the Engineers' Weapon testify to the regular use of these birds and their extraordinary reliability, especially during the battle of Vittorio Veneto, with a precise mapping of the location of the mobile dovecotes and the search for confidential information in occupied territories behind enemy lines.

Keywords. Traveling Pigeons, First World War, Mobile Military Dovecote Map

Le carte da guerra documentano anche antichissime geografie aeree che ancora sopravvivono nella modernità della prima grande guerra industriale: quelle dei colombi viaggiatori.

La documentazione rintracciata a Roma, nell'Archivio Storico dello Stato Maggiore dell'Esercito, mostra la dislocazione delle colombaie mobili sul fronte del Piave e le soluzioni pensate dallo Stato Maggiore per invitare le popolazioni dei territori occupati a fornire vitali informazioni attraverso questi animali, imprendibili a una quota di poco superiore ai 100 metri e perfettamente addestrati a far ritorno nei luoghi di nascita[1].

È nota l'importanza strategica dell'impiego di questi preziosi volatili per effettuare ricognizioni fotografiche[2], per i quali vennero prodotti supporti logistici

1 Questo contributo riprende un precedente studio pubblicato in Massimo ROSSI, *La geografia serve a fare la guerra? Riflessioni intorno a una mostra*, Fondazione Benetton Studi Ricerche-Antiga Editore, Treviso 2016, pp. 97–100.

2 Hans Jürgen SCHULTZ, « Apotheker, Erfinder und Fabrikant: Hofapotheker Dr. phil. Julius Neubronner (1852–1932) », in Gernot SCHÄFER und Rüdiger FIEDLER (Hrsg.), *125*

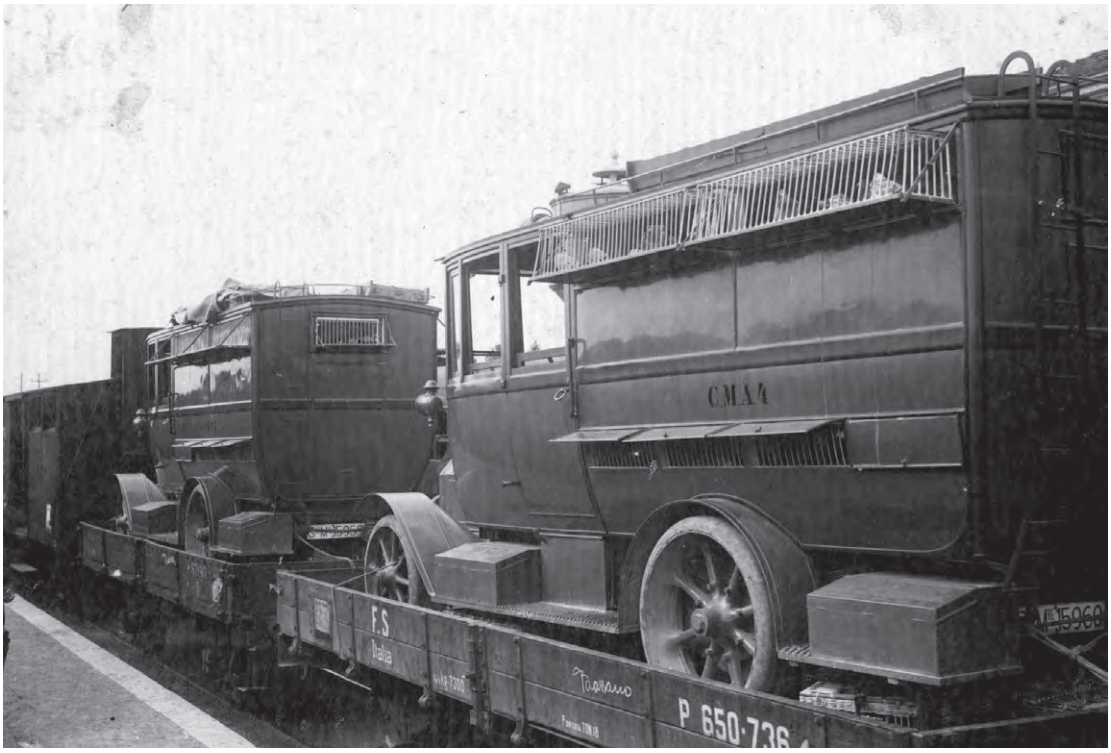


Fig. 1 Colombaie mobili su autocarri, Istituto Storico e di Cultura dell'Arma del Genio, Roma, Archivio fotografico, foto n. 011112.

come colombaie mobili su autocarri (fig. 1), colombaie fisse e materiale colombofilo vario: cestini (fig. 2), zainetti, abbeveratoi, portadispacci, taccuini, colombigrammi (fig. 3).

Agili libretti a stampa curati dallo Stato Maggiore precisano con cura le *Norme* relative al trattamento e all'educazione dei colombi, sottolineando l'importanza del rapporto esclusivo tra i pennuti e il "personale colombofilo" dedicato al loro addestramento e cura.

Scrupolose procedure riguardavano la scelta del luogo di stazione della colombaia:

> Sarà scelta una posizione scoperta, tranquilla, soleggiata [...] lontana da edifici e boscaglie, da reti telegrafiche e telefoniche ed esposta il meno

Jahre Gießener Burschenschaft Frankonia 1872–1997, Selbstverlag der Gießener Burschenschaft Frankonia, Gießen 1997, pp. 101–104.

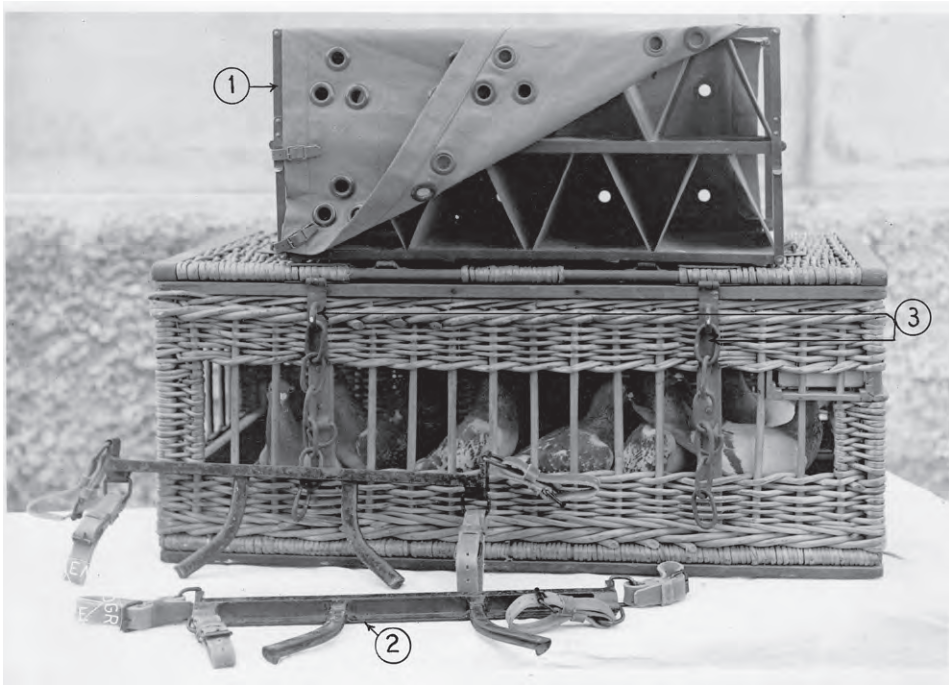


Fig. 2 Cestino contenente colombi, Istituto Storico e di Cultura dell'Arma del Genio, Roma, Archivio fotografico, foto n. 017979.

Fig. 3 Colombogramma, Fasc. E1 190, 1918, c. n.n., Ufficio Storico dello Stato Maggiore dell'Esercito, Roma.

> possibile ai venti ed all'umidità [...] la colombaia verrà orientata in modo che lo sportello di uscita dei colombi sia rivolto verso sud-est[3].

Le norme comprendevano ogni dettaglio e stabilivano rigorose procedure per la pulizia, l'adattamento e l'addestramento dei colombi ai loro compiti. Un'accurata *Relazione sul servizio dei colombi viaggiatori durante l'offensiva italiana di ottobre*[4] - dunque relativa alla battaglia di Vittorio Veneto iniziata il 24 ottobre 1918 - spiega dettagliatamente l'impiego del servizio colombofilo della 3ª armata, con il dispiegamento di sei colombaie mobili presso i comandi di divisione, tre colombaie fisse presso i comandi di corpo d'armata e altre due (una mobile e una fissa) presso il comando d'armata, per consentire il collegamento tra l'armata e le truppe operanti, e infine una colombaia fissa di estrema riserva dislocata a Strà, in provincia di Venezia.

Nel corso dell'offensiva vennero impiegati circa 1500 colombi con un lancio di 800 colombigrammi, e una perdita complessiva di 180 volatili per le cattive condizioni atmosferiche (nebbia) e le lunghe distanze superiori ai cento chilometri in linea d'aria percorse dai colombi a causa della rapida avanzata italiana. L'anonimo "Ufficiale addetto", estensore della relazione, evidenzia l'eccellente servizio prestato dai colombi, che si dimostrarono un prezioso mezzo di collegamento specie nei primi momenti dell'avanzata quando tutti gli altri mezzi di collegamento furono paralizzati [...] la velocità oraria raggiunta dai colombi durante l'offensiva variò dai 50 ai 60 km [...] un colombo, il nero matricola 32, percorse il tratto Trieste-Mogliano (130 km in linea d'aria) in un'ora e 50 minuti.

E chiude la breve relazione con la seguente considerazione:

> il servizio colombofilo si è dimostrato di una utilità grandissima. Organizzato bene e dotato di larghi mezzi, come si usa in altri eserciti, sarà sempre uno dei principali e più sicuri mezzi di collegamento di cui possa disporre un esercito in campagna[5].

3 COMANDO SUPREMO, UFFICIO TECNICO, Norme Tecniche riflettenti il trattamento e l'educazione dei colombi delle colombaie mobili militari, ottobre 1918, Roma, Comando del Corpo di Stato Maggiore, Sezione Tipo-Litografica, 1918, p. 6.

4 COMANDO DELLA 3ª ARMATA, UFFICIO COLOMBOFILO, 3 dicembre 1918, n. 964 di prot., pp. 1-2, Roma, Archivio Storico dello Stato Maggiore.

5 COMANDO DELLA 3ª ARMATA, UFFICIO COLOMBOFILO, 3 dicembre 1918, n. 964 di prot., p. 3, Roma, Archivio Storico dello Stato Maggiore.

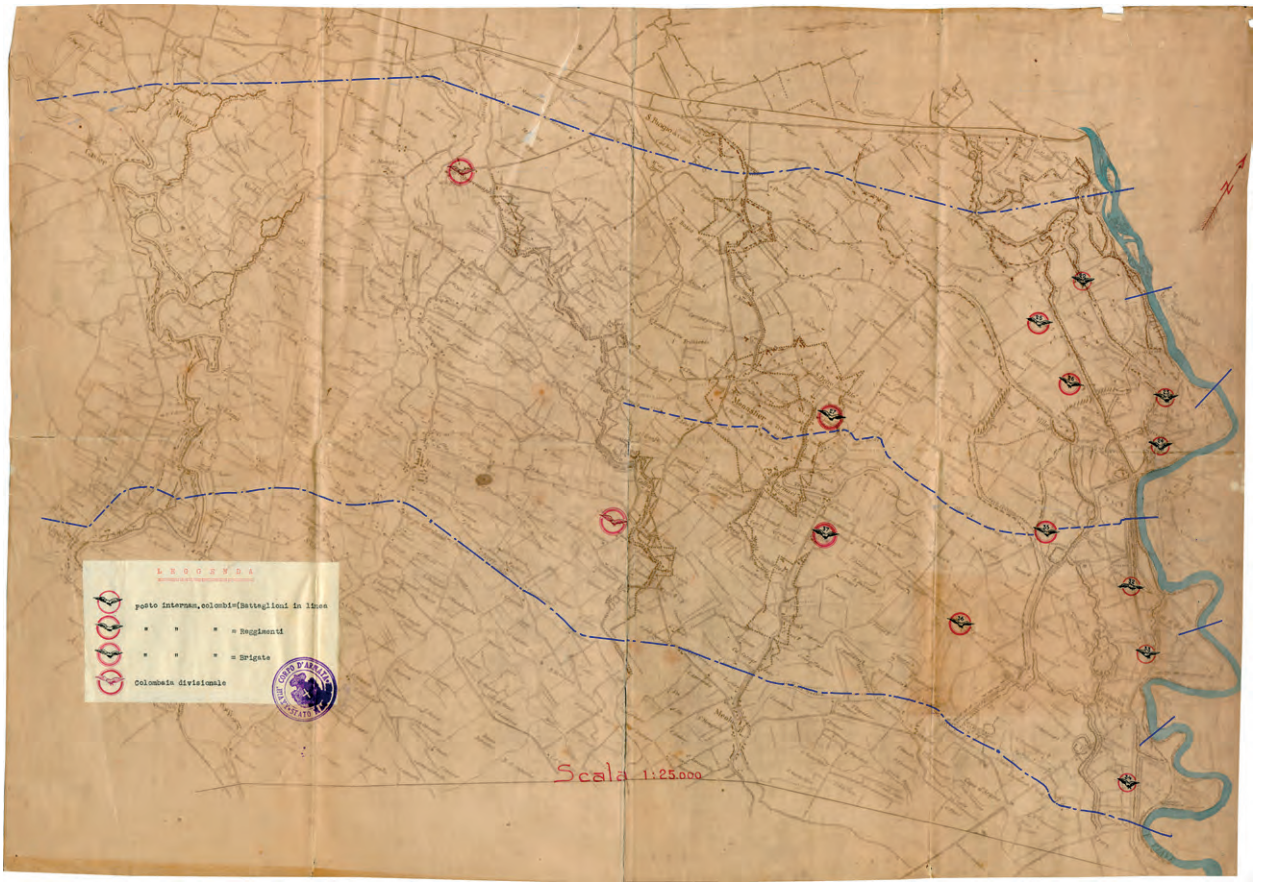
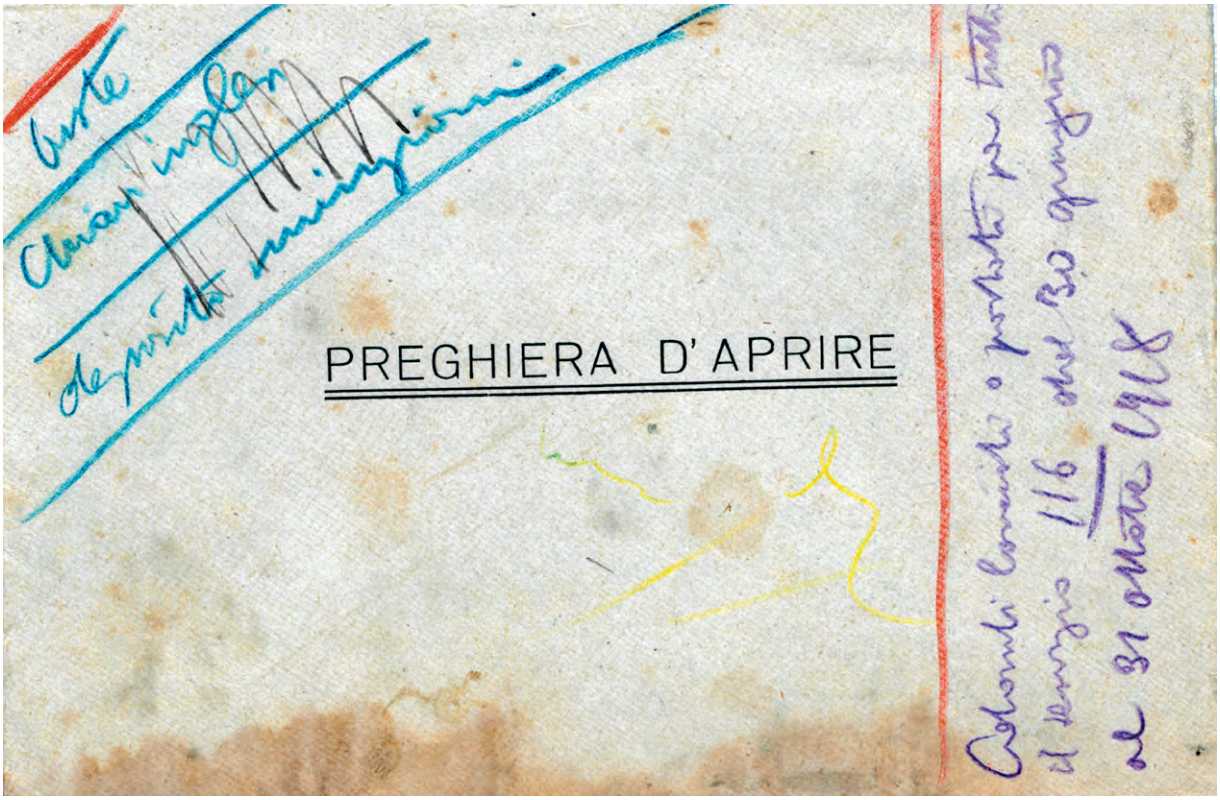


Fig. 4 Carta delle colombaie militari mobili, fasc. E1 190, 1918, c. n.n., Ufficio Storico dello Stato Maggiore dell'Esercito, Roma.

Oltre all'impiego di cui abbiamo appena trattato, i colombi viaggiatori eseguirono anche compiti di ricognizione fotografica, muniti di apparecchi fotografici di dimensioni e peso ridotti, utilmente adattati al loro petto con apposite imbragature e timer per l'autoscatto.

Nel già citato Archivio Storico dello Stato Maggiore è conservata una cartografia su base IGM in scala 1:25.000 che documenta la dislocazione delle colombaie mobili nel territorio in destra Piave tra le località di Salgareda e Fossalta e un eloquente kit appositamente studiato per essere paracadutato nei territori occupati e ricevere informazioni dalle popolazioni (Fig. 4).

Nelle immagini seguenti abbiamo riprodotto i materiali preparati dall'Ufficio colombofilo che, inseriti in una busta con la scritta esterna «Preghiera d'aprire», contengono tre fotografie che illustrano chiaramente come operare per inserire il colombogramma nella zampa del piccione e predisporlo al volo di ritorno (Figg. 5-5D). Inoltre, la busta contiene due avvisi indirizzati «A tutti i buoni italiani delle terre invase» con una serie di disposizioni da adottare.



Figg. 5-5D Busta contenente tre fotografie e un messaggio, fasc. E1 190,1918, c. n.n., Ufficio Storico dello Stato Maggiore dell'Esercito, Roma.


I
Come si introduce il biglietto nel tubetto


II
Come si chiude il tubetto

Lo scopo era di informare adeguatamente lo Stato Maggiore rispondendo alle seguenti domande:

Arrivano rinforzi? Quanti e di dove?

Arrivano in ferrovia oppure per la strada carrozzabile, in autocarro, a piedi?

Arrivano cannoni? Quanti e di che calibro?

Indicate sempre, se possibile, i numeri dei reggimenti, delle brigate, delle divisioni, dei corpi d'armata.

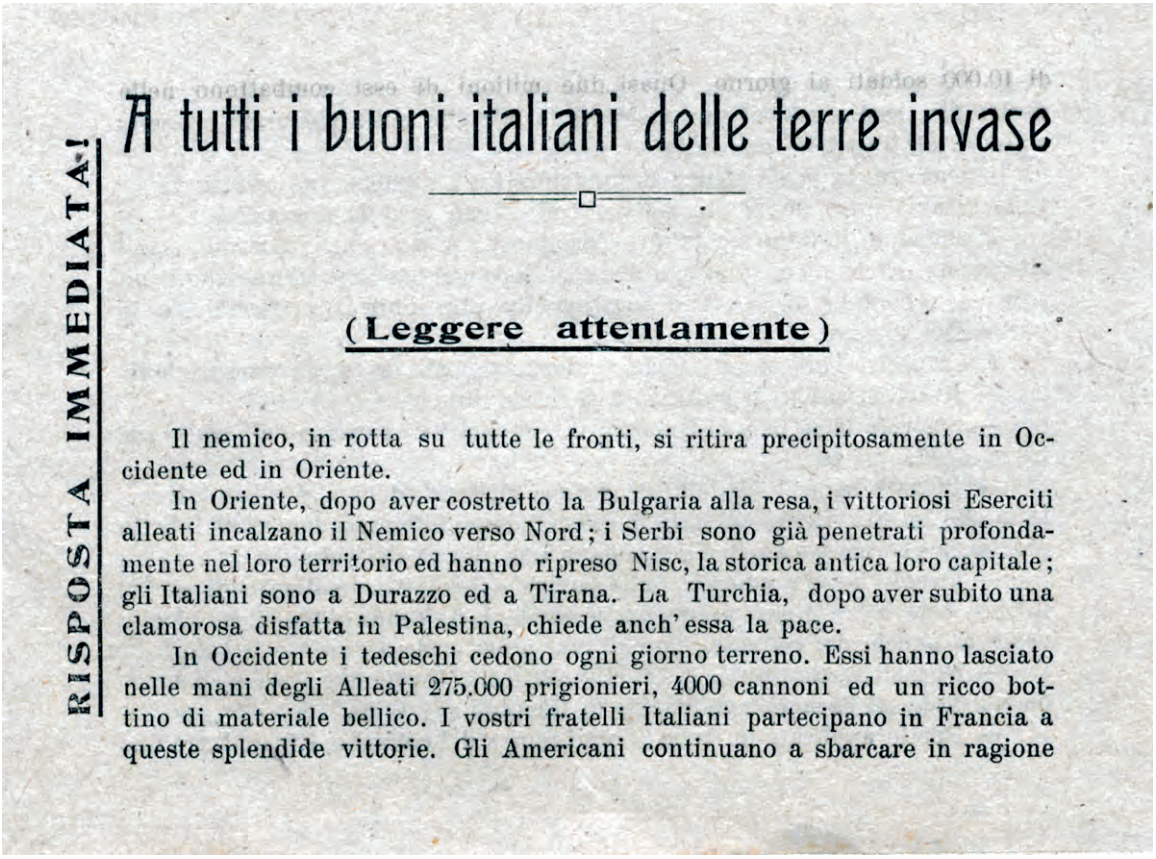
Vi sono truppe che partono e per dove?

Avete visto truppe germaniche? Oppure di altre nazioni nemiche? Le truppe nemiche sono demoralizzate? Avete notizie che siano scoppiate delle rivolte tra le truppe?

Avete visto depositi di munizioni? Dove sono?

Quali sono gli effetti prodotti sul nemico dalla nostra vittoriosa resistenza?

Vi sono delle riserve nelle retrovie?



RISPOSTA IMMEDIATA!

A tutti i buoni italiani delle terre invase

(Leggere attentamente)

Il nemico, in rotta su tutte le fronti, si ritira precipitosamente in Occidente ed in Oriente.

In Oriente, dopo aver costretto la Bulgaria alla resa, i vittoriosi Eserciti alleati incalzano il Nemico verso Nord; i Serbi sono già penetrati profondamente nel loro territorio ed hanno ripreso Nisc, la storica antica loro capitale; gli Italiani sono a Durazzo ed a Tirana. La Turchia, dopo aver subito una clamorosa disfatta in Palestina, chiede anch'essa la pace.

In Occidente i tedeschi cedono ogni giorno terreno. Essi hanno lasciato nelle mani degli Alleati 275.000 prigionieri, 4000 cannoni ed un ricco bottino di materiale bellico. I vostri fratelli Italiani partecipano in Francia a queste splendide vittorie. Gli Americani continuano a sbarcare in ragione

Gli avvisi non trascurano di raccomandare all'informatore l'attenta cura da prestare al piccione:

> dategli da mangiare (il grano lo trovate nel cestino stesso) e da bere; se è di giorno, lasciatelo dolcemente in aria; se è di notte posatelo sul tetto o sopra un albero; partirà all'alba e arriverà nelle nostre linee in una o due ore al massimo. Non temete che gli austriaci possano vederlo: è impossibile.

Preoccupazione dell'Ufficio colombofilo era anche quella di verificare «la sincerità» delle notizie ricevute, consigliando gli informatori di «indicare i nomi e il recapito di due persone (militari o borghesi) che abitano attualmente in Italia» e di ricompensare adeguatamente gli informatori, in caso di notizie rivelatisi utili, con «una gratificazione da L. 550 a L. 1000 (secondo l'importanza) per ogni dispaccio».

Conclusioni

Contrariamente a quanto si possa pensare i colombi viaggiatori vengono ancora utilizzati per trasferire messaggi o trasportare beni. È documentata la loro preziosa funzione in aree particolarmente trafficate a terra per portare medicinali o altro, sfruttando la sommità dei grattacieli, ma soprattutto il loro diffuso impiego come atleti in campionati di velocità nell'ambito di Federazioni che riuniscono gli allevatori di vari paesi. La Federazione Colombofila Italiana, con sede a Reggio Emilia, ha recentemente effettuato un lancio dimostrativo nell'ambito del ciclo di incontri pubblici sul tema *La geografia serve a fare la guerra?* per evocare il loro impiego nel corso della Grande Guerra (https://www.fbsr.it/agenda/colombi-viaggiatori-dalla-grande-guerra-oggi-cosa-serve-la-geografia/).

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Allied Military Mapping of Italy during the Second World War

by Peter Collier
Formerly University of Portsmouth

Abstract. Planning for the allied invasion of Italy started in the Survey Directorate, General Headquarters, Middle East (GHQ ME), on 22 February 1943. However, British mapping of Italy had started before February 1943 as part of general mapping on Europe at small scales in anticipation of a European war. 1:1,000,000 series mapping had commenced in 1938, 1:500,000 series mapping for the Royal Air Force (RAF) in 1941 and at 1:250,000 also for the RAF in 1940. Additional 1:250,000 series for the Army and the Army and RAF were produced a little later. Topographic maps of Italy had been produced from 1941 by direct reproduction from Italian maps. Mapping of the Italian theatre, remained a largely British responsibility following the Loper-Hotine Agreement of May 1942. After a brief account of mapping activities during the Second World War, there follows a more detailed discussion of the sources, production and style of the different map series produced. It will include a discussion of the more specialised maps, such as "collation" editions, the "goings" editions and the bilingual and multi-lingual editions produced to meet the needs of Polish, Italian and French forces.

Keywords. Military Mapping, Italy, Aerial Photography, Allied Armies

Introduction

Cartographic preparations for the allied invasion of Italy started in the Survey Directorate, General Headquarters, Middle East (GHQ ME), on 22 February 1943 following an exercise at GHQ ME two days earlier.[1] The subsequent allied military mapping of Italy can be seen as a forerunner of the far larger enterprise prior to the invasion of Normandy in 1944 and a development of some of the mapping pioneered for Operation Torch, the invasion of North-West Africa, and in the fighting in the Western Desert.

1 R.E. Fryer, *Survey Notes on Operation "Husky" 22 Fb to 10 Jul 1943*, Survey Directorate G.H.Q. Middle East Force, Egypt, 1943, p. 1.

Allied military mapping of Italy did not start in 1943, some mapping had been carried out by both the British and the French during the First World War when they had been allies of Italy in fighting the Central Powers. This mapping was of limited extent and largely focussed on the frontline areas in the Dolomites. The Service Géographique de l'Armée maintained 1:1,000,000 general mapping of Italy as part of its general map of Europe.

Primary responsibility for the mapping of Italy, and the rest of Europe, lay with the British following the Loper-Hotine Memorandum of Agreement of May 1942. In this agreement Herbert B. Loper (Chief of the Intelligence Branch of the Chief of Engineers U.S. Army) and Martin Hotine (Director of Military Surveys, War Office) it was decided to divide the world for mapping purposes between the two allied powers to avoid duplication of effort[2]. The maps and reprographic material would be exchanged to permit each ally to produce maps themselves, if required. For example the United States would produce maps locally using British material for pre-operational use in the United States, such as prior to Operation Torch, the invasion of North-West Africa.

Production of maps for the Italian theatre was carried out at a number of different locations during the course of the war. Much of the basic mapping was carried out by the Geographical Section, General Staff (G.S.G.S.) at various production sites in Great Britain. These maps normally carry a G.S.G.S. number, but most of the mapping for Operation Husky (the invasion of Sicily) was carried out by the Survey Directorate, G.H.Q. Middle East Force, based in Egypt. This mapping normally carry a Middle East Drawing and Reproduction (M.D.R.) number, or more rarely an Egypt Drawing and Reproduction (E.D.R.) number. Once an Allied Forces Head Quarters was established in North Africa map production from attached survey units was given an A.F. number. AF numbers continued to be used once the Allied Forces Head Quarters moved to Italy. Some mapping is also found with a P.D.R. number. These maps were prepared by the Survey of Palestine under contract from the Survey Directorate. Like G.S.G.S. mapping, M.D.R. and E.D.R. mapping had series numbers, although M.D.R. sheets included a sheet number, for example M.D.R. 618/8657 which is the Naval Collation

2 A.B. Clough, *Maps and Survey,* War Office, London, 1952, p. 43. Clough is the definitive work on British military surveys during the Second World War, but it also has significant amounts of information on American military mapping due to the overlapping activities of the two military surveys.

Map, Edition III of Sheet 10, Avola, of the 1:25,000 mapping compiled for the invasion of Sicily. The original number of Sheet 10, Avola, is M.D.R. 618/8468. Why different styles of series designations were adopted in the Middle East and Mediterranean Theatre from those used in G.S.G.S. is not clear as it is not discussed in Clough, Fryer or G.S.G.S.[3]

Most of the mapping carried out by western allies was based or directly copied from Italian originals,[4] although there was some original 1:25,000 mapping from aerial photography from spring 1944 by the American who had multiplex plotting equipment.[5] As much of the mapping of Italy carried out during the war was based on copies of Italian originals, it was decided that name-forms would conform to local usage to avoid confusion when both redrawn and directly copied Italian maps were used. However, there were exceptions, the 1:250,000 series G.S.G.S. 3982, Europe (Air), discussed below, used English versions of place names, such as Florence for Firenze and Naples for Napoli. It is not clear why this was as the earlier 1:1,000,000 G.S.G.S 2758 Europe used local place names. Another decision was to use the South Italy Grid Zone to cover southern Italy, and the North Italy Grid Zone to cover northern Italy. The South Italy Grid extended as far north as the northern tip of Corsica and the 43rd parallel south of Firenze. Grids posed a far smaller problem in Italy than they did in the Balkan where there were multiple grids in use.[6] There was a fear that problems would be encountered as Allied forces approached the junction between the South Italy Grid and the North Italy Grid, but the advance crossed the junction so quickly in pursuit of German forces that no problems arose.

3 Clough, 1952; Fryer, 1943; G.S.G.S., *Notes on G.S.G.S. Maps of Italy Sicily, Sardinia and Corsica,* War Office, London, 1943.

4 Peter Collier and Mike Nolan, « Military Mapping by Breat Britain », in Mark Monmonier (ed.), *The History of Cartography Volume Six: Cartography in the Twentieth Century,* University of Chicago Press, Chicago, 2015, pp. 895.

5 Clough, 1952, 311.

6 Mirela Altić, « Military Cartography of WWII: The British Geographical Section of the General Staff and the US Army Map Service and their Production of the Topographical Map Series of the Balkans (1939-1945) », *Storia Militare Della Geografia* Quaderno, (2020), p. 498.

Small Scale Mapping

The first British mapping of Italy in anticipation of a possible war was the revision of the 1:1,000,000 G.S.G.S. 2758 a general map of Europe which had been started during the First World War. The Roma sheet (K-33) was revised in 1939 together with those of Palermo (J-33) and Tunis (J-32), which covered the southern half of Sardinia. The Trieste sheet (L-33) followed in 1940, but the Lyon-Milano sheet (L31 (part) & L-32) did not follow until 1942. Initially, the specification of G.S.G.S. 2758 closely resembled that of the International Map of the World, but it was subsequently changed to the "Ground/Air style with a change in the colours, replacing the green and brown for relief layers by shades of violet and an increased emphasis on features conspicuous from the air. The changes were intended to increase the map's usefulness to air crew and include colour changes to make the maps suitable for night flying. The first sheet issued in the Ground/Sir style was Lyon-Milano.[7]

Production of a map series at 1:500,000, G.S.G.S. 4072, was commenced in 1941 specifically to meet Royal Air Force Bomber Commands requirement for a map suitable for night flying. The level of detail was greatly reduced to remove features which were not essential for navigation. Layer tinting for heights used shades of violet to aid interpretation under the amber cockpit lights. The heights of mountain and hill peaks are shown prominently with the heights of the highest peaks in an area being shown in a larger font size. Woodland is shown conspicuously on this series in a mid-green as both an aid to navigation and as an obstacle to be avoided. The coverage of Italy was completed in 1942 (Fig. 1).

The existing 1:250,000 series G.S.G.S. 3982 Europe Air was extended to cover Italy with the maps being compiled between 1940 and 1942. The maps of this series were generalised for air navigation use, which made them less suitable for military use. The series was compiled primarily from the 1:250,000 Carte d'Italia, del Touring Club Italiano. The specification adopted, with brown contours was designed for use in daytime navigation (Fig. 2). G.S.G.S. 3982 was quite quickly superseded by G.S.G.S. 4230 for Italy (Fig. 3) and G.S.G.S. 3982 for Sardinia (Fig. 4). These two series were in the Army/Air style intended for use by both the Army and the Royal Air Force. The maps by direct photographic copying from the Carte d'Italia, del Touring Club Italiano. This meant that the maps were much

7 G.S.G.S, 1943, p.2.

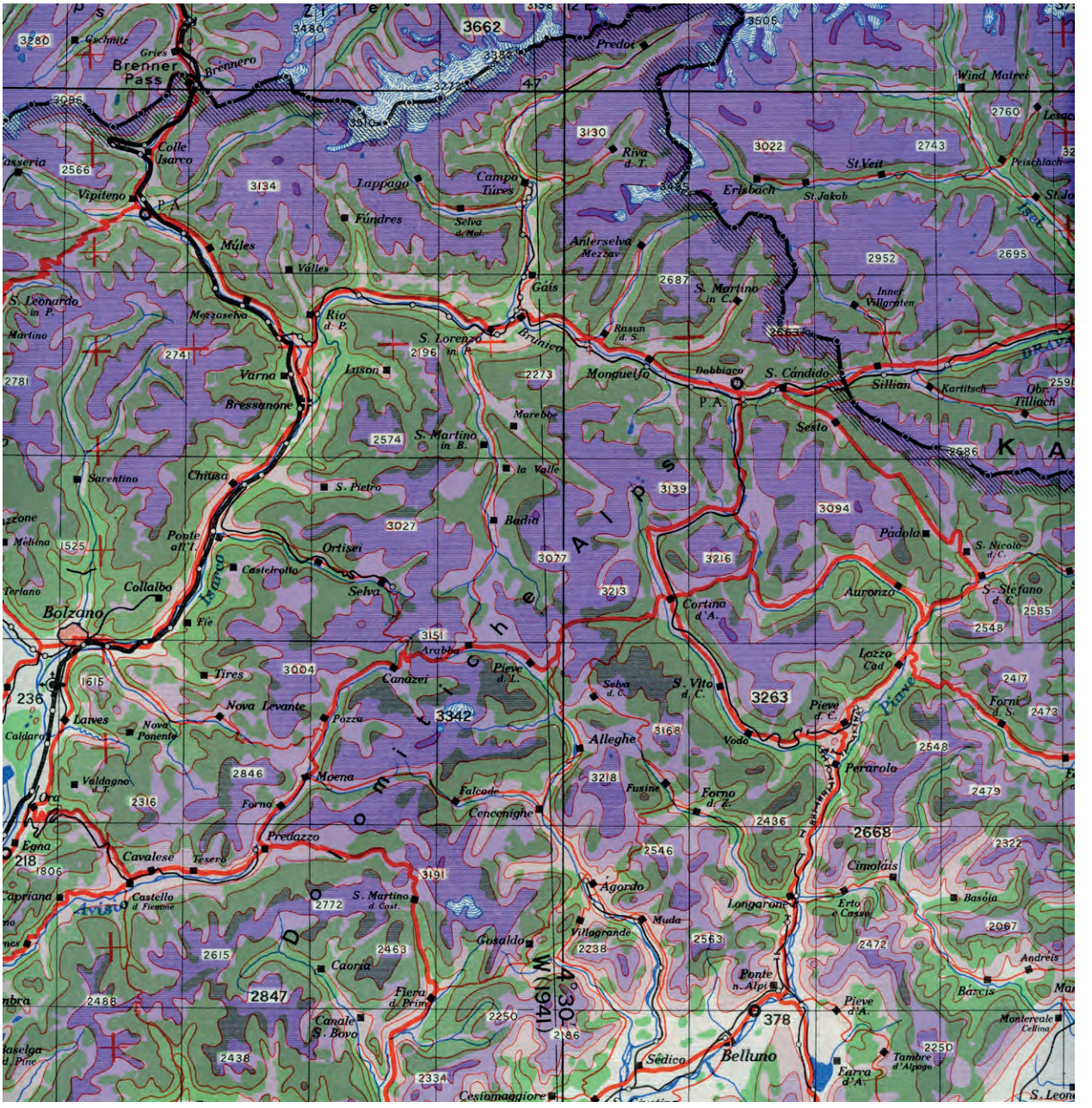

Fig. 1 Detail of the 1:500,000 Bolzano sheet (N.E. 46/10) G.S.G.S 4072 showing part of Northern Italy. The map, dated December 1941, has the distinctive colours of one made for navigation at night. (Author's collection)

Fig.2 Detail of the 1:250,000 Florence sheet (K.32/3) First Edition, G.S.G.S 3982, dated 1940, showing part of Tuscany. The map colours were designed for day-time navigation. The whole series were superseded early in the war. (Author's collection)

more detailed than those of G.S.G.S. 3982. The contours of the Italian maps were used to plot layer boundaries with layer tinting being printed in shades of violet enabling the maps to be used for night flying. The sheet lines were the same as

Fig.3 Detail of the 1:250,000 Domodossola sheet (Sheet 2) G.S.G.S. 4230 Second Edition. This example dated 1944, lacks the distinctive violet relief tints used for night navigation. (Author's collection)

those of the Italian originals. By 1 May 1943 sheets were available covering Sicily and mainland Italy south of Napoli. Seven sheets were issued for the invasion of Sicily with 30,000 copies of each printed[8].

8 FRYER, 1943, Appendix D provides a full list of all the standard maps ordered to be printed prior to the invasion of Sicily. Except for the 1:250,000 series, the Appendix lists the sheets numbers and the number of copies of each sheet to be printed. The number of overprints is not listed. Maps to the east of approximately 14° East were allocated to the Survey Directorate Middle East Force (SDMEF), those to the west of that line were allocated to Allied Forces Head Quarters (AFHQ). Unfortunately, CLOUGH (1952) only quotes global map printing numbers (just over 138 million) and does not break it down even between map scales.

Fig. 4 Detail of the 1:250,000 Sassari sheet (K. 32/II) First Edition G.S.G.S. 3982. This edition, dated 1942, was intended to be used by both ground and air forces. (Author's collection)

In 1941 a 1:1,500,000 map showing rail communications, G.S.G.S. 4176, Italy and Neighbouring Countries: Railways was issued (Fig. 5). This map was one of series produced for European countries, including neutral countries. This map was also reproduced in the United States by the Army Map Service (A.M.S.) in 1943. G.S.G.S. 4438, Europe Communications was a 1:800,000 series which covered Europe. Italy was covered by the Austria and Northern Italy sheet and the Central and Southern Italy sheet. The maps did not show relief and comprised an outline topographic map in brown, which included all place names, together with a solid light blue for the sea and lakes. This was over-printed with roads in red, railways in black and navigable waterways in a dark blue. The maps were derived from the Bartholomew 1:1,000,000 map of Europe and supplement with information from foreign official waterways maps. The waterways were classified in terms of the draughts of vessels that could use them.[9] In addition to the sheets showing all communications, printings just showing road, or railways or waterways, or any combination, were also produced.

Fig.5 Detail of the 1:1,500,000 Italy and Neighbouring Countries: Railways map published originally in 1941 as the War Office First Edition, G.S.G.S. 4176.a, this is an A.M.S. reprint from 1943. (Author's collection)

9 G.S.G.S., 1943, p.23.

1:500,000 road maps for Sicily and Sardinia were produce in preparation for the invasion of Sicily as U.S. forces were accustomed to using them while British forces used normal topographic maps.[10] To meet the needs of U.S. forces in 1943, the A.M.S. produced a 1:200,000 road map of Italy derived from the Carte d'Italia, del Touring Club Italiano. Relief was shown by hill shading in sepia. Roads were classified with steep grades shown together with distances. This map proved popular with all allied forces.[11]

Medium Scale Mapping

Initial work on the production of medium scale of Italy was started by the War Office in Britain, in late 1941, but given a low priority. This involved colour separation of the Italian 1:100,000 and copying of 1:50,000 and 1:25,000 map sheets.[12] The intention was not to print stocks in Britain, but to provide reprographic material to enable production in the Middle East if needed. This was in the form Kodalines (film negatives) or colour pulls, from which printing plates could be made. Subsequently, the War Office produced revised editions which included colour and revision from aerial photography. Initially, there was little aerial photographic cover, and much of what did exist had been taken for targeting by the Royal Air Force.

1:100,000 Scale Mapping

Of the three medium scale topographic series, the 1:100,000 is the simplest to discuss as it went through fewer changes and revisions than the 1:50,000 and 1:25,000 series. This is probably due to the series being found to be less useful except as a wall map in local headquarters. Individual sheets covered insufficient area to be useful for more strategic planning of large scale movements of bodies of troops. At the same time, the maps were too small scale and lacking in detail for ground force tactical operations and targeting by artillery. A conference held at A.F.H.Q. following the end of hostilities decided that if one of the medium scale maps had to be given up, it was the 1:100,000.[13] The chief advantage of the

10 Clough, 1952, 306.
11 Clough, 1952, 310.
12 Clough, 1952, 303.
13 Clough, 1952, 321.

1:100,000 at the start of the mapping programme was that it was the only medium scale map that covered the whole of Italy

Printing of the 1:100,000 series (G.S.G.S. 4164) by the War Office started in 1941 (Fig. 6). The first edition was monochrome, but was followed in the course of 1942 and 1943 by the second edition in four colours, black for detail, brown for contours and rock drawing, red fill for road classification, with Autostrada in solid red and the addition of filled red circles every 18mm on the map; solid red for main roads with the road number shown alongside the road also in red; other roads 5m wide or over had a pecked red fill with the pecks about 8mm long and gaps of about 3mm; secondary roads, roads 3-5m wide had red pecks with 2mm pecks and 3mm gaps, and blue for hydrology and the sea. The sea was shown in different ways on sheets of similar dates. Some sheets have a half-tone blue fill for the sea, while others have the effect of vignetting by using blue lines parallel to the shore and increasing the separation of the lines as the distance from the shore increases. All have a black military grid, with the grid numbers in blue. However, all longitudes are based on the Rome meridian, with a note on the bottom of each sheet stating that the Rome meridian is 12^{o} 27' 7.122 east of Greenwich.

A major limitation of the 1:100,000 maps was their depiction of woods. The woods are show by small black poorly defined circles which are difficult to see on many of the maps due to their small size and colour and easy to confuse with the house symbols (G.S.G.S. 1943 7). Nine sheets of Sicily which were revised from aerial photography had woods in green with an outline as a solid line and vertical hatching broken where it would have crossed detail. The sample given in G.S.G.S. (1943) is on one of the revised sheets.

All sheets printed in Great Britain only carry the G.S.G.S. number and "Photolithographed by O.S." followed by a date. Sheets printed in the Middle East normally have M.D.R. 540/ followed by an individual sheet number and who printed the sheet, typically 512 Field Survey Company, but some printings were by 13 Field Survey Company. Sheets printed in North Africa (and later in Italy) would normally have an A.F. number and who printed the sheet. Imprints from a Lithographic Section attached to 46 Company South African Engineer Corps, and 649th Engineer Battalion of the United States Army, among others are found on A.F. numbered sheets. During the preparations for Operation Husky printing in the Middle East was delayed due to the pulls being unsatisfactory for making print-

Fig. 6 Detail of the 1:100,000 Messina-Reggio Calabria sheet (254) G.S.G.S. 4164, M.D.R. 540/7819, Second Edition dated May 1943. The M.D.R. number indicates that this sheet was printed in Egypt from reprographic material supplied by the War Office in London. (Author's collection)

ing plates and the need to obtain Kodalines instead. It was recognised that where possible only Kodalines should be used.[14] Prior to the invasion of Sicily a total of 27 different sheets were printed in a print run of 25,000 copies per sheet. One map sheet, 244 which coved the Lipari Islands, had a print run of only 5,000 copies.

All sheets carried a box to show the extent revision from air photos, but with the exception of some sheets for Sicily, this rarely, if ever, show that the sheets had been revised from air photos. Following the invasion of the Italian mainland it seems that direct air photo revision was limited to the 1:50,000 and 1:25,000 mapping. 1:100,000 sheets were, however, revised from the larger scale mapping, which had been revised from air photos. An example is Firenze Sheet 106. This map was revised in February 1944 by 661 Engineering Company (Top) U.S. Army from 2nd and 3rd editions of 1:50,000 mapping, which had been revised from air photos flown in August 1943. The sheet was then overprinted with a "Heersgitter" (a German military grid) in green. The Allied military grid has numbers in brown in the sheet margins and in red on the body of the map rather than the normal blue. The sheet also has the A.F. number cancelled and replaced by 8A Misc.3469 (i.e. 8th Army miscellaneous) and an overprinting date of July 1944 by 514 Corps Field Survey Company. The precise use of this map is unclear, but it may have been intended to be used to locate German military positions using intercepted signals.

There was some demand for layer (hypsometric) tints on the 1:100,000 maps as the contours were often difficult to interpret.[15] For areas below 100 metres no layer tint was used, with green and brown being used for layers above that altitude. As hypsometric tints were only applied to the 1:100,000 series on printings in Italy in late 1943 and into 1944, G.G.G.G. 1943 does not contain an example, nor does Clough (1952), although he does include an example from a layer tinted 1:25,000 sheet.

While there was complete Italian coverage of Italy at 1:100,000, even if not all was up-to-date, much of northern Italy, especially the Po Valley was not covered at 1:50,000, and there were gaps elsewhere, around Rome, in Sardinia and Sicily. All of these gaps were however covered by 1:25,000 maps. More of a problem was the lack of currency. While much of the north was covered by post 1930

14 Fryer, 1943, 4.

15 Clough, 1952, 309.

mapping, as was Sardinia, the west coast from Napoli to north of Roma and a significant part of Emilia-Romagna, the rest of the country was covered by pre-1920 mapping, some as early as the 1860s.[16]

1:50,000 Scale Mapping

Production of the First Edition of the 1:50,000 started in 1941 and was published by the War Office as a black facsimile of the Italian map. The only addition was the South Italian Grid. Figure 7 is from the Bronte sheet 261 II and is typical of the quality of the reproductions. Like many of the sheets of areas which had seen little development in the early twentieth century, the Bronte sheet was from the nineteenth century, in this case from 1885. The first edition was printed in December 1941. A Second Edition (Coloured) was published in 1943, using a Kodaline from the War Office for the detail and pulls of the blue and red but revised and printed in Egypt and given the M.D.R. number 578/8152 (Fig. 8). Fryer notes that units in Cairo found that combining the Kodaline with the red and blue pulls created problem, and it was found quicker to redraw the red and blue.[17] The sheet carries a diagram of the area revised from air photos, but apart from the road classifications shows little change from the First Edition. The map is basically a reprint in brown of the First Edition, with the grid also now in brown, but with water features overprinted in blue and roads classified in red. As Clough notes, the Second Edition was originally printed in a grey-blue, rather than brown. In French grey-blue is "gris-bleu" which the British soldiers called "griblet".[18] The sheets were therefore referred to as griblets, even when the printing colour was changed to brown. As will be discussed below, the use of grey-blue for printing the detail on maps was revived when defence over-prints and other tactical information was printed on both 1:50,000 and 1:25,000 sheets. 18 different map sheets were printed for Operation Husky with 20,000 copies of each being made.

For areas of Italy that were covered by 1:25,000 mapping, but not by 1:50,000 maps, A.M.S. undertook to produce 1:50,000 mapping in the United States. The resultant maps were derived from a combination of 1:25,000 and aerial photography if available. The earliest First Edition sheets from 1943 were largely

16 G.S.G.S, 1943, 10.

17 Fryer, 1943, 4.

18 Clough, 1952, 305.

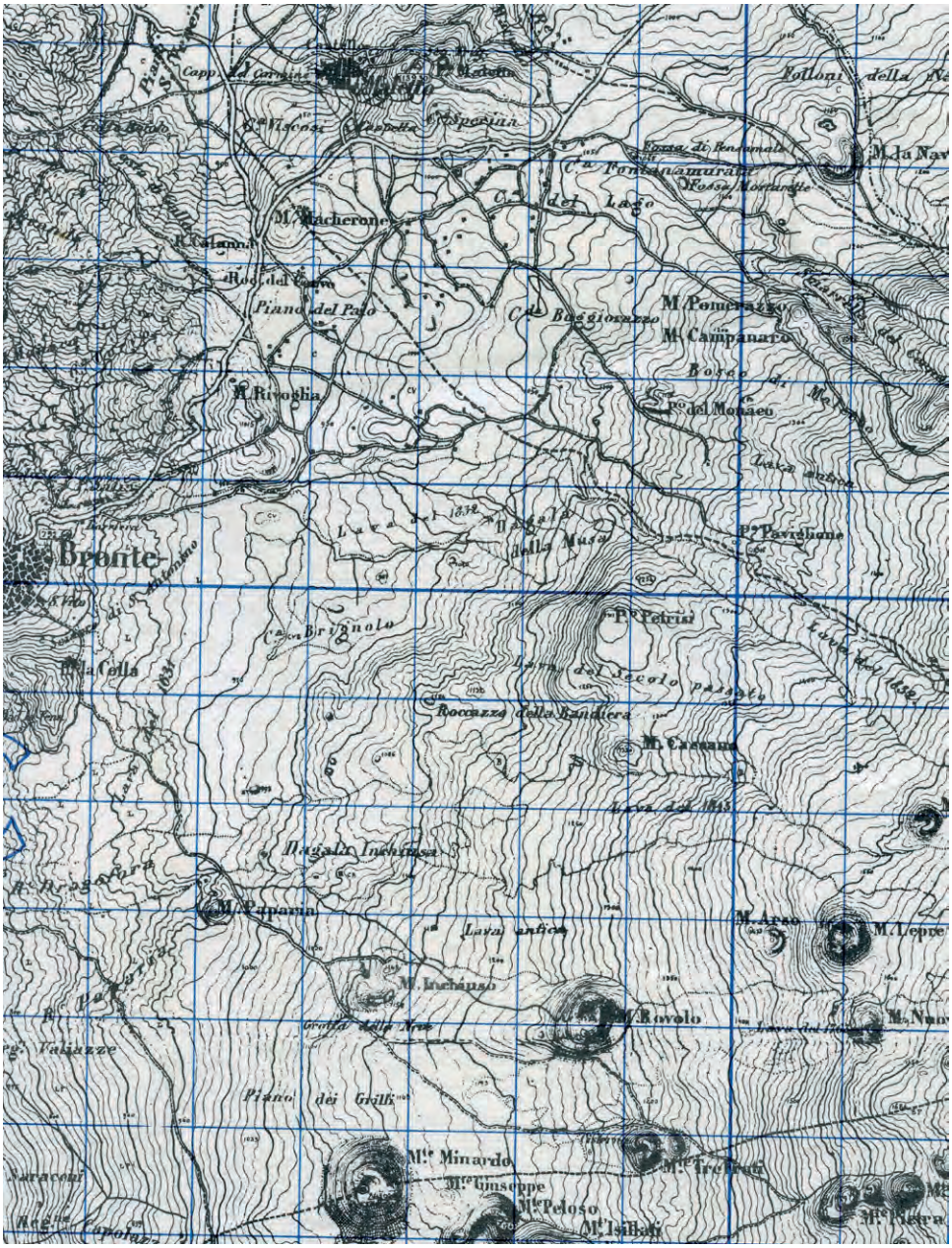

Fig 7 Detail of the 1:50,000 Bronte sheet (261 II) G.S.G.S.4229, First Edition dated 1941 shows the area around Bronte in Sicily. Printed by the War Office in London, this sheet was a direct monochrome copy of the Italian sheet from 1885 with the addition of a blue military grid. (Author's collection)

Fig.8 Detail of the 1:50,000 Bronte sheet (261-II) G.S.G.S. 4229, M.D.R. 578/8152 Second Edition (Coloured) dated May 1943. This map is a brown "griblet" with the water features over-printed in blue and roads in red. The reprographic material for the brown plated was supplied by the War Office, but the red and blue plates were produced in Egypt. (Author's collection)

derived only from existing 1;25,000 maps, with communications updated from Carte d'Italia, del Touring Club Italiano 1:200,000 maps. Later First Editions and Second Editions were often heavily revised from aerial photography. Following American practice, the diagram of the area revised from aerial photography has a note attached giving the sortie numbers and dates of the photography used.

The A.M.S. maps look quite different to the G.S.G.S./M.D.R. sheets as there is a greater use of colour, with vegetation symbols being printed in green. As everything was redrawn the line-work is much cleaner and there is no over-printing of blue on brown line for the drainage. The early First Edition, usually dated 1943, sheets adhere to the original Italian symbolisation for vegetation and the key is essentially the same as on the British sheets, with "Scattered Trees" being shown at three densities, "(Close) (Medium) (Open)". On later First Editions, usually with 1944 dates, the symbolisation for vegetation has been modified to have a much denser symbolisation for woods and only a single symbolisation for "Scattered Trees". Later First Editions also add a new symbol for "Shrine" to those for Church and Chapel on earlier sheets. Early A.M.S. sheets have the note "Heights in Meters" printed in red, but this changes in later sheets to being printed in blue (Fig. 9). Later Second Edition sheets have the symbolisation of vegetation completely changed, and the symbols enclosed in boxes in the Legend. Two new classes of vegetation "Brushwood" and Woods-Brushwood" were added. The symbolisation of urban areas was also changed. Instead of showing urban areas as a network of roads lined by solid black buildings, the urban area is as a network of white lines running through a black half-toned area which is surrounded by a thin black line. The depiction of roads was also changed from parallel black lines with different red fills, to solid black lines of different thicknesses with "A", "1", "2" or "3" in circles to indicate the class of road. The use of solid black for roads meant that the railway symbolisation also needed to be changed to avoid confusion with roads. Symbols for religious buildings also changed from a simple cross for a church to an open circle with a cross, a chapel was changed from a filled square with a cross to a filled circle with a cross and a shrine from a filled circle with a cross to a simple cross. An addition to the symbolisation was the introduction of "Photo Principal Point with Exposure Number". While earlier sheets had included a symbol for cliffs in brown, later sheets also included symbols for "Sink Holes" and "Karst", also in brown, and solid black lines for "Prominent Walls" and black cross-hatched dotted lines for "Areas of Extensive Stone Walls" (Fig. 10).

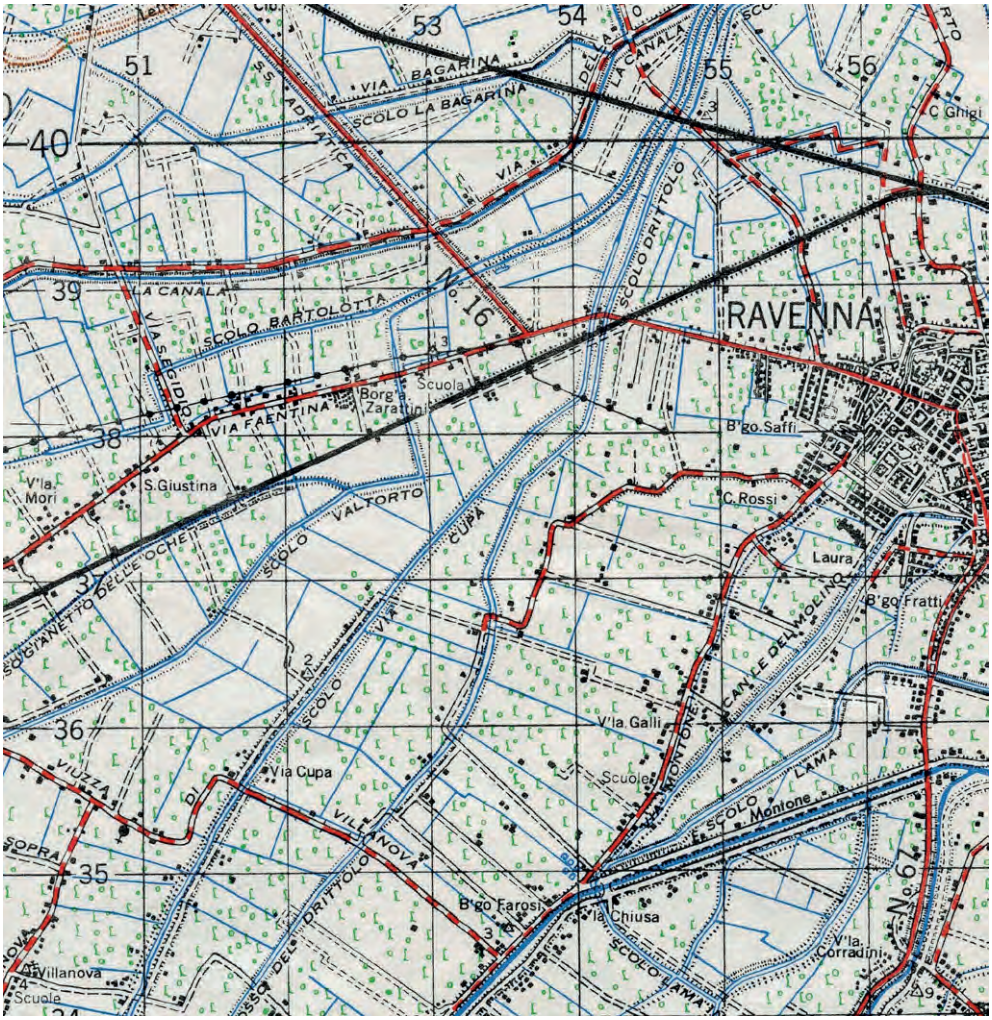

Fig. 9 Detail of the 1:50,000 Ravenna W. sheet (89-III) Second Edition A.M.S. dated 1944. This is an early style A.M.S. Second Edition style sheet with the original vegetation and other symbols but printed in colour. (Author's collection)

Layer tinted versions of some of the 1:50,000 maps were produced as part of "special mapping projects" between 10 July and 15 August 1944 as part of the preparations for the invasion of southern France (Operation Dragoon, originally Operation Anvil).[19] Some layered maps 1:50,000 sheets of Italy were produced at

19 Clough, 1952, 313.

Fig.10 Detail of the 1:50,000 Pesaro sheet (109-I), G.S.G.S. 4229, A.F. 14598, Fourth Edition printed and revised by 13 Corps. Field Survey Company Royal Engineers in July 1944, but using reprographic material produced in 1943 by A.M.S. The brown and blue plates shows the improved quality of the American drawn maps despite being printed in "griblet" form. (Author's collection)

the same time. Figure 11 is an extract from Sheet 99-III Marradi, reproduced by 514 Corps Field Survey Company in July 1944. It carries the A.F. number 14829. The base map is that for an early Second Edition A.M.S. map. In addition to the layer tints, the sheet also has "FOR STAFF USE ONLY NOT AVAILABLE FOR

GENERAL ISSUE (LAYERED)" to the right of the sheet name. To the left of the name is "NOT TO BE USED FOR ARTILLERY FIXATION". Both notes are printed in brown. Marradi was in part of the German Gothic Line, which may account for the production of the layered map.

Special 1:50,000 "griblet" maps were produced for the planned invasion of southern Italy from Sicily. The griblets were then over-printed in violet to show military installations, and red for topographical and beach information. Text in red describes the topography, such as "moderate slopes" and "Frequent landslides". Violet is also used to show the beach limits, with each beach numbered. Area limits and names are in red where appropriate there are also notes in red giving the normal port capacity of the ports (see Fig. 12). The sheets carry their normal G.S.G.S. number but also and A.F. number in violet, together with defence overprint date. There are two air photo cover diagrams, the normal Second Edition one in grey-blue and an addition one in violet with a note stating that the air photos were interpreted by N.A.C.I.U. (North Africa Central Interpretation Unit) and "Defences positioned by 516 Corps Fd. Svy. Coy. R.E. from annotated photos." "Intelligence collated by G-2. A.F.H.Q.". As will be seen in the section on 1:25,000 scale mapping, The griblets with defence overprint performed the same role as the 1:25,000 "Naval Collation Maps" produced for the invasion of Sicily. Similar "First Collation Edition" sheets with coastal and topographic information over-printed in red and beach exits and defences in violet were prepared in anticipation of possible amphibious operations further north in Italy, such as around Rimini. Collation editions of non-coastal areas, or coastal areas where no amphibious operations were anticipate (in other theatres the term collation edition was limited to areas of proposed amphibious operations), tended to have less information over-printed on them. If no defences had been interpreted from aerial photography the map would just have a red over-print together with a note "There are no defences on this sheet". Grid line numbers in red were also overprinted on the body of the map to allow easier reading of coordinates. Most Collation over-prints seem to have been printed on Second Edition griblets, but some on Third Edition and Second Edition A.M.S. griblets are also found. Bridge information includes the construction material, bridge length and roadway width in feet. Thus the Ponte Vecchio in Firenze is annotated "3 span Masonry Buildings on bridge OAL 345', Roadway 20'," (Sheet 106-II, Firenze).

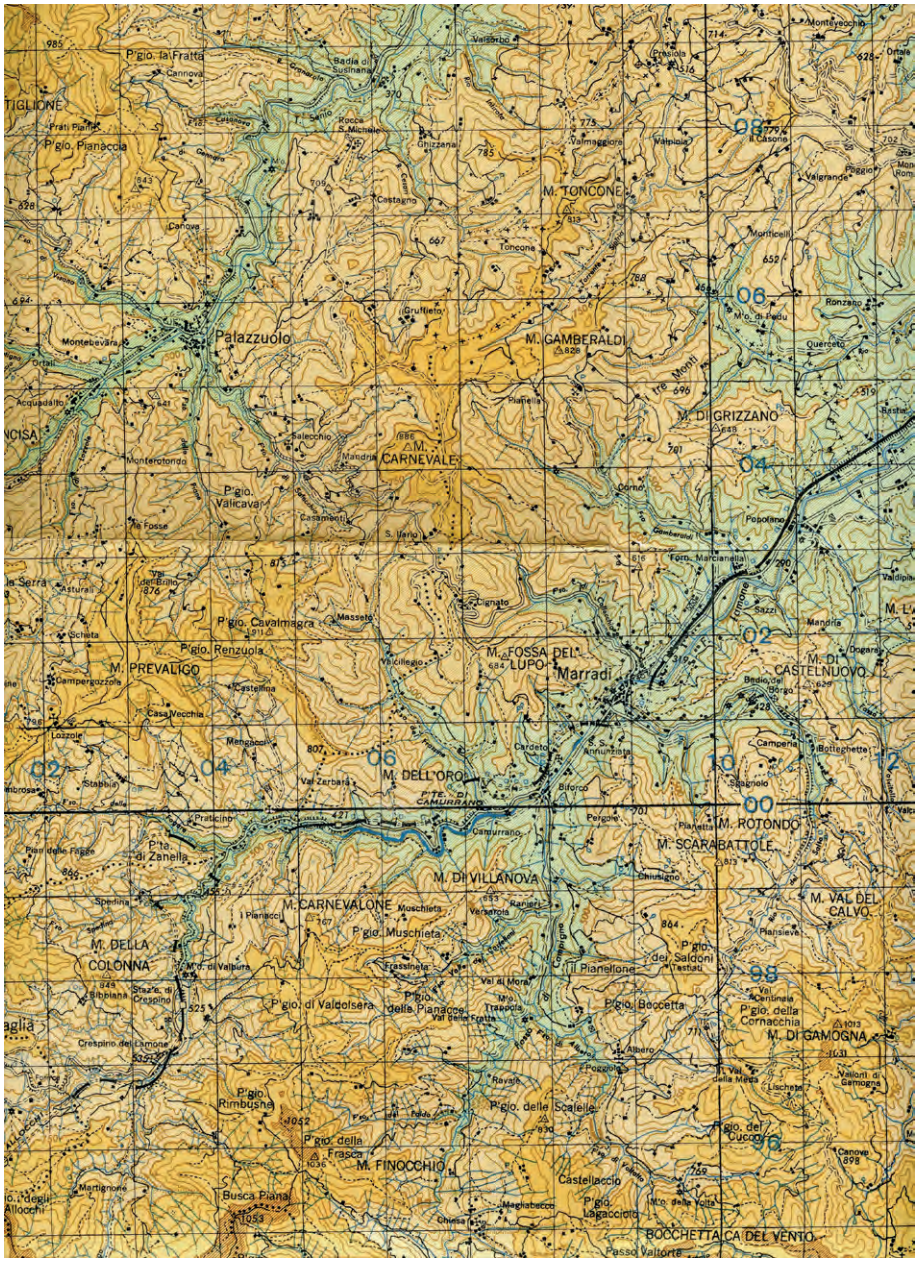

Fig. 11 Detail of the 1:50,000 Marradi sheet (99-III) G.S.G.S. 4229, .A.F. 14829 Second Edition (Layered). This is an example of a Second Edition A.M.S. map, dated 1944, that has had layer tints applied in theatre, hence the A.F. numbering. These layered maps were only for staff use and not issued to troops in the field. (Author's collection)

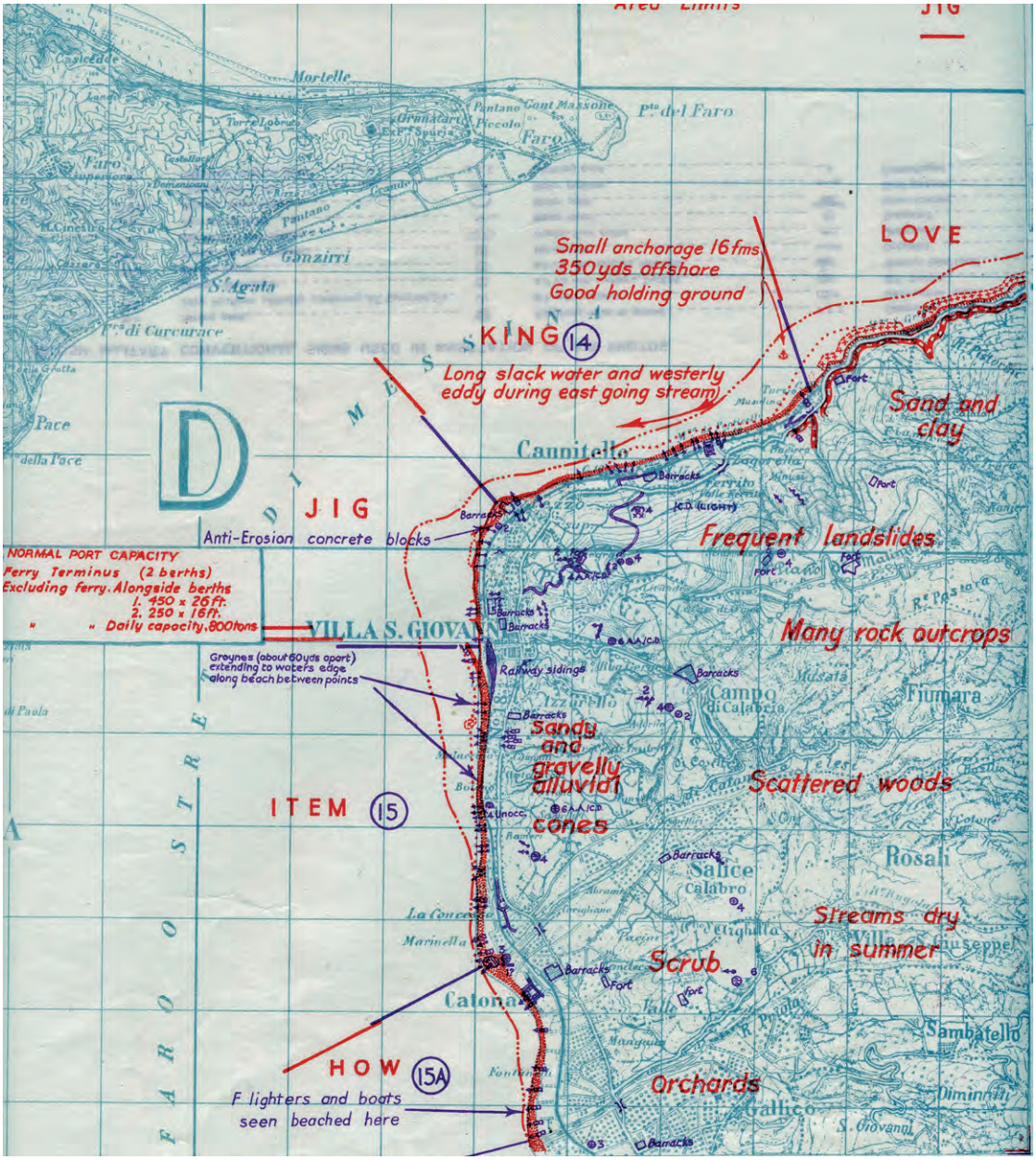

Fig.12 Detail of the 1:50,000 Messina sheet (254-IV) G.S.G.S. 4229, A.F. 1508 Second Edition (Coloured) but printed as a grey-blue "griblet". This is a typical example of the 1:50,000 sheets, date I July 1943, over-printed in violet for defences and red for coastal information and descriptions of topography. (Author's collection)

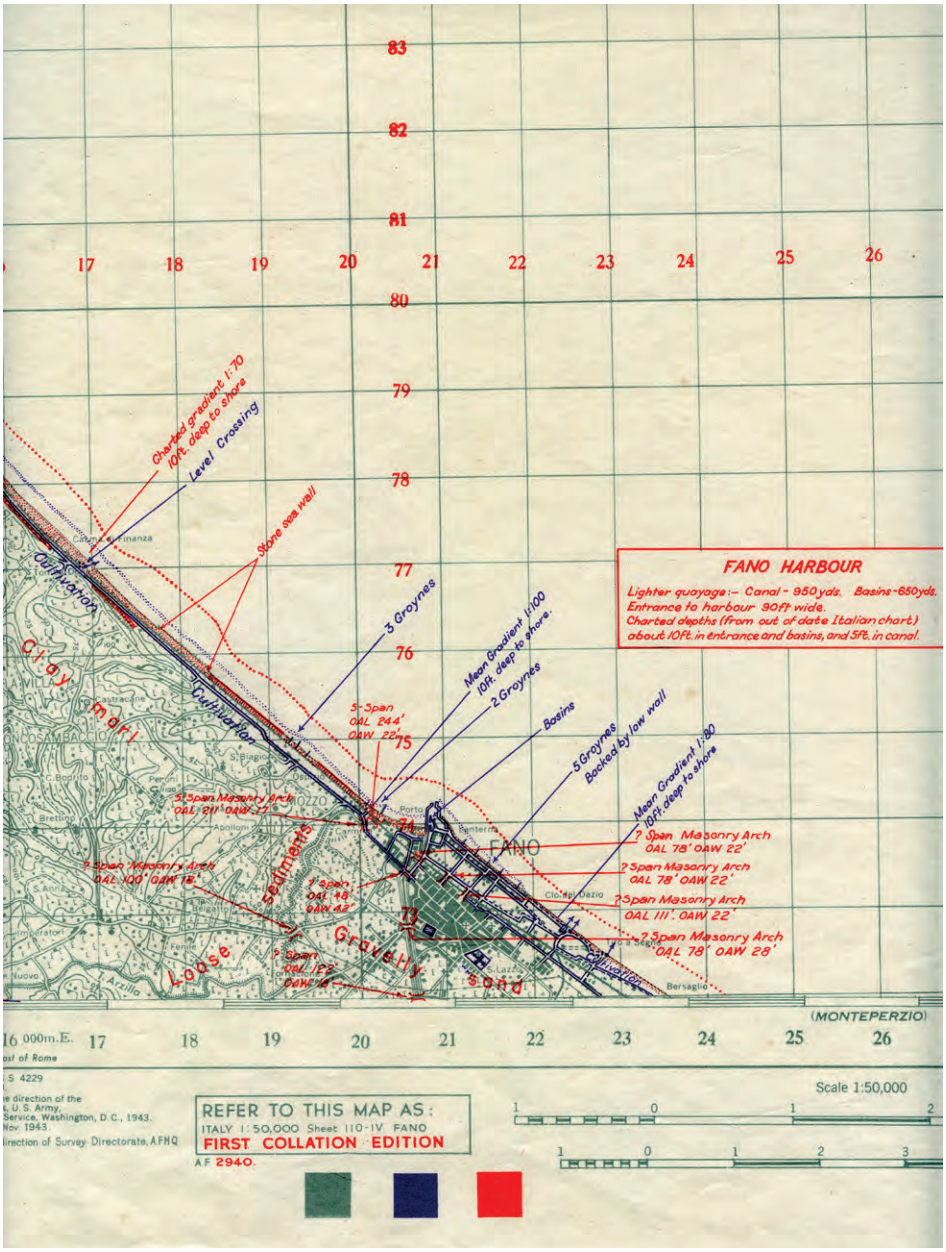

Fig 13 Detail of the 1:50,000 Fano sheet (110-IV) G.S.G.S. 4229, A.F. 2940 First Collation Edition March 1944. This map uses as a base map the A.M.S. Second Edition from 1943 printed as a "griblet" with beach defences and obstructions over-printed in violet and bridge and topographic information over-printed in red.

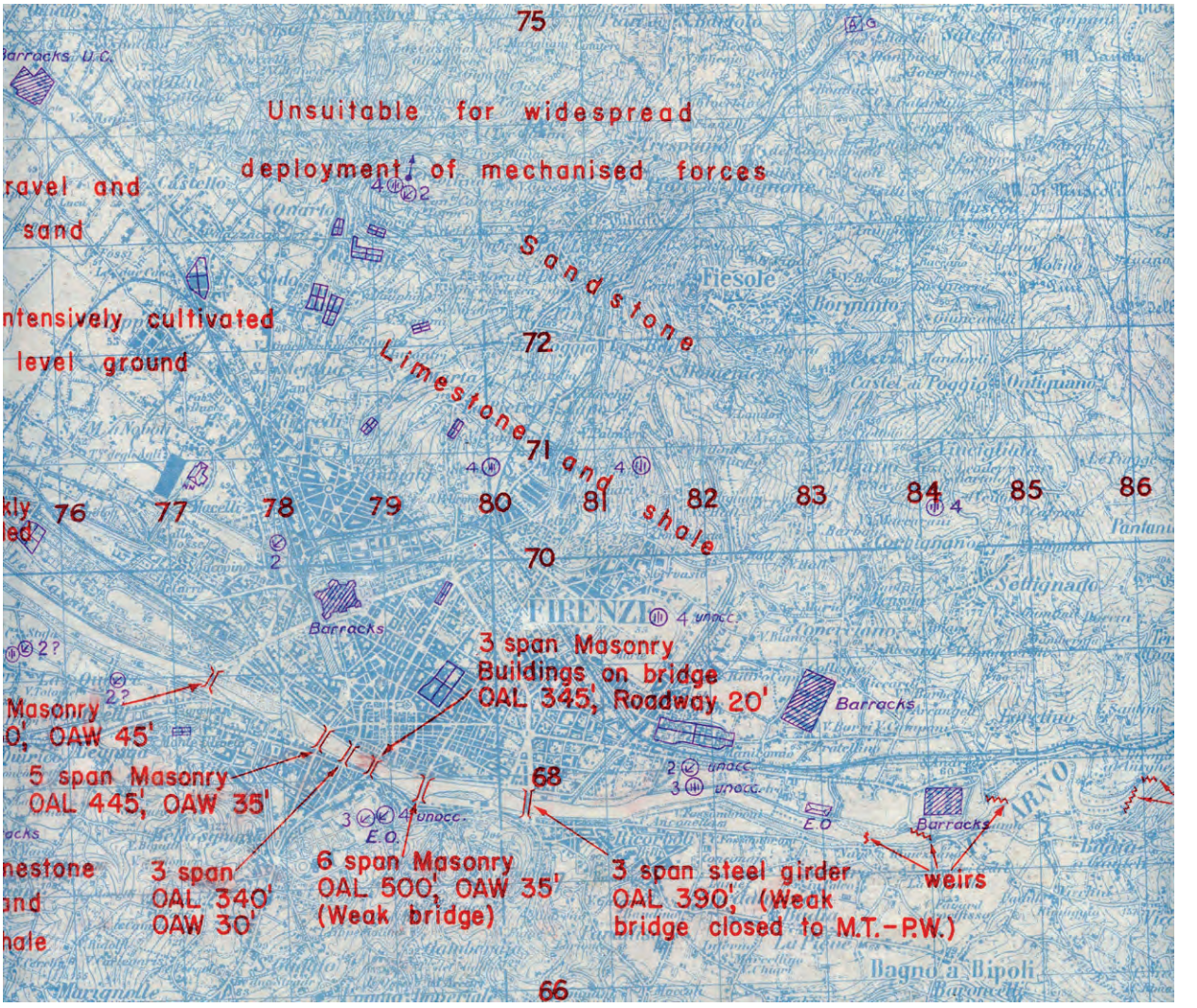

Fig.14 Detail of the 1:50,000 Firenze sheet ((106-II) G.S.G.S. 4229, A.F. 2871 First Collation Edition November 1943, has topographic and defence information over-printed on a "griblet" of a British produced Second Edition sheet. Classified as Secret, it was not down-graded until 10 May 1945. (Author's collection)

1:25,000 Scale Mapping

After the First World War a review of future mapping needs for the British Army identified 1:25,000 as the ideal scale for tactical operations and, in particular, for artillery targeting.[20] Malcolm MacLeod, the Director General of the Ordnance Survey and former Director of Military Surveys in the War Office, realising that a future war in Europe would necessitate British forces using metric maps was keen for Britain to adopt metric scales. Following the Davidson Committee report on the future of the Ordnance Survey, a new map of Britain at 1:25,000 was initiated, although a 1:50,000 map for army training purposes was rejected. The 1:25,000 scale map was referred to as the $2^{1}/_{2}$ inches to one mile scale possibly to disguise its metric nature. The use of 1:25,000 scale maps was therefore something that British forces were already becoming used to when war broke out.

The 1:25,000 allied military mapping of Italy was amongst the most complex tasks the surveyors had to undertake. The number of sheets, the number of editions of individual sheets and the variety of overprints presented a major challenge that could not have been met by British surveyors working on their own. In common with the 1:50,000 map sheets, the first editions were monochrome with colour being introduced to emphasise communications and water features on the second and subsequent editions. Initially, 1:50,000 maps were enlarged for areas not covered by Italian 1:25,000 maps. Effectively, this meant for areas to the south of the Lombard plain with the exception of areas around Roma and Napoli on the mainland and much of northern Sicily. Production of new 1:25,000 map sheets started in the spring and early summer of 1944 aided by better access to aerial photography for those areas previously covered by the enlarged 1:50,000 maps[21]. Prior to Operation Husky 67 map sheets were printed in runs of 10,000 copies by AFHQ and 57 map sheets were printed by SDMEF in runs of 8,000, a total of 1,260,000 map sheets.

The first 1:25,000 to be produced were for the invasion of Sicily and comprise approximately 200 standard map sheets plus 18 special map sheets covering the coast from Catania to Licata. Each of the 18 special map sheets covered the

20 Peter Collier, « The work of the British Government's Air Survey Committee and its impact on mapping in the Second World War », *Photogrammetric Record* 21/114 (2006), pp. 100–109.

21 Clough, 1952, p.311.

area of three standard sheets being printed double demy format (572x902 mm or 22.5x35 inches). While this made for quite unwieldy map sheets, it saved on printing time for the 18,000 copies of each needed[22]. The most important of these 1:25,000 sheets were those overprinted with additional information the "Naval Collation Maps" as they were overprint with information vital to the invasion forces. Whereas the standard sheets had "NOT TO BE PUBLISHED" printed at the top in brown, the Naval Collation Maps had that note crossed out and "SECRET" print in a larger font. The Naval Collation Maps had two overprints, a green overprint that showed topographical information which had been collated by G.S.I. and an overprint in blue which showed defences, beach information, ports, aerodromes and industry. A boxed note in blue at the bottom of each sheet stated "Information in BLUE is from Air Photography only, has been plotted from detail by A.A.P.I.U and not surveyed in. For conventional signs see A.A.P.I.U. legend. Defences and Beach Interpretation in BLUE by A.A.P.I.U. Ports, Aerodromes and Industrial Interpretation in BLUE by M.E.I.U". Four editions of these maps were produced, the First by 1 May and the Fourth by 1 July to ensure that the defence information was as up-to-date as possible before the invasion on 9 July.

Mapping in preparation for the invasion of the Italian mainland was limited to the revision of the 1:50,000 topographic sheets and the overprinting noted above. The short timescale between the invasion of Sicily and the landings on the mainland were the probable reason why no 1:25,000 mapping was produced for the landings, although Clough makes no reference to the reason. 1:25,000 mapping with overprinting of information for amphibious operations was produced for anticipated or planned operations further north in Italy. This included the mapping Elba in preparation for the assault by Free French and British forces. A bi-lingual edition of the maps was prepared with the maps overprinted with TOP SECRET – ULTRA SECRET and all annotations and legends in both French and English. The style of the overprinted maps is similar to that of the 1:50,000 maps discussed above but with colour changes. The 1:25,000 topographic sheet was printed as a grey griblet, with information derived from aerial photography was overprinted in red and information derived from other sources was overprinted in violet. The map sheets for the invasion of Elba were each individually numbered with "Copy

22 Fryer, 1943, p.5.

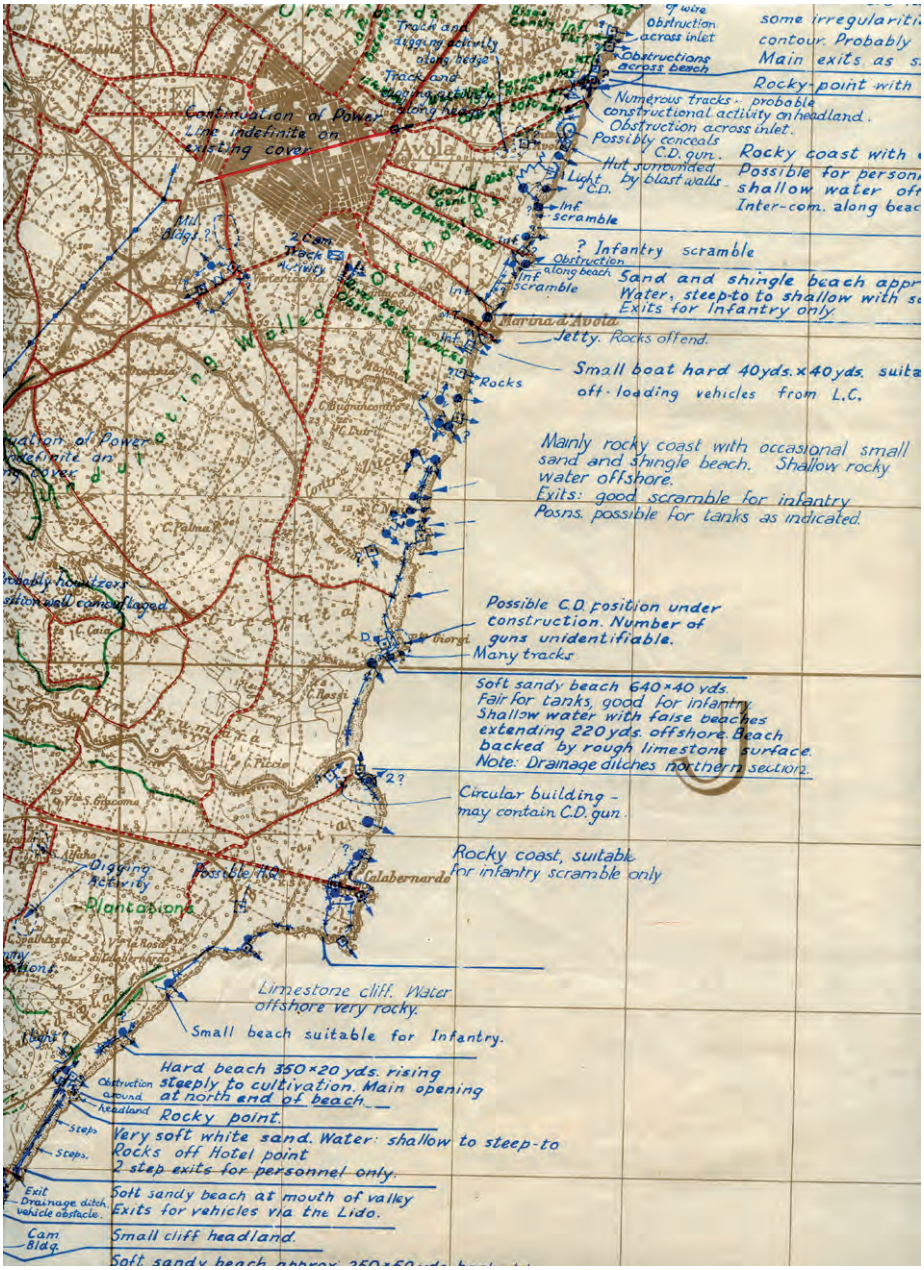

Fig. 15 Detail of the 1:25,000 Avola sheet (10), M.D.R. 618/8857 dated 17 June 1943 Edition III. This is an example to one of the double demy maps produced for Operation Husky. A brown "griblet" was over-printed in blue for defences and beach conditions and in green for topographical features and road widths. (Author's collection)

On opposite page: Fig. 16 Detail of the 1:25,000 Capoliveri sheet (126 II S.E.) G.S.G.S. 4228, A.F. 3909. This over-printed map printed on a Second Edition "griblet" base published by the War Office in 1943 had a defence over-print added on 20 April 1944 in preparation for the Free French Army assault on Elba. Unusually, there is bilingual text on the face of the map in addition to a bilingual legend on the verso of the sheet. All copies of the map were individually numbered, a system that had been adopted for "Top Secret" mapping for Operation Overlord but does not seem to have been adopted for other mapping in the Italian campaign. (Author's collection)

Nº" in violet followed by a number in black. The numbering of individual copies of a sheet had not been the practice for earlier mapping in Italy but was normal practice on similar maps produced for the invasion of Normandy. The Elba map sheets were not the only ones to have multilingual legends, although they seem to have been the only examples that had bi-lingual annotations and notes on the body of the maps. Bi-lingual legends in English and Polish were printed on maps prepared for the fighting around Monte Cassino in 1944 and tri-lingual editions were prepared with legends in English, Polish and Italian in preparation for operations in Lombardy in spring 1945.

The need for new editions of 1:25,000 maps became urgent when the allied armies' advance was blocked by the German Gustav Line which stretched from the mouth of the River Sangro on the eastern side of the Apennines to just north of where the River Garigliano entered the Tyrrhenian Sea. To meet the urgent need for 1:25,000 for artillery use rapidly product skeleton maps, called "key" maps were produced in addition to new 1:25,000 maps of areas in front to the allied positions[23]. New editions with defence overprints in red were produced on 10 and 28 April 1944 and "Artillery Tasks" overprints were produced on the 28 April defences sheets in May 1944. The artillery task sheets showed both areas to be subjected to barrages (Fig. 17) and also point targets in violet (Fig. 18)

With the fall of the Gothic Line and the allied advance to the Po Valley little detailed mapping was needed on the scale of that for the fighting around Cassino until the winter of 1944-45. During the spring of 1945 extensive mapping of the Po Valley and the approaches to the Alps was carried out. The conditions in the

23 Clough, 1952, p. 310.


BARE SLOPES
PENTES NUES
HARD ROCK – THIN SOIL
ROCHERS DUR – SOL PEU PROFOND
THIN SCRUB ON BARE ROCK
MAQUIS EPARS SUR PENTES ROCHEUSES
DENSE SCRUB
MAQUIS EPAIS
O.P.
4×152 m.m. (P.A.)
R.S.
2×152 m.m.
4×152 m.m. P.A.
4 P.A.
4 Lt./Med.
Dinghy landing
Débarquement pour bateaux en caoutchouc
Quarry loading jetty
Jetée de chargement pour carrière
1:22 from 18 ft. (deep) to shore.
INCLINAISON DES PLAGES.
"1:44 – 10 FEET (DEEP) TO SHORE" SIGNIFIE QUE LA PENTE MOYENNE, DU BORD DE L'EAU A UN POINT SITUE A LA PROFONDEUR DE 3 METRES 05 AU-DESSOUS DU NIVEAU

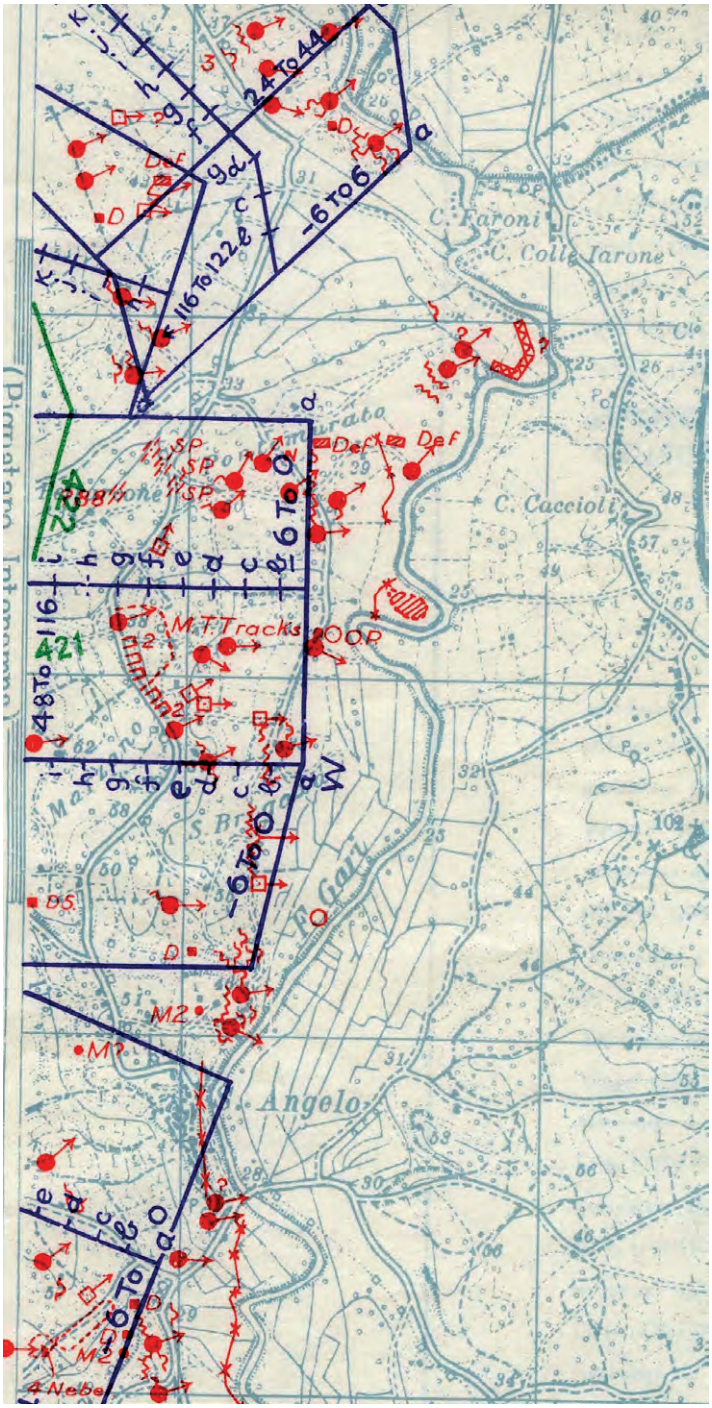

Fig. 17 Detail of the 1:25,000 Cassino sheet (160. II. N.E.) G.S.G.S. 4228 First Edition 1943 published by Engineer Fifth U.S. Army A.F.14587. This sheet has a similar publication and over-printing history to Fig. 18 but it carries an additional note "All timings are from the time of inf." (infantry) "launch boats" as this map shows the areas to be targeted by moving barrages rather than the point targeting on Fig. 18. (Author's collection)

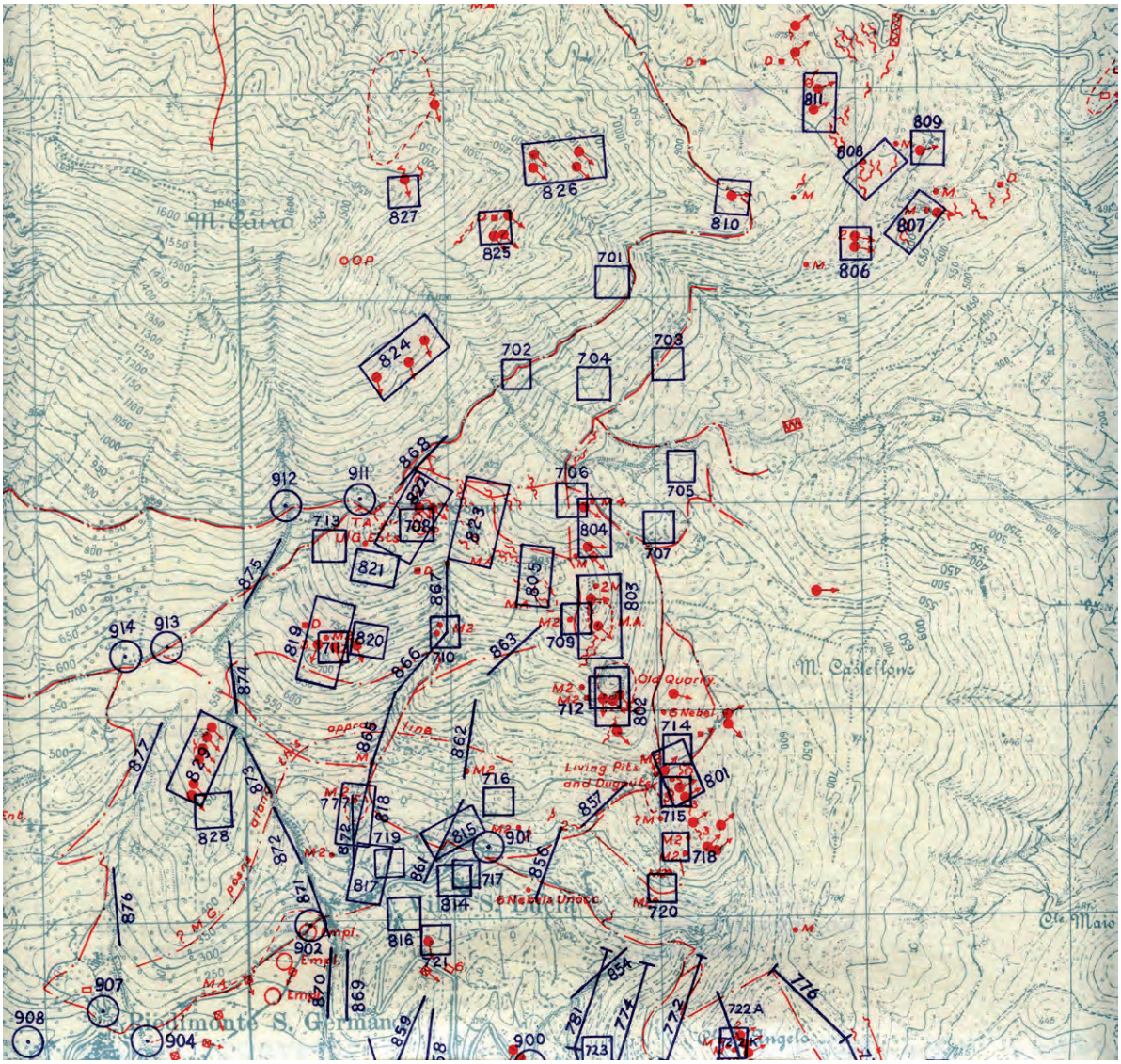

Fig. 18 Detail of the 1:25,000 Terelle sheet (160. I. S.W) G.S.G.S. 4228, A.F. 14570 was published by Engineer, Fifth Army, reproduced from an Italian map by 46 Survey Company South African Engineer Corps in January 1944, defences were added as a red over-print from aerial photography "up to and including" 28 April 1944, and "Artillery Tasks" as a violet over-print in May 1944 by 514 Corps Field Survey Company Royal Engineers. The map was intended to be used in the fighting around Cassino by allied forces including Polish soldiers. The verso carried a bilingual legend in English and Polish. (Author's collection)

Fig. 19 Detail of the Minerbio sheet (88 IV N.W.) G.S.G.S 4228 Third Edition, A.F. 15681. The brown "griblet" base is derived from a revision by the South African Survey Company, with the topographical overprint added in April 1945 by the same unit. (Author's collection)

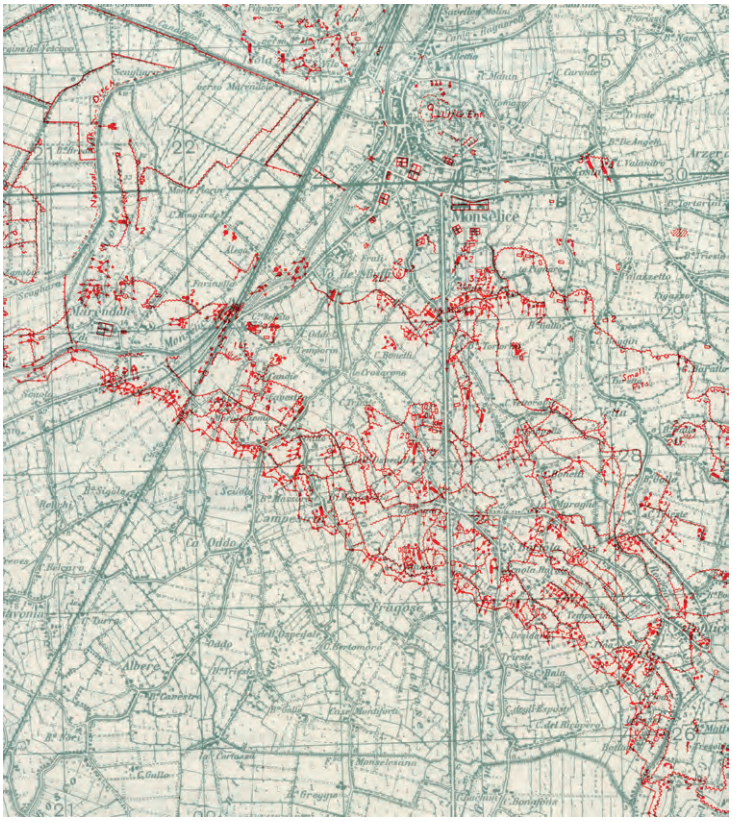

Fig. 20 Detail of the Monselice sheet (64 I S.W.) G.S.G.S. 4228 War Office Second Edition 1944, revised June 1944 by 19 Field Survey Company Royal Engineers, minor corrections March 1945 by 49 Survey Company South African Engineer Corps, over-print drawn by 7 General Field Survey Section Royal Engineers, printed on 26 April 1945 by 518 Field Survey Company Royal Engineers. (Author's collection)

Po Valley itself called for detailed topographical over-prints, accompanied by cross-sections of features likely to limit mobility. Fig. 19 is a good example of such a sheet with the different blue lines indication the width of canal and river channels. The cross-sections show the form of the canals and rivers at particular points. Bridge lengths are also marked on the map.

As the allied armies crossed the Po Valley and approach the mountains to the north, heavy fighting was still expected despite a German surrender was already being negotiated. Some of the last maps to be printed with defence overprints were produced towards the end of April 1945. Fig 20 is the area around Monselice south of Padua. The over-printing was carried out on 26 April 1945 showing a section of the German Venetian Line behind the River Adige. As British, Polish and Italian soldiers were taking part in the advance across the Po Valley, map sheets were printed with trilingual legends.

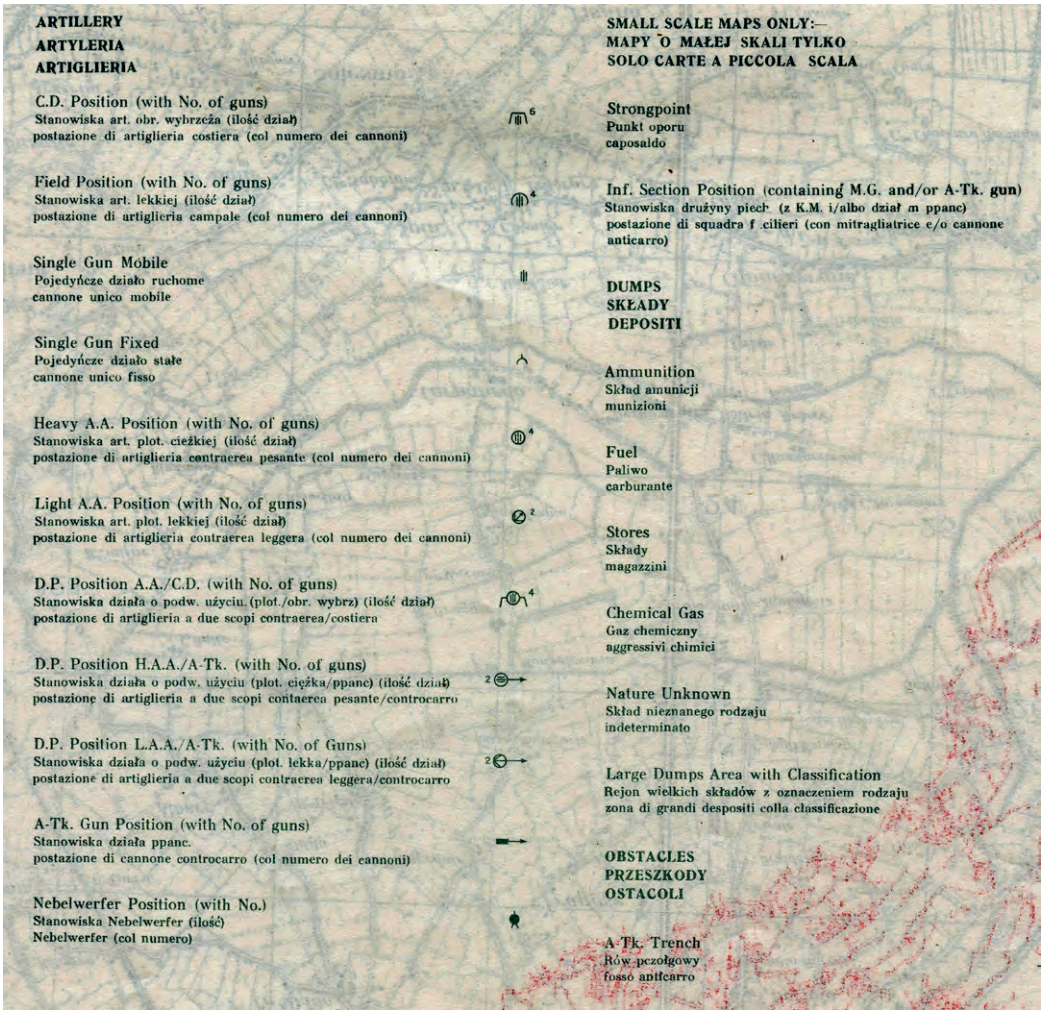

Fig. 21 Verso of Fig. 20 showing part of the trilingual legend. (Author's collection)

Town Plans

Prior to the invasion of Italy near 22 town plans had been prepared for Sicily as G.S.G.S. 4379, 44 for the Italian mainland (but including plans of Pola and Fiume and Susak) as G.S.G.S.4380, two of Sardinia as G.S.G.S 4378 and four f Sardinia as G.S.G.S. 4381. Initially, most of the town plans were simple enlargements to 1:10,000 of 1:25,000 mapping printed in black, except for water features which were in blue, except where Italian town plans were available to the War

Office. Some plans, such as Napoli had been revised from aerial photography and redrawn and other plans, such as Genoa, were in the process of revision[24]. These sheets were published as the second edition, but some plans, such as Napoli quickly went to a third edition in 1943Work on the compilation or revision of some of the town plans was carried out by the Inter-Service Topographical Department (I.S.T.D.). An example is the "Sicily Small Ports" sheet. In this case, the source material the plans of Sciacca, Mazara del Vallo and Porto di Favignana was Italian charts with revision from aerial photography. The plan of Riposto on the same sheet was compiled from "uncorrected" aerial photography (Fig 22). As was the case with other smaller towns, two of these plans were at 1:5,000, but Sciacca was at approximately 1:5,200 and Riposto was at approximately 1:10,300. The revision of the plans enlarged from 1:25,000 involved the identification of important buildings in black where the enlarged map was shown in grey, with water features in blue. While the unrevised enlargements from 1:25,000 maps were printed in black and blue, some maps, usually derived from tour guides, petrol company maps or maps from the Reale Automobile Club d'Italia (R.A.C.I.), were printed in grey. An example is the provision edition for Mantova which had a 1:15,000 plan derived from a tour guide and a "Through Roads" plan copied from the R.A.C.I. map. Where the scale of the map did not allow the labelling on the map of important buildings, roads, etc. a list of names was appended to the sheet, for example the Tivoli provisional edition from 1943.

A more unusual example is the First Edition plan of Salerno. The plan at approximately 1:5,070 was compiled and drawn from aerial photography by the Central Interpretation Unit (C.I.U.) and checked by I.S.T.D., and printed by the War Office (Fig. 23) For some reason, there is also an inset plan at 1:10,000 covering the same area, together with an index of place names and buildings. However, in addition to the C.I.U. plan which was printed in September 1943, there was also a "Plan Mosaic of Salerno" at approximately 1:10,000 prepared by the 649th Engineer Battalion, U.S. Army, an uncontrolled mosaic produced in July and printed in August 1943 as AF 1756 (Fig. 24). As the AF designation on the photo-mosaic indicates, the 649th Engineer Battalion was attached to A.F.H.Q. in North Africa. It is probable that the photo-mosaic was prepared from the same material as the C.I.U. plan either because the U.S. forces wanted a photo-mosaic

24 G.S.G.S, 1943, p. 14 contains a full list and samples of the types of plans available.

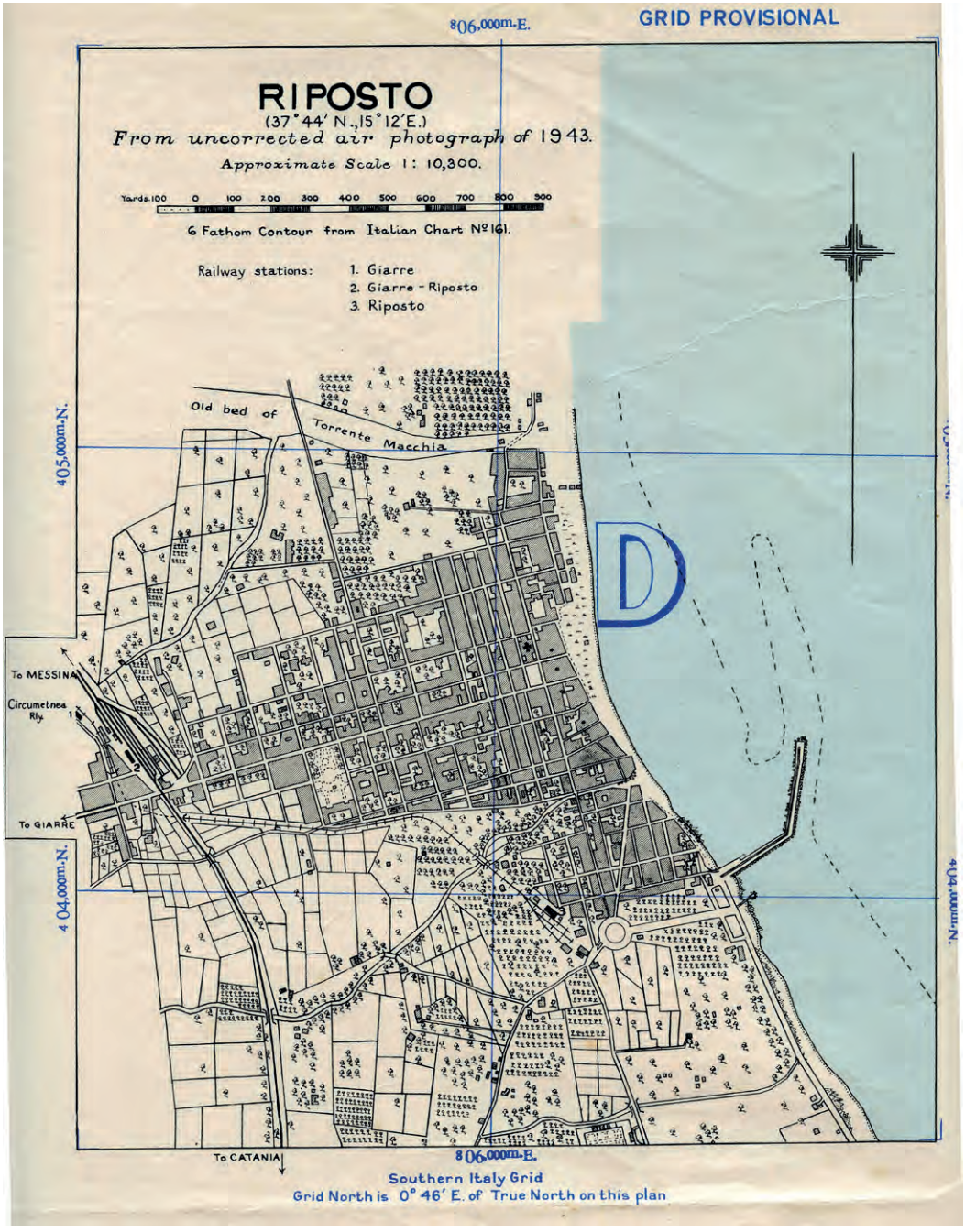

Fig. 22 Plan of Riposto from the "Sicily Small Ports" sheet G.S.G.S. 4379 First Edition, War Office 1943 (Author's collection)

Fig. 23 Detail of the 1:5070 approx. plan of Salerno G.S.G.S. 4380 First Edition, War Office 1943(Author's collection)

Fig. 24 Detail of 1:10,000 (Approx.) Town Plan Mosaic of Salerno AF 1756 August 1943. (Author's collection)

for the reasons outlined below, or as insurance in case a conventional plan was not available in time for the invasion of the Italian mainland.

Production of improved town plans continued throughout the campaign with the cartographic and printing resources of the Istituto Geografico Miliare (I.G.M.)

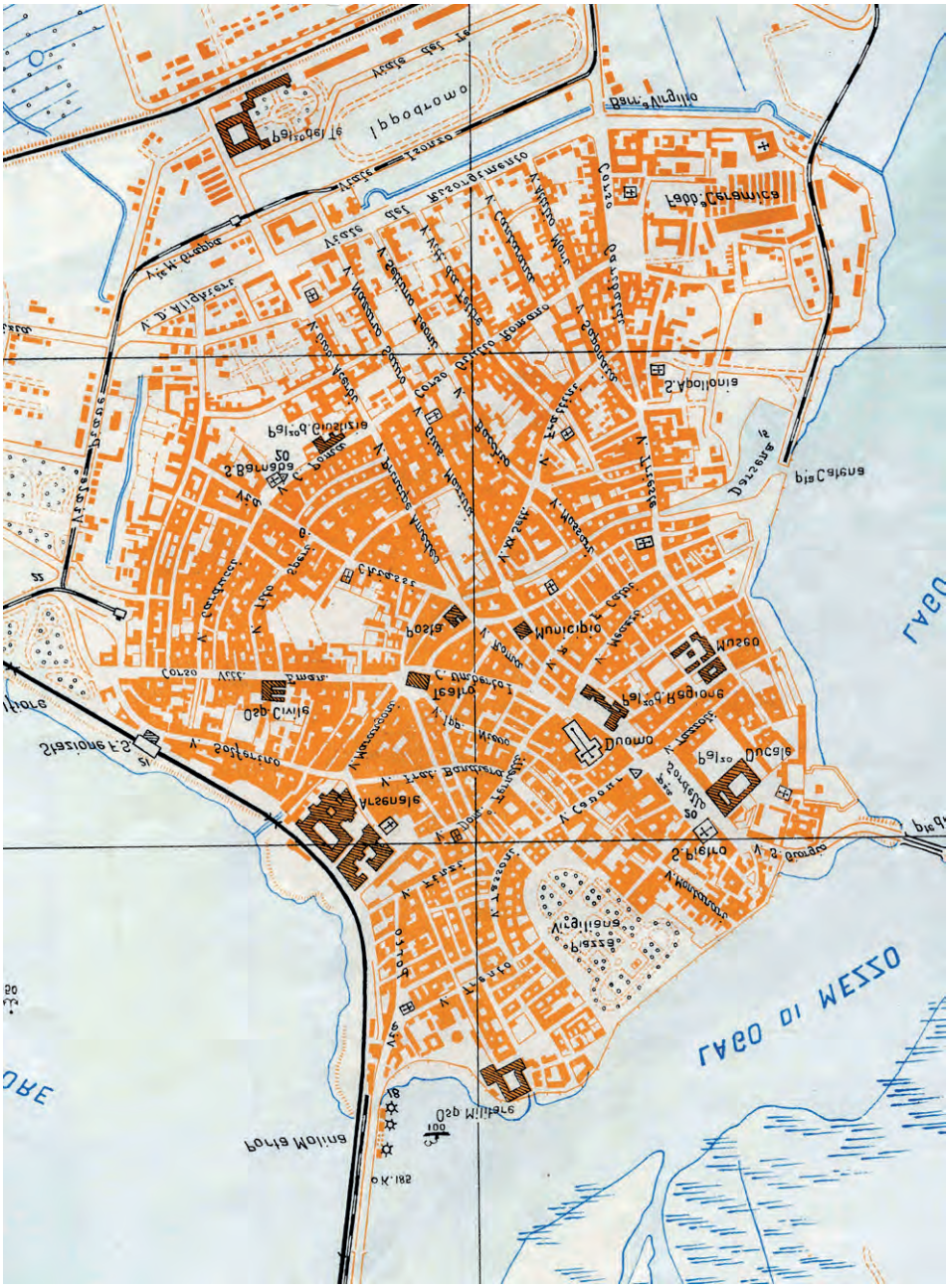

Fig. 25 Detail of 1:10,000 Town Plan of Mantova G.S.G.S. 4380 A.F. 18591,
First Edition 1945. Drawn and reproduced by Istituto Geografico Militare April-1945.
(Author's collection)

Fig.26 Verso of Fig.25, detail of Photomap of Villanova produced for the Italian occupation of Corsica. (Author's collection)

in Firenze being drawn upon. At that time the resources of the I.G.M. were being drawn upon by the Survey Branch H.G. 15 Army Group to supplement their own resources. At this time, the earlier plan of Mantova was replaced by a 1:10,000 First Edition based on the Italian 1:25,000 map and large scale aerial photographs taken between September 1943 and January 1944. What makes the Mantova plans (Fig.25), and similar ones of Cremona, interesting is that they were printed on the reverse of Italian photomaps of Corsica printed in 1943 (Fig. 26). Printing of new maps on the back of redundant map sheets was a common practice during the war. Most commonly the printing took place on the back of old or no longer needed maps previously printed by the forces printing the new maps. Following the capture of bulk map stocks during the Allied advance in North-West Europe, new maps were frequently printed on the back of old German maps, but the Mantova and Cremona plans are a rare example of the same happening on Italian maps.

Mapping and Revision from Aerial Photography

Aerial photography for mapping had become important during the First World War, both for original surveys of previously poorly or unmapped areas and for the revision of existing mapping[25]. In Britain, with the foundation of the Royal Air Force (RAF) by the merging of the Royal Flying Corps and the Naval Air Service, the air force moved away from being seen as supporting the other forces into an independent organisation which set its own priorities. These priorities centred on air defence, and strategic and tactical bombing. Aerial photography came to be seen a tool for the acquisition of targets for the bombers. A Photo Reconnaissance Unit (P.R.U.) was established to analyse the air photos acquired by photo reconnaissance aircraft and cameras were developed to be carried in those

25 See, for example, Peter Collier, « Innovative Military Mapping using Aerial Photography in the First World War: Sinai, Palestine and Mesopotamia », *Cartographic Journal,* 31 (1994), pp 100–04; Peter Collier and Rob Inkpen, « Mapping Palestine and Mesopotamia in the First World War », *Cartographic Journal* 38 (2001), pp. 143–154; Peter Collier, « The Impact on Topographic Mapping of Developments in Land and Air Survey: 1900-1939 », *Cartography and Geographic Information Science* 29/3(2002), pp. 155–174; Peter Collier, « The development of photogrammetry in World War 1 », *International Journal of Cartography* 4/3(2018), pp. 285–295 and Thomas Withington, « Military Mapping by Major Powers: United States », in Mark Monmonier (ed.), *The History of Cartography Volume Six: Cartography in the Twentieth Century,* University of Chicago Press, Chicago, 2015, pp. 884–893.

aircraft. Whether those cameras could take air photos suitable for mapping was not seen as issue by the RAF and it was only with reluctance that they became involved in aerial photography for the Ordnance Survey in the late 1930[26]. Work by the Air Survey Committee, which had been established after the First World War to develop photogrammetry, primarily to meet the needs of the army, had demonstrated the type of cameras that were best suited for air survey work[27]. The very long focal length cameras prioritised by the RAF were found to be unsuitable due to their very limited field of view. What was needed were normal angle cameras with a focal length of c.305mm (12 inches), or wide angle cameras with a focal length of c.152mm (6 inches). What was also needed was a large format negative, typically 230x230mm (9x9 inches), whereas photographic reconnaissance cameras typically employed smaller format negatives[28].

An addition problem in the Mediterranean theatre was the lack of suitable aircraft to carry out sorties of survey photography. The main air photo reconnaissance (PR) aircraft operating with the R.A.F. was the PR version of the Spitfire. While the Spitfire was the best PR aircraft for its chosen task, being fast, manoeuvrable and with a high ceiling, giving the pilot the best chance of surviving and successfully returning with the required air photos. In the first years of the war the only aircrafts available for air survey photography in the Mediterranean were twin engine bombers, the British Bristol Blenheim, and the American Martin Maryland and Baltimore.

While these were able to serve with reasonable success over North Africa, from 1942 on they were far less likely to survive in European air space where the air defences were more highly organised and effective[29]. The arrival of American forces in North Africa following Operation Torch led to the introduction of American PR aircraft, the PR version of the Lockheed P-38, the F-4. Versions of this single seat aircraft were to remain the mainstay of United State Army Air Force

26 For an account of the problems see Peter Collier and Rob Inkpen, « Photogrammetry in the Ordnance Survey from Close to MacLeod », *Photogrammetric Record* 18/103 (2003), pp. 224–243.

27 See Collier, 2006 for a discussion of the work of the Air Survey Committee.

28 Roy M. Stanley, *World War II Photo Intelligence,* Sidgwick and Jackson, London, 1981, pp. 133–186, provides a comprehensive overview of the development of cameras by the United States and Great Britain.

29 Stanley, 1981, p. 107, provides a brief account of these aircrafts and their performance characteristics.

PR work for the rest of the war. Unfortunately, the F-4 suffered from much the same limitations as the Spitfire when it came to air survey work. What was needed was a fast twin engine aircraft which had a crew of two and a fuselage capable of holding a number of cameras and even spare film magazines. Such an aircraft existed, the De Havilland Mosquito. It had been designed for the PR role and could fly higher and out run any likely enemy aircraft. Unfortunately, the R.A.F. regarded it as a PR aircraft and were extremely reluctant to release its Mosquitos for air survey photography.

In the latter stages of the North African campaign air survey photography for British Commonwealth Forces had been provided by No. 60 Squadron South African Air Force (SAAF) which had been deployed to Egypt in July 1941. In January 1942 in had started to carry out air survey photography but the Martin Marylands were slowly being lost and had to be replaced by the Douglas Baltimore in October 1942.

Losses of the Baltimores during photographic sorties led to the loan of two Mosquitos in February 1943. Flight R.A.F. 1434 was also based in the Middle East but had largely been involved air survey work in Iraq and also lacked suitable aircraft. Following Operation Torch, the allied invasion of North Africa the 5th, 12th, 15th and 23rd Reconnaissance Squadrons U.S. Army Air Force (USAAF) was deployed to North Africa where they formed part of the 3rd Reconnaissance group together with No. 682 Squadron R.A.F., No. 60 Squadron SAAF and the French Groupe de Reconnaissance GR II/33. No.682 Squadron had been equipped with two Mosquitos in April 1943 to carry out longer PR missions. On 22 March 1943 Fryer had written to General Dempsey the officer commanding No.1 Planning Staff outlining the problems in obtaining suitable photography over Sicily and was told that no survey aircraft were available for North Africa[30]. After a considerable struggle two Mosquitos were made available on 10 June and commenced sorties on 13 June, flying 19 sorties in all. However, as Fryer notes, 90% of the air photographs were taken too late for maps to be revised in time for Operation Husky. He argues that no revision is possible within two months of an invasion

30 FRYER, 1943, pp. 7–8 gives an account of the problems encountered in obtaining suitable aircraft which necessitated going right up through the chain of command to General Alexander, Commander in Chief, Middle East Command before Mediterranean Air Command Allied Forces Head Quarters would release the required Mosquitos for air survey operations. Appendix H is a copy of the letter sent by Fryer setting out the problem.

on the scale of Husky[31].

The lack of cooperation between the North African Photo Reconnaissance Wing and the surveyors led to the attachment of a survey officer to the Wing to select photography for mapping, inform the surveyors of what was available and to ensure duplicate films were provided to the War Office in London, War Department in Washington and to the Middle East Intelligence Unit. He was also required to obtain prints for the Survey Directorate, Allied Forces Head Quarters and to request areas to be flown for mapping and revision.

Following requests for additional Mosquitos, three were dispatched from the United Kingdom, but a sudden emergency led to their recall soon after arrival. The return of Mosquitos to the United Kingdom meant that the surveyors were reliant on the F4 of one of the U.S. PR squadrons to provide 6 and 24 inch photographic cover. Operating from 25,000 to 30,000 feet, the 6 inch cameras would have produced photographs of between 1:50,000 and 1:60,000. The 24 inch cameras would have produced photography between 1:25,000 and 1:30,000, but with much reduced cover compared to the 6 inch cameras. The photography obtained was used for revision of existing 1:50,000 and 1:25,000 mapping and new mapping at 1:25,000 where no sheets existed. The new mapping by the British involved the use of graphical methods, primarily radial line plotting. The arrival of the American 30 Engineer Topographical Battalion equipped with multiplex photogrammetric instruments led to their use in aerial triangulation to provide ground control where none was available, as well as for photogrammetric plotting, such as for 1:25,000 sheets of an area north of Rome in May 1944.

The copies of aerial photography supplied to the War Department in Washington were used by the U.S. Army Map Service (U.S.A.M.S.) to revise existing coverage and to provide new mapping of areas not previously mapped. Some of the mapping was provided as printed sheets, while others were provided as reprographic material for printing in North Africa or Italy. The form in which aerial photography was used is indicated in a note at the bottom left of the relevant map sheet. For example, 1:50,000 map sheet 89-III (Ravenna W.) has “Prepared under

31 Fryer, 1943, p. 7 on the revision of maps prior to Husky. Clough, 1952, pp. 50–-504 draws on Fryer for the discussion of air survey photography for Husky. Clough, 1952, pp. 339–342 includes a discussion of the air survey photography for the campaign in mainland Italy.

the direction of the Chief of Engineers, U.S. Army, by the Army Map Service (SO), U.S. Army, Washington D.C., 1944. Aerial revision by Army Map Service (GEAM), U.S. Army, Washington, D.C. 1944.", while map sheet 77B-I (Cherso) has "Prepared under the direction of the Chief of Engineers, U.S. Army, by the Army Map Service (GEAM), U.S. Army, Washington D.C., 1944. Compiled by stereophotogrammetric methods (multiplex) and by reference to Italy, 1:50,000, Sheet 77B-I, A.M.S., 1943". From this, it is possible to assume that the revision of the Ravenna W. sheet was revised by simple optical or graphical means, whereas the Cherso sheet was virtually remapped by stereophotogrammetry.

Aerial photography was also used to produce photo-mosaics[32]. The American artillery had trained using photo-mosaics for targeting and expected to be able to use them in Italy. However, training in the American Mid-West had taken place over relative flat terrain where the production of relatively easy, very different to that encountered in Southern Italy. In addition, photography in a defended air space made it much more difficult to achieve the kind of systematic coverage necessary for controlled photo-mosaics. A lack of survey resources and adequate ground control compounded the problem. In consequence, many of the photo-mosaics produced were only semi-controlled and used approximately rectified oblique photography, lacking the accuracy necessary for targeting. Half-tone reproduction also reduced their quality.

Relief Models

Relief models were used quite extensively by the allies during the Second World War. A general overview is given in Pearson[33]. Models had been prepared

32 Clough, 1952, p. 319.

33 Alastair W. Pearson, « Allied Military Model Making during World War II », *Cartography and Geographic Information Science* 29/3(2002), pp. 227–241, provides a good overview of the model making carried out in Europe and North Africa at a wide range of scales and for a variety of functions. A short version, providing a wider context is Alastair W. Pearson, « Relief Depiction: Relief Map, Relief Model, Relief Shading », in Mark Monmonier (ed.), *The History of Cartography Volume Six: Cartography in the Twentieth Century,* University of Chicago Press, Chicago, 2015, pp. 1260–1272. A purely American account is given in Herbert Milwit, *Engineer Model Makers Detachment,* Intelligence Division of the Office of Chief Engineer, European Theater, Paris, 1945. This account includes images of a number of models made of parts of Sicily and mainland Italy for amphibious operations. H.P. Reed, « The Development of the Terrain Model in the War », *Geographical Review* 36/4(1946), pp. 632–652, provides a good overview of the developments during the

for Operation Torch at a variety of scales from 1:2,000 to 1:100,000 for briefing troops due to take part in the operation. These models were produced in England by a joint team of British and American model makers in a period of intense work prior to the landings on November 8, 1942. Work was undertaken between November 1942 and August 1943 on models for the assaults on Sicily and Southern Italy. Work on the Sicilian and Italian models was carried out by a combination of teams in England and in Egypt. A 1:25,000 model was produced to cover the area from Mt. Etna to Pachino and westwards beyond Gela using information derived from Italian 1:25,000 and 1:50,000 maps supplemented by aerial photography. The whole model was mode in ten sections, each measuring 4.27 x 4.88 metres (14 feet by 16 feet). These models were illuminated to simulate the sun azimuth and elevation at the proposed time of assault and photographed obliquely to simulate an altitude of 152 metres (500 feet), the height at which the gliders would approach the coast. The sections for the American assault areas were then sent to Algiers.[34] A 1:4,000 scale model of Pantelleria was also produced in anticipation of an opposed occupation. Larger scale models, usually at 1:5,000 were produced of Syracuse, Gela, and Pachino in Sicily and Reggio and Crotone in Italy. A 1:10,000 model was also constructed of Taranto, which included ship locations and anti-submarine booms.

Various methods were used to create the models which are described in Pearson, Milwit and Reed. They were usually photo skinned to provide the plan detail, which was enhanced by painting and on the larger scale models the addition of physical objects to represent features such as buildings.

Conclusion

In a paper of this length it is not possible to cover the full range of military maps of Italy produced by the western allies during the Second World War. The focus has therefore been on those which would have been used by the armed forces either for planning or carrying out operations, the maps that ordinary soldiers and airmen would have used. A whole range of other maps were produced for strategic planning and reporting as well as maps for service personnel on leave in

war. A number of the images also appear in Milwit, 1946, implying that Reed was drawing on the same information and may have been involved in the same work.

34 Pearson, 2002, pp. 236–237.

Italian cities. A thorough combing of the archives would doubtless reveal many more. A common feature of nearly all the mapping considered here was its dependence on existing Italian mapping, with first editions frequently being direct copies of the Italian originals and only subsequent editions being revised from other sources. In a number of ways, the mapping of Italy gave the allies valuable experience for the subsequent mapping of France especially of the intended invasion areas although the work has been largely ignored in the literature on Second World War mapping.

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La production cartographique de l'Institut Cartographique Militaire en Belgique pendant la 2e Guerre mondiale[1]

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Abstract. The article reconstructs with the help of archival documents and contemporary maps the cartographic activity of the Belgian *Institut Cartographique Militaire*, predecessor of the current *Institut Géographique National*, during World War II. If the Institute left Belgium at the country's invasion by the Germans in 1914, during World War II it remained in Belgium after a brief stay in France and resumed its cartographic activities. The analysis of the archival documents and maps shows how during the four years of occupation by the Germans, the German military administration of the country and the Institute, demilitarized and residing under the authority of the *Commissariat Général à la Restauration du Pays*, shared the Institute's buildings, equipment and personnel in the framework of their respective mapping activities.

Keywords. Institut Cartographique Militaire de Belgique, Institut Géographique National de Belgique, Second World War, military cartography, topographical maps of Belgium

La Belgique pendant l'occupation

Si l'occupation durant la Grande Guerre est marquée par la barbarie, la politique menée par l'Allemagne à l'égard de la Belgique pendant la Seconde Guerre mondiale est d'une teneur différente.[2] Le 31 mai 1940, quelques jours après la capitulation du pays, l'armée allemande installe en Belgique un gouvernement militaire qui restera en place jusqu'en juillet 1944,

1 Je remercie Michaël Amara, Elise Bayers, Nathalie Liart, Jean-Luc Parmentier et William Sweetlove pour leur aide précieuse dans le cadre de cette recherche.

2 Cf. l'ouvrage à plusieurs mains de Mark Van den Wijngaert, Bruno De Wever, Fabrice Maerten, Dirk Luyten, Patrick Nefors, Luc Vandeweyer, Marnix Beyen, *België tijdens de tweede wereldoorlog*, Manteau, Antwerpen, 2015, notamment pp. 11-124.

quand l'occupant le remplace officiellement par un gouvernement civil. Pendant quatre ans, le général d'infanterie Alexander von Falkenhausen (1878-1966) sera Commandant militaire (Militärbefehlshaber) pour la Belgique et le Nord de la France. Il est responsable du maintien de l'ordre, mais également de l'insertion du potentiel économique et humain du pays dans la guerre allemande. L'administration militaire et son chef, le général Eggert Reeder (1894-1959), sont quant à eux responsables de tous les aspects politiques, économiques, sociaux et culturels du pays occupé. Leur interlocuteur belge, sauf pour la partie politique, est le Comité des secrétaires-généraux qui réunit en son sein les fonctionnaires les plus haut placés des ministères belges. Ces derniers avaient reçu par une loi votée par le parlement le 10 mai 1940, c'est-à-dire le jour de l'invasion allemande, le pouvoir d'exercer la compétence de leur ministre si celui-ci en était empêché par les circonstances de la guerre. Comme le gouvernement belge quitte le pays, pour la France d'abord, pour Londres ensuite, les secrétaires-généraux deviennent ainsi les garants de la continuité de l'administration publique pendant l'occupation. S'ils disposent officiellement d'une grande autonomie et ne doivent qu'appliquer les règlements allemands émis dans le cadre du droit de l'occupation international, dans la pratique ils se voient obligés de mener une politique de compromis qui vise à limiter ou à reporter l'impact de la politique allemande sur la vie des Belges tout en évitant que l'occupant ne s'empare entièrement de l'administration du pays. C'est dans ce contexte qu'il faut situer l'activité de l'Institut Cartographique Militaire (ICM), car contrairement à la Grande Guerre pendant laquelle l'ICM suivit le gouvernement à l'étranger, l'Institut, après un bref séjour en France, reprend ses activités à Bruxelles.

L'Institut Cartographique Militaire pendant la Guerre : les sources

L'histoire de l'ICM pendant la Seconde Guerre mondiale est mal connue. Elle est d'ailleurs peu documentée. En 1949, lors du Congrès International de Géographie de Lisbonne, Gustave-Jean Delmelle, directeur de la cartographie et ingénieur en chef de l'Institut Géographique Militaire, déclare que « cette période de guerre [du 10 mai 1940 au début de septembre 1944] est caractérisée par l'absence de travaux cartographiques officiels ».[3] Il ajoute que la majorité du per-

3 Gustave-Jean Delmelle, *Notice sur l'activité cartographique de 1938 au 1er avril 1949*, Institut Géographique Militaire, Bruxelles, 1949, p. 9. Par un décret du prince régent daté

sonnel alors présent en Belgique travaillait dans d'autres organismes ministériels, notamment pour des travaux d'urbanisme et de reconstruction.

En 1965, le général-major Mazy, alors directeur général de l'Institut Géographique Militaire, dans son *Historique de l'Institut*, consacre une page et demie à l'activité cartographique de l'Institut pendant la Guerre. Il raconte que l'Institut est évacué dans le midi de la France quelques jours après l'invasion allemande de la Belgique, et que le matériel de campagne et les dossiers des travaux rapportés la même année par le personnel civil « non laissé sur place » auraient en grande partie été perdus sur la route du retour à Bruxelles.[4] Il confirme l'affirmation de Delmelle selon laquelle durant l'occupation, le personnel aurait trouvé un travail ailleurs, notamment au Cadastre et au Ministère des Travaux Publics. Les Allemands par contre auraient utilisé les imprimeries lithographique et typographique de l'Institut, regroupées dans un organisme militaire allemand chargé de la publication de cartes, qui recruta pour ce faire du personnel. L'Institut quant à lui passe au Commissariat Général à la Restauration du Pays, un service créé par l'administration militaire le 29 juin 1940 pour centraliser et coordonner la reconstruction du pays après l'invasion ; il compte alors une quarantaine de dessinateurs, une quinzaine de topographes, quelques membres du service administratif et du personnel d'entretien. Il importe pour la suite de citer son récit des activités cartographiques de l'Institut à partir de ce moment : « Il [l'Institut] prend toutes les précautions nécessaires pour qu'en aucun cas son activité ne puisse profiter à l'occupant. Dans le cadre des missions qui lui sont fixées par le Commissariat Général à la Restauration du Pays, il n'exécute que des levés locaux, tels ceux du Mont des Arts à Bruxelles, des agglomérations de Tervueren, Malines, Tournai, Aarschot, Bruges et Saint-Trond, des sites de Bouillon, Coo et Dinant, et de l'Abbaye d'Aulne. Les géodésiens essaient d'effectuer la compensation des réseaux de 2e ordre situés au nord de la Sambre et de la Meuse, dont les levés étaient terminés en 1940 ; mais il ne s'avère pas possible d'imbriquer ces réseaux dans la maille comprise entre les trois chaînes primordiales longeant les frontières. Ils ne procèdent à aucun levé géodésique sur le terrain. L'ennemi a maintes fois

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du 5 mars 1947, l'Institut Cartographique Militaire change de nom et devient l'Institut Géographique Militaire. En vertu de la loi du 8 juin 1976, l'Institut sera transformé en Institut Géographique National.

4 Edmond Mazy, *Historique de l'Institut Géographique Militaire*, I, *Historique général. Edition provisoire*, Institut Géographique Militaire, Bruxelles, 1965, pp. 83-84.

enlevé du matériel pour l'expédier dans son pays. A diverses reprises il brûle des dossiers de calcul et le personnel lutte pour lui soustraire les plus précieux de ceux-ci. Après le débarquement allié de 1944, il vide littéralement l'Institut ». L'historiographie officielle de l'Institut est donc peu loquace quant à son activité pendant la Seconde Guerre mondiale. Elle prend soin de séparer les activités cartographiques de l'Institut de celles des Allemands. Vingt ans après les faits, il est encore nécessaire de souligner que pendant la guerre, aucune de ses activités n'a pu contribuer aux opérations militaires de l'occupant. Dans sa liste des directeurs généraux de l'Institut publiée dans une version antérieure de son *Historique*, Mazy ne cite pas de nom pour la période 1940-1944, alors que les archives, dont nous parlerons plus loin dans cet article, mentionnent, pour la période 1939-1944, le nom du civil Armand Letroye (1885-1968). Chef du bureau de calcul de l'Institut en 1939, il est alors nommé directeur général de manière provisoire.[5]

A ces publications officielles, nous pouvons ajouter deux témoignages relatifs à la situation de l'ICM lors de l'invasion allemande. Le premier témoignage se lit dans le dossier personnel du Commandant Fernand Poureau (1886-1968), matricule 14676, conservé au Centre de documentation du Musée royal de l'Armée de Bruxelles. Ce volontaire de carrière, détaché à l'ICM par disposition ministérielle en 1913, fut chargé du transfert de l'ICM à Anvers au début de la Grande Guerre, avant de rejoindre son régiment. Il passa une deuxième fois à l'ICM en décembre 1925 où il devint, en 1926, chef du service de la Reproduction de la carte. Son nom apparaît dans la marge inférieure de nombreuses cartes sorties des presses de l'Institut à partir de cette date. Le 15 mai 1940, quelques jours après l'invasion de la Belgique, il est évacué avec son service en France et arrive à Bordeaux après être passé par Ypres et Rouen. Le 30 juin 1940, le personnel militaire de l'ICM est invité par sa hiérarchie à se replier sur Toulouse, puis, fin août 1940, à regagner Bruxelles. Le matériel technique ainsi que les civils resteront à Bordeaux. Le Commandant Poureau arrive à Bruxelles le 22 août 1940, et est pris en charge par l'OTAD, l'Office des Travaux de l'Armée démobilisée. Ce service, créé fin août 1940, doit « veiller aux intérêts des officiers de l'active ou démobilisés » , et est sous la tutelle du secrétaire général des Finances. Malgré sa mise à la retraite le 1er octobre 1940, son nom continuera à figurer sur les cartes publiées pendant la Guerre.

5 Edmond Mazy, *Historique de l'Institut Géographique Militaire*, I, *Historique général. Edition provisoire limitée à 1914*, Institut Géographique Militaire, Bruxelles, 1963, p. 65.

Le deuxième témoignage provient d'un autre membre du personnel de l'ICM, en la personne d'Alphonse-Charles Willems, premier sergent-major, secrétaire à la direction de la Reproduction de la carte depuis 1936. Il est l'auteur d'un récit dactylographié en 1974 qui raconte l'exode de l'Institut en mai 1940. Il y donne de plus amples détails sur les conditions matérielles de l'évacuation de l'ICM en France et de son retour en Belgique.[6] Ainsi nous apprenons qu'une centaine de camions et voitures transportent le matériel et les militaires vers Bordeaux alors que les ouvriers et les employés partent en train avec leurs familles. Selon le témoignage de Willems, les ouvriers et employés sont rapatriés par les Allemands et reprennent le travail à l'Institut. On y apprend également que les Allemands sont allés chercher à Bordeaux les dispositifs d'impression des cartes qui avaient été évacués en mai 1940. En 1942, Willems réintègre l'Institut.[7] A la fin de son récit, Willems ajoute encore une information importante, qui contredit l'historiographie officielle : le 5 septembre 1944, l'ICM reprend ses activités d'avant la Guerre. Willems écrit : « Tout est resté intact et les presses fonctionnent normalement. Mes pauvres archives sont au grenier. C'est un tas immonde ! ».

Du côté allemand, si nous sommes mieux informés sur l'organisation de la production cartographique par l'armée allemande en Allemagne et dans les pays occupés, les publications relatives à l'activité cartographique ne nous donnent guère plus d'informations sur l'activité de l'ICM pendant la guerre. Dans un article sur les cartes de guerre allemandes, Willy Eggers (1901-1974), qui fut responsable du service de Rectification des cartes de l'armée allemande, explique en détail le fonctionnement du bureau cartographique militaire (Heeresplankammer) et décrit les procédés suivis pour produire les cartes des différents pays dans lesquels l'Allemagne avait un intérêt militaire.[8] Nous y apprenons qu'à l'été 1940, un nouveau département est créé, qui est responsable des cartes relatives aux territoires situés à l'étranger (Planmaterial Ausland) et divisé d'abord en quatre puis trois groupes, dont le deuxième est en charge des pays se trouvant à l'ouest et au sud de l'Alle-

6 Archives Générales du Royaume (AGR), CegeSoma, AB 620 Alphonse-Charles Willems, L'exode de 1940. L'odyssée de l'Institut Cartographique Militaire en mai 1940 : journal, septembre 1939-août 1940.

7 AGR, Institut Géographique National (IGN), 1336 (n° provisoire).

8 Willy Eggers, « Kriegskarten im Zweiten Weltkrieg. Planung und Herstellung. Aus der Arbeit der Heeresplankammer und des Kriegskartenhauptamtes des Oberkommandos des Heeres/Generalstab des Heeres », *Fachdienstliche Mitteilungen des Militärgeographischen Dienstes der Bundeswehr*, (1974), pp. 19-36.

magne. L'auteur ajoute qu'avec le temps l'activité cartographique de ce groupe, comme celle du premier en charge des pays à l'est et au nord de l'Allemagne, s'est déplacée majoritairement à l'étranger. Malheureusement, il ne donne aucune information sur la production cartographique dans ces pays. Par contre, il explique comment son service répondait aux demandes émises par l'armée pour obtenir la carte d'un pays en particulier. La première étape portait sur la recherche des sources cartographiques présentes dans la bibliothèque et dans les archives de l'armée. Ces cartes, dénommées originales (Originalkarten), étaient soit reproduites telles quelles, soit retravaillées par son service. Elles recevaient alors la dénomination d'édition spéciale (Sonderausgaben), information qui figurait également sur les feuilles imprimées. Theo Müller dans son aperçu de la production cartographique allemande entre 1939 et 1945 ne donne guère plus de détails sur l'activité cartographique dans les pays occupés.[9] Néanmoins, ses listes synoptiques présentant la période d'activité des différents services de l'armée allemande liés à la production cartographique permettent de déduire qu'à Bruxelles, il y avait du personnel militaire actif dans la production de cartes de guerre de 1940 à 1944 et qu'il y avait un dépôt de cartes de juillet 1940 à mars 1945.

L'Institut Cartographique Militaire pendant la Guerre: les archives et les cartes

Fin 2019, lors de son déménagement de l'Abbaye de la Cambre, où il s'était installé au XIX^{e} siècle, à l'Académie royale militaire à Bruxelles, l'Institut Géographique National (IGN), héritier direct de l'ICM, a transféré ses archives aux Archives de l'Etat à Bruxelles. A cette occasion, un inventaire provisoire a été dressé. La collection des cartes a, quant à elle, rejoint la Bibliothèque royale de Belgique. Un catalogue est en cours de préparation. Notons encore que les cartes relatives à l'Afrique ont été confiées au Musée d'Afrique centrale à Tervueren.

La lecture de l'inventaire provisoire des archives révèle un nombre très limité de documents relatifs à l'activité cartographique de l'Institut pendant la Guerre. On y trouve les rapports annuels du service géodésique ainsi qu'un rapport substantiel, rédigé en 1945, des activités géodésiques pendant la période 1940-

9 Theo Müller, Dirk Hubrich, Überblick über das Karten- und Vermessungswesen des deutschen Heeres von 1919 bis 1945 : ergänzter Neudruck mit Anhang, Amt für Geoinformationswesen der Bundeswehr, Euskirchen, 2009.

1944.[10] Dans l'avant-propos de ce rapport, on lit que l'Institut « eut une activité consacrée en ordre principal à des tâches relatives aux travaux d'urbanisation et de construction. En outre, il fut procédé à des travaux de nivellement de haute précision, à caractère exclusivement scientifique, et destinés à la mise au point et à la préparation technique d'équipes de nivellement capables d'effectuer leur travail avec le maximum de précision que l'on peut en attendre ». Malheureusement, le compte-rendu des travaux de nivellement a été enlevé du rapport.[11] Plus loin, on lit encore que « Le travail fut orienté de manière à éviter tout calcul dont les résultats eussent pu être utilisés par l'ennemi en vue de la défense de la zône [!] côtière, par exemple ».[12] Les archives contiennent également des dossiers allemands datant de 1940, comprenant les points géodésiques des domaines militaires de Maria-ter-Heide et Beverloo que les Allemands, selon une lettre datée de novembre de la même année et conservée dans la correspondance du directeur général de l'Institut pendant la Guerre, voulaient mesurer eux-mêmes.[13] La correspondance d'Armand Letroye fournit encore des informations intéressantes sur l'activité de l'Institut.[14] D'abord, dans une lettre du 13 novembre 1940 émanant du Generalkommando IV, Armeekorps confirme que l'Arbeitsstab für Karten- und Vermessungswesen in Brüssel se trouve bel et bien à l'Abbaye de la Cambre, à savoir dans les bâtiments de l'ICM. Une lettre du directeur général a.i. datant de août 1941, à entête de l'ICM – Direction générale, révèle que « l'établissement reprenant progressivement son ancienne activité, une partie du personnel détaché dans d'autres services est appelée à rejoindre l'Institut ». Une autre lettre du même directeur parle de « nombreux levés topographiques dans les régions dévastées et les zônes [!] à urbaniser » que l'Institut doit exécuter à la demande du Commissariat Général à la Restauration du Pays. D'autres lettres témoignent, en effet, d'une activité de levé topographique à Bruxelles, dans la région de Bruges et de Rochefort, au Pays de Waes, ou le long de la Dyle. La correspondance comprend plusieurs lettres d'anciens collaborateurs de l'institu-

10 AGR, IGN, 1673-77 et 1680 (n° provisoire).

11 AGR, IGN, 1697 comprenant le dossier sur la triangulation du pays prend comme point de départ ce même rapport. Une partie des calculs se trouve au verso des cartes de la Belgique éditées par les Allemands pendant la Guerre.

12 AGR, IGN, 1680 (n° provisoire).

13 AGR, NGI, 1369-70 et 1336 (n° provisoire)

14 AGR, NGI, 1336 (n° provisoire). Les lettres dont il sera question par la suite se trouvent également dans ce dossier.

tion : ouvriers, dessinateurs, topographes et aide-topographes, militaires et civils, demandant de pouvoir revenir à l'Institut. Plusieurs demandes datent de 1943 et visent à éviter le travail obligatoire en Allemagne alors exigé par l'occupant. Une lettre de l'Institut géologique de l'Université de Louvain, datée du 4 mai 1944, parle d'un tirage en bistre et bleu de la carte oro-hydrographique au 100.000e et une autre de la part du directeur de l'Institut, du 12 avril 1943, adressée au professeur Gaston-G. Dept de l'Université de Gand, donne la liste des planchettes au 20.000e nouvellement imprimées ainsi que d'un tirage de la carte au 100.000e en rouge et noir. Elle fait également mention de la difficulté d'obtenir du papier. Enfin, une longue lettre datant du 3 avril 1943, adressée par le directeur général à René Lefebure (1888-1976), directeur général de l'administration du Commissariat Général à la Restauration du Pays, dresse le rapport des activités de l'Institut pour la période allant du 29 septembre 1941 au 10 mars 1943. Ce rapport est instructif à plusieurs égards : il y est question de plus de 15.000 cartes envoyées en réponse aux demandes émanant des administrations communales, de l'Etat belge, des établissements d'instruction et de particuliers, dont certaines ont dû être réimprimées pour cause d'épuisement de stock. Le service photographique et l'imprimerie lithographique ont exécuté des agrandissements et réductions, des mises en état et tirages de différents plans et cartes pour satisfaire aux besoins des autorités belges. Des milliers d'ordres de marche, fiches de coordonnées et carnets de nivellement ont été imprimés, tous pour l'activité des services belges de l'établissement. Le papier est fourni par les Allemands qui ont pris en charge également les dépenses pour l'entretien des machines et du matériel de l'Institut. Deux remarques importantes clôturent le rapport : « il suffit de consulter les relevés des travaux exécutés pour l'Etat belge pour se rendre compte qu'ils sont loin de compter pour moitié dans les dépenses occasionnées par la réquisition du personnel » et les ouvriers requis par l'autorité occupante font 50 heures par semaine. Le personnel de l'ICM travaillait donc aussi pour l'occupant.

Parmi les documents cartographique produits par les Allemands pendant la Guerre et hérités de l'IGN en 2019, plusieurs témoignent de l'activité cartographique de l'ICM. Ils viennent compléter et enrichir la collection de cartes allemandes que la Bibliothèque Royale a achetées à des privés à la fin de la Guerre en 1945-1946 ou reçues en don de l'Institut Géographique Militaire même en 1959. Mais avant de les passer en revue, il faut mentionner le catalogue de cartes relatives à la Belgique dont une première édition fut publiée à Berlin en février 1940 (Fig. 1).

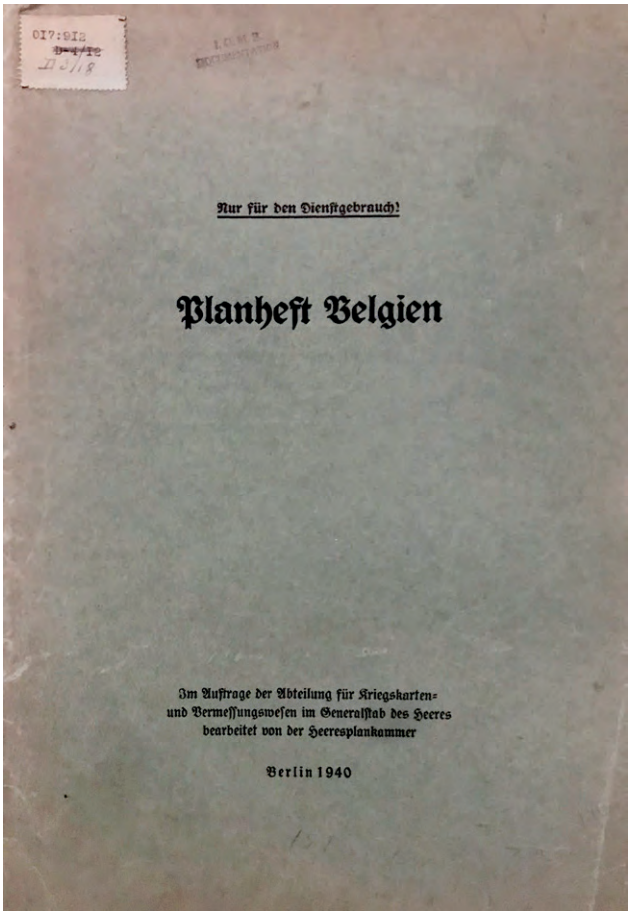

Fig. 1 Carnet de cartes pour la Belgique, édition de 1940 – KBR fonds IGN.[15]

Cette édition fournit un inventaire des cartes relatives à la Belgique dont disposait l'armée allemande quelques mois avant l'invasion. Parmi les éditions spéciales, on trouve une édition complète des cartes de Belgique au 25.000e, au 40.000e et au 100.000e. Parmi les cartes originales, seule figure la carte au 200.000e. Une publication postérieure a été collée sur la p. 23 de l'exemplaire du carnet provenant de l'IGN. La publication, longue de quatre pages, concerne les nivellements belges et leurs rattachements à ceux du Nord de la France et des Pays-Bas. Elle est dite « zusammengestellt vom Kriegs-Karten- und Vermessungsamt Brüssel » le 15 janvier 1943. La deuxième édition de ce catalogue, que nous n'avons pas (re-) trouvée dans les archives de l'Institut, mais dont un exemplaire est conservé à la Bibliothèque du Congrès à Washington DC[16], est plus intéressante encore. Plus étoffé que le premier, ce catalogue décrit plusieurs cartes de Belgique, à des

15 *Planheft Belgien*, Im Auftrage der Abteilung für Kriegskarten- und Vermessungswesen im Generalstab des Heeres bearbeitet von der Heeresplankammer, Berlin, 1940.

16 *Planheft Belgien. 2. Ausgabe. Vom 27. Januar 1944*, Im Auftrage der Abteilung für Kriegskarten- und Vermessungswesen im Generalstab des Heeres bearbeitet von der Heeresplankammer, [Berlin], 1944.

échelles différentes, produites pendant la Guerre sur la base des cartes de l'ICM (d'avant la Guerre). La première sur la liste est la carte de Belgique au 100.000e éditée en 1933. Suivent ensuite deux cartes au 50.000e, une en sépia comprenant 19 feuilles représentant la côte, l'autre en quatre couleurs qui est une continuation de la carte de France à la même échelle comprenant 14 feuilles. Toutes deux sont une réduction de la carte de Belgique au 40.000e. Enfin, il y est encore question de la carte de Belgique au 25.000e. D'origine allemande, elle est basée sur la carte belge au 20.000e.[17] Parmi les cartes originales dont l'armée allemande disposait en 1944, énumérées également dans les annexes de ce carnet, il est intéressant de mentionner la carte topographique et militaire de Belgique au 40.000e, notamment parce que la description spécifie que les plaques d'impression sont disponibles pour les 72 feuilles.[18] C'est une information importante puisque cette carte, bien qu'étant une réduction de celle au 20.000e, était utilisée par l'armée belge. Avec ces planches, l'armée allemande dispose donc d'un outil cartographique de premier ordre pour sa production propre. Sont également conservées 18 des 23 plaques d'impression de la carte des environs des garnisons à la même échelle, mentionnée à la même page du carnet. La lecture du carnet nous apprend encore qu'à partir de mars 1943, l'armée allemande avait entamé une nouvelle triangulation de la côte belge basée sur celle que l'ICM avait faite jusqu'en 1939 et qu'en cette année 1943, le bureau cartographique de Bruxelles avait été responsable d'un addendum au *Répertoire des Points Triangulés du Royaume 1939*.[19] Enfin, le carnet livre des informations sur le sort de l'ICM après la capitulation, informations qui confirment l'historiographie officielle de l'Institut et les rapports cités plus haut : l'Institut devient en 1941 un service civil, la cartographie intègre le Commissariat Général à la Restauration du Pays et s'occupe de travaux de géodésie, topographie et cartographie d'intérêt général, notamment le renouvellement de la triangulation et du nivellement du pays ainsi que la production des cartes pour les nouvelles régions métropolitaines.[20]

Parmi les cartes imprimées à l'ICM pendant la Guerre, nous étudierons d'abord la carte de Belgique au 25.000e, en noir et blanc, produit allemand figu-

17 Ibidem, A5-7.

18 Ibidem, B3.

19 Ibidem, C5 et C12.

20 Ibidem, C13-14.

rant, comme nous venons de le voir, dans le catalogue de cartes de 1940-1944.[21] En Belgique, il n'existait pas de carte nationale à cette échelle avant la Guerre. L'information donnée en allemand dans la marge inférieure des planchettes spécifie qu'il s'agit d'une réduction de la carte de Belgique au 20.000e, dont elle reprend la numérotation, et donne pour chaque planchette la date de sa dernière révision. La comparaison avec les planchettes de la carte belge montre qu'au début de la production de la carte, les Allemands ne disposaient pas toujours des dernières révisions, notamment des résultats de la nouvelle planimétrie (1920-1930) et des compléments des années 1939-1940. Actuellement, la Bibliothèque Royale conserve deux exemplaires de la carte au 25.000e, tous deux incomplets et de composition différente. L'exemplaire provenant de l'IGN, dont l'analyse est présentée ici, conserve pour plusieurs planchettes la version imprimée et le film ou transparent qui servait à la reproduction. Parfois, ce transparent concerne une édition postérieure à la version imprimée qui nous est parvenue. Dans le cas de la planchette 22/2, par exemple, le transparent présente une version qui se base sur la révision de la planchette correspondante de la carte belge faite en 1910 et corrigée en 1943 ; la version imprimée par contre se base sur une version de 1924 - dont nous n'avons pas trouvé de trace - corrigée en novembre 1942 (Fig. 2).

Une légende bilingue (français-allemand) se trouve à droite de l'image cartographique de chaque planchette. Les planchettes sans légende portent la notification d'édition provisoire. Sur les feuilles présentant les régions limitrophes avec l'Allemagne, une deuxième légende est ajoutée à gauche de la planchette, celle de la carte d'Allemagne à la même échelle utilisée pour compléter la planchette (35/5 Gemmenich, 43/3 Petergensfeld).[22] Sur la majorité des planchettes de la carte, une information apportée dans la marge inférieure indique qu'elles sont imprimées à Bruxelles en 1942 sur la base des films : Druck nach Folien : Arbeitsstab für Karten- u. Vermessungswesen. Brüssel – 1942. Sur certaines planchettes, on peut encore deviner l'indication du mois de février (39/6 Feluy) ou de mars (33/8 Looz) précédant l'année. On trouve aussi parfois la date de 1941 (la feuille 32/8 Tirlemont). Pour d'autres, une impression par l'Armee-Kartenstelle 560 est

21 Certaines planchettes sont imprimées en bistre (par exemple, 39/1-2, 43/7-8 de l'exemple provenant de l'IGN).

22 Les planchettes sont données à titre d'exemple ; l'analyse n'est pas exhaustive. Pour la France, seule la feuille 67/1 Bouillon utilise, pour la région au nord de Sedan, les plans directeurs au 20.000e.

Fig. 2a Planchette 22/2 de la Carte de Belgique au 25.000e, version imprimée – KBR fonds IGN.

mentionnée à côté de celle effectuée d'après les films (18/1-3, 25/7-8). Il s'agit d'une impression allemande antérieure à celle de Bruxelles. D'autres planchettes par contre ne portent pas l'impression bruxelloise ; elles nous apprennent dans la marge supérieure qu'elles font partie d'une seconde édition. Cette information est suivie de la date de la dernière révision de la planchette et des compléments particuliers faits en octobre ou novembre 1942 (31/2, 37/1). De nombreuses planchettes, notamment celles représentant la côte belge (4/7-8, 5/5-6, 11/7-8,

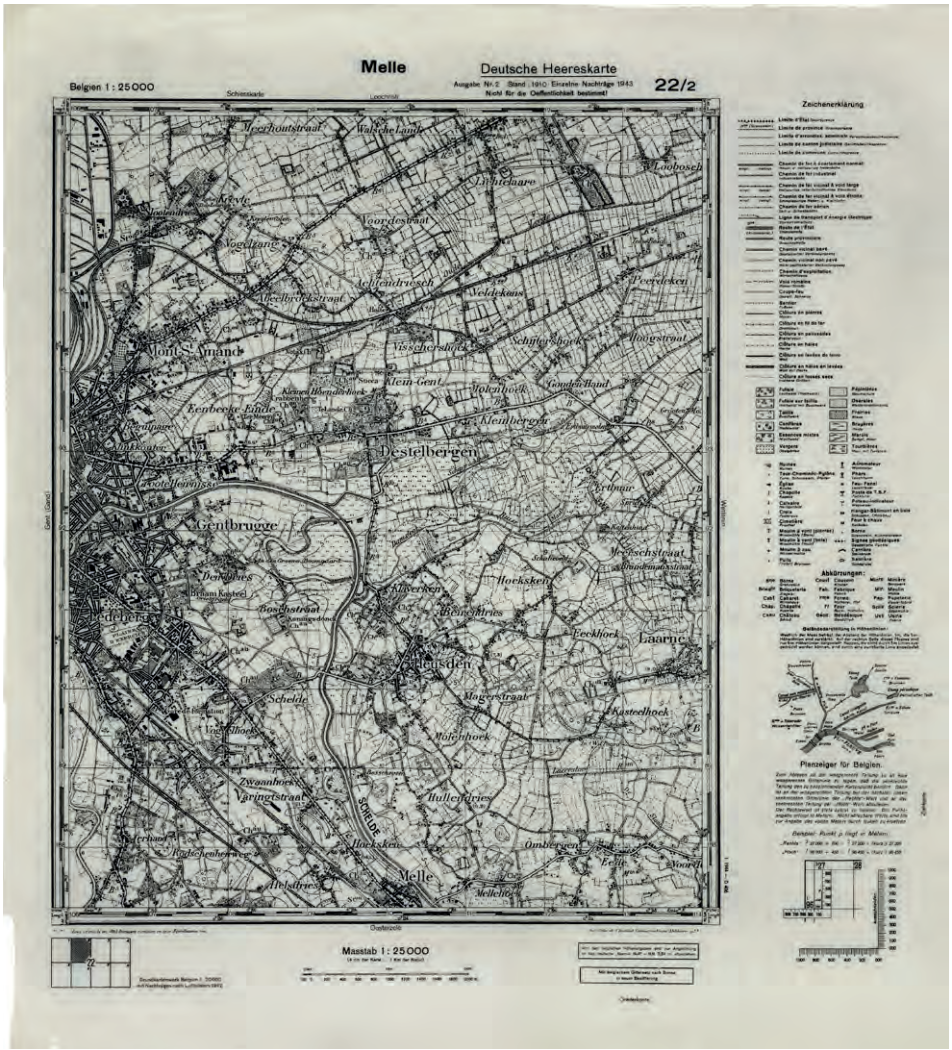

Fig. 2b Planchette 22/2 de la Carte de Belgique au 25.000e, version sur film – KBR fonds IGN.

12/1-3, 12/5-8, 13/2, 19/3-4, 19/8, 20/1-2) et les régions frontalières ou autrement stratégiques (7/7-8, 14/1-3, 14/4-8, 15/1-8, 17/3-6, 17/8, 22/1, 31/3), ont été révisées à l'aide de photos aériennes en 1942. Parfois, cette révision est accompagnée d'une exploration locale : la planchette 12/4 Houttave a été corrigée grâce aux informations obtenues sur place par le département topographique et cartographique 604 en septembre 1942. D'autres planchettes encore portent le titre de *Deutsche Heereskarte* : par exemple, la feuille 13/1 Brügge qui fait partie

d'une troisième édition avec des compléments ponctuels datant de juin 1943.

Pour certaines planchettes, la carte a donc connu au moins trois éditions et des compléments ponctuels dont les plus récents datent de juillet 1943. La première édition remonte au plus tard à mai 1940, date que l'on trouve dans la marge supérieure de quelques planchettes (43/7, 49/8). La planchette 67/2 Dohan nous informe qu'il s'agit d'une réimpression (Nachdruck) par le service topographique 602 pour un tirage de 500 exemplaires d'après l'ordre d'impression du 27 novembre 1939. La carte fut donc produite en préparation à l'invasion du pays ; sa première édition est entièrement allemande et c'est sans doute celle-ci qui figure dans la première édition du catalogue de cartes décrit plus haut. Par contre, la seconde édition corrigée et mise à jour par les Allemands a été imprimée, d'après les films, à l'ICM en 1941-42. Elle connaîtra une troisième édition en 1943.

Passons à présent aux cartes de Belgique au 20.000e et au 40.000e. Plusieurs exemplaires de ces cartes comprennent des planchettes ou des feuilles qui portent l'indication d'une impression à Bruxelles pendant l'occupation. Les archives de l'IGN comptent deux ensembles de la carte de Belgique au 20.000e. Le premier, complet, est en noir et blanc, le deuxième, incomplet, en couleurs. D'autres exemplaires, en noir et blanc, en bistre ou en couleurs, ont été acquis par la Bibliothèque Royale à la fin des années 1950. La production de cette carte à partir d'une nouvelle triangulation avait déjà été entamée après la Première Guerre mondiale. Or à la veille de l'invasion en 1940, seule une centaine de feuilles avaient été publiées, soit un peu plus d'1/5 de la carte. L'Institut poursuivra cette production après la Seconde Guerre mondiale en attendant la réalisation d'une nouvelle carte à la même échelle basée sur la photogrammétrie aérienne. En effet, plusieurs planchettes de la carte, datant de l'après-guerre, ont reçu des compléments partiels en surcharge (de couleur mauve) indiqués comme étant des « Modifications les plus importantes en attendant la publication de la nouvelle carte ». Cependant, cette dernière ne verra jamais le jour. En effet, en 1949 une feuille d'essai est présentée (39/1 Rebecq-Rognon) aux instances officielles et à l'étranger lors du Congrès International de Géographie à Lisbonne.[23] A la suite des critiques reçues, l'Institut décide de suivre l'exemple de la Grande Bretagne et d'opter pour une carte au 25.000e.[24] Les planchettes dans les exemplaires en noir et blanc

23 Institut Géographique Militaire, *Présentation de la planchette d'essai de la nouvelle carte de Belgique au 20.000e*, Institut Géographique Militaire, Bruxelles, 1949.

24 Militair Geografisch Instituut, *Het Militair Geografisch Instituut stelt zich voor*, Militair

provenant des archives de l'IGN et acquis par la Bibliothèque Royale en 1959 qui portent l'impression allemande « Druck Arbeitsstab für Kart. u. Verm.-Wesen Brüssel », datées de 1940 (7/2 et 8), 1941 (11/7-8) ou 1942 (4/7, 12/1-3 et 8-9), bien que d'origine allemande, ont donc été récupérées après la Guerre dans l'idée de continuer et de compléter la carte au 20.000e (Fig. 3).

La planchette 20/5 Loo, pourtant d'origine allemande également, ne porte pas cette indication : un exemplaire mentionne la date de 1939 dans la marge droite, l'autre celle de 1943 au même endroit. La feuille a donc connu une seconde édition pendant la Guerre. Les exemplaires en couleurs sont incomplets : celui de la Bibliothèque Royale a été complété par des planchettes en bistre ou en noir et blanc ; il a peu de planchettes d'impression allemande. L'exemplaire de l'IGN en compte davantage, toutes différentes de l'exemplaire de la Bibliothèque Royale, mais il est très incomplet.

Les feuilles de la carte au 40.000e, incomplète, en noir et blanc et en couleurs, dont le carnet de cartes de 1944 cité plus haut disait que les plaques étaient encore disponibles, nous livrent deux types d'impression.[25] La majorité des feuilles de la carte en couleurs renvoie à une seconde édition en juillet 1941 (2. Sonderausgabe 1941) « hergestellt im Auftrage Gen. St. d. H. Abt. f. Kr. Karten u. Verm. Wesen II ». Le lieu d'impression n'est pas indiqué. Toutes ont une légende bilingue (allemand-français). Par contre, quelques feuilles (1-2, 12-14, 17, 23, 27-29) portent l'information « Druck Arbeitsstab für Kart. u. Verm.-Wesen Brüssel [mois] 1941 ». Sur la base des mois indiqués, on peut dater l'impression entre juin et décembre de cette année-là. Contrairement aux autres feuilles, elles n'ont pas de légende. Toutes, à l'exception de la feuille 23, portent des compléments qui remontent aux années 1939-1940. Pour les feuilles 1-2, 12, 14, 23 et 27-28, des exemplaires avec le premier type d'impression sont également conservées. Ces feuilles ne présentent pas les compléments qui figurent sur les feuilles avec l'impression bruxelloise. La tonalité des couleurs utilisées est différente dans les deux impressions, ce qui pourrait s'expliquer par l'existence de différents lieux d'impression (Fig. 4).

Geografisch Instituut, Brussel, 1972, pp. 20-21 ; Institut Géographique Militaire, *Présentation de la nouvelle carte de Belgique au 25.000e*, Bruxelles, 1950.

25 L'analyse présentée ici est celle de l'exemplaire en couleurs de l'IGN. Les exemplaires en couleurs et en noir et blanc de la Bibliothèque Royale n'ont que peu de feuilles avec l'impression allemande (resp. 9 et 4).

Fig. 3 Planchette 12/2 de la Carte de Belgique au 20.000e, édition allemande de 1942 – KBR IV 9417.

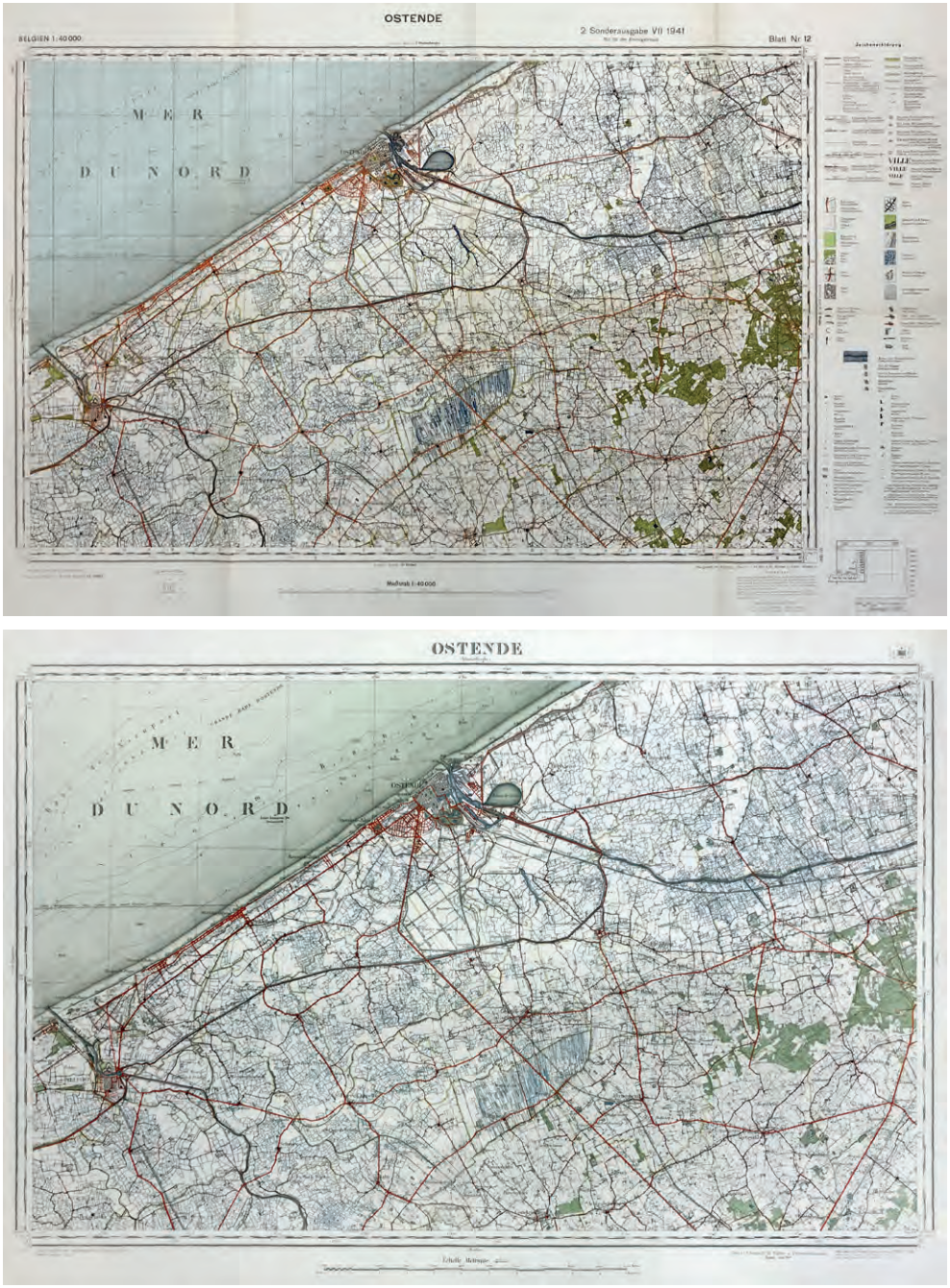

Fig.4 Feuille 12 de la Carte de Belgique au 40.000e, éditions allemandes de 1941 – KBR fonds IGN.

Avant la fin de l'année 1941, certaines feuilles de cette carte avaient déjà connu trois éditions.

Dans les archives de l'IGN ont également été retrouvés plusieurs exemplaires, dont un avec des annotations manuscrites, de la carte de la côte belge au 100.000e : *Einfarbige Küstenkarte von Belgien u. Südholland in 2 Blättern : Westblatt. Massstab 1:100 000* Stand: 1938/39. Einzelne Nachträge 1943. Bearbeitung : Korpskartenstelle 489. Druck: Kriegskarten-und Verm. Amt Brüssel. Elle est basée sur la carte de Belgique au 100.000e. Un exemplaire porte le cachet de l'ICM. En 1942, les Allemands avaient mené une intense politique de photographie aérienne qui incita à la correction des feuilles témoignant de la situation d'avant-guerre.

Enfin, un dernier témoin avéré de l'activité cartographique à Bruxelles a été retrouvé dans les archives de l'Institut. Il s'agit d'un plan de la zone métropolitaine d'Anvers au 20.000e imprimé à l'ICM pour le Commissariat Général à la Restauration du Pays: *Stadsgewest Antwerpen schaal 1:20.000*. Commissariaat generaal voor 's lands wederopbouw - bijgewerkt tot 1 januari 1942 – Cartografisch Instituut.

Plusieurs cartes et plans provenant des archives de l'IGN n'indiquent pas d'impression bruxelloise, mais pourraient, pour leur contenu et la date de l'édition, être attribués à l'activité de l'ICM ou, pour le moins, renvoyer à une participation de ce dernier à leur production. Il existe ainsi deux exemplaires d'un plan de Bruxelles au 20.000e imprimé en 1943: *Stadtplan von Brüssel*. Gen. St. des H. Abt. für Kriegskarten u. Verm. Wesen ; VI. 1943 – D. 406. Ce plan allemand est conservé dans une farde avec deux reproductions d'après-guerre, faites par l'ICM devenu entre-temps Institut Géographique Militaire. Ensuite, nous y avons retrouvé plusieurs exemplaires de la feuille de Liège de la carte de Belgique au 100.000e, en couleurs, dans son édition allemande de 1939, avec en noir l'ajout du « Câble souterrain des Ponts et Chaussées (en projet) », et, enfin, plusieurs exemplaires d'une carte au 300.000e qui montre l'état routier de la Belgique en juillet 1939 : *Belgien Strassenzustandskarte Stand: Juli 1939* - Generalstab des Heeres, Abteilung für Kriegskarten u. Vermessungswesen.

D'autres cartes de production allemande ont été retrouvées dans les archives de l'IGN. Ces séries couvrent les pays environnant la Belgique, où elles furent par ailleurs imprimées. Par contre, la présence des films des feuilles de l'édition

allemande de la carte d'Angleterre et d'Ecosse au 100.000e par l'Ordnance Survey pourrait indiquer que l'imprimerie de l'ICM n'était pas uniquement exploitée à des fins d'impression de cartes de la Belgique.

L'ICM a donc bel et bien produit des cartes pendant l'occupation. Les presses tournaient à plein régime, au service des Allemands comme des Belges. Quand ils ont commencé à produire des cartes de Belgique, les Allemands ne disposaient pas des révisions des années 1920-1930, mais une fois installés à Bruxelles, ils devaient y avoir eu accès, comme nous le montrent les nouvelles éditions. De plus, en 1942 et 1943, ils disposaient d'informations complémentaires grâce aux photos aériennes et aux vérifications sur place. La question qui se pose est de savoir comment ce travail a été organisé au sein de l'abbaye de la Cambre, ou encore dans quelle mesure le personnel de l'Institut a été impliqué dans la production de cartes pour l'armée allemande. Le rapport de Letroye de 1943 cité plus haut semble suggérer une implication imposée par l'occupant. Pour tenter d'y répondre, nous avons consulté un dernier document d'archives.

L'Institut Cartographique Militaire pendant la Guerre: Les archives personnelles d'Oscar Plisnier

Oscar Plisnier (1885-1952) fut secrétaire-général du ministère des Finances pendant la Guerre. Il était président du Comité des secrétaires-généraux responsable de l'administration publique du pays sous l'occupation. Dans ses papiers personnels, conservés aux Archives du Royaume, un dossier est entièrement consacré à l'ICM, son personnel et ses activités, et couvre la période septembre 1940 - août 1944.[26]

Nous y apprenons qu'Armand Letroye, rentré à Bruxelles avec les documents évacués, trouve les locaux de l'ICM occupés par les Allemands qui ont gardé tous les documents et veulent faire revenir à Bruxelles les pièces se trouvant dans les dépôts de Bruges et de Saint-Nicolas. Le dossier conserve l'inventaire de 1939

26 AGR, Oscar Plisnier, 507 D II/3. Le dossier n'est plus complet, mais l'analyse détaillée des documents en début du dossier permet de reconstruire le contenu de l'ensemble des documents qui y figuraient. Sur Plisnier comme secrétaire-général du Ministère des finances pendant la Seconde Guerre mondiale, voir Mark van den Wijngaert, *Het beleid van het comité van de Secretarissen-generaal in België tijdens de Duitse bezetting (1940-1944)*, Paleis der Academiën, Brussel, 1975.

comprenant les documents à évacuer lors de l'invasion et ceux qui resteraient à l'ICM. Du côté belge, on insiste dès le début de septembre 1940 pour remettre en état de fonctionnement l'ICM tout en le libérant de son implication militaire. Du côté allemand, la section topographique à Berlin demande au service cartographique de l'armée allemande de réactiver l'ICM et de poursuivre certains travaux de triangulation sur le territoire belge en recourant aux services du personnel et au matériel belges. En mars 1941, selon la même source allemande, « l'Institut effectue différents ordres d'impressions [!], de ses propres mesurages ainsi que des ordres du Commandant en chef pour la Belgique et le Nord de la France » et les travaux de triangulation sont en préparation. Le 25 août 1942, un rapport dressé par l'Inspection des Finances constate une irrégularité dans le chef de l'Institut, à savoir que son personnel travaillerait de façon exclusive sous les ordres de l'occupant sans que ce dernier ne donne aucune spécification quant au caractère du travail effectué.

Quelques mois plus tard, une note du 30 décembre 1942 qualifie de secrets les travaux effectués par le personnel réquisitionné de l'ICM. Il est vrai qu'un règlement du 6 mars 1942 permet à l'occupant de réquisitionner du personnel en Belgique « pour un intérêt particulier ». Sept mois plus tard, hommes et femmes d'un certain âge peuvent également être réquisitionnés pour aller travailler en Allemagne. Le personnel de l'ICM n'échappe pas à cette politique: dans un document daté du 4 mars 1943, l'administration militaire allemande reconnait que le personnel de l'ICM travaille sous la direction de l'Office des Cartes de guerre et de mesurage à Bruxelles (Kriegskarten- u. Vermessungsamt). Plusieurs lettres dans le dossier font part d'une discussion entre l'administration militaire allemande et l'administration belge à propos des responsabilités financières à l'égard du personnel réquisitionné par l'occupant.

En outre, du côté belge, on se pose la question de savoir si la Belgique peut invoquer l'art. 52 de la Convention de la Haye qui interdit à l'occupant de recourir à la population locale pour mener des opérations de guerre contre son propre pays. L'administration militaire allemande refuse cependant cette interprétation des faits ; consulté à ce propos, maître Marx soutient à son tour que, comme il s'agit de reproduire des cartes existantes, qui se trouvent donc dans le domaine public, ou d'imprimer des cartes dont le type est procuré par l'occupant lui-même, l'art. 52 n'est pas d'application, ni l'art. 116 du code pénal « ne frappant que celui qui agit volontairement ».

Grâce à l'avis de maître Marx, nous apprenons que des cartes destinées à l'armée allemande sont (également) imprimées à Bruxelles en dehors de l'Institut, par l'imprimerie de la Wehrmacht et par l'imprimerie « De Wrycker, Chaussée de Bruxelles », sans doute l'imprimerie O. De Rycker et Mendel spécialisée en chromolithographie. Fin juillet 1944, l'administration militaire allemande demande formellement que l'Institut s'occupe de la transformation des cartes au 40.000e relatives au territoire situé à l'Est de Bruxelles en cartes au 50.000e ainsi que de la révision des cartes actuelles à l'aide des photographies aériennes allemandes. Face au refus de l'autorité belge, le 14 août 1944 l'Institut et son personnel sont formellement réquisitionnés par le commandement militaire. Quelques semaines plus tard, le 4 septembre 1944, Bruxelles est libérée.

Conclusion

Les informations que nous avons pu rassembler, les publications récentes et d'époque, les rapports et correspondances, et les documents d'archives et cartes permettent de décrire la période de l'occupation de l'ICM comme suit. L'armée allemande occupe les bâtiments de l'ICM à l'abbaye de la Cambre désertés par ses occupants lors de la capitulation de Bruxelles. Le 22 août 1940, le service cartographique rentre à Bruxelles ; l'Institut se réorganise afin de reprendre ses activités cartographiques dans l'intérêt du pays. La même année déjà, à la demande de Berlin, le service cartographique allemand réactive l'ICM en y faisant travailler du personnel belge et en utilisant ses ressources matérielles. La Belgique connaît donc le même sort que les autres pays d'Europe occupés par les Allemands où les services cartographique et topographique de l'armée allemande s'emparent des agences cartographiques et de leurs installations.[27] Comme c'est le cas en France, où le Service Géographique de l'Armée est remplacé par une organisation civile du nom Institut Géographique National en juin 1940, l'Insti-

27 Cf. Joachim Neumann, « Military mapping by Germany », In Mark Monmonier (ed.), *Cartography in the Twentieth Century, History of Cartography*, Vol. 6, University of Chicago Press, Chicago, 2015, pp. 909–921, p. 915. Voir également Susan Powell et Heiko Mühr, « Capturing the Complex Histories of German World War II Captured Maps », in *That Map Belonged to Somebody: The Importance of Provenance for Map Librarians, Journal of Map & Geography Libraries Advances in Geospatial Information, Collections & Archives*, 16, 2 (2020), pp. 166-193, et Julia Sweetkind-Singer, « Acquisition of World War II Captured Maps: A Case Study », *ibidem*, pp. 140-165.

tut peut continuer à mener ses propres activités.[28] Le 11 juillet 1941, l'Institut est officiellement démilitarisé et devient une institution civile rattachée au Commissariat Général à la Restauration du Pays. Pendant quatre ans, Allemands et Belges vont cohabiter dans les bâtiments de l'ICM et se partager au moins une partie du matériel présent dans ces bâtiments ainsi que le personnel. Les Belges font des levés topographiques dans le cadre de leur mandat reçu de la part du Commissariat Général, les Allemands s'occupent des mesures géodésiques des bases militaires belges de Marie-ter-Heide et du Bourg-Léopold. Des cartes existantes sont mises à jour, corrigées et imprimées sur les presses de l'Institut pour l'armée allemande aussi bien que pour les administrations et privés belges. Pour imprimer les cartes notamment, l'occupant n'hésite pas à réquisitionner des membres du personnel de l'Institut, qui pour la plupart y travaillaient déjà avant la Guerre. Peut-être demande-t-il davantage, mais rien ne nous permet de le confirmer. Vers la fin de la Guerre, par contre, l'occupant exige que le personnel de l'ICM s'occupe également de la révision des cartes pour l'armée allemande. Confronté à un refus formel de l'administration belge, il réquisitionne l'ICM et son personnel.

Durant quatre années le directeur-général A. I. Letroye, un civil, mène une politique du moindre mal qui vise à maintenir un équilibre, certes précaire, entre patriotisme et collaboration avec l'ennemi. Ainsi, d'un côté, il réintègre les anciens collaborateurs de l'Institut afin de pouvoir répondre aux demandes de cartes émanant de ses supérieurs et, à partir de fin 1942, pour éviter qu'ils soient forcés de quitter le pays dans le cadre du travail obligatoire en Allemagne. De l'autre, en partie pour pouvoir continuer à fonctionner, c'est-à-dire notamment obtenir le papier devenu rare à partir de 1942 et faire entretenir les installations, en partie par force majeure, il doit accepter qu'une partie de son personnel soit appelée à travailler pour les Allemands. Enfin, il est à noter que les travaux exécutés par l'ICM pendant la Guerre seront encore utilisés pendant des années.

28 Peter Collier, « Military mapping of Europe », in Mark Monmonier (ed.), *Cartography in the Twentieth Century, History of Cartography*, Vol. 6, University of Chicago Press, Chicago, 2015, pp. 962–966, p. 964. Selon l'auteur, les Allemands n'utilisaient les agences cartographiques des pays occupés que pour leurs équipement et leurs cartes. Le cas de Belgique présenté ici montre au contraire que les Allemands ont joué un rôle plutôt actif dans le fonctionnement de l'ICM pendant l'occupation, jusqu'à utiliser son personnel pour leur production cartographique.

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Evolution of Military Aerial Imagery 1859-2015: From Balloons to Drones

by Marco Belogi (Italian Army) - Elena Leoni (Italian Army - Reserve)

Abstract. Aerial photography for military purposes started around 1880, when all major European armies used balloons as observation platforms. Starting from the first shot in 1911, the airplane gradually became the main photographic platform through all WWI to take both oblique and vertical aerial shots of front lines. The years 1919-1939 saw the development of topographic mapping from aerial photos, which led all colonial powers to map their areas of influence and to carry out "secret" aero-photographic missions. During WWII, all nations created specific air photographic planes for detecting targets, preparing attack missions and assessing damage, solving huge problems of altitude and autonomy and organizing dedicated photographic units. The Cold War led to the development of recce jet planes, where panchromatic, infrared and radar imagery sensors were installed on the nose of the aircraft. USA also developed strategic air photo collection systems including the U-2 and SR-71 "Blackbird".
The years 1959-1970 saw also the development of satellite photography: CIA's Corona Project laid the foundation for intelligence satellite imagery. Between the 1970s and 2000s, new digital electro-optical or radar sensors for satellites with increasing resolution were developed both for military and civilian use. In parallel, unmanned Aerial Vehicles can take and send oblique motion video, while others can carry out systematic vertical footage of the terrain, such as the Buckeye system in Iraq and Afghanistan. From old balloon photographs to recent Buckeye imagery, an important secondary use of this military technology has been the opportunity to better study archaeological and monumental sites.

Keywords: Military, Aerial Imagery, Air Photography, WWI, WWII, Cold War

Early Aerial Imagery

Military aerial imagery is covered or mentioned in many articles or publications, but usually this topic is approached from limited perspectives (strictly military, technical, survey, mapping, urbanistic, archaeological, etc.). This study is an attempt to present a comprehensive histor-

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ical evolution of aims, methodologies, observation platforms, remote sensors, organizations, and possible civilian use of this truly military activity, as well as giving a glimpse about its main leading actors.

In military related operations, remote sensing of an adversary entity (persons, place, thing, or activity) can be divided into reconnaissance (periodic observation) or surveillance (continuous observation) and needs both observation platforms and remote sensors. While the first remote sensing was made by human terrestrial observation with the later help of magnification lenses, the first observation platforms other that elevated terrain were observation towers, which had the limit to extend only a short distance upward.

After the first balloon flight in 1783, the French were the first to observe the adversary from the air and to form a military Aerostatic Corps in 1794, but this was soon disbanded after its two different companies were captured or lost their equipment. The American Civil War (1861-1865) finally tested the effectiveness of balloons in battlefield reconnaissance with balloon operator Thaddeus Lowe, who reported movements of Confederate armies. On the same battlefields, the official military observer Count Ferdinand Von Zeppelin had the idea to overcome the limited area of view of the tethered balloon, thus creating the first dirigible in 1874. This rigid airship, despite always relegated to a secondary role as military observation platform, would be periodically revitalized until recent years under the name of Aerostat due to the advantage of its persistence in air.

In parallel, the idea of using aerial photography as sensor for military purposes was developed between years 1859 and 1880. In fact, together with observation from balloons to observe the movements of troops and to guide the firing of artillery, terrestrial stereo photographic images were popular since the mid-1850s. The famous French photographer Nadar (real name Gaspard-Félix Tournachon, 1820-1910)[1], who was a pioneer of balloon photography, is credited with having proposed balloon photography to the French army in 1859 in support of its operations in Italy.

Unfortunately, until the end of 19th century the use of aerial photography was still hampered by the problem of impression and development of the plates coated with collodion, which had to remain moist during the flight. It was only in

1 Adam BEGLEY, *The Great Nadar: The Man Behind the Camera*, Tim Duggan Books, New York, 2017.

1880, on the idea of the English physicist Richard Maddox[2], that the photographic plates were coated with dry gelatin, allowing for subsequent development after landing. Thanks to this invention, the period from 1880 to 1910 saw the development of military balloon photography.

Following the example of the major armies, in November 1884 First Lieutenant Alessandro Pecori Giraldi (1858-1948) promoted the establishment of a "Sezione Aerostatica" (Aerostatic Section) embedded in the Mixed Brigade of the Military Engineers of the Italian Army. This section, later named "Compagnia Specialisti del Genio" (Engineer Specialists Company), participated in the Eritrea Military Campaign between 1887 and 1888. In that occasion, Pecori Giraldi and his company were deployed in Saati, the Eritrean village recently reconquered by the Italian troops on 1 February 1888. His small photographic album shows the panoramic views of the forts, glimpses of the landscape, the encampments and the ascents of the three balloons (named Serrati, Volta and Lana) anchored to the ground by ropes and cables[3].

In 1896 Captain Maurizio Moris promoted the establishment in Rome of a "Photographic Section" embedded in the Aerostatic Section of 3rd Military Engineer Regiment. This section, which in 1887 came under the newly developed Aerostatic Specialist Company and in 1894 under the more complex Aerostatic Specialist Brigade, in June 1899 carried out the first ascension for archaeological purposes in Rome[4].

In Russia, in May 1886 military engineer and commander of an aeronautical unit Alexander Matveyevich Kovanko (1856-1919), together with Dmitry Mendeleev (the same scientist who created the periodic table), became the first in Russia to take a photograph from the balloon during a flight over St. Petersburg with a special camera constructed by Professor Vyacheslav Ivan Sreznevsky.[5]

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2 Helmut GERNSHEIM, *The Rise of Photography 1850-1880*, Thames and Hudson, London 1988.

3 5 Reparto–Ufficio Storico (SMA), Raccolta Capitano Alessandro Pecori Giraldi, Archivio dell'Ufficio Storico dell'Aeronautica Militare.

4 Patrizia FORTINI, Veronica ROMOLI, « La collaborazione tra il Genio Militare e Giacomo Boni per la nascita della fotografia aerea archeologica », In *100 anni di Archeologia aerea in Italia. Atti del Convegno Internazionale, Roma, 15-17 aprile 2009*, pp. 23–32.

5 Ivan T. ANTIPOV, « The Development of Photogrammetry in Russia », http://www.close-*range.com/docs/The_Development_of_Photogrammetry_in_Russia--Antipov.pdf*.

During the Russo-Japanese War of 1904-1905, three Russian specialized aerial battalions (one of them was the 1st East Siberian under Colonel Kovanko) used tethered balloons and kites created by Russian engineer and balloonist Sergei Ulyanin. Before the advent of the aircraft, these kites were big enough to lift an observer two hundred meters off the ground, high enough for reconnaissance and photographic survey of terrain as far as four to seven kilometers away without being noticed.[6]

The first experiment on topographic planimetric survey was performed in Rome in the winter of 1902-03 by Italian Army Lieutenant Attilio Ranza, who photographed a section of the course of the Tiber River. In 1908 Captain Cesare Tardivo, director of the Photographic Section for two years, took photographs at a scale of 1: 3.500 on an area of fifty kilometers along the Tiber River. Tardivo basically started the aerophotogrammetry, which is a three-dimensional measurement, drawing or model of some real-world features on the ground captured from air photographs. He presented this new topography technique from the balloon in 1910 at the International Conference of Photography in Brussels and in 1913 at the 1st International Conference of Photogrammetry in Vienna, creating great admiration both for the concepts and accuracy results. His manual from 1911 recommended truncated pyramidal cameras for shooting, with telephoto lenses ranging from 4 to 10 magnifications. The movements of the balloon were compensated by the use of mechanical release shutters with exposure times of less than 1/1000 of a second. The plates were in 13x18 or 18x24 cm format.[7]

The years around 1910 also marked the start of development of aerial photography by airplane. The first aerial photography motion picture from an airplane was taken on 19 April 1909 by Major Maurizio Moris as Wilbur Wright's passenger on the Centocelle airfield, during a series of demonstration flights.[8] The first credited use of aerial war photography occurred during a reconnaissance flight carried out on 24 January 1912 by Captain Carlo Maria Piazza in a Blériot XI during the Italian-Turkish war in Tripolitania. Piazza had a Newman & Guardia

6 Nikolay DANILEVSKY, *The Aerial Kites of Captain Ulyanin*, Vozdukhoplavatel' Magazine, St. Petersburg, Usmanov Publishing, 1910.

7 Francesco GUERRA, Luca PILOT, *Historic Photoplanes*, Laboratorio di Fotogrammetria, CIRCE, Istituto Universitario di Architettura di Venezia, Italy, 2008.

8 Video: Wilbur Wright und seine Flugmaschine (Wilbur Wright e la sua Macchina Volante), Société Générale des Cinématographes Eclipse, 1909.

Fig. 1 Postcard showing Italian Aerostieri (Balloonmen) over Rome.
(Author's collection)

Baby Sibyl camera with Zeiss lens supplied from the Engineer Corps in Tripoli and mounted vertically downwards on his plane, which allowed only one slide per flight.[9] In the following months, an automatic plate change system was developed to increase the number of photos per mission.[10]

9 Alberto GRAMPA, *Carlo Maria Piazza Cavaliere del cielo*, Busto Arsizio, 2007.

10 Manlio MOLFESE, *L'aviazione da ricognizione italiana durante la grande guerra europea (maggio 1915-novembre 1918)*, Provveditorato generale dello Stato, Roma, 1925.

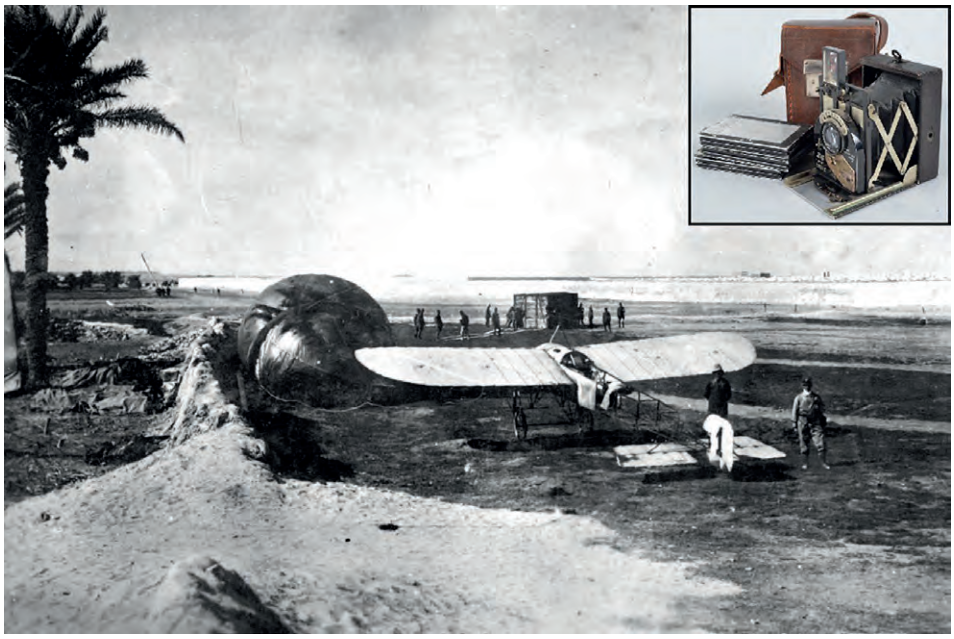


Fig. 2 Blériot XI of Captain Carlo Maria Piazza, who carried out the first reconnaissance flight on 24 January 1912 during the Italian-Turkish war in Tripolitania. Also note the photographic reconnaissance balloon. In the smaller image, Newman & Guardia Baby Sibyl camera with Zeiss lens used for this mission. (https://www.modellismopiu.it/modules/newbb_plus/print.php?forum=160&topic_id=131586, modified by authors)

Aerial Photography in WWI

Despite this first interesting experiment, in 1914 all main armies entered the First World War with an institutionalized tethered balloon observation system. The balloons could climb up to two kilometers high, but they were easy to shoot down and were unstable observation platforms in any wind, despite attempts of stabilization. Furthermore, they could not navigate from place to place in such a way as to allow rapid and continuous photography of large areas. Finally, the camera had to be operated through elaborate mechanisms for pointing and manipulating the imaging and plate-changing devices.

All these issues led to the gradual affirmation of the aircraft as photographic platform, with the major countries involved (France, Britain, Russia, Austro-Hungary, Italy and Germany) developing their own reconnaissance aircraft. In August

1914 most of the fighting countries had only few propeller aircraft, which flew 2-4,000 meters above the ground and were exclusively dedicated to "ethically correct" reconnaissance and artillery fire of the enemy. Only in the following months they were increasingly used to take vertical aerial photos of entrenchments near the front lines. If at the beginning priority was to make the aircraft a stable platform, soon it was realized that priority was its survivability, achieved mainly with fast and high flight.

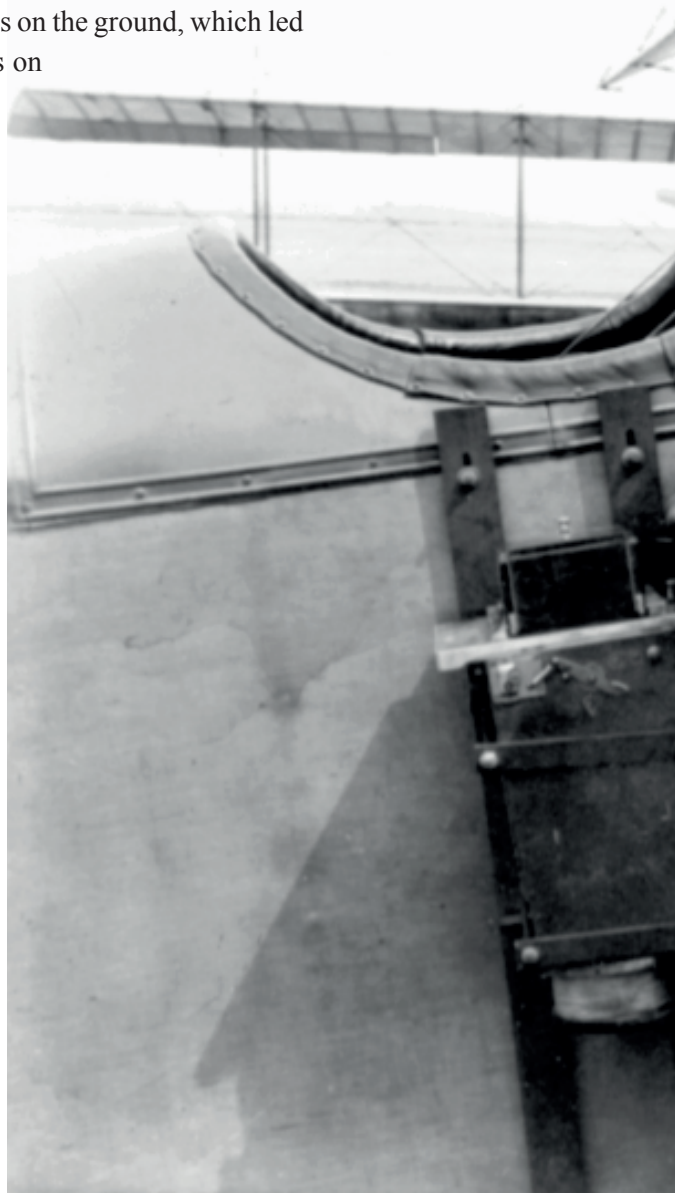
The first aim of aerial photography from a military propeller aircraft was the "spotting" of a definite individual target, which included particular trenches or pivotal points in a trench system before an attack, roads or bridges along avenues of approach, batteries or big guns both before and after their bombardment. The technique of spotting consisted in getting properly over the target and then securing the exposure at just the right moment. If cameras were completely hand operated, this needed an auxiliary operator other than pilot, who due to his limited view perspective could otherwise entirely miss a large or elongated objective.

The task of spotting was mainly fulfilled through oblique aerial photography. In comparison with vertical views, oblique views are much easier to be interpreted especially with reference to elevations and depressions of land: obstacles like moats, walls and embankments would hardly be noticed on vertical views, at least without special training. Oblique views taken from low altitudes of the territory to be attacked remained crucial for the infantry in the later stages of the war. Aerial oblique photographs could be either high angle (proper oblique) or low angle views (panoramic), "bird's-eye views" (if taken from different sides) and even stereo oblique, in this last case needing special instrumental equipment and techniques.

The task to obtain aerial oblique photographs with a camera fixed in the fuselage in a vertical position was simply fulfilled by banking the plane steeply, but this technique was not recommended for taking a consecutive series of exposures. The most satisfactory arrangements were to mount the camera obliquely in the plane or to use a mirror or prism, in front or behind the lens of a vertically mounted camera. While the first method has been employed mainly by the French, the English had to use the second method because their cameras were fed by gravity. The oblique, longitudinal or lateral mounting was mainly depending on the aircraft characteristics. In the longitudinal mounting it was necessary to fly directly

toward the objective, with the small advantage of less motion in the image, but with the big disadvantage of shooting only a single cross section of the target, not to mention the high risk involved in the maneuver. However, longitudinal mounting was necessary with the bulky 120-centimeter cameras, which simply could not be slung athwart the plane. In addition, mosaics of oblique photographs could be made only by complex systems of conical mounting. In any case, oblique photographs remained necessary to observe enemy positions staying at safe distance during fighting.[11]

The second task for aerial photography was the aid for artillery and the need to reach the so-called situational awareness on the ground, which led to the photography of continuous strips on the ground. At the same time, it was clear that this effect was possible only width almost-vertical photographs. In this way aerial photography, in a continuous crescendo, passed from single lenses shooting to the creation of photographic mosaics that allowed HQs to have a clear view of the front. However, the intelligence value of aerial reconnaissance in World War I was always considered secondary to that of leading artillery fire. Already during the bloody Battle of the Somme in 1915, the British Royal Flying Corps took 19,000 aerial images of German trench positions and reprinted them 430,000 times.[12]



11 James Warren BAGLEY, *The Use of the Panoramic Camera in Topographic Surveying*, US Geological Survey, 1917.

12 Terrence J. FINNEGAN, *Shooting the Front, Allied Air Reconnaissance in the First World War*, The History Press, Spellmount, 2011.

Fig. 3 This British "Type C" aerial camera is externally mounted on an American Curtiss JN-4 aircraft. (U.S. National Archives and Records Administration)

An interesting application of aerial photography to achieve situational awareness was the creation of the so-called trench maps. In order to be able to trace the trenches and the enemy artillery positions, near-vertical aerial photographs were superimposed with various methods to the existing mapping, which had been produced in previous decades starting from angular measurements on the ground. In order to print and mount mosaics, the first step was to determine if each overlapping negative had to be scaled by comparing it with an illuminated glass map sketch. The second step was to print negatives by simple contact or, in case they needed to be scaled, through an enlarging camera. An alternative method, mainly used by Germans, was to trim successive film negatives so that the trimmed sections will exactly juxtapose, instead of overlap. The sections were then mounted at their edges by stickers on a large sheet of glass and finally printed together. All these methods assumed the previous existence of an accurate map, so they were not usable in unmapped regions. In addition, photographic distortions due to lens, shutter, film warping, and paper shrinkage did not allow to produce any kind of precision mapping.

Due to the increasing number of reconnaissance flights, the infantry and artillery started to camouflage their structures from aerial observation by building fake or dummy constructions, and by covering buildings and camps with vegetation, painted canvas and earth. This led to the exploitation between 1916 and 1918 of the aerial stereoscopy.[13] Stereoscopic views or stereograms, made either by photography consist of pairs of pictures made of the same object from two different points. With a minimum overlap of 60% between each frame, the pairs of images could be viewed through a stereoscope to produce a 3D effect. In this way, the two aerial photos could show an elevation and concreteness otherwise not possible in the ordinary flat aerial vista.[14] Often, indeed, these attributes are essential for detecting and recognizing the nature of objects seen from above. Stereoscopic aerial photography has been justly termed "the worst foe of camouflage." The first techniques of interpretation of vertical aerial photographs were

13 Herbert E. IVES, *Airplane Photography*, Philadelphia and London J. B. Lippincott Company, 1920.

14 The ability to see objects in relief is possible when both eyes see the same objects in their fields of vision. Due to the separation of the eyes, the real appearance of all objects not too far away is different, and it is from the interpretation of these differences that the brain gets the feeling of relief.

very much relying on the correct exploitation of the shadows made by terrain and human features. Furthermore, simple mechanical devices, called stereo-plotters, were introduced to orient two photographs relative to each other and relative to the ground.

The whole practical problem of making a photographic map from the air consisted in taking a large number of slightly overlapping negatives, all from the same altitude, with the plane flying uniformly level. It was the observer's duty to time the intervals between exposures so that they overlap enough, but not so much as to be wasteful of plates or film. He must also change magazines or films so quickly as to miss no territory, or if some be missed, his is the task of directing

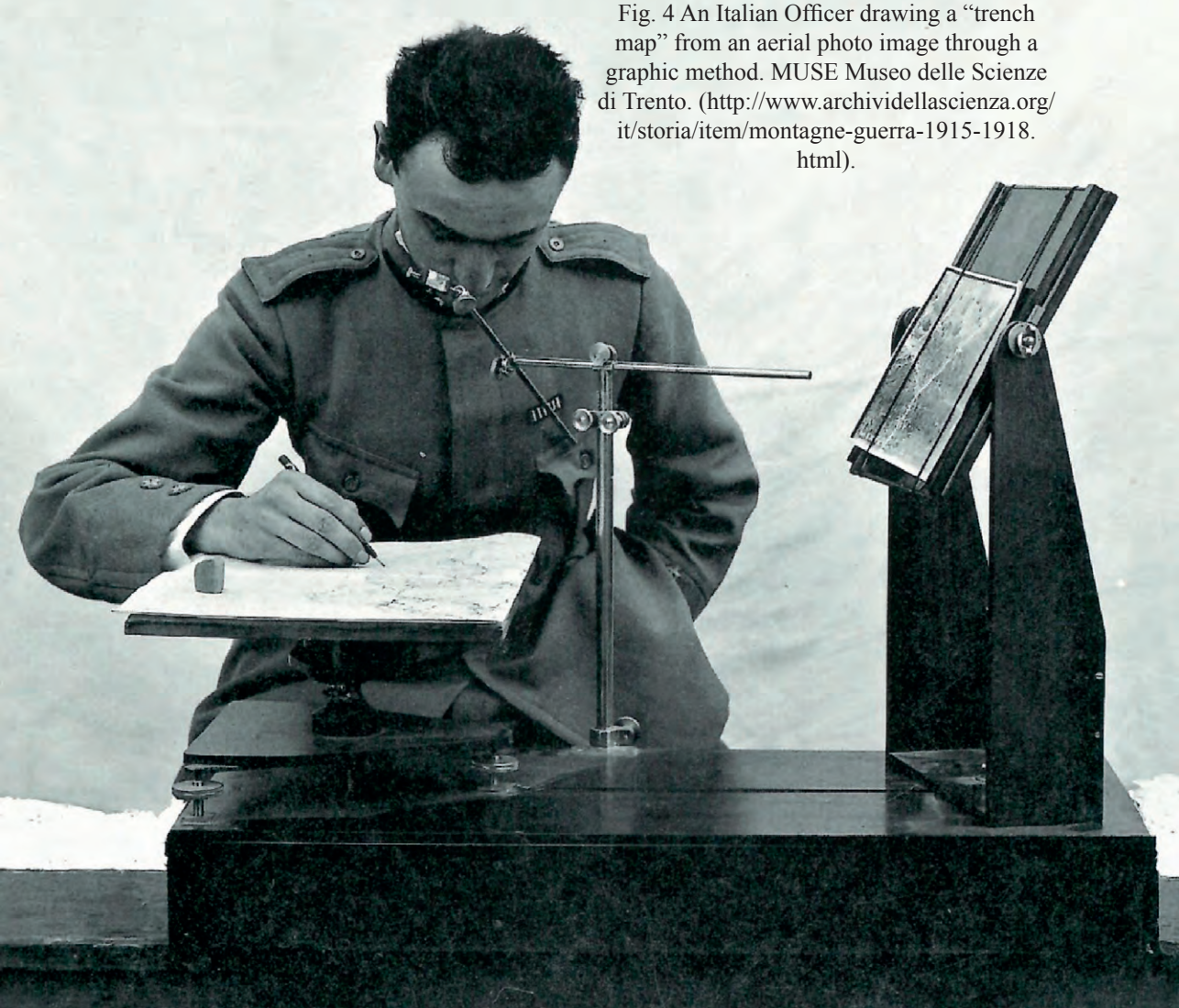


Fig. 4 An Italian Officer drawing a "trench map" from an aerial photo image through a graphic method. MUSE Museo delle Scienze di Trento. (http://www.archividellascienza.org/it/storia/item/montagne-guerra-1915-1918.html).

the pilot back to the point of the last exposure, where they begin a new series. The most usual overlap was 20%, except for stereos, which call for 50 to 75%. An alternative method of securing parallel strips, which in wartime was highly recommended if enough airplanes equipped for photography were available, was for several aircraft to fly side by side, maintaining their proper separation. The most suitable cameras for mapping were unquestionably those of the entirely automatic type, whose use always demanded knowledge of the ground speed. Cameras of each nation were different in sizes and shapes, but all shared the same limits in the operation process: there were no viewing screens and most of them were plate cameras. In addition, many times the photos taken were blurry due to the slow shutter speed of the cameras compared to the speed of the plane. These issues were improved only towards the end of the war.

When war broke out in August 1914, the French paved the way for aerial reconnaissance. In October, each Army Corps included an aerial photographic section made up of specialized personnel, with pioneering camera development and the gathering of intelligence information from aerial photographs. A school was established in Paris attended by observers and pilots from all other nations, thus creating the famous "French School". Field exercises for pilot and observer training were conducted at several additional sites in France. French pilots mainly used DeMaria cameras, with a focal length of 50 or 120 cm.

On the other hand, Germany had a scientific advantage in the lenses field with the adoption in 1913 of the first aerial camera, the Görz, equipped with Carl Zeiss optics[15]. This optics included the F25, F50 and F70, with focal lengths from 25 to 70 cm and photographic plates 13 × 18 cm. Austria-Hungary followed their lead: at the end of 1917 the Austrian air force took about 4,000 photographs a day, updating the entire Italian front every 2 weeks. The Central Powers used many different aircrafts, but mostly the Rumpler and Albatros types which fitted Görz and ICA cameras. The radio-equipped unarmed reconnaissance aircraft Rumpler C. VII Rubild (short for photographic airplane) stood out for its long range and high altitude, reaching 6,500 m.

In Great Britain, in March 1913 a unit of the newly formed Royal Flying Corps (RFC) was created specializing in aerial photography, on three squadrons with

15 Robert M. CLARK, *Geospatial Intelligence: Origins and Evolution*, Georgetown University Press, Washington DC, 2020.

Fig. 5 A British Royal Flying Corps laboratory unit showing all different aero-camera types. (USAFA McDermott Library Special Collections)

Pan-Ross circumstance cameras. In 1915 the "A" type camera was developed which, being a portable device, was risky to handle during flight. In the summer of 1915, the "C" type was developed, with the same body as the "A" type, but with a semi-automatic plate refilling system consisting of two magazines placed on top of the camera. Thanks to this magazine, the images could be taken in rapid succession. Towards the end of the war came into service the L-type camera, which could be placed inside the aircraft. In the meantime, British photography specialist invented a method for developing the glass plate negatives during flight, so that printed copies would be soon available just after landing.

While Great Britain invented a semi-automatic plate refill system, Italy was not inferior. The first aerial cameras used were mounted by Italians on the sides of aircraft to obtain vertical views, but as vibration of the aircraft was a serious problem, Italy was the first country to have an anti-vibration camera, the Lamperti & Garbagnati with 24 plates, generally mounted sideways on the excellent Ansaldo SVA 5 aircraft, which reached 200 km/h of speed.

In August 1917, First Lieutenant Ermenegildo Santoni was assigned first to the 44th and then to the 42nd Italian airplane squadron as an aerial observer. In order to solve the need to take photographs in sequence to map the terrain, he created an automatic intervalometer, the first sample of which was already produced in the second half of 1917. The device was based on a small variable pitch propeller which operated the photographic advance lever and on a sight notch for the check of the apparent sliding of the ground underneath. Santoni patented his invention on August 1918, the first of a series of over forty licenses.

The United States, while entering at the end of the conflict without much experience, aligned itself with the British and the French and assigned to each Army Corps of the American Expeditionary Forces (AEF) an observation group, each consisting of two or more observation squadrons and one photographic section for the processing and printing of the frames. However, Americans introduced a crucial improvement for aerial cameras, that was to provide more ground coverage. In fact, a single photograph from a single-lens cameras could cover only a relatively small area, while recconnaissance aircraft could not afford to loiter for an extended period of time over the adversary lines to take more photographs. This issue was partially solved by topographic engineer James W. Bagley and Captain Fred Moffit, who developed the T-1 tri-lens camera from a French model to produce one vertical image and two oblique images. In addition, United States were the first to introduce the camera roll. In fact, the Eastman Kodak Company designed the K-1 camera which, with a 6-inch (15.24 cm) film and integrated film roll, was the primary American camera used in the final days of the war.

All World War I cameras were still depicting only the visible part of the electromagnetic spectrum to produce black and white panchromatic images. Their photographs had a variable number of formats (for example 13×18 cm camera with a focal length of 26 cm; 18×24 cm camera with focal lengths of 52 and 120 cm) and had different markings and numbers to identify not only the air force unit, but also the north direction.

In fact, during WWI airplane photography was mainly used for focused battlefield reconnaissance rather than for mapping. For example, between 1915 and 1918 British RFC carried out air photographic survey in Palestine and in Mesopotamia, but they used the simple method to build up mosaics in order to redraw existing maps with the addition of more details.

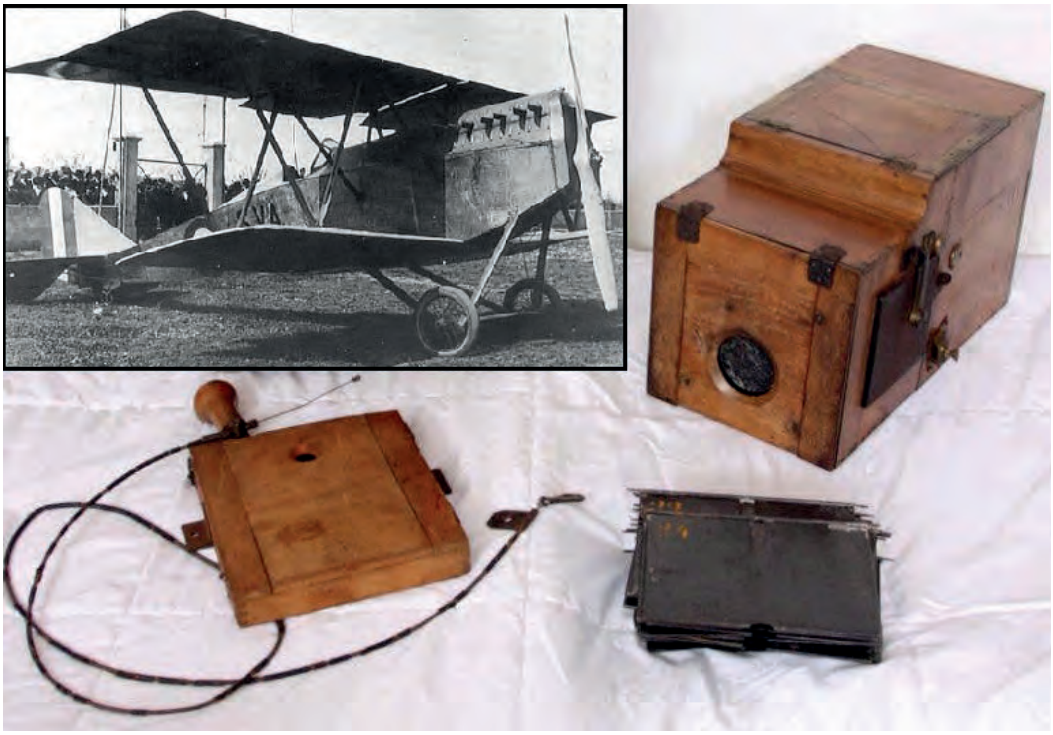


Fig. 6 Lamperti & Garbagnati with 24 plates, generally mounted sideways on the excellent Ansaldo SVA 5 aircraft, which reached 200 km/h of speed. (http://www.papermodeldownloads.com/aircraft/Ansaldo-SVA/SVA.html, modified by authors)

The Interwar Period

The building up of a map from scratch was possible only soon after the war, when the development of cameras and photographic techniques allowed extensive aerial mapping, which turned out to be much faster than ground surveys.[16] For example, in Great Britain in 1920 the British War Office created the Air Survey Committee in order to investigate the exclusive use of photogrammetric air survey to draw maps. This required the definition of specifications for specific aerial photogrammetry cameras. This meant that surveyed ground control points were needed at both ends of every strip of photography. With this new method, it was necessary to carry out ground geometrical triangulation to determine the

16 Peter COLLIER, « The Work of the British Government's Air Survey Committee and its Impact on Mapping in the Second World War », *Photogrammetric Record* 21 (2006), pp. 100–109.

exact coordinates of a certain number of terrain features which were at the same time recognizable on an air photograph (the so-called control points). These control points would later allow the drawing of an outline map, whose details were to be supplied by aerial photographs. But this operation needed to operate on a non-hostile territory. The first military photogrammetric mapping to integrate ground survey was carried out in Palestine in 1919, but the mapping in Mesopotamia when it came into British hands on the same year can be considered the first example of mapping for military purposes using exclusively aerial photogrammetry.[17]

Another issue evaluated by Air Survey Committee was to find simple, low-cost map plotting methods. But still in that year the air survey instruments were essentially terrestrial plotters adapted to deal with differently inclined air photographs through different graphic methods. Only the competitive development of optical-mechanical projection instruments by inventors and producers from different nations solved the problem. Already in 1919 Umberto Nistri, as Commander of Aerial Observation School in Centocelle (Rome) patented the "Photocartograph" optical projection instrument. Around the same years the French Georges Poivilliers designed the "Stereotopograph" for the Service géographique de l'armée, followed by more developed models. Between 1921 and 1926 Reinhard Hugershoff created an optical-mechanical table instrument called "Aerokartograph". In 1922 Walther Bauersfeld's Carl Zeiss Company in Jena developed the "Stereoplanigraph" C-1 optical projection instrument, followed in 1930 by the C-4, which was also adopted in the United States. In 1925 the Wild Company manufactured the first Universal "Autograph" and Officine Galileo with Professor Santoni manufactured the "Autoriduttore" (1920) and the "Stereocartograph" (1925) mechanical projection instruments. All of these photogrammetric stereo plotters allowed the topographic map to be drawn with a pantograph starting from two successive partially overlapping images. In order to orient these stereo pair, a feature of topographical cameras was the presence of markers imprinted on the frame, which made it possible to identify the perspective center of the aerial view through references on the edge of the frame itself.[18]

17 Caren KAPLAN, « Mapping "Mesopotamia": The Emergence of Aerial Photography in Early Twentieth-Century Iraq», in Caren KAPLAN, *Aerial Aftermaths: Wartime from Above*, Duke University Press, Durham, USA, 2018, pp. 138–179.

18 Peter COLLIER, « The Impact on Topographic Mapping of Developments in Land and Air

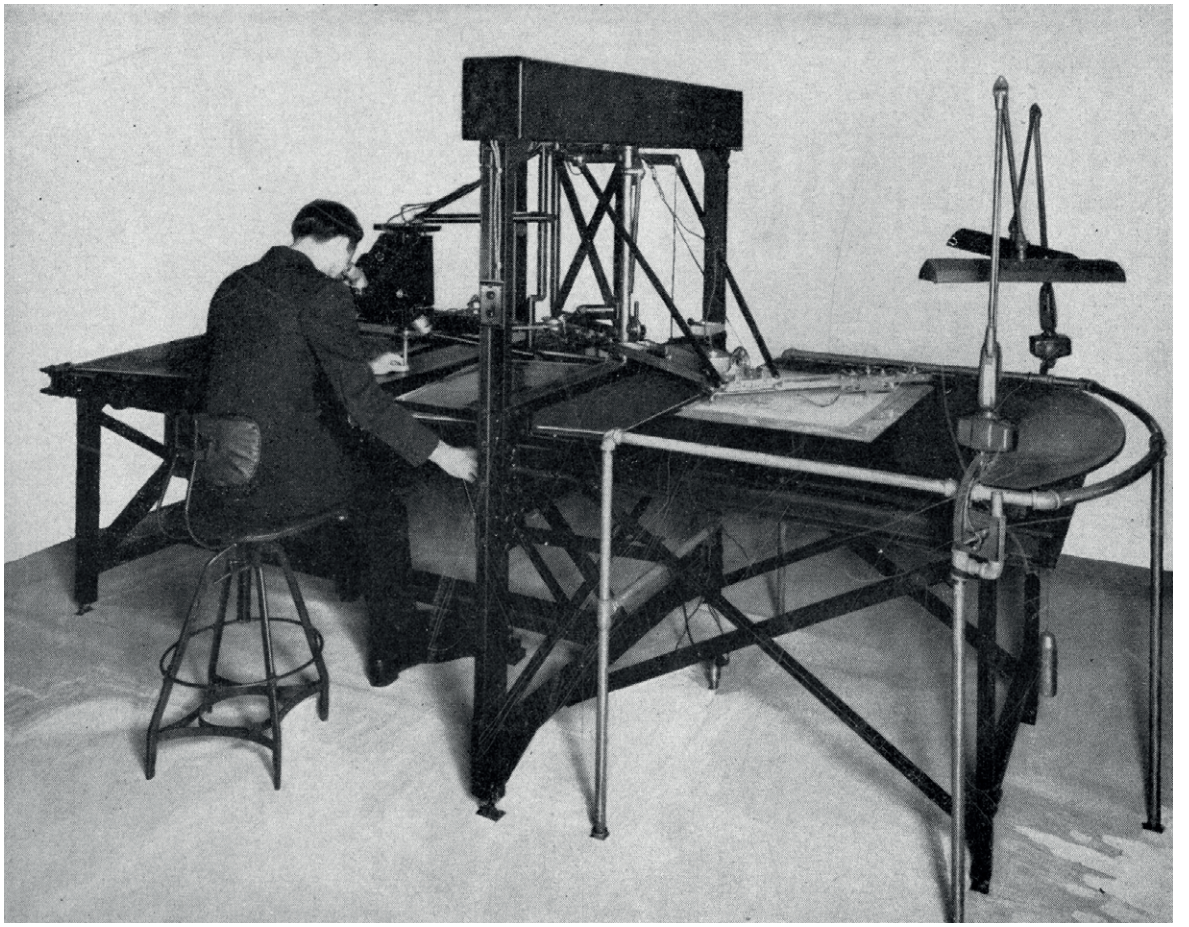


Fig. 7 US Model A stereoplotter (1939).
(https://celebrating200years.noaa.gov/foundations/mapping/image11.html)

Due to these achievements, the years until 1930 saw an international race for the development of photogrammetric instrumentation. German (Zeiss), French (Poivilliers) and Swiss (Wild) firms engineered different plotter designs, while the British and American ones lagged behind for a while.[19] Also in Italy, under the impulse of the General Staff of the Italian Army who made plans for the map-

Survey: 1900–1939 », *Cartography and Geographic Information Science* 29/3 (2002), pp. 155–174.

19 Heinz GRUNER, *Reinhard Hugershoff*, XI1 International Congress of Photogrammetry 23 July to 5 August, 1972.

ping of Eritrea, Somalia, Ethiopia and Libya, Ermenegildo Santoni created the Stereosimplex photogrammetric stereo plotter at the Officine Galileo in Florence. Among the many people involved in military aerial photography at that time was Thomas Edward Lawrence, also known as Lawrence of Arabia (1888-1935). Lawrence joined the recently formed Royal Air Force (RAF) on August 30, 1922 under the name of John Hume Ross. After basic training he was assigned to the RAF Farnborough School of Photography on 7 November 1922 to begin training as an aerial photographer. He chose this position because his father, who was a pioneer of photography, had taught him the technique of matter. During that period Lawrence was assigned photographic work for several British Museum expeditions, but his true identity was soon discovered and in January 1923 he was forced to leave the RAF.

Once the opportunity to map vast territories through this instrumental method became efficient enough, all major national powers tried to achieve a potential military advantage over the others. In fact, the years between 1930 and 1939 saw the increasing use of the aerial photography to map vast territories, with all colonial powers engaged in the creation of the cartography of their respective areas of influence. This stimulated the development of increasingly improved cameras for vertical shooting, virtually free from vibrations and with great autonomy of shots.

Among all, Germany was at the vanguard of private photogrammetry with its numerous companies, including the Hansa-Luftbild in Berlin, the Photogrammetrie in Munich, the Aerokartographisches Institut in Breslau (now Wroclaw) and the Bildflug in Bonn. At the beginning of 1934, all these organizations were brought together to form the Deutsches Einheitsluftbildinstitut (German Unified Aerial Photograph Institute) of the Berlin-based Hansa-Luftbild with autonomous branches, each with: Aerial Photography Section, Photomosaic Section and Stereoplotting Section.

The years after World War I saw also a further development in camera technology. One field to improve in camera configuration was to optimize the ratio between focal length, roll dimensions and body weight. In 1919, British Captain Victor Laws designed the excellent F8 camera, which used a 17.78x17.78 cm roll film and could be used with lenses of various focal lengths. In 1925 was produced the F24 which, with a size of only 12.7x12.7 cm, had less definition but was lighter, stronger and more reliable. The F24, in various configurations, would become the British standard camera of the Second World War.

In the aftermath of WWI, the USA strengthened the organization for the creation and study of aerial photographs, relying on the British experience. As stability and shutter speed remained a problem with aerial cameras, Sherman Fairchild (1896-1971) took charge of building a camera with the shutter located inside the lens, finally completing it in 1920. This design significantly improved image quality, becoming the standard for aerial cameras systems in the following decades. After founding the Fairchild Aerial Camera Corporation, he improved the previous T-1 tri-lens camera in cooperation with its original developer James W. Bagley, building the four-lens T-2 (1928) and five-lens T-3 models, the latter giving one vertical and 3 or 4 oblique images in one film exposure. Fairchild also made the F-1 series airplanes in 1926, with top wings and closed cabins to provide a more secure and stable platform from which to perform aerial photogrammetry.

On the Italian side, in 1924 Ermenegildo Santoni, as reserve officer and expert within Istituto Geografico Militare (Geographical Military Institute), engineered two 210 mm focal length cameras reciprocally mounted at 30° and fed by two magazines of 60 13x18 cm plates, covering about 350 km^2. A solar periscope connected to the system defined the inclination of the machines at the moment of shooting. Also, his 1938 camera model adopted for the first time in Italy the film (60 m for a total of 300 frames), which during the exposure was made to adhere by compression.[20]

Despite the various technical developments achieved at the end of the First World War, the exclusive attention to photogrammetric aerial mapping distracted from the formation of a real military operational capacity through the adequate synergy between organization, means and procedures. As already mentioned, the only military aerial photographic activity which was really improved by nations was about carrying out "secret" aero photographic missions.

Regarding Great Britain, in 1939 Frederick Sidney Cotton, a former pilot in the photographic sector of the Royal Naval Air Service, was enlisted in the Air Information Service and equipped a Lockheed 12A with one vertical and two oblique cameras. Cotton, flying at about 7,000 meters, could photograph an area

20 Enzo SANTORO, *La Fotogrammetria presso l'Istituto Geografico Militare*, in Lo Sguardo di Icaro – Le collezioni dell'Aerofototeca Nazionale per la conoscenza del territorio, Roma 2003.

Fig. 8 Oblique air photo of Pantelleria Island taken by a British aircraft in 1936.
(From Marco BELOGI, Pantelleria 1943 - D-Day nel mediterraneo, Liberedizioni, Gavardo, 2001)

ten kilometers long and 16 km wide and flew 15 secret missions to targets in Germany, Italy and the Mediterranean.[21] It is also of particular interest the series of oblique aerial photos which were taken from 1936 onwards to verify the secret fortification works in Pantelleria Island. The photos were by Supermarine Scapa seaplanes from the 201st Squadron at Kalafrana (Malta) at a distance of six miles in order to not infringe the prohibition of flying over the island.[22]

From German side, between 1934 and 1939 Lieutenant Theodore Rowehl of

21 Roy CONYERS NESBIT, *Eyes of the RAF: A History of Photo-Reconnaissance*, Sutton Pub Ltd, London, 1996.

22 Marco BELOGI, *Pantelleria 1943 - D-Day nel mediterraneo*, Liberedizioni, Gavardo, 2001.

the Luftwaffe, who was an aerial reconnaissance pilot during the First World War, under the cover of Lufthansa flights took aerial photographs with a He-111V2 over the Soviet Union, the English Channel, the North Sea and the Baltic Sea through heavy paired vertical cameras.

Aerial Photography in WWII

The World War II period (1939-1945) brought tremendous growth and recognition to the field of aerial photography, transforming it into a real weapon. In addition, there was a surge in government interest in photogrammetry in order to support the map making efforts. During WWII, uses of aerial photography were further differentiated. Primarily, photographic reconnaissance examined potential targets, thus allowing the analysts to determine the opponent's vital infrastructure, to trace the attack routes and to prepare the target list for the aircraft crews. Additionally, post-attack sorties provided the bombing damage assessment needed to assess success. While vertical shots remained crucial to build maps, oblique shots were more descriptive and often more useful for detecting targets and preparing attack missions.

During the conflict the Germans, which had an initial technical-organizational advantage, were gradually overtaken by the British and then by the Americans. In fact, when the United States entered the war in 1941, they practically had no military photointerpretation experience, but through massive training programs they achieved the best photographic interpretation skills of any nation in the world. On the other side, the Germans continued to use photography as a tactical support and never came to the strategic use of American photographic reconnaissance. As for Great Britain, in 1939 the RAF still did not have a specialized photographic reconnaissance aircraft.

Due to the high death rate among early reconnaissance flights, some Supermarine Spitfire fighter planes were depleted of machine guns and radios, sealed to improve aerodynamics, and their engines were modified to optimize performance at altitudes up to 12,000 meters. To improve visibility, a drop-shaped bubble canopy was fitted. Two F24 cameras were mounted vertically and synchronized to provide two slightly overlapping photos. Eventually, the aircraft were equipped with additional fuel tanks and were painted a pale shade of blue to make the aircraft less visible. Operation at high altitudes led to cameras being frozen, to

fogged lenses, or to film being cracked, but RAF engineers solved the problem by channeling hot air from the engine through the camera housings. After these changes, this special purpose aircraft was nicknamed "Cottoned" Spitfire also with reference to his developer, Sidney Cotton, who at that time was heading up the RAF 1 Photographic Development Unit (PDU) at Heston Aerodrome. Additional photography units were also created: No.2 in the Middle East (later in Heliopolis in Egypt), Unit No. 3 on the seas and No. 4 in Gibraltar.

The main merit of Great Britain was to maximize the synergy between the available cameras and aircraft. In fact, the poor resolution of the F24 camera, which provided poor detail from 10,000 meters, was resolved with the adoption of the Swiss photogrammetric stereo plotter Wild A5 which magnified up to 8 times. In 1942 the F52 camera was introduced with 21.59x17.78 cm frames, with 35.56, 50.8 and 91.44 mm lenses and with 250 or 500 exposure magazines. In order to be able to take pictures at low altitudes an unarmed version of the Spitfire Mk VII was developed, with a pale pink color to hide in the low banks of clouds. Another very efficient reconnaissance aircraft was the twin-engine Mosquito, which had the advantage of a second operator able to adjust the cameras during the flight and which was also able to flight at altitudes up to 12,000 meters.

Through the year 1943 British Bomber Command managed to have all its aircraft engaged in night bombing equipped with a camera and able to shoot at least one photograph in synchronization with a photo-flash cylinder released together with the first bomb, or together with the target indicator in case of Pathfinder aircraft. Yet, this technical solution remained very unpopular among the aircrews mainly because of the risk of premature explosion of the flash cylinder and because, due to the long film exposure necessary (at least ten seconds) to not miss the brief illumination of the flash, it was not possible to perform any evasion maneuver.

In the early years of the conflict RAF secretly enlisted civilian photo-interpreters from the Aircraft Operating Company and its associate Aerofilms: between them the aristocratic figure of Constance Babington Smith (1912-2000) stands out as "Queen of Photo Interpreters". Being passionate about aviation, in the 1930s she wrote articles in Airplane magazine. When the war broke out, she joined the RAF Women's Auxiliary Service. In April 1941 she was a Section Officer of an air interpretation section embedded in the RAF's Central Photo Interpretation Unit in Medmenham, which later became an Allied unit. She coordinated geolo-

Fig. 9 This image shows a RAF photographer fitting two F24 cameras into a Mk Ic Photo-Reconnaissance Spitfire in 1939-1940. (https://www.militaryimages.net/media/spitfire-cameras.7515/)

gists, geographers, archaeologists, mathematicians, botanists, and cartographers for the preparations for the landing in Normandy. In November 1943 she first identified the prototype of the German V1 "flying bomb" in Peenemünde.

When the US Army Air Force (USAAF) entered the war in Europe, they lacked an aircraft designed specifically for aerial reconnaissance with adequate speed, altitude and range. The famous Lockheed P-38 "Lightning" fighter-bomber was modified into the F-4 and then the F-5 version by replacing the guns with four cameras. Models of 200 F-4s and F-5s were produced, while other series P-38s were modified for photographic function. In mid-1943 the P-38 began to be replaced by the longer-range P-51 "Mustang" in its F6 reconnaissance variant.

In the Pacific, vast distances and poor infrastructures were a huge obstacle. The Royal Australian Air Force (RAAF) and Royal New Zealand Air Force (RNZAF) had some air reconnaissance capability in the South Pacific, but the first true U.S. strategic reconnaissance capability in the Pacific began in April 1942, when Captain Karl Lewis Polifka formed the 8th Photographic Squadron in Port Moresby (New Guinea) with five P-38 in the F-4 photographic version equipped with additional fuel tanks. The USAAF later introduced the F-13, a Boeing B-29 Superfortress modified to conduct long-range aerial reconnaissance. On November 1, 1944, an F-13 flew a 14-hour mission from Saipan to Tokyo at an altitude of 10,000 meters and since then 118 F-13s have flown hundreds of missions over Japan mapping each significant target.[23] USAAF developed a vast range of cameras depending on their focal lengths varying from 6 (15.24 cm) to 24 (60.96 cm) inches. Each camera station type (Trimetrogon, Vertical, Split-Vertical, Oblique, Photo-Navigator and Radar Observer), in combination with a specific focal lens, was suited for each kind of military purpose (Charting and Mapping, Reconnaissance, Intelligence, Night Photography, Opportunity, Radar Scope Photography, Motion Picture).

The main role in this development was taken by the Fairchild Company. The Fairchild Graflex K-20 handling camera was the primary reconnaissance camera used by the Allied forces. It could shoot 100 9"x9" (22.6x22.6 cm) negative frames in a single roll, although 50 was the most common figure. The K-17 camera was designed for both vertical and oblique photography. It was also fed by

23 William M. CAHILL, « Imaging the Empire: the 3rd Photographic Reconnaissance Squadron in World War », *Air Power History* 59/1 (2012), 12–19.

Fig. 10 Constance Babington-Smith, who worked at the Allied Aerial Central Interpretation Unit, is considered as the "Queen of Photo Interpreters". (https://www.walpersberg.de/history/)

a 200 "9x9" negative roll magazine. In 1943, at the request of the USAAF, Professor Harold Edgerton of the Massachusetts Institute of Technology built a flash unit for nighttime aerial reconnaissance photography. The aerial camera was just 60 cm longer than a 35mm camera, but the flash tube was made of tough quartz glass coiled into a spiral positioned in an 80 cm reflector pointing down from the plane's belly or tail. Banks of capacitors, weighing up to 240 kg each, were slung on the plane's bomb racks. The flash unit was tested on 5 June 1944 over the D-Day target areas, where the nighttime landscape showed that the Normandy invasion was not expected in the designated landing areas.

A further photographic device was Sonne stereoscopic strip camera, which being shutterless photographed a continuous strip of terrain on a sensitized film that was moving continuously across a fixed slit, thus allowing low altitude photography at extremely high plane speeds. The large photo scales produced (up to

1/300) were very helpful in reducing distortion and improving detail in dangerous low-altitude photography from aircraft like the Lockheed P 38. The camera used black-and-white or color film and a single or stereo lens. This device had been developed by the air imagery pioneer Colonel George W. Goddard, who in February 1944 was sent to England to assist in setting up the reconnaissance program for the 325th Reconnaissance Wing. Goddard helped in modifying F-8 Mosquitos for radar photography, and assisted in the development of night photography using the Edgerton D-2 skyflash.

At the same time, Luftwaffe's most used camera was the Rb 30 series, introduced in 1938. It was a large format camera designed primarily for carrying out cartography work. At the start of World War II, the Rb 20/30 was widespread throughout the Luftwaffe; however, as allied aircraft slowly forced the Luftwaffe to fly at higher altitudes, the focal length of the lenses had to increase and was replaced by the Rb 75/30. These cameras, with diaphragm shutter inside the lens, were mounted vertically, single or in pairs, with a 64 m roller, to give 32x32 cm frames. An assortment of Junkers Ju 88, Dornier Do 17 and Messerschmitt Bf 110 were used for pre-raid tactical collection and post-raid missions for damage assessment. Unlike the RAF, the Luftwaffe made very few modifications to their reconnaissance aircraft, which remained armed. As the war progressed, the Allies intercepted Luftwaffe reconnaissance flights until September 1944, when the new Arado Ar 234 with its speed and altitude managed to penetrate the British airspace. Specialized aircraft such as the curious Blohm & Voss BV 141 were produced only towards the end of the war.

In 1943 the office of the chief of aerial photography was reorganized as Department 7 of the General Staff, under the leadership of Rowehl, with six operational groups. The Hansa-Luftbild, although still outside Department 7, was militarized and renamed Sonderluftbildabteilung (Sobia). As the equipment to carry out a systematic mapping was insufficient and trained technicians were scarce, mosaics and anaglyphs printouts[24] often replaced topographic maps. In particular anaglyphs printouts were used by German Commands to plan the defense of Gothic Line. In the absence of adequate cartography of their areas of operations, the Germans also used many photomaps, made through rapid geometrical correc-

24 Anaglyph is the stereoscopic 3D effect achieved by means of encoding each eye's image using filters of usually chromatically opposite colours, typically red and cyan.

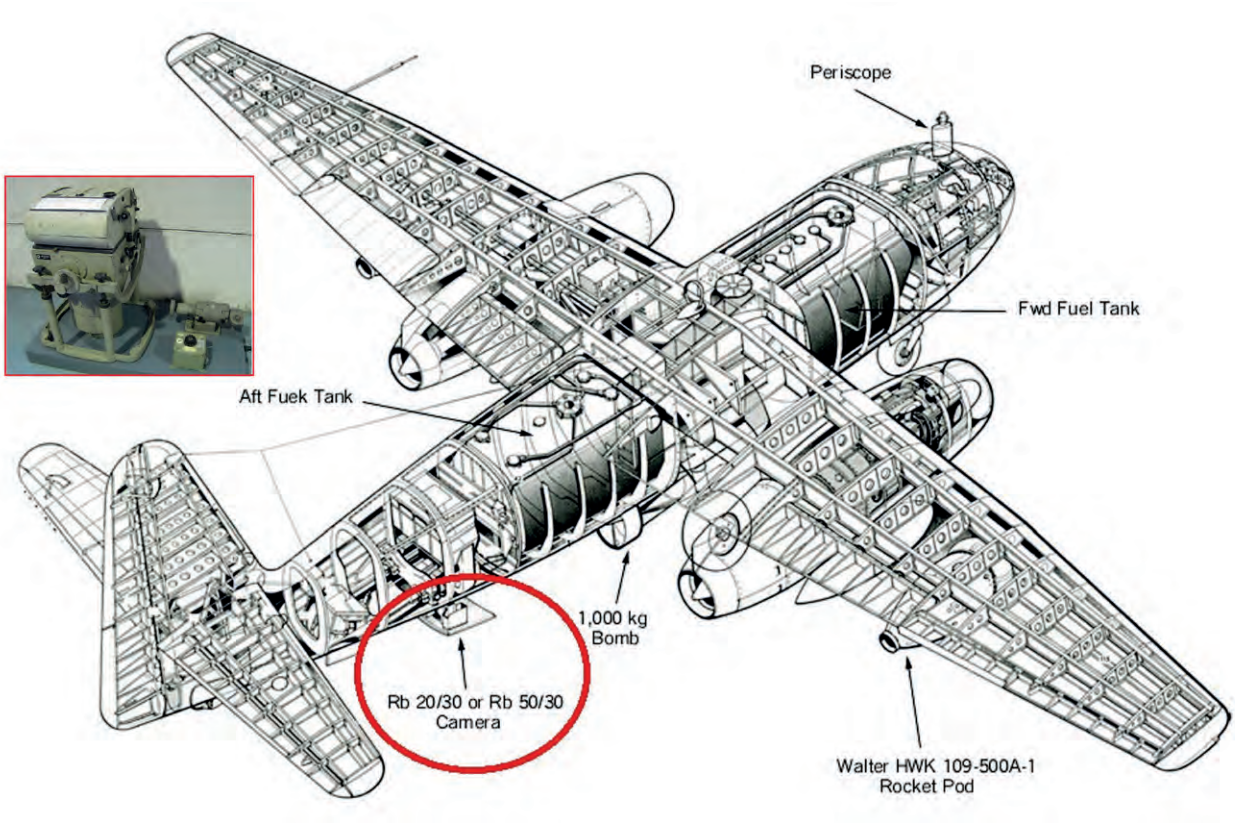


Fig. 11 Arado Ar 234 B was the world's first operational jet bomber and reconnaissance aircraft. The first Ar 234 combat mission was a reconnaissance flight over the Allied beachhead in Normandy, 1944. In the smaller image, a Rb 50/30 aerial camera which could equip the aircraft. (http://www.aviation-history.com/arado/234.html, modified by authors).

tion and mosaicking of aerial photos and the addition of marginal information. The Allies troops widely used photomaps, for example to plan the crossing of Po River in northern Italy.

At the same time, Japanese Forces appreciated the value of aerial reconnaissance developing very high-quality reconnaissance airplanes. Japan boasted a well-developed aviation industry and produced high-quality specialized reconnaissance aircraft such as the Kawanishi H8K "Emily" and the Mitsubishi Ki-46 "Dinah". Prior to the war, the Japanese had performed meticulous aerial mapping of Malaysia and the Philippines, but bitter rivalry between their militaries

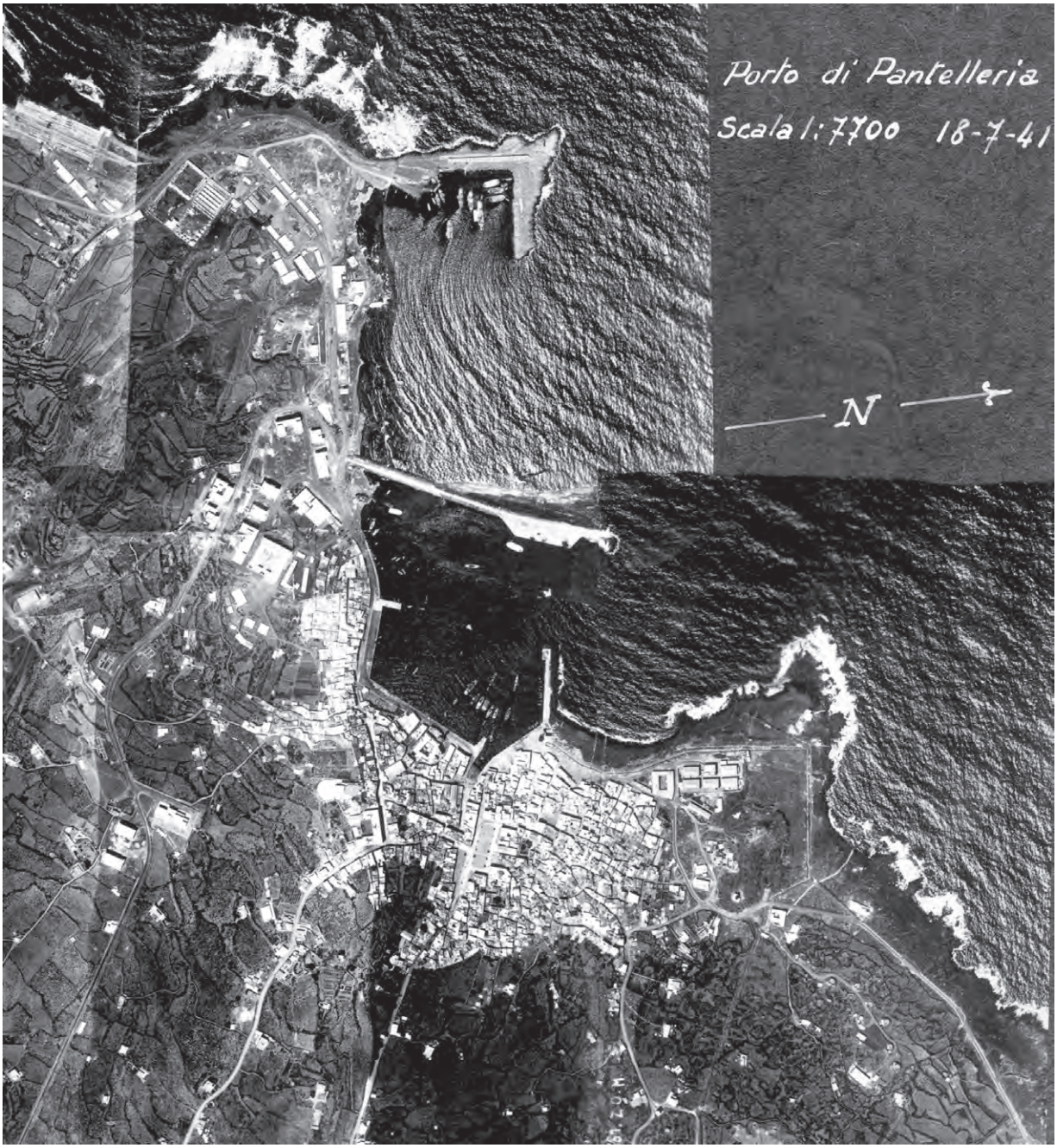


Fig. 12 A 1941 Italian air photo plan of Pantelleria Island harbour (From Marco BELOGI, Pantelleria 1943 - D-Day nel mediterraneo, Liberedizioni, Gavardo, 2001)

Fig. 13 General Dwight Eisenhower (first on left), Head Commander of the Allied Forces of North Africa and future commander of the operations in Normandy, portrayed in the air photo depot at La Marsa (Tunisia). On the right, Lieutenant Colonel Elliot Roosevelt, commander of the North African Allied Photographic Reconnaissance Wing. (From Marco BELOGI, Pantelleria 1943 - D-Day nel mediterraneo, Liberedizioni, Gavardo, 2001)

prevented the Japanese from realizing their full aerial reconnaissance potential. Eventually, once the Japanese lost air superiority, their reconnaissance aircraft were too vulnerable to be effective.

A separate analysis is necessary about the Allied photo-reconnaissance organization between 1943 and 1945. With the landing in Morocco in November 1942, the Americans took over the leadership of the aerial photography organization. The son of the President of the United States, Lieutenant Colonel Elliot Roosevelt, became the commander of the North African Allied Photographic Reconnaissance Wing first based at La Marsa in Tunisia. This unit coordinated both American and British aerial photography flying groups.

The first systematic use of aerial photography for operational purposes by the Allies happened during the seizing of Pantelleria Island in Sicily. From 18 May to 11 June 1943, on the premise of the invasion of Sicily, the Allies subjected

the island of Pantelleria to a massive aerial bombardment with 6,200 tons of explosives in order to force the Italian garrison to surrender. To calculate the scale of the offensive effort, a special study group was created led by Professor Solly Zuckerman, who suggested using the "Corkscrew" operation as a test to evaluate the potential of an air force against permanent fortifications similar to those in Normandy. Based on statistical procedures Zuckerman theorized a high-density bombing in order to cause at least indirect damage to the batteries. Using zenith and oblique photographs, Zuckerman's team made an accurate and systematic analysis of the island's defenses, carried out a rigorous recording of the number of sorties and bombs destined for each target and finally evaluated the damage to the batteries using graphs.[25]

In November 1943 the North African Allied Photographic Reconnaissance Wing was renamed Mediterranean Allied Photographic Reconnaissance Wing (MAPRW) and was based in San Severo in Puglia, with a subsequent detachment in Naples. A notable Royal Intelligence Corps photographic interpreter serving within the MAPRW was John Bradford (1918-1975), who noted the remains of many archaeological sites while analyzing aerial photographs.[26] At the same time, in order to prevent the bombing of cultural property he worked closely with Monuments Man Lt. Col. John Bryan Ward-Perkins, Director of the Monuments, Fine Arts and Archives (MFAA) section in Italy. Just after the war, along with Ward-Perkins, Bradford also helped in establishing air photograph collections in the American, British, and Swedish Academies in Rome, as well as at Oxford University.[27] The Free France Groupe de Reconnaissance 2/33 also operated under the MAPRW, that of the famous poet and writer Major Antoine de Sant'Exupery, who died at the controls of his Lookeed F-5B reconnaissance plane on 30 July 1944.

The organization was dissolved in October 1944 in favor of the 106th Group, formed in May for the invasion of France. Lieutenant Colonel Roosvelt was sent for some months to cooperate with the Soviets in Ukraine, noting the primitive photographic survey carried out by the Russians.

25 BELOGI, 2001.

26 Giuseppe CERAUDO e Fabio PICCARRETA, *Archeologia Aerea*, Studi di Aerotopografia Archeologica I, Istituto Poligrafico e Zecca Dello Stato, 2004.

27 Monuments Men Foundation. https://www.monumentsmenfoundation.org/bradford-capt-john-s-p

Fig. 14 Antoine de Saint-Exupéry with the P-38 Photo Reconnaissance planes used by the Free France Groupe de Reconnaissance 2/33. (Credit plus.randomania.fr).

Cold War and Beyond: From Aerial Photography to Imagery Intelligence

After the Second World War, the emphasis in aerial photography returned to that of pre-war days, with camera manufactures' mostly focusing in crafting better devices for more detail and accuracy. The development of aerial photography for military purposes was also boosted by the Cold War (1946-1989). The Korean War (1950-53) led to the development of US jet planes, in which cameras initially coming from the previous decade were this time generally installed on the nose of the aircraft. A small improvement was the automatic recording of shooting data (date, flight ID, altitude, compass, etc.) in order to facilitate the archiving and reconstruction of the map.

Another achievement by USA was the exploitation for war use of infrared

photography, which was sensitive to infrared light reflecting from green chloroplast rich trees and leaves. While panchromatic black and white film consists of a negative material with a sensitivity range comparable to that of the human eye, infrared black and white film is sensitive to the spectral region ranging from 0.7 micrometers to 0.9 micrometers (i.e. near infrared band). This technique, first developed in 1910, needed long exposures and special glass filters and initially was used only for landscape photography. Infrared ground photography was reportedly used to attempt to see though smoke and fog during First Word War and became popular in the 1930s when many manufacturers (Ilford, Kodak, Agfa, Leica) produced infrared-sensitive films. But the exposure time needed by films was still not suitable for military air operations, so it was only in 1942 that Kodak developed Aerochrome 1443 false-color slide reversal film in the form of Aero Kodacolor Reversal Film for camouflage detection.[28] The special feature of this film was that it could be processed anywhere without elaborate equipment.[29] A faster version of this color film (Ektachrome) was standardized only in 1945, mainly for operational use in the Pacific. Since then, infrared films had a steady life of around 50 years for military air photography until being replaced by digital imaging.

Camouflage detection film was depicting natural broad-leaf foliage in a reddish color, while infrared absorbing materials, such as paints that were used to simulate foliage, appeared purplish or bluish in color. Unlike the color infrared film for camouflage detection, the black and white infrared photography was produced with a conventional camera system by using a black and white infrared-sensitive film. The result was a thermal difference image which looked like a low-grade photograph, where hot vehicle motors, fires, and other heated objects were visible as hot spots. Black and white infrared photographs were also showing the difference between wet and dry surfaces and also had excellent haze penetration capabilities. The standard color photography was particularly useful in the identification of industrial stockpiles, vegetations, soil types and rock outcrops. In addition, it had good water penetration capabilities and was useful in the recognition of water depth determination.

28 Raife G. TARKINGTON, *An aspect of colour photography and interpretation*, Research Laboratories, Eastman Kodak Company, Rochester, N. Y, 1953.

29 A typical exposure for this film was approximately 1⁄300 second at f⁄5.6. This exposure is based on a solar altitude of 40 degrees, a clear day, and an aircraft altitude of 10,000 feet.

A further development was the Side-Looking Airborne Radar (SLAR) imagery, which allowed the production of a map-like presentation of the terrain by recording the radar reflectance on aerial film. Due to the low resolution of the resulting imagery, special interpretation techniques were required to extract information.[30] Due to the different nature of products to manage (photography, infrared and radar) the US Army in 1964 changed the name of Photographic Intelligence into Imagery Intelligence. In 1950 the British introduced in service a jet-powered replacement for Mosquito. The result was the English Electric Canberra which, together with its American version B-57, served for more than 50 years. It was the best long-range aircraft of the second half of last century, being able to reach an altitude of 21,000 meters, even if not for a long time.

During the Cold War, the United States also developed strategic photo collection platforms and sensors. The K-42 Camera, nicknamed "Pie Face", or the "Boston Camera" from Boston University, was engineered in 1951 and was the largest aerial camera ever made in the world. It weighed up to 3 tons and was mounted on the huge RB-36 Peacemaker strategic bomber airplane. This camera could take oblique or vertical photos at a shutter speed of 1/400 of a second through a hidden aperture and had a focal length of no less than 6 meters, made possible by two mirrors. The fact that it could photograph a golf ball from an altitude of 14,000 m became proverbial for the following years.

In 1953, under the auspices of the Central Intelligence Agency, photographic scientist Dr. Edwin Land, optics scientist Dr. James Baker and project engineer William McFadden tested a panoramic automatic camera, with a lens barrel capable of rotating from side to side and filming from horizon to horizon. This camera had an image-movement compensation that could compensate for the motion of the aircraft and the vibration of the engine and the movement of the highly sensitive, fast, and ultra-thin Kodak film especially designed for the project. This camera, which was finally engineered by Hycon Corporation under the name of 73B[31], was mounted on the new Lockheed U-2 reconnaissance aircraft, codenamed Aquatone, developed by engineer Clarence Leonard "Kelly" John-

30 Robert BOLIN, *Field Manual FM 5-30, Engineer Intelligence*, Headquarters, Department of The Army, September 1967.

31 https://airandspace.si.edu/collection-objects/camera-aerial-hycon-73b/nasm_A19771125000.

Fig. 15 The first strategic reconnaissance aircraft was the RB-36D specialized photo-reconnaissance version of the B-36D. In the smaller image, a K-42 Camera, nicknamed “Pie Face” or the “Boston Camera”. (Image modified by authors).


The "Boston Camera"

son. The U-2 was able to fly above the safer altitude of 18,000 m travelling for 5,500 km and gliding for 1,500 km.[32] Hycon 73B panoramic camera could shoot from U-2 under fuselage through seven glass encased windows, recording 200 km wide views along a 3,500 km path and it could provide up to 4000 pairs of stereoscopic photographs. Its 36-inch focal length lens could resolve features as small as 75 centimeters from an altitude of 20 kilometers. The film was loaded onto two counter-rotating film spools, one located forward and the other aft in the camera body to maintain the center of gravity within in the aircraft.

In 1956, after his Open Skies proposal (authorized bilateral surveillance flights over declared military facilities) was rejected by the Soviets the year before, President Eisenhower authorized the first Lockheed U-2 secret reconnaissance missions over Soviet Block (Poland and East Germany). The loss of one of these aircraft in the Soviet Union in 1960 created an international accident with the capture of the pilot, Francis Gary Powers. The U-2 aircraft also played a leading role in the Cuban missile crisis in 1962 and flew over China and Vietnam.

The last strategic aircraft before the advent of satellites was the Lockheed SR-71 "Blackbird", which thanks also to a largely titanium structure could operate at high speeds (Mach 3.2) and altitudes (25,900 meters) and was also protected by sensors and by a stealth technology. The "Blackbird" was equipped with different optical cameras.[33] The forward oblique Terrain Objective Camera (TOC), manufactured by Fairchild, had a 6 inch (15.24 cm) focal length lens with 9 inch (22.86 cm) wide film, achieved a medium ground resolution (8 meters) and was designed for tracking flight. Two side Operational Objective Cameras (OOCs), initially manufactured by the Italian ITEK, were panoramic cameras with a focal length of 13 inches (33 cm) that used 70mm-wide film. Both OOC cameras were able to scan horizontally from -5 degrees below the plane's nadir to +45 degrees on their respective sides and were able to adjust their framing speeds to the momentary ground speed. Each photo overlapped the area covered by the previous photo by 55%, so that stereo views could be obtained. The OOC's were discontinued in the early 1970's in favor of two lateral Optical Bar Cameras (OBCs),

32 Thomas FENSCH, *The CIA and the U-2 Program: 1954–1974*, New Century Books, Chula Vista, California USA, 2001.

33 Richard GRAHAM, *SR-71: The Complete Illustrated History of the Blackbird*, *The World's Highest, Fastest Plane*, Zenith Press, Minneapolis, 2013.

Fig. 16 Technicians load a Hycon 73B camera into a U-2's equipment bay. (U.S. Air Force photo).

also previously manufactured by ITEK, were high resolution panoramic cameras with an initial 24-inch (60.96 cm) focal length, later extended to 30 inches (76.2 cm). They could photograph 100,000 square miles of the Earth's surface per hour. Finally, two lateral computer-aided Hycon HR-308B Technical Objective Camera (TEOC) allowed very high-resolution photography of designated areas with an average ground resolution of 15 cm thanks to their 48-inch (121.92 cm) focal length.

Fig. 17 On the foreground of Lockheed SR-71 "Blackbird", there are its main photographic sensors: the Technical Objective Camera TEOC and the Optical Bar Camera (OBC). (Photo Courtesy Dave Nolte, Boeing).

The Cold War marked also a big way forward for tactical aerial photography. During the Vietnam War, the United States had the possibility to employ no less than 112 different combinations of aircraft, sensors and services, but due to the increased demand for close air support, it was necessary to create a Combat Operations Center to control and coordinate photographic and visual reconnaissance and electronic intelligence carried out by the 460th Tactical Reconnaissance Wing of the 7th Air Force.[34] The US Air Force used photographic versions of the RF-101 and the Phantom RF-4C airplanes, through elongating their noses to accommodate the cameras.

The Navy used the RA-3B Skywarrior, which with its ability to fly at 650 km/h at a height of 500 m, could approach the objectives with a surprise effect. In addition to the pilots, it housed a photo-navigator and a photo technician and up to 12 oblique and vertical cameras. The Army was instead using the twin engine Mohawk OV1 aircraft equipped either with high a performance camera, with a newly developed infrared equipment or with a side-looking airborne radar (SLAR) to be used at night, often in conjunction with C-130 flareships from Air Force.

From 1965 to 1972, the 1st Military Intelligence Battalion (Air Reconnaissance Support), also known as the 1st MIBARS was placed at Tan Son Nuth airbase near Saigon and played a unique role in the Vietnam War to produce tactical military information.[35] As photointerpretation was limited by the triple level of jungle vegetation, during night operations, thermal infrared sensors were used.

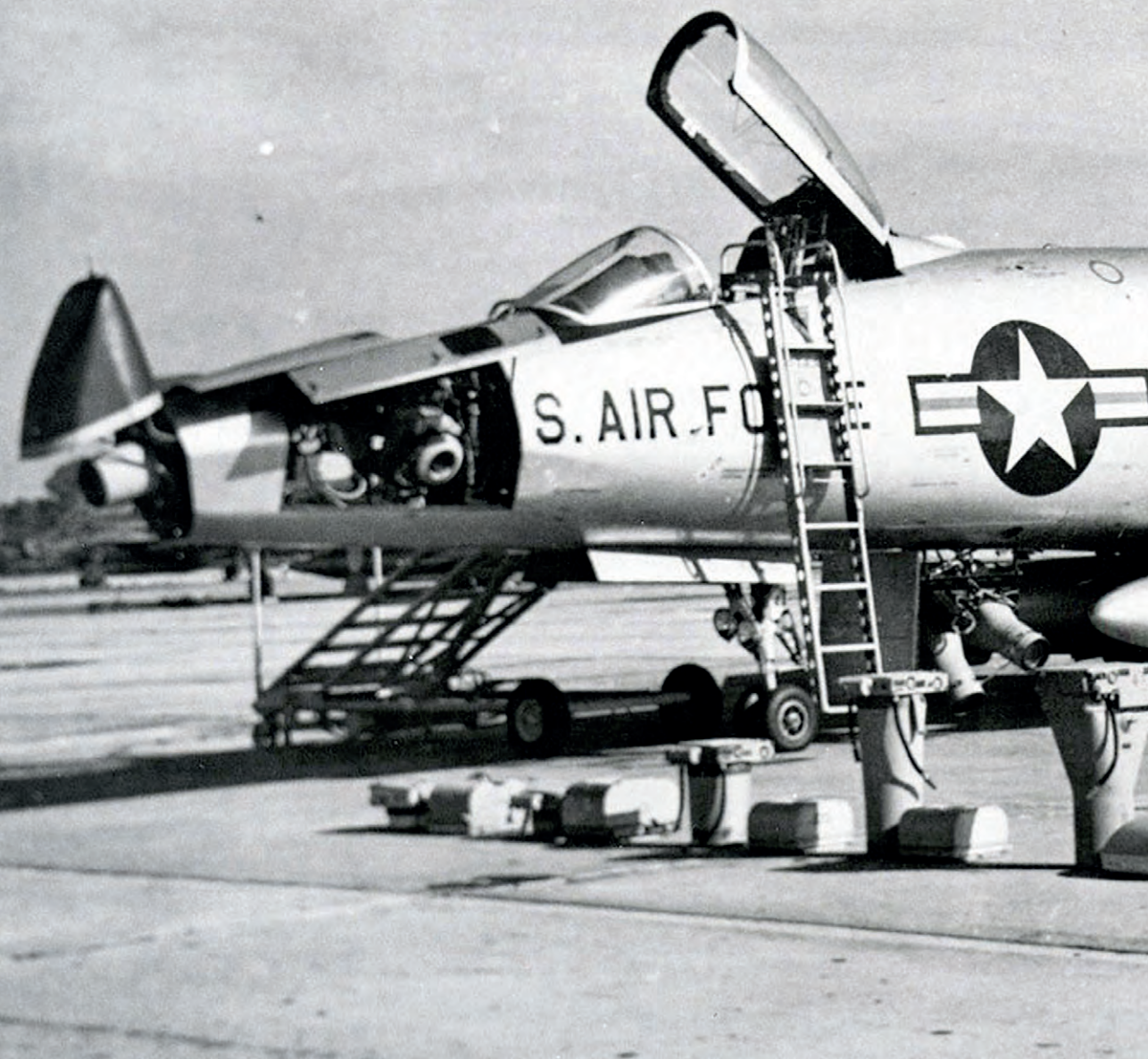
Analogic aerial photography exploitation was at that time completely mature and led to different Intelligence products. Together with the traditional mosaics of aerial photographs (two or more photographs arranged to give a continuous picture of an entire area) and photomaps (a photo image base with the addition of grid lines, marginal data, and place names) there were also composite photomaps (printed from three or more vertical and oblique photographs negatives which were exposed simultaneously by a multi-lens camera), Sonne photoprints (depicting a continuous strip of terrain photographed at low altitude) and pictomaps (a photo image base with the addition of cultural, planimetric, and topographic

34 Joseph MCCHRISTIAN, *Vietnam Studies, The role of Military Intelligence 1965-1967*, Department of the Army, Washington DC, 1974.

35 http://1stmibarsinvietnam.org/

information improved by adding shadows caused by relief and color tones to accentuate vegetation, open areas).

Panoramic photography was also still crucial, as the resulting image was a "sweep" presentation of the terrain, usually from horizon to horizon and perpendicular to the line of flight. This had the appearance of a left and right oblique separated by vertical exposure with no lines of demarcation. Panoramic cameras were also used in the forward oblique position and give a forward panoramic view of the terrain which is useful in briefing pilots on the approach into an area.



The shift from mechanical and analogue electronic technology to digital electronics in the late 1960s and early 1970s allowed cartographers to quickly and accurately orient photographs in producing maps beyond the mechanical approximation of stereo-plotters and lead to the transition between paper-based maps to digital maps. Moreover, the fact that aerial photography no longer was exactly describing the many forms of imagery collected using radiation outside the visible region of spectrum led to coin the new term of remote sensing.

Fig. 18 USAF RF-101C aircraft camera configuration during Vietnam War: four KA-45 cameras with one lens pointed forward, one pointed straight down, and two angled to the side. Optical cameras were at that time also used at night with photoflash cartridges, while infrared cameras were used both at night and in bad weather. (U.S. Air Force photo).

In parallel, the years between 1959 and 1970 saw the development of satellite photography from satellite. The US was the first to use space satellites for reconnaissance, soon followed by the Soviets. But just before that, a launch test of the thirteenth V-2 missile confiscated to Germany contained a motion picture camera, protected by the landing crash, delivered the first picture from 100 kilometers up, followed by a thousand of them between 1946 and 1950 reaching 160 km.

The launch of Sputnik satellite in 1957 created a crucial precedent in international law, because for the first time a camera platform an aircraft was able to overfly the theoretical national sovereignty airspace above all other countries, including US. President Dwight David Eisenhower took official advantage of this situation and approved the CIA's Corona Project (1959-1972) in February 1958, which laid the foundation for satellite imagery by taking photographs of, among other areas, China and the Soviet Union.[36] In addition, the US created in 1961 the National Reconnaissance Office (NRO), whose existence remained secret until 1992. It is interesting to underline that the use of reciprocal surveillance by space satellites was never a matter of legal dispute over the Cold War (then under the euphemisms of "National Technical Means" or "Overhead Collection") and it is still accepted today.

The first four versions of the Corona were designated RX-1 to KH-4 (KH denoted Keyhole); KH-4 went through three versions. The KH-1's camera (codenamed Discoverer) had a nominal ground resolution of 12m. In 1963 the KH-2 and KH-3 reached resolutions of 3 m. The KH-4 mission launched in 1962, took a major breakthrough in technology by using the Mural camera to deliver stereoscopic images. In 1967, the KH-4B's J-3 camera had entered service with a resolution of 1.5m. This final version of Corona continued to fly over until 1972. Despite many technical failures, a total of 145 Corona missions produced over 800,000 images. In order to obtain a good resolution, the satellite orbit was lowered from 160 to 120 kilometers, but the drag from the higher atmosphere was quickly shortening the time to remain in space. Nevertheless, each one-day mission collected ground images as much as 24 U-2 missions. Today, declassified images of the Middle East and Central Asia are used for archaeological research. It is curious to note that the exposed films returned to the Earth in capsules, which military C-119 aircraft recovered in mid-air over the Pacific Ocean.

36 Curtis PEEBLES, *The Corona Project: America's First Spy Satellites*, Annapolis, Maryland, Naval Institute Press, 1997.

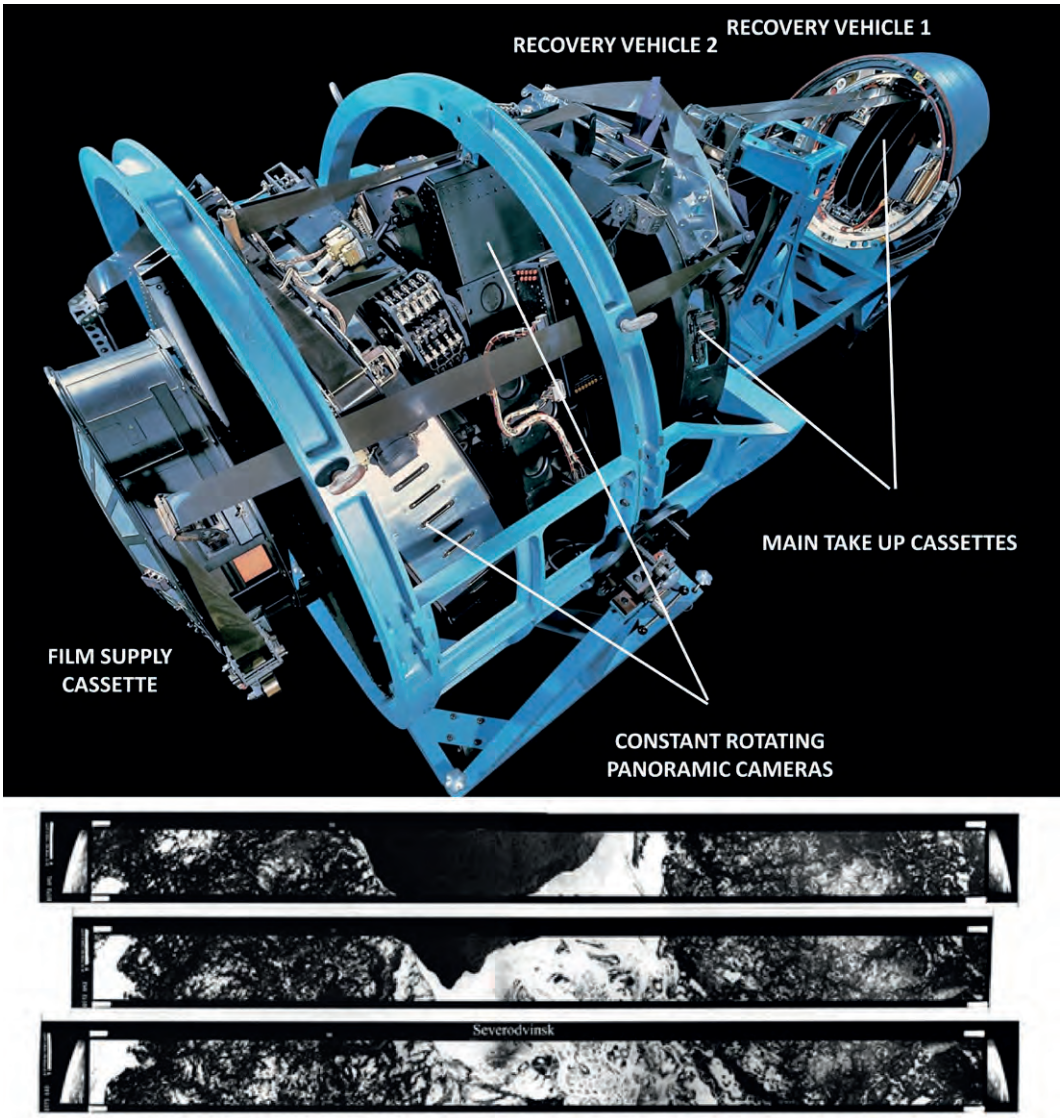


Fig. 19 The KH-4B was the last and most advanced camera system used in Corona Project. Two optical lenses in black barrel-shaped housings; two film supply canisters at aft end; camera has cylindrical shape with film return bucket at front end. Film return capsules containing the exposed film separated from the spacecraft in orbit, re-entered the atmosphere, and were recovered in mid-air. Image strips below: when the satellite's main camera shot a picture of the ground, two small cameras took an image of the Earth's horizon at the same time on the same piece of film. The horizon cameras helped to know the position of the spacecraft relative to the Earth and verify the geographical area covered in the photo (see the ends of the film strips).

The last satellite using photographic technology was the KH-9 Hexagon, which had an elliptical orbit (160 km at perigee and 275 at apogee) designed to occur around the regions of most intelligence interest (at that time URRS and China). Between March 1973 and October 1980, twelve KH-9 missions were flown. It is interesting to note that satellite was equipped with stereoscopic cameras, which allowed the mapping of vast areas, as well as the creation of terrain elevation data.

On the Soviet Union side, it must be mentioned the Zenit series of military photoreconnaissance satellites launched between 1961 and 1994, whose public name was Kosmos in order to hide their scope. Zenit satellite was similar to a Vostok spacecraft, with return and service modules, the last one consisting into a spherical re-entry capsule of 2.3 meters. This capsule contained the camera system, its film, recovery beacons, parachutes and a destruct charge. The mission duration was 13-15 days.[37] Differently from the American Corona, the return capsule carried both the film and the cameras, thus simplifying the design and engineering of the camera system and allowing reuse of cameras. The first operational satellite was Zenit 2 launched in 1961, which had four cameras of 1000 mm focal length and one of 200 mm in order to give a context to the high-resolution pictures. Each camera from Krasnogorsk Optical-Mechanical Factory had 1500 frames, each holding an image covering a square of 60x60 km, while ground resolution was 10 m or probably more.

The Zenit 4 (1963) was intended for high-resolution photography and carried one camera of 3000 mm focal length as well as a 200 mm camera, reaching probably 1–2 meters ground resolution. While the Zenit 4 MK and MKM (1970) were specifically designed to fly in lower orbits to improve image resolution, the Zenit 4 MT (1971) was a special version intended for mapping photogrammetry and carried an SA-106 topographic camera, a laser altimeter and Doppler apparatus, the latter two to be able to determine its own exact position.

The Zenit 6U was launched in 1976 and was engineered for both low-altitude, high-resolution missions and higher-altitude, general observation missions. The Zenit 8, launched in 1984, was the last of the series and was designed for military mapping photogrammetry (possibly in relation with the difficult soviet Afghani-

37 Peter GORIN, « Zenit – The First Soviet Photo-Reconnaissance Satellite », *Journal of the British Interplanetary Society* 50 (1997), pp. 441–448.

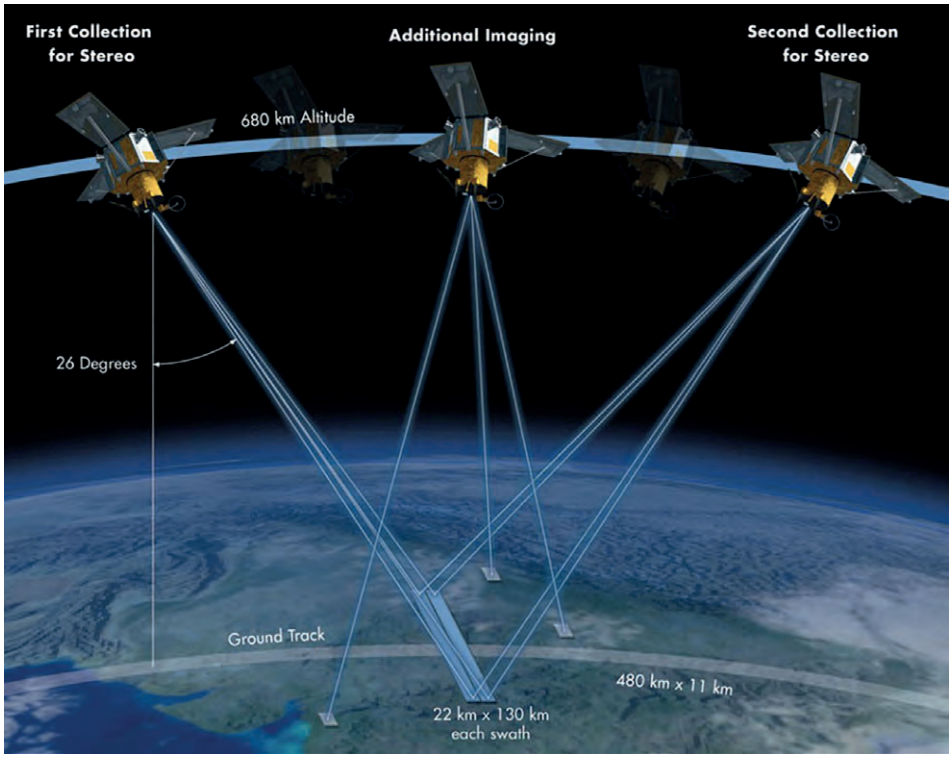


Fig. 20 For satellite imaging, it is better a low Earth orbit (acronym LEO) between 300 and 1,600 km above Earth surface. Many sensors are also able to perform in-line stereo collection. (https://eijournal.com/print/articles/buying-optical-satellite-imagery).

stan campaign): being heavier, it used a Soyuz launch vehicle instead of the previous Vostok module. It has to be noted that soviet reconnaissance remote sensing satellites maintained analogic photographic technology till the end.

There are different altitudes and orbits that a satellite can be put into, each with advantages and disadvantages for intelligence purposes. For imaging, it is better a low Earth orbit (acronym LEO) between 300 and 1,600 km above Earth surface. In this case, it is possible to observe a ground target for a short period (about 8 minutes). The medium Earth orbit (acronym MEO) at about 20,000 km allows surveilling a given area for a little longer, but image quality will be lower. The orbit at 40,000 km, which takes eastwards along the equator, takes the same time of the Earth's rotation (24 h) and is called Geosynchronous Equatorial Orbit (GEO) keeps the satellite over the same point of Earth all times and allows continuous surveillance, despite with a low resolution imaging. Furthermore, the

inclination (angle of the orbit measured from the equatorial plane) determines what areas of the Earth can be observed.

Some low Earth orbit satellites use the polar orbit, which with its 90 degrees inclination allows a fixed north-south movement path across the poles while earth is rotating underneath and therefore provides access to the entire globe, provided that every point of the Earth is visible at one time or another. Imaging satellites often use the so-called sun-synchronous orbit, which has an inclination of 98 degrees and allows the satellite passing over any given point on the Earth at about the same time each day.

Across their first decade of service, the main limitation of photographic satellites was the long time between the shooting of the photographs and the printed images being available to Intel analysts. At the beginning of 1970s, new digital electro-optical sensors were developed. The first digital imaging satellite able to detect also multispectral bands was the Landsat which was launched in 1972, but due to its still limited resolution on ground (60 m) it was still not suitable for intelligence purposes. In December 1976 the KH-11 reconnaissance satellite was launched, which thanks to its electro-optical sensors was able to transmit its images through a relay satellite.

During the Cold War the US had a quasi-monopoly on reconnaissance satellites, but by 1980s the growing worldwide concurrency of satellite industry convinced the US Government about the opportunity to try to foster its own. This led to the approving of the 1984 Land Remote Sensing Commercialization Act, which allowed the development of a commercial satellite industry. In 1985 the governmental National Oceanic and Atmospheric Administration (NOAA) transferred the Landsat Program to the Earth Observation Satellite Company (EOSAT), but the bid to commercialize Landsat data finally failed. In 1992, through a new Land Remote Sensing Commercialization Act, the US Government decided to support its own companies (EarthWatch, Space Imaging and Orbimage) with purchasing contracts for its mapping agencies, but again with limited success. In the meantime, in February 1986 the French launched the remote sensing satellite SPOT (Systeme Pour l'Observation de la Terre). This platform provided higher resolution images with a shorter revisit time at lower prices and both for military and civilian use. The end of 1990s witnessed the growth of international and commercial satellite imaging with Ikonos (1999), QuickBird and OrbView (2003) and others with increasing resolution.

In 2019, there are around 700 Earth observation satellites in orbit, most of them are operating in LEO and are dual-use. Many sensors are also able to perform in-line stereo collection in order to allow production of elevation data as Digital Elevation Model (DEM) if including all objects (plants, buildings,…) of earth's surface or Digital Terrain Model (DTM) if representing the bare ground surface without any object. One of the most recent is the Chinese Gaofen-11, launched on 31 July 2018. Following the paths of the old Corona, it uses an elliptical near-polar orbit with and apogge of 690 km and a perigee of 250 km, which gives the best ground image resolution. However, both early photographs and recent digital images taken from space are affected by the cloud cover problem. In any case, it remains the fact that satellites are limited to predictable and non-modifiable orbits and transit times.

Since the 1980s, the development of Synthetic Aperture Radar (SAR) imaging has made it possible to survey areas of interest at night and through the clouds. In the 1990s this technology was also applied to planes like the U2 itself and the Joint STARS (modified Boeing 707) in order to obtain radar imagery from ranges around 250 km. In addition, since 1980 SAR was also installed into a new generation of tethered aerostats called Tethered Aerostat Radar System (TARS) which, together with optical and signal sensors, were intended to check illegal traffics including those on low flying aircrafts. TARS were also used in Iraq in 2004 and Afghanistan in 2007. In addition to electro-optical or radar images, the new military aerial photography uses Unmanned Aerial Vehicles (UAVs) to obtain updates on the area of operation.

During and after WWII, drones were used as gun targets for artillery and airplanes, but the first reconnaissance photographic drone entered in service in Vietnam and China in 1964 based on the existing jet-powered Teledyne Ryan Firebee, named Model 147 and flew until 1975. As happened for satellites, the problem of delivering photographic results were solved in the 1980s, when mounted video cameras could stream video directly to a ground site allowing not only reconnaissance, but also surveillance for an extended time. The first generation of modern UAV was the Israeli Tadiran Mastiff in the Israeli-Lebanon War, which still had the limit of being in line of sight of its ground station. Following UAVs were able to stream and receive commands through a communication satellite. While today most UAVs send oblique view motion video in the visible or near infrared

spectrum[38], there are UAVs that perform systematic vertical footage of the terrain, such as the Buckeye system developed by the US Military Engineers.

The Buckeye provides high-resolution, high-precision, unclassified imagery for intelligence, surveillance, reconnaissance and urban mapping. The Buckeye system consists of a real color electro-optical digital camera, assisted by a Lidar (Light Detection and Ranging), sensor capable of measuring the elevation of the ground, in order to correct the geometry of the image. The strip of land recorded is about 500 m wide in the typical case in which the fixed-wing flight platform (usually a drone) flies at 3000 m of altitude. In this case the resolution on the ground is 10 cm, while it can go down to 3 cm if the platform flies at a height of 250 m. In November 2004, the Buckeye was deployed to Kirkuk in Iraq to be able to identify suspicious changes in areas that led to the identification of IEDs, but also to be able to map inhabited areas. In 2011 (the year the system was withdrawn) 85,000 km^2 had been covered, that is 11% of the Iraqi territory. The Buckeye was also deployed in Bagram, Kandahar and Shindad in Afghanistan, with coverage that at the end of 2013, when the system was withdrawn, reached 160,000 km^2. It is a well-known fact that since their appearance military aerial photographic and imagery archives constitute a valuable – and sometimes crucial – source of information for urban planners in the short term, but overall for historians and archaeologists in the long term.

Starting from the first balloon photographs in Rome through the battlefields and built-up areas of First and Second World War and the vast terrain views of the Cold War, military aerial imagery it has been used for to seek for ancient sites or to reconstruct old landscapes. But it must be remembered that military imagery coverage always followed a military logic. Therefore, it is normal that the areas of major intelligence interest were mostly photographed, even in repeated times in a short time, while some other areas were often neglected. As an example, in 2015 archival images of the Buckeye have been made available to Afghan urban planning authorities and archaeologists working on the positioning and study of the country's more than 2,000 archaeological and monumental sites.[39] Thanks to

38 Vladimír KOVAŘÍK, *Imagery Intelligence (IMINT)*, University of Defence, Brno 2011.

39 Elena LEONI, « Geospatial Accuracy Matters! A preliminary study about the impact on CP in Afghanistan », paper presented at Penn Cultural Heritage Conference, 2017.

Fig. 21 The US Buckeye Unmanned Air Vehicle is able to take digital imagery on the ground at 10 cm resolution. In the larger image, a view of the Indo-Parthian settlement of Spirwan Ghar in Qandar Province, Afghanistan, which was obliterated by a military infrastructure. (From Elena LEONI, « Geospatial Accuracy Matters! A preliminary study about the impact on CP in Afghanistan », paper presented at Penn Cultural Heritage Conference, 2017)

these images, many sites just mentioned in the literature have been identified[40], some even occupied by military installations. These include the Indo-Parthian settlement of Spirwan Ghar in the Qandahar area and the ancient city of Faizabad north-east of Kabul. However, it should be noted that Buckeye entirely covered, even with repeated passages, only the main areas of threat, which were normally found in correspondence with flat or built-up areas. As a result, most of the moun-

40 Warwick BALL, *Archaeological Gazetteer of Afghanistan*, Research publication on Civilization, Synthesis n. 8, Paris, 1982.

tainous areas, which make up a large part of Afghanistan, remained uncovered.

This last consideration could be extended to all military imaging datasets ever produced: with the exception of commercial dual-use satellites, it is a fact that all priority areas for an aerial imaging survey are always determined by the adversary threat. There is no exception to oblique image and motion video coverage by modern military UAVs.

Military aerial imaging through its history has given a huge contribution to many civilian applications – mapping above all – and despite nowadays its importance has somehow decreased, it still can contribute to the future public knowledge of otherwise invisible areas, like for example the ones that are currently hidden through security-commercial agreements or the ones that are under a status of crisis or conflict.

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